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INCENTIVES, VALUES AND PROVISION OF ECOSYSTEM SERVICES AND RESTORATION

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ABSTRACT

This dissertation presents results from studies that empirically examine incentives, values and provision of ecosystem services and restoration employing both real-money field experiments and hypothetical stated preference mail surveys.

Manuscript I reports on a real-money discrete choice experiment (DCE) to assess values for ecosystem restoration efforts focused on non-native plants management in a nature reserve in southern California, USA. Employing a split sample design, participants' values and preferences for ecosystem restoration projects are compared under a theoretically incentive compatible provision rule, i.e., a single decision-maker's choice, against a non-incentive compatible provision rule, i.e., a plurality vote using three-option choices for restoring native habitats and birds. A provision rule is a rule or process by which an environmental good is provided and provides an explicit nexus between participants' choices and actual policy outcomes. In the field experimental settings, participants contributed actual dollars to deliver actual ecosystem restoration projects on the ground. Results from these field experiments suggest that the two provision rules produce statistically equivalent preference functions irrespective of theoretical prediction of incentive compatibility properties of such provision rules. These results may imply that participants in consequential DCE surveys may respond truthfully to the choices despite the absence of a provision rule that is theoretically incentive compatible.

Manuscript II reports on a hypothetical DCE survey, which asks survey participants about their values and preferences for attributes of forested wetland parcels. A split sample approach is employed to examine survey participants' values

and preferences for attributes of protecting wooded wetlands using two survey formats. The first survey format asks a group of survey participants two choice tasks and the second survey format asks a different group of participants a series of twelve choice tasks. This manuscript empirically examines whether the alternative choice formats produce consistent responses and thus similar value estimates using trichotomous choices (or three alternatives in each choice task) of wetland parcels protection. Our results suggest that the alternative choice formats produce statistically different underlying preference functions as well as significantly different estimates of scale parameters related to error terms. Further explorations of the participants' choices from the repeated survey format (or the responses from twelve choice tasks) suggest evidence of precedent-dependent effects relating to a potential to retain higher *net surplus* from the *most-valued* alternative in the current task relative to the most-valued alternative in the preceding task may induce participants to be less cost sensitive and thus have a higher WTP across the sequence.

Manuscript III reports on a real-money field experiment designed to generate revenues through experiment participants' offers to implement manure management projects that improve water quality in local watershed system. The field experiments employ a voluntary donation elicitation as well as a newly established public good institution called individualized price auction (IPA). Participants offers are empirically compared between the two public good institutions both incorporating the incentive mechanisms from experimental economics literature including provision point (PP) with a money back guarantee (MBG) and proportional rebate (PR) of any excess funds beyond the PP. Using a split sample design in a field experimental setting, we ask

participants to contribute real dollars towards ecosystem-service public good projects focused on water quality improvements from implementing best manure management practices in local livestock farms in the local watershed system. Our results suggest that voluntary donation elicitation generated higher offers, on average, than those under an IPA approach for all available range of water quality improvements (or quantities of the ecosystem-service public good). Even though participants under both public good institutions made approximately constant offers across the available range of quantities of the good, they showed a statistically different pattern of contribution across the public good treatments. A two-limit tobit model results suggest a statistically significant heterogeneity in offers generated across the public good treatments based on socio-demographic profiles of participants.

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I hereby declare that any opinions expressed in this dissertation are those of the author and do not necessarily reflect the views of the institutions or grants providing financial support mentioned above.

PREFACE

This dissertation uses Manuscript Format to report the results of three research projects with interconnected themes to assess values of ecosystem services and restoration. All the procedures for the field experiments and surveys reported in this dissertation were approved by Institutional Review Board (IRB) at the University of Rhode Island.

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INTRODUCTION

Environmental economists have used stated preference or survey-based methods to learn about the values of environmental goods and services. Under stated-preference methods, researchers develop choice scenarios regarding the goods under consideration and ask individuals to "state" their values for the goods. Because these environmental goods and services cannot be traded in common commodity markets, environmental economists have relied on these methods to create market-like scenarios to learn about values of these goods. Also, many environmental goods and services possess non-use values and these methods may be the only way to learn about those values. Learning about the values of non-market goods is important because these values are an integral part of many government-mandated benefit-cost analysis. These values have also been used as evidence in legal proceedings over environmental damages, e.g., after an oil-spill event. Overall, these values can be crucial to evaluate public policies affecting the use and management of natural resources that produce these goods and services for better environmental decision-making. Therefore, creating an incentive compatible scenario, i.e., developing the scenario such that individuals state their utility-maximizing choices, may be crucial in order to interpret those values based on standard economic theory.

One of the popular stated-preference valuation methods is a discrete choice experiment (DCE) method in which environmental goods are described by a bundle of attributes or characteristics and individuals are asked to choose their preferred alternative or option from a set of alternatives. There exist divergent views among economists regarding interpreting the results of DCE studies due to "stated" nature of the choices rather than "revealed" market transactions. However, there is also a consensus among economists that if the choices are obtained from incentive compatible scenarios, where individuals are stating their utility-maximizing choices, the responses from DCE studies can be interpreted in terms of the standard economic theory.

There are various elements or dimensions that may affect incentive structures of choice scenarios in a DCE study. One important dimension often ignored in most previous studies is an explicit description of a provision rule by which an environmental good under consideration is provided based on participants' choices. Manuscript 1 of this dissertation empirically examines this aspect of incentive compatibility of DCE studies. Employing real-money in-person field experiments, I empirically examined whether the type of provision rule affects value estimates for ecosystem restoration attributes. That is I compared estimated values produced by a DCE employing a single decision-maker's choice rule, an incentive compatible provision rule, and the corresponding estimates from a DCE using a plurality vote, a non-incentive compatible provision rule under trichotomous elicitation format. Our results suggest that value estimates are statistically equivalent across the provision rules, implying that consequential DCE studies may produce value estimates that are robust to the weaknesses in incentives of the DCE (particularly the absence of incentive compatibility).

A DCE study elicits values for multi-attribute environmental goods and services by asking survey participants a repeated series of choice scenarios consisting of two or more alternatives. This repeated response format in DCE studies has been questioned in terms of truthfulness of responses across the sequence based on both theoretical prediction as well as empirical evidence of a systematic change in stated preferences across the sequence. Manuscript 2 of this dissertation examines this issue in DCE by empirically comparing value estimates produced by a DCE study using two choice scenarios and a DCE with a repeated series of twelve choice scenarios. Employing a split-sample design, participants were asked about their preferred wetland preservation parcels in local towns of Rhode Island, USA. Our results suggest evidence of precedent-dependent effects relating to a potential to retain higher *net surplus* from the *most-valued* alternative in the current task relative to the *most-valued* alternative in the preceding task may induce participants to be less sensitive to cost and thus appear to have a higher WTP across the sequence.

Valuing public goods and their efficient provision have posed a fundamental challenge to both economists and fundraisers because the providers of the public goods can not exclude potential beneficiaries who do not contribute toward the cost of provision. This non-excludability nature creates a natural incentive for individuals to "free-ride" on others' contribution. Thus, public goods institutions often result in under-provision of the good. Economists have been using modifications in public goods institutions through experiments to mitigate the "free-riding" behavior. One such pragmatic institution is a public good institution motivated by Lindahl's framework, called the Individualized Price Auction (IPA) implemented with incentive mechanisms from experimental economics literature. In Manuscript 3 of this dissertation, I empirically examined participants' offers in terms of willingness-to-contribute for ecosystem-service publics goods under the IPA approach against the corresponding offers under a standard voluntary donation mechanism both implemented using incentive mechanisms including a provision point (PP) with a money-back guarantee (MBG) and a proportional rebate (PR) of any excess funds beyond the PP. Our results from real-money in-person field experiments suggest that a less-structured voluntary donation elicitation generated higher offers compared to a more-structured IPA approach.

The major goal of this dissertation research is to contribute to both DCE literature as well as the public good experiments literature to further our understanding in terms of examining ways to assess better estimates of values for the goods and services that cannot be traded in common commodity markets and important insights towards creating novel markets for the ecosystem services. This dissertation is composed in *Manuscript Format* and I present results of three research projects with interconnected themes as individual manuscripts. Finally, I complete the dissertation with concluding remarks.

MANUSCRIPT 1

CONSEQUENTIAL CASH CHOICE EXPERIMENTS AND RESTORATION OF NROC'S ECOSYSTEM: DO THE PROVISION RULES MATTER?

Prepared for submission to mainstream journal in environmental and natural resource economics

1.1 Abstract

Although investigating incentive properties of stated preference surveys has been a central topic in the non-market valuation literature, economic incentives defined by the inclusion of a provision rule in the discrete choice experiments (DCE) framework have not been adequately examined. We examine whether incentive compatibility of provision rules likely affects responses from DCE surveys. We compare participants' marginal values, and marginal willingness to pay (mWTP) estimates from DCE surveys under a theoretically incentive compatible provision rule, i.e., a single decision-maker's choice, against a non-incentive compatible provision rule, i.e., a plurality vote. We compared estimated preference functions that may be derived from modeling trichotomous choices under the assumption of utility maximization. The choices included ecosystem restoration projects focused on non-native plants management in the Nature Reserve of Orange County (NROC), California. We employed a split sample design in a consequential DCE framework, which involved choices that require both actual cash payment and resulted in the actual implementation of ecosystem restoration projects. We also compare those choices to responses to a set of hypothetical choices. Results from a panel mixed logit model suggest that the two provision rules produce statistically similar preference functions in terms of marginal values as well as statistically equivalent marginal willingness to pay (mWTP) for ecosystem restoration attributes, irrespective of the theoretical prediction regarding incentive compatibility properties of the provision rules. These results suggest that participants in consequential DCE surveys may respond truthfully to the choices despite the absence of a provision rule that is theoretically incentive compatible.

Key words Consequentiality, discrete choice experiment, ecosystem restoration, mixed logit model, provision rule, public goods

1.2 Introduction

Participants' responses from survey-based methods of eliciting preferences for the valuation of non-market public goods are often questioned on the grounds of truthfulness, although the stated preference methods have been widely used by many government and private institutions for benefit cost analysis. Among economists, there are divergent beliefs when it comes to interpreting the responses from such survey-based methods because the economic incentives that define these responses remain poorly understood (Vossler, Doyon, & Rondeau, 2012). Many previous empirical studies have tended to focus on examining the incentive properties of responses from stated preference surveys compared to responses from such surveys which have direct financial consequences (e.g., Mozumder & Berrens, 2007; Johnston, 2006; Brown, Ajzen, & Hrubes, 2003; Taylor, McKee, Laury, & Cummings, 2001; Cummings & Taylor, 1999). This comparison suggests that stated preference surveys that have hypothetical choices frequently have higher willingness to pay (WTP) than from the surveys that have choices requiring actual payment and bearing direct financial consequences.[1] However, Carson & Groves (2007) argue that responses from *consequential* surveys[2] can be interpreted in terms of standard economic theory such as a mechanism design theory concerning incentive structures.

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[1] We also recognize literature on the convergent validity of stated preferences, such as Carson, Flores, Martin, & Wright (1996), Murphy, Stevens, & Yadav (2010), Murphy,

[2] Carson & Groves (2007) define surveys as being consequential if the results are seen by survey participants as potentially influencing the surveying agency's actions and participants care about the outcomes of those actions. Carson, Groves, & List (2006)

An important aspect of consequentiality in DCE surveys relates to an explicit description of a provision rule, a mechanism or process by which participants' responses determine a collective policy outcome. The provision rule is therefore considered important information bearing on incentive structures. When a provision rule is not explicitly described, survey participants may be uncertain about how their choices determine actual outcomes and this uncertainty may affect the incentives to truthfully reveal their values. An explicit description of a provision rule may present survey participants with specific incentives to respond to valuation questions. Relatively little is known about how survey participants respond to the incentives presented through including a provision rule in discrete choice experiments and how these incentives shape the responses to the valuation questions. Using a split-sample approach, this study empirically compares marginal values and marginal willingness to pay (mWTP) estimates for ecosystem restoration attributes focused on invasive plants management under a theoretically incentive-compatible provision rule, i.e., a single decision-maker's choice, against a non-incentive compatible provision rule, i.e., a plurality vote. In mechanism design theory, a single decision-maker's choice rule is called a dictatorship rule and is an incentive compatible mechanism for choice situations with three or more alternatives as in our study. We referred to this rule in our field experiment as "Single decision-maker's choice" to avoid any negative connotation of 'dictatorship' terminology. The plurality rule has been well established in the literature as being incentive compatible for single binary choice situations. For

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showed that neoclassical theory is applicable except when the influence of participants' choices on the agency's actions or decisions, either deterministic or probabilistic, is considered zero.

choice situations involving three or more alternatives like our study, this rule is not generally incentive compatible because there may exist strategic reasons to misrepresent true values. For example, the individual's beliefs relating to the distribution of preferences within the voting group may alter the incentives for truthful responses (Taylor, Morrison, & Boyle, 2010).

We compared participants' values and preferences from consequential DCEs under these alternative provision rules, which require actual payment and bear direct financial consequences, and which result in actual implementation of ecosystem restoration projects. Our results suggest that the preference functions and value estimates are statistically similar across the provision rules and suggest that regardless of whether the provision rule is theoretically incentive compatible or not, participants may respond truthfully to the choices in consequential DCE surveys.

Advancements in mechanism design theory[3] (Brams & Fishburn, 2000; Moulin, 1991; Satterthwaite, 1975; Gibbard, 1973) have attracted researchers' attention to empirically examining economic incentives in DCE surveys that motivate survey participants to disclose their privately held information, particularly the values for public goods under alternative provision rules or mechanisms (Carson & Groves, 2007). In mechanism design theory, an incentive compatible mechanism is one in which group or collective preferences align with individual preferences such that an

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[3] Mechanism design theory is a field in game theory studying solution concepts for a class of private information games and usually involves motivating agents to disclose their private information. It relates to designing a voting rule or mechanism to truthfully identify a consistent collective outcome, from a fixed set of alternatives, on the basis of voters' privately held preferences.

individual can always do at least as well by choosing consistently with truthful revelation of personal values as by any other choice. For example, when participants are choosing between two alternative restoration plans in a single[4] binary choice, the majority (or plurality) vote provision rule (the alternative that receives the most votes wins) is incentive compatible (Arrow et al., 1999). However, when participants are choosing among three or more alternatives, the plurality vote rule may no longer be incentive compatible as the voting strategies may depend on individual's subjective beliefs about the distribution of preferences within the voting group. Also a participant may simply select the status quo option to avoid placing an undue burden on others, when in fact the status quo option is not that participant's most preferred alternative; such an altuistic motivation is often called other-regarding behavior (Taylor, Morrison, & Boyle, 2010). Since many stated preference studies have multinomial choice situations (three or more alternatives in each choice task), the plurality vote does not serve as an incentive compatible mechanism. In order to examine incentive properties of multinomial choice situations, we establish a single decision-maker's choice as the incentive compatible base rule against which to compare a model of values and preferences based on data generated under the plurality vote.

There are few previous studies that have examined the responses to choices in DCE surveys where a provision rule is explicitly described to the participants. Collins & Vossler (2009), in their laboratory induced-value experiments, have examined provision rules using two-alternative and three-alternative choice situations and found

[4] Carson & Groves (2007) argued about the independence of choices and Vossler, Doyon, & Rondeau (2012) formally proved that independence among repeated choices should be maintained.

more deviations from induced preferences for two-alternative choices and for alternatives to a single plurality vote as compared to results under the rule in which the outcome was determined by both participants' and "regulator" votes. They also found a statistically significant but modest degree of bias towards selecting the status-quo option. Taylor, Morrison, & Boyle (2010) compared participants' values under alternative provision rules using hypothetical choices as well as choices that require actual payment and bear direct financial consequences for both private and public goods. For private goods, mWTP estimates from hypothetical choices are not significantly different than those estimates from the choices that require actual payment. However, for public goods they found a statistically higher mWTP from hypothetical choices than corresponding value estimates from choices bearing direct financial consequences. They also concluded that the bias in value estimates is the largest when no provision rule was included and found no significant difference in value estimates across included provision rules for public goods treatments. Vossler et al. (2012) developed an explicit game-theoretic model of individual decisions and formalized conditions under which DCE surveys with a single binary choice question or a series of binary choice questions are incentive compatible following Carson & Groves (2007). They complemented their theoretical model with field experiments and concluded that truthful revelation may be possible if participants perceived that they have more than a weak chance of influencing policy outcomes.

Using a split-sample approach, our study empirically compares marginal values and mWTP for ecosystem restoration projects focused on non-native plants management from consequential DCE surveys under two provision rules – a single decision-maker's choice and a plurality vote – using three-alternative choices. Our study employed three-option choices because trichotomous choice is a common value elicitation format in DCE survey for stated preference valuation studies. A single decision-maker's choice provision rule is the base incentive compatible rule in our study, against which the plurality vote rule is compared. We employed the plurality vote rule because a natural assumption may be that the alternative receiving the greatest support or votes will be implemented for the provision of public goods, even though a DCE survey often does not explicitly describe a provision rule (Taylor et al., 2010).

Our field application involved ecosystem restoration choices with more attributes than those in previous studies examining provision rules, as well as a unique situation that allows us to identify potential sub-interest groups representing various motivations for supporting ecosystem restoration which could lead to strategic voting or behavior. We produced an experimental design utilizing a state-of-the-art efficient design approach, which uniquely produced a set of choices that are potentially implementable from a pool of real, implementable scenarios and also produced a set of hypothetical choices that extended the range of levels of attributes covered in implementable choices. Our results suggest that the preference function is statistically similar across the provision rules irrespective of the incentive compatibility, at least theoretically, of the provision rule, which is consistent with the findings from DCE studies using dichotomous choices. We broaden this conclusion to a DCE study involving trichotomous choices. The results suggest that the value estimates produced by multinomial choice experiment surveys may be consistent with estimates of the true Hicksian values.

The paper is organized as follows. Section 1.3 discusses the theoretical framework to model responses from a DCE survey in relation to incentive compatibility based in mechanism design theory. Section 1.4 details the field application. Section 1.5 presents the results of hypothesis tests. Section 1.6 concludes and discusses the implications of the results.

1.3 The conceptual model

1.3.1 Discrete choice experiments and provision rules

We model participants' responses to ecosystem restoration choices using a standard economic model, the Random Utility Model (RUM) (McFadden, 1974). The RUM assumes a sample of N participants with the choice of J ecosystem restoration alternatives on T choice sets or choice tasks. The utility that participant n derives from choosing restoration alternative j on choice set t is given by $U_{njt} = V_{njt} + \varepsilon_{njt}$, where V_{njt} is an estimable component of the utility estimated from observed attributes relating to ecosystem restoration alternatives and participants, and where ε_{njt} is a portion of utility relating to unknown randomness from the researcher's perspective. The probability that participant n chooses alternative j in choice task t denoted by P_{njt} is given by:

(1) $$P_{njt} = \Pr (U_{njt} > U_{nkt} \ \forall \ j \neq k) = \Pr (V_{njt} + \varepsilon_{njt} > V_{nkt} + \varepsilon_{nkt} \ \forall \ j \neq k)$$

$$= \Pr (\varepsilon_{njt} - \varepsilon_{nkt} > V_{nkt} - V_{njt} \ \forall \ j \neq k)$$

According to expression (1), a participant compares utilities received from available alternatives in each choice set and chooses the alternative that provides him or her the highest utility. The appropriate assumption about the distribution of random error terms (ε_{njt}) will yield a corresponding empirical choice model. This expression, however, does not typically consider any influence of a provision rule on participant's utilities from available alternatives and thus choices. We will test whether choices under different provision rules produce similar estimates of the preference function that presumably underlies individuals' choices.

Our survey participants responded to two sets of ecosystem restoration choices- the first set includes choices representing real-world scenarios and immediately implementable projects and the second set involves choices representing future candidate projects (or hypothetical choices) for restoration. In our questionnaire, we interspersed the real, implementable choice opportunities between choices involving candidate projects as explained below. Each survey participant received both sets of choices. We will also examine whether the value estimates significantly differ between the two sets of choices.

1.3.2 Experimental plan

First we examine the influence of including a single decision-maker's choice rule on the estimated utilities from alternatives and how this influence may affect participants' responses. Under this rule, the researchers will randomly draw a choice task from among a series of implementable, real choice tasks. This random draw is required to maintain the independence between choice tasks and one-to-one correspondence between choices and the outcomes as noted in Vossler et al. (2012). Under our incentive-compatible decision rule, the researchers will also randomly select a participant who will be the “single decision-maker,” whose response on the randomly selected choice task will be the ecosystem restoration project that will be implemented. Under this single decision-maker’s choice rule, each participant has an equal chance of being the single decision-maker and, given that she is chosen as the single decision-maker, she cannot do better than choosing the true utility-maximizing alternative based on her preferences in each choice set or task. Thus, a single decision-maker’s choice rule is a theoretically incentive compatible rule.[5] In comparison, we also examine how the inclusion of a plurality vote provision rule may impact utilities from alternatives and thus affect the responses. Under this rule, the researchers randomly selected a choice task and the project that receives the most votes is selected for implementation. In our ecosystem restoration application participants are asked to choose among two alternative restoration projects, labeled “Project A” and “Project B” or to retain the status quo, a “no action” alternative.

The plurality vote rule is not generally incentive compatible in multinomial choice situations like our study, as the voting strategies may depend on subjective beliefs about the distribution of preferences within the voting group. For example, there may be a sub-interest group that may have a favorable, or “pro,” attitude for restoration projects that involve community members as trained volunteers or specific

[5] This rule may not be very appealing in actual decision-making applications, because many participants would expect something like a voting rule, but we set up this rule as a "base rule" to compare preferences with plurality vote rule. This rule is the only incentive compatible rule in case of three-option choice situations.

preferences regarding the level of public access to restoration sites. In addition, participants may simply select a status quo option to avoid placing a burden on others [6] when, in fact, the status quo option is not the utility-maximizing alternative. The potential for the other-regarding behavior may further complicate the incentive properties of a plurality vote provision rule (Taylor et al., 2010). Thus a plurality vote rule in case of three-alternative choice situations is not incentive compatible.

1.3.3 Empirical model

We employed a panel mixed logit (Hole, 2008; Train, 2003; Revelt & Train, 1998; Train, 1998) specification to model participants' choices of ecosystem restoration projects. The panel mixed logit model allows the utility coefficients to vary across participants to incorporate heterogeneity in preferences and does not impose the assumption of Independence of Irrelevant Alternatives (IIA) which is imposed in a conditional logit model. Following Revelt & Train, 1998, we assume that a sample of N survey participants face J alternatives in T choice tasks. The utility derived by participant n by choosing alternative j in choice task t can be written $U_{njt}=\beta_n'X_{njt}+\varepsilon_{njt}$ where β_n is a participant-specific vector of utility parameters, X_{njt} is the vector of observed characteristics relating to survey participant n and attributes relating to alternative j on choice task t, and ε_{njt} is an IID extreme value distributed error term. The density for β is represented as $f(\beta|\theta)$ where θ denote the parameters of the assumed distribution, such as $\beta_n \sim N$ (mean β, σ) for normally distributed parameters.

[6] The status quo avoids imposing payments on others in a voting rule.

The probability of participant n choosing alternative j on choice set t, conditional on knowing β_n, is given by the conditional logit formula (McFadden, 1974):

(2) $P_{njt}(\beta_n) = exp(\beta_n' X_{njt}) / \Sigma_{j'} exp(\beta_n' X_{nj't})$

The probability of the observed choices, conditional on knowing β_n, is given by: $S_n(\beta_n) = \Pi_t \{P_{nj(n,t)t}(\beta_n)\}$ where $_{j(n, t)}$ indicates the alternative participant n chooses in choice task t. The unconditional probability of the observed choices is given by the conditional probability integrated over the distribution of β: $P_n(\theta) = \int S_n(\beta) f(\beta|\theta) d\beta$. Thus, the unconditional probability is a weighted average of a product of logit formulas evaluated at different values of β where the weights are given by the density f. The log-likelihood then is given by: $LL(\theta) = \Sigma_n \ln P_n(\theta)$. This expression cannot be solved analytically, but can be approximated using simulated log-likelihood: $SLL(\theta) = \Sigma_n \ln\{(1/R) \Sigma_r S_n(\beta^r)\}$, where R is the number of replications and β^r is the r^{th} draw from $f(\beta|\theta)$. The empirical utility function involving attributes of ecosystem restoration alternatives as well as participant-specific characteristics employed in the study will be discussed later.

1.3.4 Hypothesis testing

In order to examine whether the decision rule affects the set of mean estimates of marginal utility parameters and mean estimates of mWTP values for ecosystem restoration, we formally express the following hypotheses:

Hypothesis 1: The type of provision rule does not significantly influence a set of mean estimates of marginal utility parameters, denoted by β.

H_O: $\beta^{singleDC} = \beta^{pVOTE}$ and **H_A**: $\beta^{singleDC} \neq \beta^{pVOTE}$,

where β^{rule} represents a set of mean marginal utility parameters in the population estimated using responses from a sample of participants making choices under the single decision-maker's choice (rule=singleDC) or the plurality vote rule (rule=pVOTE).

In order to test **Hypothesis 1**, we will conduct a Likelihood Ratio (LR) test by imposing restrictions on a set of mean marginal utility parameters for one of the subsamples to examine whether the restrictions are true. Based on our earlier discussion on the theoretical predictions regarding the incentive compatibility of the two provision rules under trichotomous choice scenarios, we expect to reject the null hypothesis of no significant difference in marginal utility estimates across the rules.

Hypothesis 2: The type of provision rule does not significantly alter mean marginal willingness to pay (mWTP) estimates for ecosystem restoration attribute X.

H_O: $mWTP_X^{singleDC} = mWTP_X^{pVOTE}$ and **H_A**: $mWTP_X^{singleDC} \neq mWTP_X^{pVOTE}$,

where $mWTP_X = -1*(\beta^{rule}_X / \beta^{rule}_{Cost})$ represents the ratio of the mean marginal utility parameter of an attribute X (β_X) and the mean marginal utility of income (negative of β_{Cost}) estimated from the two subsamples, "rule"=singleDC, pVOTE. Since both numerator (non-monetary restoration attribute X) and denominator (Cost attribute) of mWTP values will be randomly distributed coefficients from a mixed logit model (described below), these mWTP estimates can be calculated by using simulation. The simulated mWTP distributions can be obtained by dividing the draws from the distributions of non-monetary coefficients by draws from the distribution of the cost coefficient.

In order to test **Hypothesis 2**, we will conduct an empirical numeric procedure, known as complete combinatorial convolutions, to determine whether simulated mWTP distributions for restoration attributes are statistically different across the rules (Poe et al., 2005; Poe et al., 1997; Poe et al., 1994). Based on our earlier discussion on the theoretical predictions regarding the incentive compatibility of the two provision rules under trichotomous choice scenarios, we expect to reject the null hypothesis of no significant difference in simulated mWTP distributions across the rules.

We will also examine whether potential subgroups of participants, representing specific strategic interests or motivations for certain aspects of restoration, have significantly different preference functions, by examining significance of relevant interaction terms (defined below) in the utility function. Furthermore, we will compare participants' responses for the potentially implementable, real choices and hypothetical choices to examine whether participants have similar preferences irrespective of financial consequences of restoration choices.

1.4 A field application to NROC's native ecosystem restoration

1.4.1 Study context, restoration attributes and experimental design

We examined the hypotheses using two in-person field experiments employing the discrete choice experiments (DCEs) framework. The choice surveys were part of a broader study, which aimed at assessing the effectiveness of alternative management techniques to control non-native or invasive plants in order to restore native habitats, particularly for target bird species. The choice experiments, within the broader project objectives, were to assess public values and priorities for ecosystem restoration attributes focused on the native habitats and target bird species and incorporate such values and priorities into a decision support tool to be used by environmental managers for prioritizing future restoration efforts. The study site is the Nature Reserve of Orange County (NROC), which is a 37,000-acre nature reserve in southern California established in 1996 to restore native habitats and natural processes supporting grasslands and Cactus Wren and California Gnatcatcher bird species.

Interviews with ecosystem restoration experts from the NROC, Irvine Ranch Conservancy (IRC), and other local conservation groups and a series of seven focus groups (Johnston, Weaver, Smith, & Swallow, 1995) with local citizens were employed to identify relevant project attributes and to develop, revise and pretest survey instruments for overall clarity, salience of attributes, and comprehensiveness of ecosystem restoration choices and general instructions. Participants in our focus group discussions expressed an interest in multiple dimensions of ecosystem restoration in the NROC. Some examples include favorable attitudes towards involving community members as trained volunteers in the restoration process[7] or preferences regarding the level of public access sites for various activities. Based on these observations during focus group discussions, we hypothesize that there may exist subgroup(s) of participants representing those interests or motivations which may lead those groups to

[7] Individuals expressed the belief that volunteers become experienced and educated advocates for NROC and ecosystem restoration generally.

respond strategically to the restoration choices. Table 1.1 presents identified project attributes and their corresponding levels, namely restoration effort, habitat and bird species focus, size of restoration site, public access, involvement of trained volunteers, likelihood of success of a restoration project, and cost to the participants.

Table 1.1 Ecosystem restoration project attributes and levels

Attribute	Variable[a]	Levels
Restoration Effort	**High_Effort**[b]: a dummy variable; =1 if high effort; =0 if low effort	1. High effort: Project restores 0-30% native cover up to 51-75%. 2. Low effort: Project restores 30-50% native cover up to 51-75%.
Habitat and Bird Species Focus	**Habitat_Cactus**[b]: effects-coded variable, =1 if restoration in coastal cactus scrub; =0 if restoration in native grasslands =-1 if restoration in coastal sage scrub **Habitat_Ngrass**[b]: effects-coded variable, =1 if restoration in native grasslands; =0 if restoration in coastal cactus scrub; =-1 if restoration in coastal sage scrub	1. Coastal Cactus Scrub: Restoration is implemented in native cactus scrub habitat, which supports *Cactus wren*[c]*,* and often supports *California gnatcatcher*[d]. 2. Native Grasslands: Restoration is implemented in native grasslands habitat, which supports *other native wildlife.* 3. Coastal Sage Scrub: Restoration is implemented in native sage scrub habitat, which supports *California gnatcatcher*.
Public Access	**High_Access*:*** effects-coded variable; =1 if area allows high public access; =0 if area allows medium public access; =-1 if area allows low public access **Medium_Access*:*** effects-coded variable; =1 if area allows medium public access;	1. High Public Access: Area allows access for running, hiking, mountain biking, with designated areas for dogs and horse-back riding when ecologically feasible. 2. Medium Public Access: Area allows access for running, hiking, mountain biking.

	=0 if area allows high public access; =-1 if area allows low public access	3. Low Public Access: Area allows access for research with permits and guided tours only.
Trained Volunteers	**Volunteers*:*** a dummy variable; =1 if project involves trained volunteers; =0 if project does not involve volunteers.	1. Yes: Project involves trained volunteers in addition to restoration professionals. 2. No: Project does not involve trained volunteers in addition to restoration professionals.
Likelihood of Success	**High_Success*:*** a dummy variable; =1 if project has high likelihood of success; =0 if project has medium likelihood of success.	1. High Likelihood of Success: Due to easy access for maintenance and / or surrounded by native landscape. 2. Medium Likelihood of Success: Due to moderate access for maintenance and / or surrounded by mixed native-nonnative landscape.
Size of Restoration	**Size**[b]***:*** Size of candidate restoration sites, in acres	1, 2, 3, 5, 7, and 9
Cost to participant	**Cost**[b]**:** Cost to participant from personal budget of $150	$40, $60, $75, $90, $105, and $110
Status quo option	**SQ**[b]**:** A dummy variable equals **1** for the status quo option or "neither project", and equals **0** for a parcel (Project A or Project B).	

[a]Non-monetary ecosystem restoration attributes in vector X_{njt} were assumed to follow normal distribution and the cost attribute ($Cost_{njt}$) was assumed to follow log-normal distribution while estimating the utility function in Eq. (3).

[b]Ecosystem restoration attributes included in vector $X^{\wedge}_{njt}$ were specified as fixed parameters in Eq. (3).

[c]Cactus Wren is listed as California State Species of Special Concern and was selected as one of the "Target Species" in Orange County's Central and Coastal Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP) in 1993 and a surrogate for conservation of coastal cactus scrub habitat.

[d]California Gnatcatcher is listed as a federally-threatened species by the United States Fish and Wildlife Service (USFWS). The gnatcatcher is also a focus of the California Department of Fish and Game's Natural Community Conservation Planning Act, and

is one of the three “Target Species” in Orange County’s Central and Coastal NCCP/HCP.

We employed an efficient design[8] because a full factorial design using attributes and levels in Table 1.1 will result in a very large number of choice sets, which is not practical. We used responses to draft surveys, obtained through focus group pretests, to support priors on the parameters of ecosystem restoration attributes to produce the final design. Our efficient design process was unique because we created 14 choice sets or tasks covering the attribute levels in Table 1.1, but the efficient design was chosen to include 6 choice sets for which projects fit the description of real, implementable ecosystem restoration projects and the remaining 8 choice sets for which project descriptions represent hypothetical, candidate projects for future consideration. Experts from NROC and IRC provided a description of a total of 18 real-world scenarios, which were fed into Ngene to produce a set of 6 potentially implementable choice tasks. The printed survey distinguished the 6 real, and potentially implementable, choice sets from the 8 hypothetical choice sets using an explicit label, stating "Feasible, potentially implementable projects in 2012, Choice “[L],” where L represents one of the following unique letters: P, Q, R, X, Y, and Z. All 14 choice tasks were efficiently blocked into two groups of 7 tasks to control for ordering effects, if any, which could produce noise in our analysis. Each participant in

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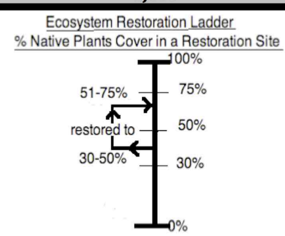
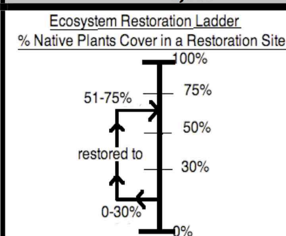
[8] This is a design that yields data enabling estimation of the preference parameters with standard errors as low as possible. Ngene 1.1 (ChoiceMetrics, 2011), a software specifically designed to produce experimental design for DCE surveys, was used to produce this design. We are thankful to the technical experts from Ngene software, who developed a separate software module to accommodate our unique design need.

our experiments received all 14 choice tasks. In each survey booklet, the 14 choice questions were arranged beginning with a hypothetical question and alternating with real, implementable questions. Manuscript 1- Appendix A1 provides the complete 14 choice questions.

Figure 1.1 An example of real, implementable ecosystem restoration choice task

Feasible, potentially implementable projects in 2012, Choice …

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration to **Native Grassland**, needed to support **other native wildlife**	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**3** acres	**2** acres	
Public Access	Area allows **access** for **running, hiking and mountain biking**	Area allows **access** for **research with permits and guided tours only**	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$60**, from my **$150.**	I will pay **$105**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU VOTE? (CHOOSE ONLY ONE)	❒ **I vote for PROJECT A**	❒ **I vote for PROJECT B**	❒ **I vote for PROJECT C**

Note: Choices that were not implementable in the 2012 NROC field season did not have the box shown above the choice question.

Each choice task, real and potentially implementable (or hypothetical), included two ecosystem restoration projects, labeled "Project A" and "Project B" and the status quo as a "no action" alternative (Figure 1.1). We developed a choice survey entitled "Ecosystem Auctions for Decision Support (EADS): Economic Choices for

Ecosystem Restoration for Environmental Decision-Making in the Nature Reserve of Orange County (NROC), California". The choice survey consisted of a total of 3 sections. The first section used a 7 point Agree-Disagree scale and asked participants about their general opinion towards ecosystem restoration, their perspectives on involving volunteers or public access near restoration sites, and incorporating public values and priorities in future restoration decisions. The second section presented participants with the 14 choice tasks along with information and instructions on the corresponding provision rule. We also included a subsection that asked participants follow up questions, on a 5-point Likert-scale, about how they answered choice tasks. The third section asked participants about their socio-demographic characteristics. Manuscript 1- Appendix A3 provides a complete survey booklet.

1.4.2 Participants, procedures, and the provision rules

Participants for in-person field experiments were recruited through local environmental organizations, namely Nature Reserve of Orange County (NROC); Irvine Ranch Conservancy (IRC); Back to Natives Restoration; Laguna Greenbelt; Newport Bay Conservancy; Laguna Canyon Foundation; Friends of Harbors, Beaches and Parks; and Sea and Sage Audubon Society. An email invitation was sent to the email lists of these organizations and individuals were asked to register voluntarily in one of the two in-person field experiments, called "Ecosystem Restoration Decision-Making Workshop", held at an educational facility of Orange County Parks, at the Peter and Mary Muth Interpretive Center. At least two rounds of email reminders were sent during the recruitment period, offering a $40 participation fee. The first workshop was on Wednesday, May 16, 2012, from 5:30 -7:30 pm and had 57 volunteers sign up, and the second workshop was on Thursday, May 17, 2012, at the same time and had 53 individuals sign up. Twenty-three individuals who were available for both workshops were randomly assigned to one.

For field experiments, a PowerPoint presentation about the project in general, experimental instructions, information about the project attributes, and description of the corresponding provision rule, was made by the same experiment moderator (Manuscript 1- Appendix A2). The information provided through the presentation was kept as similar as possible across the two experiment nights. The only difference in information provided across the two nights is the description of the corresponding provision rule. For the field experiments, each participant was provided with a budget of $150 from the research grant[9], of which $40 was guaranteed for participants to take

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[9] The authors recognize the literature on *house money effect*, a term coined by Thaler and Johnson (1990) based on "mental accounting" theory proposed by Thaler (1980), to describe behavioral discrepancies due to an initial endowment given to participants to make decisions in economic experiments. They found that participants in risky lottery experiments who have experienced monetary gains or profit are often willing to take more risk because they do not treat those gains as their own money. There is mixed evidence on the presence of the house money effect in a variety of experimental settings suggesting that the effect may be specific to the environment being tested. While this effect has been found in dictator game experiments (Cherry et al., 2002; Engel, 2011), public good experiments (Harrison, 2007), experimental auctions (Ackert et al., 2006) and capital expenditures (Keasy and Moon, 1996), Clark (2002) and Cherry et al. (2005) did not find such effect in their public goods experiments. Spraggon and Oxoby (2009) reported a negative effect of the "windfall gain" on contribution in their public goods experiment. In our field experiments, the research

home as a participation fee and participants could spend the remaining $110 on the projects or take it home, depending on the decision-outcome for the evenings' experiment. Participants were encouraged to consider the budget provided as their out of pocket money which they can spend on the projects or take home to spend on utility bills, family gifts, and donations to charities or any other purposes important to them. For example, the following excerpt is from the introduction section of the survey:

> "…Recall that any money you keep can be used for other personal priorities, including family expenses, gifts, donations to conservation or important charities, or any other purpose…"

Participants were also reminded about what they could do with the money not spent on restoration projects, right before they faced choice tasks, with the following paragraph:

> "…We request that you consider restoration projects in each choice question in terms of **what each project might or might not accomplish, how it matters to you, whether it is worth the money cost to you, and how your vote might influence the group outcome for tonight**. Recall money not spent on these projects may be used by you at home for other priority expenses or charities…" (Emphasis in original)

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moderator repeatedly emphasized and encouraged participants to consider money given to them as their "out of pocket" money by highlighting the personal priorities they can spend money on if they decided to take the money home in both PowerPoint presentation and the instructions in the survey booklet; these reminders included the potential to use retained funds for philanthropic or other conservation organizations.

At the end of each session, one ecosystem restoration project was determined as the project to be implemented based on the corresponding rule in force for the evening and the payment to the participants was made based on the selected project. Participants were told that NROC and IRC would be implementing the chosen projects determined by their choices.

Participants were presented with the exact same project background information, example choices, choice tasks and other questions except the description of the provision rule used. The following is an excerpt from the instructions of a plurality vote rule:

> "**Determining the group outcome at the end of tonight's workshop**
>
> Once everyone has finished responding to all choice questions, **one choice question number will be selected randomly** from the group of choice questions labeled as **Feasible, potentially implementable projects in 2012, Choice-…"**. Each participant's response on this choice question will be counted as **a vote**. The project that gets **the most votes** will be chosen as **the group outcome** of tonight's decisions and will be implemented in this (2012/2013) NROC field season. **Your payment** will be determined based on the **group outcome** chosen according to **majority vote (or plurality vote)** rule as described above." (Emphasis in original)

As the single decision-maker's choice rule involved two stages- (i) randomly choosing a choice task, and (ii) also randomly choosing a single decision-maker whose response on the selected choice task becomes the project to be implemented, the following excerpt was presented to participants to describe how the single decision-maker's choice rule will be implemented:

> **"Determining the group outcome at the end of tonight's workshop**
>
> Once everyone has finished responding to all choice questions, **one choice question number will be selected randomly** from the group of choice questions labeled as **"Feasible, potentially implementable projects in 2012 Choice-…"** .One **Survey ID number** will also be selected randomly. The project, **chosen by the person holding the randomly selected Survey ID number on the randomly selected choice question**, will be chosen as the group outcome of tonight's decisions and will be implemented in this (2012/13) NROC field season. **Your payment** will be determined based on the **group outcome** chosen according to **the randomly chosen single decision-maker's choice** as described above." (Emphasis in original)

1.4.3 Outcome of the decision-making Workshops

After all participants completed their surveys, the survey booklets were collected to implement the corresponding provision rule on each night of the Workshops. On each night, the experiment moderator randomly picked a choice task number (or corresponding letter) on which the corresponding provision rule was implemented. By random chance, both Workshop nights resulted in drawing the same real, implementable choice question (**"Feasible, potentially implementable projects in 2012 Choice-Q")** and the outcome based on the implementation of corresponding rule was the same (**"Project A")**, meaning both nights resulted in selecting the same restoration project[10]. Thus, the decision-making workshops resulted in restoration projects described as “Low” level of restoration in Cactus Scrub habitat in 2 acres (1 acre from each night) in an area that allows for medium level of public access without involving volunteers and is expected to result in high likelihood of success. Participants in both Workshops nights were told that the Nature Reserve of Orange County (NROC) and Irvine Ranch Conservancy will be responsible for implementing the selected ecosystem restoration projects and interested experiment participants can learn more about the projects through these organizations.

1.4.3 Descriptive statistics

Of 57 volunteers for the first workshop, 43 actually arrived on time and participated in the plurality vote rule. Of 53 for the second workshop, 38 arrived on time and participated in the single decision-maker’s choice rule. Of these participants, twenty-three had been available for either evening and assigned randomly to a workshop.

We utilized responses to seven-point Likert scale statements, varying from Strongly Disagree to Strongly Agree, regarding participants’ views and attitudes towards various aspects of ecosystem restoration in the NROC to construct continuous factor variables using a factor analysis approach (Kaiser, 1958); (Harman, 1976). We employed a principal component factor (PCF) with *varimax* rotation to construct four

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[10] NROC and IRC confirmed that that two projects fitting same description were feasible, so, in fact, the same project was implemented twice but on slightly different locations; the precise location within NROC lands was not part of the descriptions in the choice questions.

continuous-valued factors from participants' responses to the statements. The rotated factor loadings were then used to convert responses to the statements from each individual participant to "standardized scores" using the regression scores method (Milan & Whittaker, 1995) in the Stata statistical package. The details of the statements used and rotated factor loadings are presented in Table 1.2.

Table 1.2 Rotated factor loadings on Likert-scale statements

Statements[a]	**"Involve Community"**	**"Standardized Public Access"**	**"Comprehensive and Sustainable Restoration"**	**"Conservation for Quality of Life"**	**"Value Information"**	**"Restoration for Long-term Events"**
I would prefer restoration be completed quickly utilizing park staff and contractors or professionals with higher expected success rates but higher costs, than completed over a greater length of time (years) utilizing park staff and volunteers at much lower cost but more variable success rate.	**-0.7215**	0.1425	0.2974	0.0713	-0.0025	0.0638
I value restoration actions more when I have access to information about the project and its goals.	0.0686	0.0054	0.0025	0.0730	0**.9133**	0.0425
I personally believe that preservation of the full ecosystem is the most effective means of preserving individual sensitive species.	-0.4753	-0.0728	**0.6912**	-0.1337	0.2013	0.0175
I personally believe that conservation or stewardship actions are essential parts of	-0.0005	-0.2312	0.1836	**0.6384**	0.4017	0.1991

managing the reserve lands.						
Seeing restoration projects and their associated flagging or markers detracts from my outdoor experience.	-0.0089	**0.6501**	-0.1016	-0.2335	0.2229	-0.2338
I personally believe that restoration of habitat that is most suitable to native wildlife is more important than vegetation management focused around aesthetics or other public priorities.	-0.0775	**-0.6169**	0.2233	0.0454	-0.0038	-0.3835
I would rather have public access to all areas of open space on a standardized rotation cycle than unlimited public access in some areas and restricted or no public access to others.	0.1014	**0.7324**	0.1066	0.1736	-0.1530	-0.0976
For the same cost, I would rather have less area restored, but involve underprivileged groups, students or other community members, than more area restored with contractors or professionals.	**0.6602**	0.1053	0.1572	-0.2916	-0.0652	0.1092
It is important to me personally that land managers incorporate public values or priorities as an input to ecosystem restoration decisions.	**0.7694**	0.1695	0.1012	0.0378	0.2140	-0.0810
I personally believe that restorations within public view should utilize educational signage.	0.2289	0.0294	**0.7452**	0.2290	-0.1409	0.2759
I personally believe that restoration projects should incorporate restoration, monitoring and maintenance methods that ensure a sustainable restoration.	-0.0137	-0.4559	**0.5404**	0.1614	0.0659	-0.2454
I personally believe that ecosystem restoration	-0.0909	0.0657	0.0352	**0.8682**	-0.0062	-0.0373

efforts or activities in the NROC positively affect the quality of life of the local communities around the reserve.						
I personally believe that restoration projects should incorporate restoration, monitoring and maintenance methods that address potential long-term issues of stochastic events (drought, fire) and climate change.	-0.0564	-0.0380	0.1171	0.0290	0.0674	**0.8747**

[a] Survey participants rated each statement using a seven-point Likert-scale varying from Strongly Agree (1) to Strongly Disagree (7). Numbers in bold represent *varimax* rotated highest factor loading (normalized to mean 0 and SD 1) for a given statement indicating agreement for positive coefficient and vice versa. Total variation explained by the six factors is 68.54%.

Table 1.3 reports some basic socio-demographic characteristics of the participants across the two provision rules. A chi-squared test of independence for categorical variables and two-sample t-test between the means of continuous variables between the decision rules are reported in Table 1.3. These test results suggest that the two participant groups are not significantly different in terms of socio-demographic characteristics and environmental attitudes, except participants in the two workshops displayed a statistically significant difference between the means of the factor indicating a favorable attitude for "Comprehensive and Sustainable Restoration." We also compared participants' socio-demographic characteristics to available data on the population of Orange County, California (US Census Bureau, 2010). These comparisons suggest that the distribution of the proportion of male and female participants (Pearson $\chi2=1.457$, df=2, p=0.4826), homeowners and renters (Pearson

$\chi2$=2.205, df=2, p=0.3320), high ($75,000 or more a year) and low income (<$75,000 a year) (Pearson $\chi2$=3.617, df=2, p=0.1639) are not significantly different from that of the population of Orange County. However, both field experiments had significantly higher percentages of individuals with graduate degrees (Pearson $\chi2$=22.927, df=2, p<0.0001) than that of the population of the county.

Table 1.3 Descriptive statistics about participants across provision rules

Categorical variables	**Description**	**Provision rules**		
		Plurality Vote (pVOTE, N=43)	**Single Decision-Maker's Choice (singleDC, N=38)**	**Pearson $\chi2$, 1df (p)**
		Sample Mean (SD)	**Sample Mean (SD)**	
Male	1 if a participant is male; 0 otherwise	0.44 (0.50)	0.52 (0.50)	0.5763 (0.448)
Home owner	1 if a participant owns a home; 0 otherwise	0.67 (0.47)	0.68 (0.47)	0.0089 (0.925)
Graduate degree	1 if a participant has a graduate degree; 0 otherwise	0.39 (0.49)	0.39 (0.49)	0.0000 (0.996)
Low income	1 if a participant's household income is less than $75,000; 0 otherwise	0.41 (0.49)	0.55 (0.50)	1.4515 (0.228)
Donate	1 if a participant donates money to an environmental group; 0 otherwise	0.65 (0.48)	0.63 (0.48)	0.0337 (0.854)
Participated in restoration	1 if a participant has ever participated in any ecosystem restoration projects; 0 otherwise	0.58 (0.50)	0.73 (0.44)	2.1551 (0.142)
Hiker	1 if a participant has ranked "hiking" as the most important	0.55 (0.50)	0.44 (0.50)	0.9903 (0.32)

	recreational activity around the NROC; 0 otherwise			
Education tour ("EduTour")	1 if a participant has ranked "educational tours" as the most important recreational activity around the NROC; 0 otherwise	0.23 (0.43)	0.26 (0.45)	0.1016 (0.75)
"Public" aspect	1 if a participant has ranked "public aspects of restoration i.e., public access and trained volunteers" as the most influential attributes in their decisions; 0 otherwise	0.30 (0.46)	0.34 (0.48)	0.1465 (0.702)
Continuous variables	**Description**	**Sample Mean (SD)**	**Sample Mean (SD)**	**t-stat, 79 df (p)**
Resident (years)	Number of years a participant lived in or around Orange County	27.30 (16.84)	31.22 (17.14)	1.0368 (0.303)
"Involve Community"	A continuous factor score indicating pro-attitude for involving community members in the restoration	0.06 (1.00)	-0.07 (1.00)	0.5933 (0.5547)
"Standardized Public Access"	A continuous factor score favoring standardized public access on the areas of open space in the NROC	0.06 (1.06)	-0.07 (0.92)	0.6562 (0.5136)
"Comprehensive and Sustainable Restoration"	A continuous factor score indicating a favor for methods to ensure comprehensive and sustainable restoration	0.20 (0.79)	-0.23 (1.15)	2.0261 (0.0461)
"Conservation for Quality of Life"	A continuous factor score indicating a belief that conservation actions in the NROC affect the quality of life around it.	-0.001 (1.01)	0.001 (0.99)	0.0131 (0.9896)
"Value Information"	A continuous factor score indicating that participants value	-0.003 (0.96)	0.003 (1.04)	0.032 (0.9746)

	conservation actions more when they have access to information			
"Restoration for Long-term Events"	A continuous factor score indicating a pro-attitude for restoration actions that address long-term issues of stochastic events like drought, fire and climate change	0.06 (0.89)	-0.06 (1.11)	0.5803 (0.5634)

1.5 Results

1.5.1 Empirical model specification

We assume that the indirect utility is a linear function of ecosystem restoration attributes, the cost to participants, and selected interactions. First we established an unrestricted specification of the utility for a project, as represented below, and estimated using a panel mixed logit model[11] (Hole, 2008; Haan & Uhlendorff, 2006; Train, 2003; Train, 1998; Revelt & Train, 1998) with the pooled data, and then tested the parameter restrictions of interest against the unrestricted model. Thus, we defined:

(3) $V_{njt}=\beta_{SQ}SQ_j+\beta_X X_{njt}+\beta_{Cost}Cost_{njt}+(\beta_{HikerSQ}SQ_j+\beta_{HikerX}X_{njt}+\beta_{HikerCost}Cost_{njt})\bullet Hiker_n$

[11] A Likelihood Ratio (LR) test suggests that a mixed logit model is a better fit than the corresponding standard conditional logit model ($\chi2$=439.3132, df=10, p-value<0.0001). We employed the *mixlogit* module in Stata (Hole, 2007) to estimate our models with "id (*participant id*)" option to adjust for the potential non-independence of responses to 14 choice tasks from a survey participant. Only SQ_j, X_{njt}, and $Cost_{njt}$ and their interactions with the dummy variable, DP, for a total of 20 variables, were specified as random variables because the software module cannot accommodate all interactions as random variables. Since the focus of our LR test is on comparing the significance of coefficients on the SQ_j, X_{njt}, and $Cost_{njt}$ across the rules, we treated other interactions as fixed parameters.

$$+(\beta_{EduTourSQ}SQ_j+\beta_{EduTourX}X_{njt}+\beta_{EduTourCost}Cost_{njt})\bullet EduTour_n+(\beta_{DRealSQ}SQ_j +\beta_{DRealX^\wedge}X^{\wedge}_{njt}+\beta_{DRealCost}Cost_{njt})\bullet DReal_t+(\beta_{SQP}SQ_j+\beta_{XP}X_{njt}+\beta_{CostP}Cost_{njt})\bullet DP +(\beta_{HikerSQP}SQ_j+\beta_{HikerXP}X_{njt}+\beta_{HikerCostP}Cost_{nj})\bullet Hiker_n\bullet DP+(\beta_{EduTourSQP}SQ_j +\beta_{EduTourXP}X_{njt}+\beta_{EduTourCostP}Cost_{njt})\bullet EduTour_n\bullet DP+(\beta_{DRealSQP}SQ_j+\beta_{DRealX^\wedge P}X^{\wedge}_{njt}+ \beta_{DRealCostP}Cost_{njt})\bullet DReal_t\bullet DP$$

where β_{SQ} represents the coefficient measuring the utility of the status quo option (SQ_j); SQ_j represents a dummy variable taking a value of 1 for the status quo option or "no action" alternative and the value of 0 for an ecosystem restoration project; $\beta_{HikerSQ}$ $\beta_{EduTourSQ}$ $\beta_{DRealSQ}$ adjusts (or adds) the utility of the status quo option due to dummy variables "$Hiker_n$", "$EduTour_n$" and "$DReal_t$" for participants under a single decision-maker's rule (DP=0); "$Hiker_n$" is a dummy variable taking a value of 1 for a participant who has ranked "hiking" as the most important recreational activity around the NROC and a value of 0 otherwise; "$EduTour_n$" is a dummy variable taking a value of 1 for a participant who has ranked "educational tours" as the most important recreational activity around the NROC and a value of 0 otherwise; "$DReal_t$" is a dummy variable equals 1 for real, immediately implementable choice task and equal 0 otherwise; β_X represents the vector of coefficients measuring the mean marginal utility parameters of non-monetary restoration attributes (X_{njt}); X_{njt} represents a vector of non-monetary attributes of restoration projects; β_{HikerX} $\beta_{EduTourX}$ adjusts (or adds) the fixed marginal utility parameters for the non-monetary restoration attributes due to the dummy variables "$Hiker_n$", "$EduTour_n$"; β_{DRealX} adjust (or adds) the marginal utility parameters for the selected non-monetary restoration attributes ($X^{\wedge}_{njt}$)[12] due to the dummy variable "$DReal_t$"; β_{Cost} represents the coefficient measuring the mean marginal utility parameter of cost to participants ($Cost_{njt}$; negative of which is known as marginal utility of income); $Cost_{njt}$ represents the cost to participants; $\beta_{HikerCost}$ $\beta_{EduTourCost}$, $\beta_{DRealCost}$ adjusts (or adds) the fixed marginal utility parameters to the mean marginal utility of the cost to participants ($Cost_{njt}$) due to the dummy variables "$Hiker_n$", "$EduTour_n$" and "$DReal_t$"; DP represents a dummy variable taking a value of 1 for the subsample of participants making choices under a plurality vote provision rule and the value of 0 for the subsample of participants making choices under a single decision-maker's choice provision rule. Our model specification in Eq. (3) sets up the base case as the utility under the single decision-maker's choice rule (DP=0) and the corresponding parameters with the last subscript "P" represent the corresponding adjustments (additions to the utility parameters) under the plurality vote decision rule (DP=1).

[12] Ecosystem restoration attributes defined in Table 1.1 were included in the $X^{\wedge}_{njt}$, but "High_Access", "Medium_Access", "Volunteers", and "High_Success" were excluded in the estimation because the levels of these attributes in real, implementable ecosystem restoration projects for the 2012 field season were constrained by the availability of real-world scenarios, thus creating colinearity. This reality limits our ability to compare the utility parameters for these specific attributes across the real, implementable and hypothetical choices but does not affect other estimations otherwise.

1.5.2 Hypothesis test results

In order to test **Hypothesis 1**, we estimated a panel mixed logit model of the indirect utility specification in Eq. (3) from the pooled data and examined the significance of a set of parameter restrictions on the unrestricted model using a likelihood ratio (LR) test. The LR test failed to reject the null of no significant difference, meaning a set of mean utility parameters, i.e., the mean marginal utilities of non-monetary restoration attributes, the mean marginal utility of income, and the mean utility of the status quo option, are statistically equivalent across the subsamples (across the two workshops) (LR Test: $\beta_{SQP}=\beta_{XP}=\beta_{CostP}=0$; $\chi2=14.77$, df=20, p=0.7894)[13]. This result suggests that the two provision rules produce statistically equivalent underlying preference functions.

We also conducted a LR test to examine whether the set of fixed marginal utility parameters is statistically different for a group of participants characterized by different interests or motivations.[14] For example, a group of participants who has

[13] One may question about the "power" of the test in terms of avoiding Type II error. Type II error is the failure to reject a false null hypothesis, meaning inability of a statistical test to detect the significant effect when, in fact, the difference exists. The LR tests reported here are based on the data from 81 individuals each responding to 14 potentially independent choices, totaling 1134 observations. The authors present the results of the tests on the assumption that 1134 observations will be sufficient to detect the difference, if there is any, as determining the "power" for already computationally-complex mixed logit model is beyond the scope of this paper.

[14] In an effort to identify individuals who might be more or less likely to respond strategically to choice opportunities favoring a particular interest, we created one additional choice task, the 15th choice task, consisting of the status quo and three

ranked "hiking" as the most important recreational activity around the NROC (see "Hiker" in Table 1.3) may have a statistically different preference function compared to the participants who do not represent that interest or motivation. Also this distinct, if any, preference function may be affected by the type of provision rule, such as under a plurality vote due to its incentive structure to allow for potential strategic responses. Similarly, participants who have ranked "educational tours" as the most important activity around NROC may have such strategic motivations to have a distinct preference function relative to the participants who do not share those interests or motivations (see "EduTour" in Table 1.3), for example, under the plurality vote that allows for strategic opportunities as predicted by the theory. We examined whether these distinct groups of participants have statistically different functions using a LR test by imposing the restrictions on the appropriate interactions in Eq. (3). LR tests suggest that none of these distinct groups have statistically different preference functions and also these preference functions are statistically equivalent across the provision rules (LR Test: $\beta_{HikerSQ}=\beta_{HikerX}=\beta_{HikerCost}=\beta_{HikerSQP}=\beta_{HikerXP}=\beta_{HikerCostP}=0$; $\chi2=24.3751$, df=20, p=0.2264 and LR Test: $\beta_{EduTourSQ}=\beta_{EduTourX}=\beta_{EduTourCost}=\beta_{EduTourSQP}=\beta_{EduTourXP}=\beta_{EduTourCostP}=0$; $\chi2=13.1761$, df=20, p=0.8697). These LR tests

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restoration projects using a separate orthogonal design. The three restoration projects represented a specific focus on the public access, size of candidate sites, and the involvement of community members as trained volunteers by allowing the attributes indicating these dimensions in options A, B, and C respectively to vary and keeping all other attributes, as defined in Table 1.1, constant across the three options. We did not find significant results of using participants' response to this 15th choice task in identifying potential strategic voters in our preliminary models and thus these data are excluded in the further discussions.

suggest that these distinct groups of participants, who we expected may have statistically different preference functions due to their distinct interests or motivations, have statistically equivalent preference functions and further their underlying preference functions are not altered by the type of the provision rule.

We further examined whether participants' marginal utility parameters are significantly different across the real, implementable and hypothetical choices of ecosystem restoration. A LR test implies that participants have statistically equivalent marginal utility parameters between the real and hypothetical choices and the type of provision rule does not significantly alter these marginal utility parameters (LR Test: $\beta_{DRealSQ}=\beta_{DRealX^\wedge}=\beta_{DRealCost}=\beta_{DRealSQP}=\beta_{DRealX^\wedge P}=\beta_{DRealCostP}=0$; $\chi 2=9.6117$, df=12, p= 0.6499).

Since our empirical model specified the coefficients on the attributes of ecosystem restoration (β_X, β_{XP}) as well as the coefficient on the cost to participants (β_{Cost}, β_{CostP}) as random variables, we employed a Monte-Carlo simulation[15] to estimate the mean marginal willingness to pay (mWTP) values for restoration attributes. These values across the decision rules are reported in Table 1.4. We used parameter estimates of the unrestricted model presented in Eq. (3) to simulate the mWTP distributions. In order to test **Hypothesis 2**, we conducted pair-wise convolution tests (Poe et al., 2005; Poe et al., 1997) to empirically determine the significance of the difference in mWTP distributions for restoration attributes across the provision rules. mWTP distributions and the results of the pair-wise convolution

[15] We used *simulate* command in Stata (Cameron & Trivedi, 2010) to perform Monte-Carlo simulations with 10^5 replications.

tests are presented in Table 1.4. The results of these tests suggest that mWTP distributions for restoration attributes are statistically equivalent across the provision rules, implying similar value estimates for restoration attributes across the rules.

Table 1.4 mWTP values for attributes of restoration across the provision rules

Variable[a]	Provision rules		Convolutions test (p)[c]
	Single Decision-Maker's Choice (singleDC)[b] [95% C.I.]	Plurality vote (pVOTE)[b] [95% C.I.]	
High_Effort	79.35 [77.23, 81.49]	335.73 [313.61, 359.95]	0.4355
Habitat_Cactus	-6.55 [-6.69, -6.41]	-28.91 [-38.07, -20.07]	0.4861
Habitat_Ngrass	7.12 [6.24, 7.99]	105.11 [97.43, 113.48]	0.4032
High_Access	-5.38 [-7.24, -3.51]	43.15 [29.92, 56,73]	0.4661
Medium_Access	21.99 [21.23, 22.75]	154.54 [144.01, 166.08]	0.3992
Volunteers	78.40 [76.82, 80.01]	377.40 [359.59, 396.83]	0.378
High_Success	83.26 [81.12, 85.42]	591.45 [561.32, 624.61]	0.3695
Size	23.77 [23.11, 24.45]	101.76 [96.01, 108.04]	0.4243

[a]mWTP for a variable is calculated as the ratio of the mean marginal utility of that variable (i.e., β_X) and the marginal utility of income (β_{Cost} multiplied by -1). The mean marginal utility for a continuous variable is the estimated coefficient on that variable using the indirect utility in Eq. (3). For dummy or effects-coded variables, it is the difference in the utility of altering an attribute from the level represented by the omitted and the base category to the level represented by the particular dummy and effects-coded variable respectively. Table 1.1 defines these variables.

[b]These values were calculated by using simulation in Stata's (version 12) "*simulate*" module. The simulated WTP distributions were obtained by dividing draws from the

corresponding non-monetary restoration attribute (normal distribution assumed) by draws from the distribution of the "Cost" coefficient (log-normal distribution assumed) with 10^5 replications. 95% confidence interval of the mWTP distributions are reported in squared brackets and were calculated using Krinsky & Robb (1986) method.

[c]P-values from the Convolutions test for difference in mWTP distributions across the rules, i.e., Ho: $mWTP_X^{singleDC} = mWTP_X^{pVOTE}$, where $mWTP_X^{singleDC}$ is mWTP distribution for an attribute X for the subsample of participants facing the choices with the single decision-maker's choice rule (DP=0) and $mWTP_X^{pVOTE}$ is the corresponding mWTP distribution under the plurality vote rule (DP=1).

1.5.3 Panel mixed logit model results

The estimation results of the panel mixed logit model of the utility model specification in Eq. (3) are presented in Manuscript 1-Appendix A.4. Table 1.5 reports the restricted model after imposing restrictions on statistically insignificant interactions, i.e.,$\beta_{HikerSQ}=\beta_{HikerX}=\beta_{HikerCost}=\beta_{HikerSQP}=\beta_{HikerXP}=\beta_{HikerCostP}=\beta_{EduTourSQ}=\beta_{EduTourX}=\beta_{EduTourCost}=\beta_{EduTourSQP}=\beta_{EduTourXP}=\beta_{EduTourCostP}=\beta_{DRealSQ}=\beta_{DRealX\text{^}}=\beta_{DRealCost}=\beta_{DRealSQP}=\beta_{DRealX\text{^}P}=\beta_{DRealCostP}=0$. The estimation results (in Table 1.5) show that the status quo option, on average, decreases participants' utility, all other things holding fixed (when DP=0). Participants have a significant positive marginal utility of income (see Cost in Table 1.5), meaning the more costly an ecosystem restoration project becomes, the lower will be participants' utility, all other things holding constant (when DP=0). A high level of restoration effort, medium level of public access, involving trained volunteers in restoration projects, high likelihood of success of restoration projects, and the size of the restoration sites all significantly increased participants' utility and high significance on the corresponding standard deviation (SD) estimates suggest heterogeneity in preferences in relation to these attributes (Table 1.5) (when DP=0). However, the corresponding adjustments (or additions) to the mean marginal utility parameters for participants facing choices under the plurality vote are not statistically significant when DP=1.

Table 1.5 Panel mixed logit model results

Variable	Coefficient (se) [p-value]	Std. Dev. (se of Std. Dev.) [p-value]
Random parameters		
SQ (n)	-1.4346 (0.6443) [0.026]	2.3307 (0.4629) [0.0001]
High_Effort (n)	1.3392 (0.2785) [0.0001]	1.1588 (0.2343) [0.0001]
Habitat_Cactus (n)	-0.1106 (0.1197) [0.355]	0.0649 (0.1364) [0.634]
Habitat_Ngrass (n)	0.1201 (0.1749) [0.492]	-0.5836 (0.1810) [0.001]
High_Access (n)	-0.0906 (0.2530) [0.72]	1.2508 (0.1683) [0.0001]
Medium_Access (n)	0.3711 (0.1575) [0.018]	0.4486 (0.1560) [0.004]
Volunteers (n)	1.3234 (0.2732) [0.0001]	0.6737 (0.2447) [0.006]
High_Success (n)	1.4053 (0.3322) [0.0001]	1.1311 (0.2212) [0.0001]
Size (n)	0.4013 (0.1032) [0.0001]	0.3712 (0.0957) [0.001]
Cost[a]	-0.0279 (0.0058) [0.0001]	0.0225 (0.0037) [0.0001]
SQ•DP (n)	-1.6581 (1.1274) [0.141]	5.1163 (0.7086) [0.0001]
High_Effort•DP (n)	0.2006 (0.4057) [0.621]	1.2111 (0.3531) [0.001]
Habitat_Cactus•DP (n)	-0.0220 (0.2102) [0.917]	0.8352 (0.1864) [0.497]
Habitat_Ngrass•DP (n)	0.3621 (0.2745) [0.187]	0.2006 (0.2129) [0.346]
High_Access•DP (n)	0.2884 (0.3349) [0.389]	0.0477 (0.2847) [0.867]
Medium_Access•DP (n)	0.3379 (0.2371) [0.154]	0.6798 (0.1804) [0.0001]
Volunteers•DP (n)	0.4081 (0.3767) [0.279]	0.3463 (0.2488) [0.164]
High_Success•DP (n)	1.3080 (0.8723) [0.134]	1.2203 (0.3401) [0.0001]
Size•DP (n)	0.0655 (0.1451) [0.652]	0.0214 (0.0944) [0.821]
Cost•DP[a]	-0.0004 (0.0084) [0.967]	0.0601 (0.0079) [0.0001]
Model statistics		
Number of observations	3402	
Number of participants	81	
Number of parameters	40	
Log-likelihood (LL)	-734.10824	
AIC	1548.216	

BIC	1793.501
Wald $\chi 2$, 20 df (p)	541.41 ($p<0.0001$)

[a]The reported values are parameters (mean and sd) of the underlying normal distributions of log-normally distributed cost variables.

1.5.4 Additional analysis

Table 1.6 presents follow-up questions asked to participants about how they responded to choices of ecosystem restoration projects. Results suggest that participants thought the choices were somewhat difficult and were "almost always" to "often times" relevant to their concerns about the management of the NROC's conservation lands. More than 85% of participants in both subsamples thought that their responses were never influenced by their perception about what others in the room (the corresponding experiment group) would do. More than 75% of participants in both subsamples responded that the proportion of implementable choices presented to them influenced their responses from "occasionally" to "never at all". More than 70% of participants in both subsamples responded that their responses were never influenced by the corresponding provision rule used to determine the restoration projects for implementation. Although the follow-up questions may not be incentive compatible, these results also indicate that the participants' responses to restoration choices were neither influenced by the corresponding provision rule used nor by participants' perception about what other participants in the group would do.

Table 1.6 Responses to follow up questions across the provision rules

How often did you feel that…	Degree to which participants perceived each of the statements below[a] [% pVOTE participants] {% singleDC participants}				
	Almost always (%)	Very often (%)	Often times (%)	Occasionally (%)	Never at al (%)
(1) …the choice questions were difficult?	[2.33] {2.63}	[13.95] {7.89}	[18.60] {26.32}	[55.81] {47.37}	[9.30] {15.79}
(2) …the choice questions were relevant to your concerns about the management of the NROC conservation lands?	[27.91] {36.84}	[37.21] {28.95}	[25.58] {21.05}	[9.30] {10.53}	[0.00] {2.63}
(3) …your responses to the choice questions were influenced by the perception about what others in the room would do?	[2.33] {0.00}	[2.33] {0.00}	[0.00] {2.63}	[9.30] {0.00}	[86.05] {97.37}
(4) …your responses to the choice questions were influenced by the fact that only a proportion of the choice questions is a pool of feasible choices for implementation in 2012?	[4.65] {2.63}	[2.33] {15.79}	[16.28] {2.63}	[37.21] {10.53}	[39.53] {68.42}
(5) …your responses to the choice questions were influenced by the fact that the group outcome tonight, from all feasible choices, will be determined by **randomly chosen decision-maker's choice on randomly selected feasible choice question** ? (Emphasis in original)[b]	[0.00] {2.63}	[2.33] {2.63}	[6.98] {2.63}	[13.95] {18.42}	[76.74] {73.68}

[a]We conducted chi-squared test of independence between the responses of participants to these qualitative attitude statements across the subsamples (DP=1,0) and found no significant difference on above statements except for the (4^{th}) statement above (Pearson $\chi2$=17.25, df=4, p=0.002).

[b]The emphasized text (bold and underlined) was replaced by "**the majority vote on randomly selected feasible choice question"** in the survey booklet that included the plurality vote provision rule.

1.6 Conclusions and implications

In this paper, we empirically examined how incentives presented through including provision rules in consequential discrete choice experiments affect the responses to the valuation questions. Using a split sample approach, we compared the marginal utilities and mWTP values for ecosystem restoration attributes focused on non-native plants management in the NROC under two alternative provision rules: a single decision-maker's choice and a plurality vote. A single decision-maker's choice has been well established as an incentive compatible provision rule, whereas a plurality vote is generally not an incentive compatible provision rule for three-option choice situations. We employed consequential DCE surveys, designed to assess values of ecosystem restoration focused on non-native plants management, which involved direct financial consequences for participants, resulting in actual implementation of ecosystem restoration projects. A panel mixed logit model suggests that marginal utility parameters and mWTP estimates for restoration attributes are statistically equivalent across the provision rules.

Of few previous studies that examined provision rules in a DCE study, Collins & Vossler (2009) examined provision rules using two-alternative and three-alternative choice situations in a laboratory experimental setting and found more deviations from induced preferences for two-alternative choices and for alternatives to a single plurality vote as compared to results under the rule in which the outcome was determined by both participants and “regulator” votes. They also found a statistically significant but modest degree of bias towards selecting the status-quo option. While the results of no significant difference in marginal utility parameters and mWTP estimates for restoration attributes across the provision rules, irrespective of theoretical incentive compatibility properties, are consistent with Taylor et al. (2010) and Vossler et al. (2012), this study expands the result to the trichotomous choice experiment, which is widely used in environmental valuation research. In stated preferences studies, the trichotomous format has likely been the most common choice experiment format, and it has been favored because it focuses respondents’ attention on the need to make tradeoffs across attributes in various scenarios (Louviere, Hensher, & Swait, 2000). Our results here suggest that the absence of incentive compatibility in trichotomous choice questions may not be a caveat of concern in such stated preference studies generally. Our descriptive results on the follow-up questions also suggested that more than two-thirds of participants stated that their decisions were neither influenced by their perception about what others in the group would do nor by the corresponding provision rule used, although there is no way to ensure incentive properties of the responses to these perception statements. Yet these self-reported perceptions are consistent with our preference model results.

Although participants in our focus group discussions expressed and indicated some degree of interest or motivation towards specific aspects or dimensions of ecosystem restoration in the NROC, which led us to hypothesize the potential existence of strategic voting behavior in the field experiments, we did not find evidence of the existence of any such behavior. We may not have a clear understanding on why participants did not seem to behave strategically as predicted by the theory under a plurality vote rule, although the strategic motivations may come out sharply when the participants have highly polarized views, politically motivated or otherwise, on the public goods under consideration, as noted by Vossler et al. (2012). Although the attributes included in the restoration choices represented different aspects or dimensions of restoration efforts and were explained clearly in the presentation, the strategic effect or bias in case of a novel choice situation may be arguably a second-order effect and may require higher-level think. The relevance of strategic effect or bias may depend on the level of familiarity of the good and the choice setting. Such consideration could explain the outcome from our field experiment that suggests participants in a three-option choice experiment may nonetheless make choices in a manner that is statistically equivalent to a choice model estimated from data produced in an incentive compatible setting. Our results also may support the idea of "cognitive dissonance" as suggested by Akerlof and Dickens (1982), a behavior by which individuals facing complex and somewhat unfamiliar choices may adopt a truth-telling strategy rather than risking sending misleading signals that may harm the individual's self-interest.

Furthermore, we found no significant difference in the marginal utilities of restoration attributes between potentially implementable, real choice tasks and hypothetical choice tasks, meaning results suggest that participants treated the attributes between real, implementable and hypothetical choices equivalently. This result contrasts with previous empirical results of significantly higher WTP estimates from hypothetical payment compared to real payment situations. This finding may be related to spillover effects (Cherry, Crocker, & Shogren, 2003) from real, implementable choices to the hypothetical choices, suggesting that a mixed survey involving at least some real choices might deserve consideration when stated preference researchers have an opportunity to use at least some consequential scenarios. This approach is analogous to past efforts to integrate revealed and stated preferences (e.g., Adamowicz, Louviere, & Williams, 1994), by using the availability of real choice scenarios to establish a consequential context for survey participants while using hypothetical scenarios to expand the range and mix of attributes evaluated.

1.7 Manuscript 1 References

Ackert, L., Charupat, N., Church, B. & Deaves, R. (2006). An experimental examination of the house money effect in a multi-period setting. *Experimental Economics, 9*: 5-16.

Adamowicz, W., Louviere, J., & Williams, M. (1994). Combining revealed and stated preference methods for valuing environmental amenities. *Journal of Environmental Economics and Management*, *26*(3), 271–292.

Akerlof, G.A., & Dickens, W.T. (1982). The economic consequences of cognitive dissonance. *American Economic Review*, *72*(3), 307–319.

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R., & Schuman, H. (1999). *Report of the NOAA panel on contingent valuation* (Federal Register No. 58) (pp. 4601–4614).

Brams, S. J., & Fishburn, P. C. (2000). Fair division of indivisible items between two people with identical preferences: Envy-freeness, Pareto-optimality, and equity. *Social Choice and Welfare*, *17*(2), 247–267.

Brown, T. C., Ajzen, I., & Hrubes, D. (2003). Further tests of entreaties to avoid hypothetical bias in referendum contingent valuation. *Journal of Environmental Economics and Management*, *46*(2), 353–361.

Cameron, A. C., & Trivedi, P. K. (2010). *Microeconometrics Using Stata*. College Station, Texas: Stata Press.

Carson, R., Flores, N. E., Martin, K. M., & Wright, J. L. (1996). Contingent valuation and revealed preference methodologies: Comparing the estimates for quasi-public goods. *Land Economics*, *72*(1), 80–99.

Carson, R., & Groves, T. (2007). Incentive and informational properties of preference questions. *Environmental and Resource Economics*, *37*(1), 181–210.

Carson, R., Groves, T., & List, J. (2006). *Probabilistic influence and supplemental benefits: A field test of the two key assumptions underlying stated preferences*.

Cherry, T.L., Kroll, S. & Shogren, J.F. (2005). The impact of endowment heterogeneity and origin on public good contributions: Evidence from the Lab. *Journal of Economic Behavior and Organization 57*: 357–365.

Cherry, T. L., Crocker, T. D., & Shogren, J. F. (2003). Rationality spillovers. *Journal of Environmental Economics and Management*, *45*(1), 63–84.

Cherry T.L., Frykblom, P., & Shogren, J.F. (2002). Hardnose the dictator. *American Economic Review*, *92* (4), 1218-1221.

ChoiceMetrics. (2011). *Ngene 1.1 User Manual & Reference Guide*. ChoiceMetrics Pty Ltd, Australia.

Clark, J.(2002). House money effects in public good experiments. *Experimental Economics, 5*, 223-231.

Collins, J. P., & Vossler, C. A. (2009). Incentive compatibility tests of choice experiment value elicitation questions. *Journal of Environmental Economics and Management*, *58*(2), 226–235.

Cummings, R. G., & Taylor, L. O. (1999). Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation Method. *American Economic Review*, *89*(3), 649–665.

Engel, C. (2011). Dictator games: A meta study. E*xperimental Economics*, *14*(4), 583-610.

Gibbard, A. (1973). Manipulation of voting schemes: A general result. *Econometrica*, *41*(4), 587–601.

Haan, P., & Uhlendorff, A. (2006). Estimation of multinomial logit models with unobserved heterogeneity using maximum simulated likelihood. *Stata Journal*, *6*(2), 229–245.

Harman, H. H. (1976). *Modern factor analysis*. University of Chicago Press, Chicago.

Harrison G.W. (2007). House money effects in public good experiments: comment. *Experimental Economics*, *10*, 429-437.

Hole, A. R. (2007). Fitting mixed logit models by using maximum simulated likelihood. *Stata Journal*, *7*(3), 388–401.

Hole, A. R. (2008). Modeling heterogeneity in patients' preferences for the attributes of a general practitioner appointment. *Journal of Health Economics*, *27* (4): 1078–1094.

Johnston, R. J. (2006). Is hypothetical bias universal? Validating contingent valuation responses using a binding public referendum. *Journal of Environmental Economics and Management*, *52*(1), 469–481.

Johnston, R. J., Weaver, T. F., Smith, L. A., & Swallow, S. K. (1995). Contingent valuation focus groups: Insights from ethnographic interview techniques. *Agricultural and Resource Economics Review*, *24*(1).

Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika*, *23*(3), 187–200.

Keasey, K., &Moon, P. (1996). Gambling with the house money in capital expenditure decisions: An experimental analysis. *Economics Letters 50*: 105-110.

Krinsky, I. & Robb, A.L. (1986). On approximating the statistical properties of elasticities. *Review of Economics and Statistics*, *68*: 715-719.

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2000). *Stated choice methods: Analysis and applications*. Cambridge University Press.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. *In Frontiers in Econometrics*. Academic Press.

Milan, L., & Whittaker, J. (1995). Application of the parametric bootstrap to models that Incorporate a singular value decomposition. *Applied Statistics*, *44*(1), 31.

Moulin, H. (1991). *Axioms Cooperative Decision Making*. Cambridge University Press.

Mozumder, P., & Berrens, R. P. (2007). Investigating hypothetical bias: Induced-value tests of the referendum voting mechanism with uncertainty. *Applied Economics Letters*, *14*(10), 705–709.

Murphy, J. J., Allen, P. G., Stevens, T. H., & Weatherhead, D. (2005). A meta-analysis of hypothetical bias in stated preference valuation. *Environmental and Resource Economics*, *30*(3), 313–325.

Murphy, J. J., Stevens, T. H., & Yadav, L. (2010). A comparison of induced value and home-grown value experiments to test for hypothetical bias in contingent valuation. *Environmental and Resource Economics*, *47*(1), 111–123.

Murphy, J. J., Stevens, T., & Weatherhead, D. (2005). Is cheap talk effective at eliminating hypothetical bias in a provision point mechanism? *Environmental and Resource Economics*, *30*(3), 327–343.

Poe, G. L., Giraud, K. L., & Loomis, J. B. (2005). Computational methods for measuring the difference of empirical distributions. *American Journal of Agricultural Economics*, *87*, 353–365.

Poe, G. L., Welsh, M. P., & Champ, P. A. (1997). Measuring the difference in mean willingness to pay when dichotomous choice contingent valuation responses are not independent. *Land Economics*, *73*, 255–267.

Poe, G. L., Severance-Lossin, E. K., & Welsh, W. P. (1994). Measuring the difference (X - Y) of simulated distributions: A convolutions approach. *American Journal of Agricultural Economics*, *76*, 904–915.

Revelt, D., & Train, K. (1998). Mixed logit with repeated choices: Households' choices of appliance efficiency level. *The Review of Economics and Statistics*, *80*(4), 647–657.

Satterthwaite, M. A. (1975). Strategy-proofness and Arrow's conditions: Existence and correspondence theorems for voting procedures and social welfare functions. *Journal of Economic Theory*, *10*(2), 187–217.

Spraggon, J. and Oxoby, R.J. (2009). An experimental investigation of endowment source heterogeneity in two-person public good games. *Economics letters 104*: 102-105.

Taylor, L. O., McKee, M., Laury, S. K., & Cummings, R. G. (2001). Induced-value tests of the referendum voting mechanism. *Economics Letters*, *71*(1), 61–65.

Taylor, L. O., Morrison, M. D., & Boyle, K. J. (2010). Exchange rules and the incentive compatibility of choice experiments. *Environmental and Resource Economics*, *47*(2), 197–220.

Thaler, R. and E. Johnson. (1990). Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice. *Management Science 36*: 643-660.

Thaler, R. (1980). Towards a positive theory of consumer choice. *Journal of Economic Behavior and Organization 1*: 39-60.

Train, K. (2003). *Discrete Choice Methods with Simulation*. Cambridge University Press.

Train, K. E. (1998). Recreation demand models with taste differences over people. *Land Economics*, *74*(2), 230–239.

US Census Bureau. (2010). *American community survey 2008-2012 and 2010 demographic profile*. Retrieved from http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml#none

Vossler, C. A., Doyon, M., & Rondeau, D. (2012). Truth in consequentiality: Theory and field evidence on discrete choice experiments. *American Economic Journal: Microeconomics*, *4*(4), 145–171.

MANUSCRIPT 1–APPENDIX A

This appendix provides details about the experimental design of ecosystem restoration choices, background presentation for field experiments participants, a sample survey booklet and estimation results of the unrestricted model.

A1. Efficient experimental design of ecosystem restoration choices

Our efficient experimental design utilized both real-world scenarios of candidate restoration projects provided by the experts from NROC and IRC as well as the hypothetical combinations of levels of ecosystem restoration attributes presented in Table 1.1. We employed d-efficiency measure in Ngene 1.1 to produce the following restoration choices for our field experiments.

Design Question #	Restoration effort	Habitat and Bird Species Focus	Size of Restoration	Public Access	Trained Volunteers	Likelihood of Success	Cost ($)
1. Project A	Low	Cactus	1 acre	Medium	No	High	40
Project B	Low	Coastal Sage	2 acres	High	No	High	90
2. Project A	Low	Cactus	1 acre	Medium	No	High	40
Project B	Low	Coastal Sage	2 acres	High	No	High	90
3. Project A	Low	Native Grassland	3 acres	Medium	Yes	Medium	60
Project B	High	Cactus Scrub	2 acres	Low	Yes	High	75
4. Project A	Low	Coastal Sage	1 acre	Medium	No	High	110
Project B	High	Cactus Scrub	1 acre	Low	Yes	High	110
5. Project A	Low	Native Grassland	3 acres	Medium	Yes	Medium	60
Project B	High	Cactus Scrub	2 acres	Low	Yes	High	105
6. Project A	High	Cactus Scrub	1 acre	Low	Yes	High	105
Project B	Low	Coastal Sage	1 acre	High	No	High	90
7. Project A	High	Coastal Sage	9 acres	Low	No	High	110
Project B	Low	Cactus Scrub	3 acres	High	Yes	Medium	40
8. Project A	Low	Coastal Sage	3 acres	Medium	Yes	Medium	110
Project B	High	Naïve Grassland	3 acres	Low	No	High	40
9. Project A	Low	Native Grassland	2 acres	Low	No	Medium	110
Project B	High	Coastal Sage	2 acres	High	Yes	High	40
10. Project A	High	Coastal Sage	5 acres	Low	Yes	Medium	75
Project B	Low	Cactus Scrub	9 acres	High	No	High	110
11. Project A	High	Native Grassland	9 acres	High	No	Medium	110

Project B	Low	Cactus Scrub	7 acres	Medium	Yes	High	60
12. Project A	Low	Native Grassland	5 acres	Low	Yes	High	105
Project B	High	Cactus Scrub	1 acre	Medium	No	High	60
13. Project A	Low	Coastal Sage	7 acres	Low	No	Medium	110
Project B	High	Native Grassland	7 acres	Medium	Yes	High	40
14. Project A	Low	Cactus Scrub	5 acres	High	Yes	Medium	90
Project B	High	Coastal Sage	5 acres	Medium	No	High	60

Please note that Design Question # 1-6 represent immediately implementable restoration choices (or 'real' scenarios explicitly labeled as "Feasible, potentially implementable projects, Choice-L" where L represents one of the letters- P, Q, R, X, Y, and Z respectively) whereas the remaining 8 combinations (Design Question # 7-14) represent future restoration projects (or 'hypothetical' scenarios). In order to avoid potential order effects, two groups (first group- Design Question # 12, 1, 13, 3, 9, 4, 14 and the second group- Design Question # 8, 6, 7, 2, 10, 5, 11) of 7 choice questions were blocked into two orders- the first group followed by the second group and the vice versa. Each participant was randomly assigned to a survey booklet consisting of only one of the two orders.

A2. Background presentation to field experiment participants

In order to present participants with same set of information on the ecosystem restoration in the NROC, inform about what they will be asked to do, and how their decisions or choices influence the outcomes (or which ecosystem restoration projects get implemented on the ground), the experiment moderator used the following PowerPoint presentation slides.

In Slide # 2, the experiment moderator briefly discussed the broader goals of the project entitled "Orange County Invasive Management (OCIM)" and introduced this component of the OCIM called “Ecosystem Auctions for Decision Support (EADS)” and its main objectives. The moderator gave an overview of major activities under the OCIM and briefly introduced about the science of ecosystem restoration through the removal or management of invasive plants in slides # 3-8. The remaining slides were designed to provide participants with information on the content of the survey, description of the ecosystem restoration attributes, example choice question, and how their responses determine the outcomes of the workshops or the corresponding provision rule.

The presentation also made clear that each participant was provided with a personal budget of $150 of which $40 was guaranteed as the participation fee and the participants could decide whether they want to spend the remaining $110 on the ecosystem restoration projects of their choice or take home for their other priorities more important than the restoration efforts in the NROC. Participants were also encouraged to consider their decisions carefully regarding what their personal values and priorities are, what each project can or can not accomplish, how it matters to them and whether it is worth the money they pay for the projects while making choices or decisions. The moderator tried to keep the information and content of the description as similar as possible across the two groups. The only difference in the background presentation across the groups of participants was the description of the corresponding provision rule for each night as shown in slide # 20. The example slides shown below were presented for the participants’ group that considered single decision-maker’s choice provision rule.

Ecosystem Auctions for Decision Support (EADS)

in the Nature Reserve of Orange County (NROC):

Economic Choices for Ecosystem Restoration Decision-Making

Achyut Kafle,
Graduate Student, University of Rhode Island
and
Stephen K. Swallow
Professor, University of Connecticut

Irvine Ranch Conservancy · Nature Reserve of Orange County · The Nature Conservancy · UC Berkeley · University of Connecticut · The University of Rhode Island

Project Overview

- **Orange County Invasive Management (OCIM):** Assess the effectiveness of invasive plant species control or management methods to restore native bird species and habitat.
  - Thanks to Sara J. Dickens, UC Berkeley and Kristine Preston, NROC for their slides
- **Ecosystem Auctions for Decision Support (EADS):** Assess public values or priorities based on ecosystem restoration choices through auctions.
- Develop a decision-support tool for land managers or other appropriate stakeholders

2

OCIM Guiding Principles

Land management requires the efficient allocation of a limited budget:

•Weigh ecological constraints and long-term recovery in planning for invasive management .

•Recognize tradeoffs imposed by environmental and economic constraints that vary across the landscape.

Sustainable invasive species management

•science-based site evaluations

•**economic valuation**

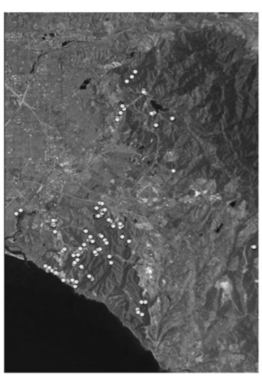
•stakeholder feedback

3

OCIM Core Objective

- **Assess the effectiveness of restoration techniques across orange county.**
- Compare across gradients:
  - Physical/topographical: soil, aspect, slope,
  - Vegetation: % cover of native and exotic spp.
  - land-use history: grazed, mowed, herbicide, road
  - management history (passive, active, intermediate).
- Develop a web based tool that predicts likelihood of restoration success based on site environmental and historical land used variables and economical constraints.

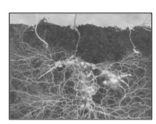
4



Distribution of Lands Sampled

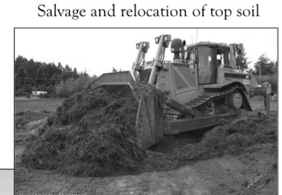
131 Sites Sampled	
Land Ownership	**% of Sites**
Orange County Parks	38
City of Irvine	25
California State Parks	18
UC Irvine Reserve	5
The Irvine Company	4
The County of Orange	4
TCA	4
City of Newport Beach	2

5



Mychorrizae inoculation

Salvage and relocation of top soil



Soil discing

6

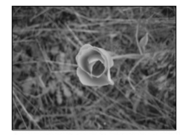
Exotic Plant Control

Control Method	Percent of Sites
Herbicide	72
Mowing/weed whipping	30
Weeding	24
Prescribed fire	5
Grazing	2
Grow kill cycles	2
Solarization	2

7

Some Conclusions

- Greater management efforts = greater restoration success.
- Size of restoration did not impact plant community composition.
- Top soil and mycorrhizae application increased native shrub cover.
- Top soil application reduced exotic grass cover
- Herbicide reduced target exotics and increases native shrub cover, but not native forb and grass species.
- Long-term maintenance and multiple treatments are most effective.
- Seeding and planting increased native shrubs.



8

EADS Survey Sections

- **Section 1.0** asks about your perception or attitude about various aspects of ecosystem restoration activities in the NROC lands.
- **Section 2.0** asks you to choose your most preferred restoration project among projects A,B and C (No action) in each choice question.
- **Section 3.0** asks about your background information for data analysis and interpretative purposes.

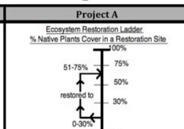
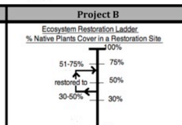
9

Section 2.0: Ecosystem Restoration Choice Questions

- **Choice Question:**
  - Two restoration projects (A and B) that differ in various attributes, and Project C (no action) are bundled together in each choice question.
- **Your Task:**
  - Choose your most preferred project among the three in each choice question **based on your personal preferences or priorities.**

10

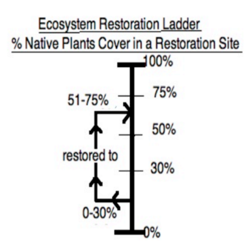
Example Choice Question

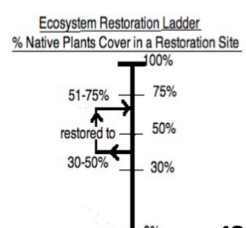
Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Projec A or B.
Habitat and Bird Species Focus	Restoration to **Native Grassland**, needed to support **other native wildlife**	Restoration in **Cactus Scrub,** supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**2** acres	**3** acres	
Public Access	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	Area allows **access** for **running, hiking and mountain biking**	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$110**, from my **$150.**	I will pay **$60**, from my **$150.**	I keep my $150.
HOW WOULD YOU VOTE? (CHOOSE ONLY ONE)	❐ **I vote for PROJECT A**	❐ **I vote for PROJECT B**	❐ **I vote for PROJECT C**

11

Project Attributes

- **Restoration Effort**

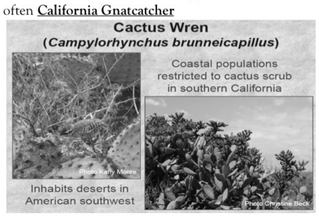




12

Project Attributes…

- Habitat and Bird Species Focus
  - Restoration in **Cactus Scrub**, supports **Cactus Wren** and often **California Gnatcatcher**



13

Project Attributes…

- Habitat and Bird Species Focus…
  - Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**

14

Project Attributes…

- Restoration in **Native Grassland**, needed to support **other native wildlife**

15

Project Attributes…

- **Public Access**
  - **Low:** Area allows **access** for **research with permits and guided tours only**
  - **Medium:** Area allows **access** for **running, hiking, and mountain biking**
  - **High:** Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible.
- **Trained Volunteers**
  - **Yes,** project **involves** trained volunteers in addition to restoration professionals
  - **No,** project **does not involve** trained volunteers in addition to restoration professionals

16

Project Attributes…

- **Likelihood of Success**
  - **High** due to **easy access** for maintenance and / or **surrounded by native landscape**
  - **Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**

17

Project Attributes…

- **Cost to You, From $150**
  - We will provide you **$150** from our research grant to make decision with in each task.
  - This is *your cost* contribution to help make the project happen.
  - Combined with contributions from tonight, we will have enough funds to pay all costs for implementation.

18

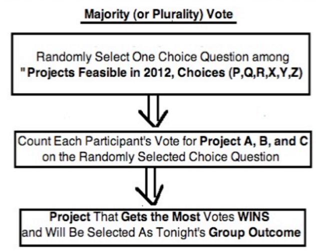
Project Attributes...

- We are asking you to consider
  - What each project might or might not accomplish,
  - How it matters to you, and
  - Whether it is worth the money cost to you
- Any decision with the **$150** budget we provide you is an excellent choice including following:
  - Buy groceries
  - Pay electric or utility bills
  - Buy gifts for kids or family
  - Donate to conservation organizations
  - Donate to other charities
  - Pay for recreation or entertainment

19

Restoration on Ground

- One restoration project will be selected based on your choice and your group's decisions using *Majority (or Plurality) Vote.*



20

Your Choice and Group Decision-Making

- We request you to consider
  - your personal values and priorities,
  - and how your choices might or might not influence your group's decision while making these choices.
- All choices are important:
  - all of your choices will be used to develop a decision support model to help NROC and other relevant environmental managers prioritize future restoration decisions

21

Thank You !

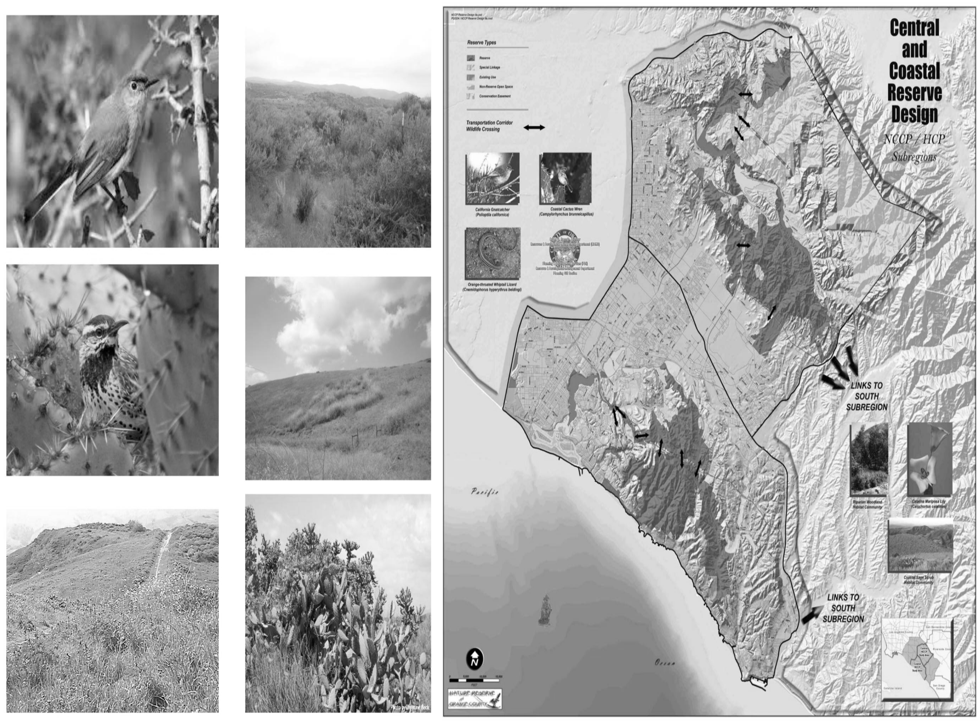
Any Questions ???

22

A3. A sample survey booklet (Single Decision-Maker’s Choice)

The content of the survey was exactly same across the subsamples except the description of the corresponding provision rule and necessary corrections accordingly.

Ecosystem Auctions for Decision Support (EADS): Economic Choices of Ecosystem Restoration for Environmental Decision-Making in the Nature Reserve of Orange County (NROC), California



We need your responses to help us identify priorities for ecosystem restoration projects in the NROC and develop a decision support tool for land managers to incorporate your values or priorities in future restoration decisions.

NATURE RESERVE of ORANGE COUNTY | IRVINE RANCH CONSERVANCY | The Nature Conservancy, Protecting nature. Preserving life. | Berkeley, University of California | University of Connecticut | THE UNIVERSITY OF RHODE ISLAND

Section 1.0

Please indicate, by placing (X) under the column, the degree to which you agree or disagree with each of the statements below.

Statements	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
I would prefer restoration be completed quickly utilizing park staff and contractors or professionals with higher expected success rates but higher costs, than completed over a greater length of time (years) utilizing park staff and volunteers at much lower cost but more variable success rate.							
I value restoration actions more when I have access to information about the project and its goals.							
I personally believe that preservation of the full ecosystem is the most effective means of preserving individual sensitive species.							
I personally believe that conservation or stewardship actions are essential parts of managing the reserve lands.							
Seeing restoration projects and their associated flagging or markers detracts from my outdoor experience.							
I personally believe that restoration of habitat that is most suitable to native wildlife is more important than vegetation management focused around aesthetics or other public priorities.							
I would rather have public access to all areas of open space on a standardized rotation cycle than unlimited public access in some areas and restricted or no public access to others.							
For the same cost, I would rather have less area restored, but involve underprivileged groups, students or other community members, than more area restored with contractors or professionals.							
It is important to me personally that land managers incorporate public values or priorities as an input to ecosystem restoration decisions.							
I personally believe that restorations within public view should utilize educational signage.							
I personally believe that restoration projects should incorporate restoration, monitoring and maintenance methods that ensure a sustainable restoration.							
I personally believe that ecosystem restoration efforts or activities in the NROC positively affect the quality of life of the local communities around the reserve.							
I personally believe that restoration projects should incorporate restoration, monitoring and maintenance methods that address potential long-term issues of stochastic events (drought, fire) and climate change.							

1

Section 2: Ecosystem Restoration Choices

For choice questions in this section, you will make a series of decisions, choosing between ecosystem restoration projects that differ in levels of restoration effort, native habitat and bird species focus, size (acreage), public access and involvement of volunteers, likelihood of success and cost to you. Within each choice question, you may choose to contribute to one of restoration projects, Projects A or B, or you may choose Project C, which is the "no action" option. **Your task in each question is to choose the project you prefer most, based on your personal preferences or priorities and how your choices could influence the group outcome.**

For each of the choice questions in this section, each participant will be given a **personal budget of $150** to contribute a portion of it to the restoration project of his or her choice and a portion he or she keeps for other priorities. The "**Cost to you"** attribute describes what you would need to contribute from **your personal budget of $150** if the group outcome at the end of tonight is the project described. The overall cost of the project will be covered by contributions from the group and our grant budget. Recall that any money you keep can be used for other personal priorities, including family expenses, gifts, donations to conservation or important charities, or any other purpose. ❒ Please check this box.

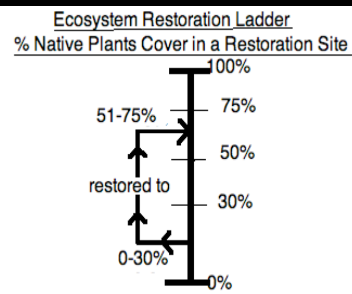
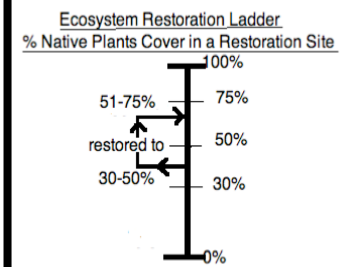
Section 2.1: Determining the group outcome at the end of tonight' workshop

Once everyone has finished responding to all choice questions, **one choice question** number **will be selected randomly** from the group of choice questions labeled as **"Feasible, potentially implementable projects in 2012, Choice-….."**. One **Survey ID number** will also be selected randomly. The project, **chosen by the person holding the randomly selected Survey ID number on the randomly selected choice question**, will be chosen as the **group outcome** of tonight's decisions and will be implemented in this (2012/13) NROC field season. **Your payment** will be determined based on the **group outcome** chosen according to **randomly chosen single decision-maker's choice** as described above.

Please read the instructions carefully before making any decision. It is very important that you understand the instructions to make informed decisions. If you have any questions as we proceed through this session, please do not talk to your friends or neighbors. Rather, please raise your hand so that the workshop moderator can come to you and address your question.

Section 2.2: Example Choice Question

Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Native Grassland**, needed to support **other native wildlife**	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**2** acres	**3** acres	
Public Access	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	Area allows **access** for **running, hiking and mountain biking**	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$110**, from my **$150.**	I will pay **$60**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

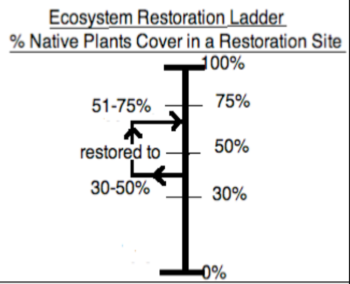
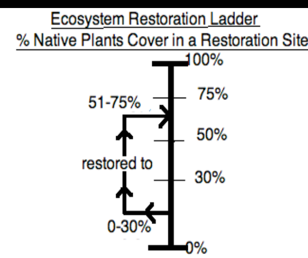
Once everyone has finished responding to all choice questions, **one question number** among choice questions labeled as **"Feasible, potentially implementable projects in 2012-Choice…."** will be selected randomly. Suppose, the example question above is chosen by this random process. **One Survey ID number** will also be selected randomly. Suppose, **your Survey ID number** was selected by this random process. Suppose you chose Project A. In this scenario, project A will be chosen as the **group outcome** for implementation in this (2012/2013) NROC field season as it is **chosen by the person holding the randomly selected Survey ID number on the randomly selected choice question.** You will get paid $40 ($150-$110) as Project A was chosen as the **group outcome**.

Note: We will **not** reveal the person whose Survey ID number is chosen. After all surveys are collected, we will randomly choose the Survey ID number. Then we will ask for 3 volunteers to help us find the correct Survey ID number and the **choice recorded on the randomly chosen feasible choice question** of that Survey ID. Then we will announce the result. We request that you do not show or talk about your Survey ID number to others in the room.

Section 2.3: Economic Choice Questions

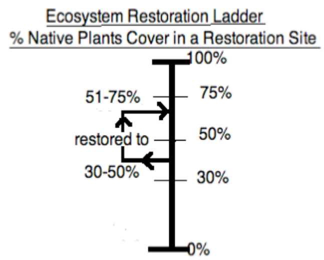
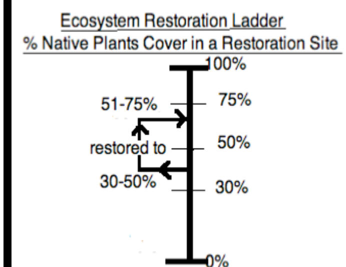
We provide you **a personal budget of $150** with which to make decisions **in each choice question** below, and we ask that you **decide on contributing** a portion of this to the restoration **project of your choice** and **a portion you keep**. Please recall that the **group outcome** of all these choices for tonight will be based on **random selection of a choice question** among choice questions labeled as **"Feasible, potentially implementable projects in 2012-Choice…."** and **the randomly chosen single decision maker's choice on the selected random question** as described above. We request that you consider restoration projects in each choice question in terms of **what each project might or might not accomplish, how it matters to you, whether it is worth the money cost to you, and how your choice might influence the group outcome for tonight**. Please recall money not spent on these projects may be used by you at home for other priority expenses or charities. ❐ Please check this box.

Question 1. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration to **Native Grassland**, needed to support **other native wildlife**	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**3** acres	**5** acres	
Public Access	Area allows **access** for **research with permits and guided tours only**	Area allows **access** for **running, hiking and mountain biking**	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**No**, project **does not involve** trained volunteers in addition to restoration professionals	
Likelihood of Success	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	
Cost to You	I will pay **$60**, from my **$150.**	I will pay **$110**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

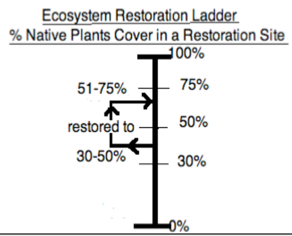
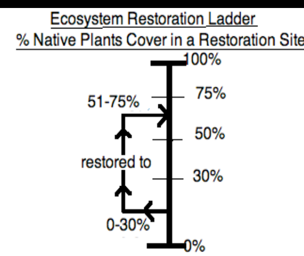
Feasible, potentially implementable projects in 2012, Choice-P

Question 2. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	
Size of Restoration	**1** acre	**2** acres	
Public Access	Area allows **access** for **running, hiking and mountain biking**	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible.	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**No**, project **does not involve** trained volunteers in addition to restoration professionals	
Likelihood of Success	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$40**, from my **$150.**	I will pay **$90**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

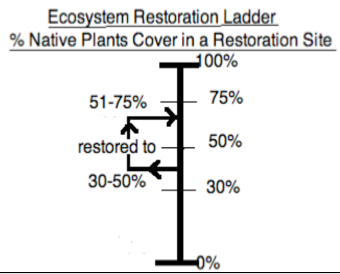
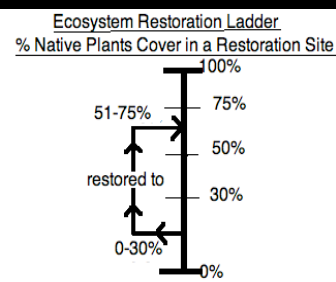
Feasible, potentially implementable projects in 2012, Choice-P

Question 3. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	**Project A**	**Project B**	**Project C**
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	Restoration to **Native Grassland**, needed to support **other native wildlife**	
Size of Restoration	**7** acres	**7** acres	
Public Access	Area allows **access** for **research with permits and guided tours only**	Area allows **access** for **running, hiking and mountain biking**	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$40**, from my **$150.**	I will pay **$110**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

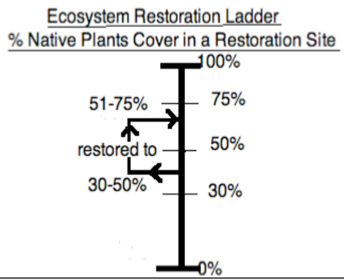
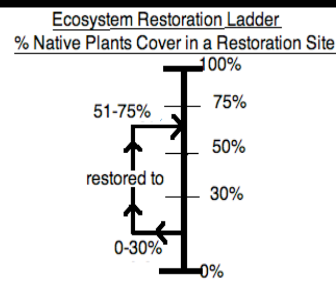
Feasible, potentially implementable projects in 2012, Choice-R

Question 4. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration to **Native Grassland**, needed to support **other native wildlife**	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**3** acres	**2** acres	
Public Access	Area allows **access** for **running, hiking and mountain biking**	Area allows **access** for **research with permits and guided tours only**	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$60**, from my **$150.**	I will pay **$75**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

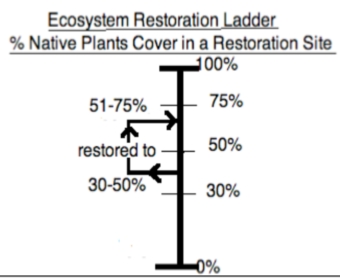
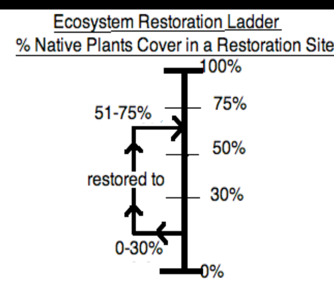
Feasible, potentially implementable projects in 2012, Choice-R

Question 5. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration to **Native Grassland**, needed to support **other native wildlife**	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	
Size of Restoration	**2** acres	**2** acres	
Public Access	Area allows **access** for **research with permits and guided tours only**	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$110**, from my **$150.**	I will pay **$40**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

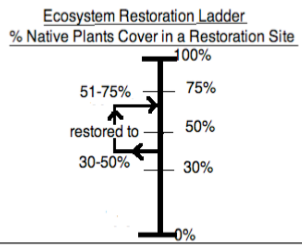
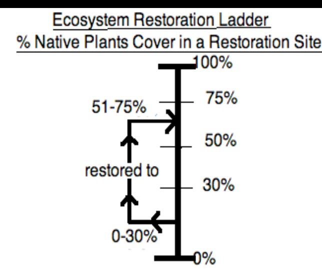
Feasible, potentially implementable projects in 2012, Choice-X

Question 6. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

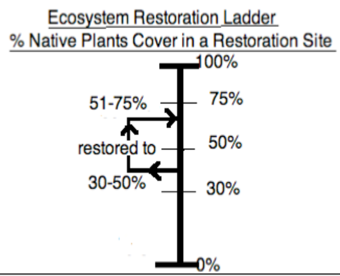
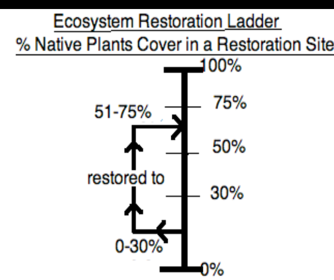
Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Coastal Sage Scrub,** supports **California Gnatcatcher**	Restoration in **Cactus Scrub,** supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**1** acre	**1** acre	
Public Access	Area allows **access** for **running, hiking and mountain biking**	Area allows **access** for **research with permits and guided tours only**	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$110**, from my **$150.**	I will pay **$110**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

Feasible, potentially implementable projects in 2012, Choice-X

Question 7. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

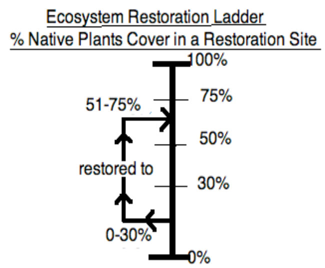
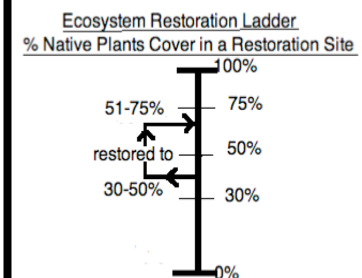
Project Attributes	**Project A**	**Project B**	**Project C**
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	
Size of Restoration	**5** acres	**5** acres	
Public Access	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	Area allows **access** for **running, hiking and mountain biking**	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**No**, project **does not involve** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$90**, from my **$150.**	I will pay **$60**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

Question 8. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	**Project A**	**Project B**	**Project C**
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	Restoration to **Native Grassland**, needed to support **other native wildlife**	
Size of Restoration	**3** acres	**3** acres	
Public Access	Area allows **access** for **running, hiking and mountain biking**	Area allows **access** for **research with permits and guided tours only**	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**No**, project **does not involve** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$110**, from my **$150.**	I will pay **$40**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

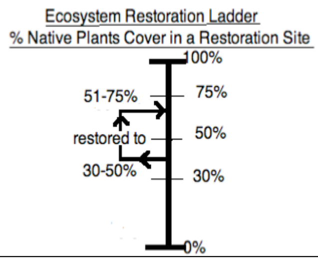
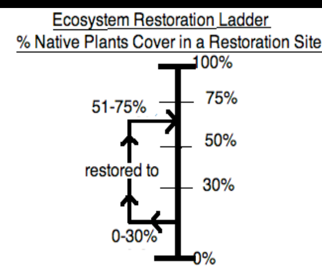
Feasible, potentially implementable projects in 2012, Choice-Z

Question 9. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	**Project A**	**Project B**	**Project C**
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	
Size of Restoration	**1** acre	**1** acre	
Public Access	Area allows **access** for **research with permits and guided tours only**	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**No**, project **does not involve** trained volunteers in addition to restoration professionals	
Likelihood of Success	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$105**, from my **$150.**	I will pay **$90**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

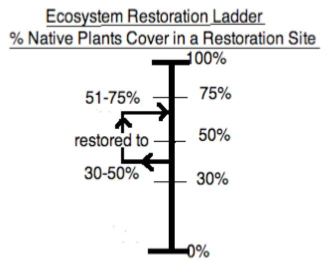
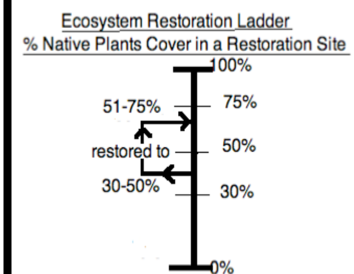
Feasible, potentially implementable projects in 2012, Choice-Z

Question 10. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**9** acres	**3** acres	
Public Access	Area allows **access** for **research with permits and guided tours only**	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	
Cost to You	I will pay **$110**, from my **$150.**	I will pay **$40**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

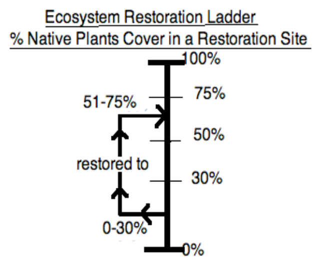
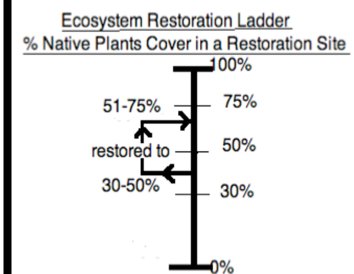
Feasible, potentially implementable projects in 2012, Choice-Q

Question 11. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	**Project A**	**Project B**	**Project C**
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	
Size of Restoration	**1** acre	**2** acres	
Public Access	Area allows **access** for **running, hiking and mountain biking**	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**No**, project **does not involve** trained volunteers in addition to restoration professionals	
Likelihood of Success	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$40**, from my **$150.**	I will pay **$110**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

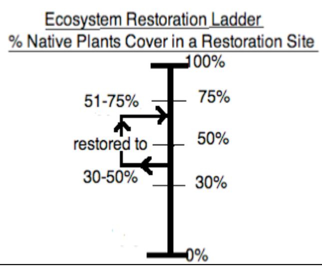
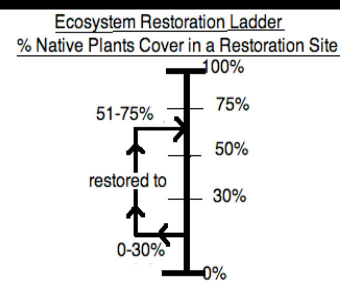
Feasible, potentially implementable projects in 2012, Choice-Q

Question 12. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration in **Coastal Sage Scrub**, supports **California Gnatcatcher**	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**5** acres	**9** acres	
Public Access	Area allows **access** for **research with permits and guided tours only**	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**No**, project **does not involve** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$75**, from my **$150.**	I will pay **$110**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❐ **I choose PROJECT A**	❐ **I choose PROJECT B**	❐ **I choose PROJECT C**

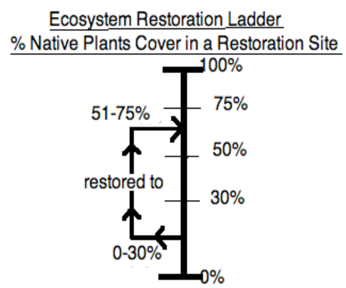
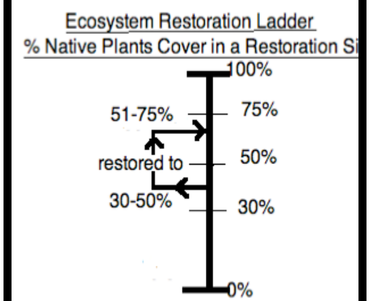
Feasible, potentially implementable projects in 2012, Choice-Y

Question 13. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort			Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration to **Native Grassland**, needed to support **other native wildlife**	Restoration in **Cactus Scrub,** supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**3** acres	**2** acres	
Public Access	Area allows **access** for **running, hiking and mountain biking**	Area allows **access** for **research with permits and guided tours only**	
Trained Volunteers	**Yes,** project **involves** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$60**, from my **$150.**	I will pay **$105**, from my **$150.**	I keep my **$150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❒ **I choose PROJECT A**	❒ **I choose PROJECT B**	❒ **I choose PROJECT C**

Feasible, potentially implementable projects in 2012, Choice-Y

Question 14. Given a choice between the following ecosystem restoration projects A, B, and C, how would you choose?

Project Attributes	Project A	Project B	Project C
Restoration Effort	 	 	Neither of these projects. I choose to keep my $150 for my other priorities rather than paying my cost for either Project A or B.
Habitat and Bird Species Focus	Restoration to **Native Grassland**, needed to support **other native wildlife**	Restoration in **Cactus Scrub**, supports **Cactus Wren**, and often **California Gnatcatcher**	
Size of Restoration	**9** acres	**7** acres	
Public Access	Area allows **access** for **running, hiking, mountain biking, with designated areas for dogs and horse-back riding** when ecologically feasible	Area allows **access** for **running, hiking and mountain biking**	
Trained Volunteers	**No**, project **does not involve** trained volunteers in addition to restoration professionals	**Yes,** project **involves** trained volunteers in addition to restoration professionals	
Likelihood of Success	**Medium** due to **moderate access** for maintenance and / or **surrounded by mixed native-nonnative landscape**	**High** due to **easy access** for maintenance and / or **surrounded by native landscape**	
Cost to You	I will pay **$110**, from my **$150.**	I will pay **$60**, from my **$150.**	I keep my $**150**.
HOW WOULD YOU CHOOSE? (CHOOSE ONLY ONE)	❐ **I choose PROJECT A**	❐ **I choose PROJECT B**	❐ **I choose PROJECT C**

Section 2.4: Follow-Up on Ecosystem Restoration Choices

Please indicate, by placing (X) under the column, the degree to which you perceived each of the statements below.

How often did you feel that…	Almost always	Very often	Often times	Occasionally	Never at all
the choice questions were difficult?					
the choice questions were relevant to your concerns about management of the NROC conservation lands?					
your responses to the choice questions were influenced by your perception about what others in the room would do?					
your responses to the choice questions were influenced by the fact that only a proportion of the choice questions is a pool of feasible choices for implementation in 2012?					
your responses to the choice questions were influenced by the fact that the group outcome for tonight, from all feasible, choices will be determined by **randomly chosen decision-maker's choice on randomly selected feasible choice question** ?					

Please rank the following project attributes, that influenced your choices or decisions most. Please put "1" for most influential and "7" for least influential to you and so on.

1. **Restoration Effort** …………….
2. **Habitat and Bird Species Focus** …………….
3. **Size of Restoration** …………….
4. **Public Access** …………….
5. **Trained Volunteers** …………….
6. **Likelihood of Success** …………….
7. **Cost to You** …………….

Section 3.0: About your background

This section is to help us understand our participants' characteristics. These questions are also very important to us for interpreting and predicting our results out of sample, in order to help this research better benefit everyone in society. Recall, after the session ends, we will never link you to your answers and all information will be kept strictly confidential.

1. What is your gender? Male Female
2. How long have you been lived around Orange County? **…………….years**
3. Do you own or rent your primary residence? Own
   Rent
4. What is your highest level of education?
   a. High school or less
   b. Bachelor's degree or some college
   c. Graduate degree (Masters or Ph.D.) or some graduate school
5. What type of recreational activity, if any, are you engaged in around NROC? Rank recreational activity below in order of importance to you. Please put "1" for the most important, "7" for least important, and so on. (Put "N/A" if you don't do the activity)
   a. Mountain biking **…………….**
   b. Horse-back riding **…………….**
   c. Walking with leashed dogs **…………….**
   d. Running **…………….**
   e. Hiking **…………….**
   f. Educational tours
   g. Other; please describe……………………………
6. With which of the following groups, if any, are you most closely affiliated (Circle One)?
   a. Irvine Ranch Conservancy (IRC)
   b. Back to NativesRESTORATION
   c. Laguna Greenbelt
   d. Newport Bay Conservancy
   e. Laguna Canyon Foundation
   f. Friends of Harbor, Beaches and Parks
   g. Sea and Sage Audubon Society
   h. Other **……………………………….**
7. In most years do you donate money to an environmental group?
   a. Yes ⇒ approximately how much do you donate in total each year? $**…………….**
   b. No
8. Have you ever participated in any ecosystem restoration projects voluntarily or otherwise?
   a. Yes ⇒ approximately how many days per year? **…………….days**
   b. No
9. What category best describes your annual household income before taxes?

a. <$25,000
b. $25,000-$50,000
c. $50,000-$75,000
d. $75,000-$100,000
e. $100,000-$150,000
f. > $150,000

Thank you for participating in the economic choices of ecosystem restoration for environmental decision-making. We appreciate your valuable time and input to this project. Please add any additional comments you may have.

A4. Unrestricted mixed logit model of the utility specification in Eq. (3)

Variable	Coefficient (se) [p]	Std. Dev. (se of Std. Dev.) [p]
Non-random parameters		
Base parameters ($\beta_{HikerSQ}$, β_{HikerX}, $\beta_{HikerCost}$) when Hiker=1 and DP=0		
SQ•Hiker	0.1684 (1.5248) [0.912]	N/A
High_Effort•Hiker	1.3420 (0.7355) [0.068]	N/A
Habitat_Cactus•Hiker	-0.3071 (0.3751) [0.413]	N/A
Habitat_Ngrass•Hiker	0.4223 (0.5015) [0.4]	N/A
High_Access•Hiker	0.3213 (0.6263) [0.608]	N/A
Medium_Access•Hiker	0.1363 (0.4039) [0.736]	N/A
Volunteers•Hiker	0.0895 (0.6782) [0.895]	N/A
High_Success•Hiker	1.6809 (0.9064) [0.064]	N/A
Size•Hiker	0.8976 (0.2648) [0.001]	N/A
Cost•Hiker	0.0046 (0.0158) [0.769]	N/A
Additions to base parameters ($\beta_{HikerSQP}$, $\beta_{HikerXP}$, $\beta_{HikerCostP}$) when Hiker=1 and DP=1		
SQ•Hiker	1.7695 (1.9715) [0.369]	N/A
High_Effort•Hiker	-0.1695 (1.2993) [0.896]	N/A
Habitat_Cactus•Hiker	1.3894 (0.5496) [0.011]	N/A
Habitat_Ngrass•Hiker	-1.2465 (0.8078) [0.123]	N/A
High_Access•Hiker	-0.1395 (0.8423) [0.868]	N/A
Medium_Access•Hiker	0.3239 (0.6029) [0.591]	N/A
Volunteers•Hiker	1.2759 (0.9988) [0.201]	N/A
High_Success•Hiker	-2.7282 (1.4033) [0.052]	N/A
Size•Hiker	-0.7290 (0.3351) [0.03]	N/A
Cost•Hiker	0.0013 (0.0205) [0.951]	N/A
Base parameters ($\beta_{EduTourSQ}$, $\beta_{EduTourX}$, $\beta_{EduTourCost}$) when EduTour=1 and DP=0		
SQ•EduTour	-2.5629 (1.3338) [0.055]	N/A
High_Effort•EduTour	0.7867 (0.7351) [0.285]	N/A
Habitat_Cactus•EduTour	-0.0739 (0.3899) [0.85]	N/A
Habitat_Ngrass•EduTour	0.2304 (0.4806) [0.632]	N/A
High_Access• EduTour	-0.3844 (0.5469) [0.482]	N/A
Medium_Access• EduTour	-0.5687 (0.4042) [0.159]	N/A
Volunteers• EduTour	-1.0234 (0.6980) [0.143]	N/A
High_Success• EduTour	-0.1108 (0.7248) [0.878]	N/A
Size• EduTour	0.2024 (0.2321) [0.383]	N/A
Cost• EduTour	-0.0138 (0.0133) [0.299]	N/A
Additions to base parameters ($\beta_{EduTourSQP}$, $\beta_{EduTourXP}$, $\beta_{EduTourCostP}$) when EduTour=1 and DP=1		
SQ•EduTour•DP	3.9187 (2.3669) [0.098]	N/A
High_Effort• EduTour•DP	-0.0884 (1.1079) [0.936]	N/A
Habitat_Cactus• EduTour•DP	0.2199 (0.5873) [0.708]	N/A
Habitat_Ngrass• EduTour•DP	0.6128 (0.9394) [0.514]	N/A

High_Access• EduTour•DP	0.0651 (0.7613) [0.932]	N/A
Medium_Access• EduTour•DP	0.3955 (0.7126) [0.579]	N/A
Volunteers• EduTour•DP	-0.5968 (1.0283) [0.562]	N/A
High_Success• EduTour•DP	-0.3835 (1.1938) [0.748]	N/A
Size• EduTour•DP	-0.2046 (0.3374) [0.544]	N/A
Cost• EduTour•DP	-0.0161 (0.0200) [0.42]	N/A
Base parameters ($\beta_{DRealSQ}$, $\beta_{DRealX^{\wedge}}$, $\beta_{DRealCost}$) when DReal=1 and DP=0		
SQ•DReal	-0.9596 (2.3199) [0.679]	N/A
High_Effort•DReal	0.1369 (2.0957) [0.948]	N/A
Habitat_Cactus•DReal	-0.8039 (1.1180) [0.472]	N/A
Habitat_Ngrass•DReal	0.5886 (1.2855) [0.647]	N/A
Size•DReal	0.4940 (0.7501) [0.51]	N/A
Cost•DReal	-0.0259 (0.0220) [0.238]	N/A
Additions to base parameters ($\beta_{DRealSQP}$, $\beta_{DRealX^{\wedge}P}$, $\beta_{DRealCostP}$) when DReal=1 and DP=1		
SQ•DReal•DP	2.6022 (3.4962) [0.457]	N/A
High_Effort•DReal•DP	-0.6749 (3.0820) [0.827]	N/A
Habitat_Cactus•DReal•DP	1.6147 (1.6913) [0.34]	N/A
Habitat_Ngrass•DReal•DP	-1.4263 (1.8915) [0.451]	N/A
Size•DReal•DP	0.2434 (1.1267) [0.829]	N/A
Cost•DReal•DP	0.0387 (0.0328) [0.237]	N/A
Random parameters		
SQ (n)	-1.2403 (1.4384) [0.389]	2.7863 (0.4298) [0.0001]
High_Effort (n)	1.1470 (0.5712) [0.045]	1.5481 (0.3191) [0.0001]
Habitat_Cactus (n)	0.3717 (0.4507) [0.41]	-0.5986 (0.2683) [0.026]
Habitat_Ngrass (n)	-0.4455 (0.5229) [0.394]	0.9866 (0.3083)[0.001]
High_Access (n)	0.1896 (0.5036) [0.707]	1.7918 (0.3364) [0.0001]
Medium_Access (n)	0.3936 (0.4377) [0.369]	-0.9079 (0.2494) [0.0001]
Volunteers (n)	2.2449 (0.6344)[0.0001]	-1.1389 (0.2921) [0.0001]
High_Success (n)	1.8765 (0.7505) [0.012]	1.7229 (0.3854) [0.0001]
Size (n)	-0.0199 (0.2265) [0.93]	0.2407 (0.0698) [0.001]
Cost[a]	-0.0253 (0.0143) [0.078]	0.0380 (0.0057) [0.0001]
SQ•DP	-2.4774 (2.2896) [0.279]	-4.8679 (0.8065) [0.0001]
High_Effort•DP (n)	-0.0721 (0.8653) [0.934]	-1.0598 (0.3178) [0.001]
Habitat_Cactus•DP (n)	-1.2293 (0.6995) [0.079]	0.2388 (0.3514) [0.497]
Habitat_Ngrass•DP (n)	1.4158 (0.8413) [0.092]	-1.0701 (0.3535) [0.002]
High_Access•DP (n)	0.5819 (0.7461) [0.435]	1.3096 (0.3011) [0.0001]
Medium_Access•DP (n)	-0.0033 (0.6822) [0.996]	-1.1762 (0.2430) [0.0001]
Volunteers•DP (n)	-0.2823 (0.8455) [0.738]	0.2484 (0.1080) [0.664]
High_Success•DP (n)	1.9599 (1.3949) [0.16]	3.7768 (0.8078) [0.0001]
Size•DP (n)	0.6063 (0.3777) [0.108]	0.1674 (0.0681) [0.014]
Cost•DP[a]	-0.0188 (0.0223) [0.398]	0.0464 (0.0069) [0.0001]
Model statistics		
Number of observations	3402	
Number of participants	81	

Log-likelihood (LL)	-710.17241
AIC	1604.345
BIC	2168.5
Wald $\chi 2$, 20 df (p)	522.54 ($p<0.0001$)

[a]The reported values are parameters (mean and sd) of the underlying normal distributions of log-normally distributed cost variables.

MANUSCRIPT 2

DO REPEATED CHOICE TASKS AFFECT CHOICE OUTCOMES IN DISCRETE CHOICE EXPERIMENTS? AN APPLICATION TO RHODE ISLAND'S WOODED WETLAND PROTECTION

Prepared for submission to mainstream journal of environmental and natural resource economics

2.1 Abstract

The Discrete choice experiment (DCE) method often asks survey participants a series of choice tasks to elicit values for multi-attribute environmental goods and services. Asking a repeated sequence reduces data collection cost because the cost of recruiting the participants is high and getting more data from each person is cost effective. Although the repeated choice format increases the preference information obtained from each survey participant, the stated preference literature raises questions, in theory and with empirical evidence, of *order effects* regarding the truthfulness and thus usefulness of such additional preference information, and to what extent these concerns affect the validity of valuation estimates. Order effects refer to various behavioral phenomena that create a systematic change in expressed preferences across a series of choice tasks. Employing a split sample approach, this paper empirically compares survey participants' marginal values and marginal willingness to pay (mWTP) for attributes of protecting wooded wetlands using two survey lengths or formats. The first survey format asks a group of survey participants only two choice tasks and the second format asks a different group of participants a series of twelve choice tasks. Both survey formats involve trichotomous choices regarding protection of wetlands. Our results suggest that the alternative survey formats produce statistically different underlying preference functions as well as statistically different estimates of scale parameters related to the uncertainty in participants' responses. We further examined participants' choices from a series of twelve choice tasks, by creating a set of variables or interactions representing the corresponding effects, to investigate potential heterogeneity (or effect) in the mean of the cost parameter and the utility of the status quo option across the sequence. We discovered no evidence of position-dependent order effects in our application. But, our results produce evidence of precedent-dependent effects relating to a potential to retain higher *net surplus* from the *most-valued* alternative in the current task relative to the *most-valued* alternative in the preceding task may induce participants to be less cost- sensitive and thus appear to have a higher WTP across the sequence.

Key words: Discrete choice experiment, order effects, precedent-dependent effects, repeated choice tasks, strategic responses, wooded wetland protection

2.2 Introduction

Discrete choice experiments (DCEs) elicit values for multi-attribute environmental goods and services by asking survey participants a series of choice tasks consisting of two or more alternatives. DCE studies using the repeated format assume that survey participants have stable preferences across the repeated sequence of choice tasks, meaning there is no systematic change in stated preferences along the series of valuation scenarios. Even though participants are told to consider each choice task as an independent scenario, the repeated format may confound the incentive structures of the choice task and thus may produce responses that may not be truthful or may suffer from strategic or other biases. Participants' responses on a series of repeated choices may depend on their own preferences, expectations or beliefs about other participants' preferences, as well as an assumed rule or process by which preference information from the repeated choices will be aggregated across the sequence of choices (Carson & Groves, 2007; Moulin, 1994). Moreover, empirical evidence of systematic change in stated preferences observed along the sequence of valuation scenarios also strengthens the theoretical predictions (Day et al., 2012). Therefore, the truthfulness of additional preference information obtained from such repeated choice format has been challenged.

In this paper, we empirically examine whether the two survey formats, the first format involving two choices tasks and the second format involving a series of twelve choice tasks, yield statistically equivalent underlying preference functions by comparing marginal values and mWTP estimates for wetland parcel attributes. We employed a split sample approach where one group of participants faced two choice tasks and a different group of participants faced a series of twelve choice tasks. Both groups faced trichotomous choices, two wetland parcels that differ in the levels of attributes representing various characteristics of forested wetlands and a "conserve neither parcel" option as the status quo alternative. Our results suggest that the alternative survey formats yield statistically different preference functions as well as scale parameters relating to the uncertainty in responses. We further explored whether the responses from the survey format involving twelve choice tasks suggest any form of systematic alterations of stated preferences along the sequence of choice tasks, broadly termed as *order effects* in the stated preference literature. This exploration suggests that our data display evidence of precedent-dependent order effects relating to a potential to retain higher *net surplus* from the *most-valued* alternative in the current task relative to the *most-valued* alternative in the preceding task may induce participants to be less sensitive to cost and thus appear to have a higher WTP across the sequence.

A well-known result from mechanism design theory (Gibbard, 1973; Satterthwaite, 1975) is that a single binary discrete choice question, one alternative usually being the status quo option, with majority provision rule[16] is an incentive

[16]A provision rule is a rule or process by which participants' responses determine choice outcomes, and thus provides an explicit nexus between survey choices and outcomes. Explicit description of a provision rule may give participants certain incentives to truthfully respond to, and thereby identify their most preferred option in choice tasks. Previous studies examining responses under alternative provision rules suggest that participants may still make consistent choices irrespective of incentive compatible provision rules as defined by mechanism design theory (Vossler, Doyon, & Rondeau, 2012; Manuscript 1 in this dissertation).

compatible mechanism, meaning truthful responses are dominant choices and participants would do no better by choosing alternative options (Farquharson, 1969; Arrow et al., 1999; Carson & Groves, 2007). A repeated sequence of binary choices is often used to improve informational efficiency of preference data relative to a single binary choice and the cost of data acquisition.

This repeated survey format, however, may create incentives for non-truthful responses. For example, participants' beliefs about how their responses or the preference information will be aggregated across the sequence of the choices by the surveying agency may induce them not to truthfully state their preferences (Carson & Groves, 2007). Furthermore, when participants are presented with multiple variants of more or less the same environmental good or service at very different prices along the sequence of valuation scenarios, uncertainty surrounding the price may create incentives not to truthfully respond to the choices in the sequence. In sum, participants' responses to the repeated sequence may depend on their own preferences, the person's experience relating to learning their own preferences through the sequence of choices for an unfamiliar choice context, expectations about others' preferences, and also the assumed rule or process by which the preference information across the sequence will be aggregated, suggesting that truthful responses may not be dominant choices for participants under the repeated survey format (Moulin, 1994).

Employing an explicit game-theoretic model of individual decisions, Vossler, Doyon, & Rondeau (2012) showed that incentive compatibility requires independence between the choice tasks and at most one choice task (or a policy option) can be implemented or provided from a sequence of binary choices. The incentive properties of repeated survey format involving multinomial choice tasks are further complicated by a core result in mechanism design theory that no response format involving more than two alternatives can be incentive compatible without substantial additional restrictions on participants' preferences (Gibbard, 1973; Satterthwaite, 1975). These theoretical predictions about the incentive structures of the repeated survey format suggest that truthful responses may not always be dominant choices when participants are asked a series of choice tasks in a DCE study.

There exist a number of studies that show a systematic change in preferences along the sequence of valuation scenarios. A number of phenomena of preference formation and different explanations for such systematic alterations of stated preferences along the sequence of choice tasks have been proposed. Day et al. (2012) reviewed the previous studies and broadly categorized *order effects*, a term representing various phenomena of a systematic change in stated preferences along a sequence of choice tasks, into two groups. The first relates to a systematic change in preferences due to the position of choice task in the sequence, also known as *position-dependent* order effects. The second relates to systematic changes in expressed preferences along the sequence of valuation scenarios due to the nature of alternatives in the previous tasks, also known as *precedent-dependent* order effects.

Position-dependent order effects represent a set of confounding of standard choice behaviors, which may result from different forms of *learning effects* such as *institutional learning* (Braga & Starmer, 2005) or *value learning* (Plott, 1993) or *fatigue effects* (Bradley & Daly, 1994; Savage & Waldman, 2008) or a lack of credibility (Carson & Groves, 2007). The *learning effects* may arise when participants become more familiar with the environmental good or service under consideration, the context, and the choice tasks in early choices and ultimately make choices consistent with their preferences later in the sequence. Early choice tasks serve as opportunities to learn about less familiar environmental goods or services and the choice context, resulting in *institutional learning* (Braga & Starmer, 2005). Likewise, participants, after initial confusion, may be '*discovering'* features of their own preferences, also called *value learning* (Plott, 1993), while responding to the sequence of choices. These learning effects may be characterized by an initial increased randomness[17] in early choice tasks followed by less random responses in later choice tasks in the sequence. Alternatively, participants may become fatigued answering a series of choice tasks, resulting in the *fatigue effects*, which may be characterized when participants increasingly favor the status quo option or a particular attribute along with an increased randomness in responses in the sequence. Also, participants face a series of choice tasks representing more or less the same level of the environmental good at varying price levels in the sequence. This presentation may induce a sense of *failing credibility* in the surveying agency or the alternatives as potential options for implementation, which could manifest as an increasing tendency to reject costly options in favor of the status quo, as well as an increased randomness in responses in the sequence, because participants may simply not invest time and effort to make choices consistent with their preferences.

[17] Randomness in choices is represented by an estimate of scale factor using a heteroskedastic model and is inversely proportional to the variances of error terms.

Precedent-dependent order effects occur when participants systematically change their preferences based on the nature of the choice task in the sequence and represent a set of non-standard choice behaviors. Participants may compare subsequent choice tasks relative to the options or levels of attributes in the "first choice task" often referred to *starting task effects* (Herriges & Shogren, 1996; Ladenburg & Olsen, 2008). Participants may take subsequent choice tasks as a 'good deal' or a 'bad deal' relative to the "reference" alternatives or "reference" level of attributes developed from observations in previous choice tasks, often termed as *reference effects* (Isoni, 2011; Mazumdar, Raj, & Sinha, 2005). Participants may interpret a series of options offering a non-market good at varying prices as an opportunity to manipulate the outcome or the optimal level of provision or pricing to their advantage or both, and thus may judge subsequent choice tasks relative to the "best" alternative or "best" level of attributes presented in previous choice tasks, resulting in *strategic misrepresentation* (Carson & Groves, 2007).

There are also studies that examined the effect of advanced disclosure or step-wise disclosure of the repeated survey format on the order effects. Employing a contingent valuation (CV) study to value nested levels of environmental improvement, Bateman et al. (2004) examined the advanced and stepwise disclosure formats and found a significant difference in value estimates due to order of presentation in the step-wise disclosure format, but the advanced disclosure response format did not produce such a significant difference, implying the advanced disclosure format may mitigate *position-dependent* order effects. Likewise, Scheufele & Bennett (2013) did not find any influence of advanced awareness of repeated choices on the implications for order effects in the sequence of choices. However, Bateman, Day, Dupont, & Georgiou (2009), in a DCE study involving two binary choice tasks, found statistically different preferences in the second choice task relative to the choices in the first task, resulting in *precedent-dependent* order effects relating to *starting task effects*.

Previous studies examining order effects in the repeated response survey format employed binary choice elicitation in which participants faced a choice between an alternative level of the environmental good or service under investigation and the status quo alternative. A recent study by Scheufele & Bennett (2012), using repeated binary discrete choice experiments, examined whether *strategic opportunities* provided by the order in which choice sets are presented affect choice decisions and found evidence of such effects in terms of participants' increased cost sensitivity and thus lowering willingness to pay (WTP) estimates if the same or similar level of provision was offered in the previous choice task at a lower cost than if it was not. However, they found that the cost sensitivity and thus WTP remains unaffected if the same or similar level of provision was offered in the previous choice task at a higher cost. Their results also indicate that the cost sensitivity increases (and WTP decreases) as participants progress through the sequence of choice tasks. As noted by Scheufele & Bennett (2012), the order effects reported in the SP literature have not been adequately examined under multinomial response format. A trichotomous choice elicitation format as applied here asks participants about two wetland-parcel preservation alternatives and the status quo option. Since each choice task provides two non-status quo alternatives at different cost levels across the sequence, this choice situation may provide strategic opportunities for participants that may manifest through the effects on the cost parameter estimate as well as on the utility of the status quo option. Thus, the major objective of this paper is to examine the effect of a set of variables and interactions, representing position-dependent as well as precedent-dependent effects, on the marginal utility of cost to participants and also on the utility of the status quo option. Statistically significant effect of these variables on the cost parameter and the utility of the status quo option may subsequently imply effects on the marginal willingness to pay (mWTP) for wetland attributes, as well as total WTP for alternative wetland parcels, relative to the status quo option across the sequence.

We employed a split sample approach, meaning one group of participants received two choice tasks and a different group of participants received a series of twelve choice tasks, to examine whether the alternative survey formats influence marginal values as well as marginal willingness to pay (mWTP) for attributes of protecting forested wetland parcels. This paper utilized data from a stated preference survey using discrete choice experiment (DCE) method to assess values of various attributes for protecting forested wetland parcels in the northern towns of Rhode Island, USA. Our results suggest that the alternative survey formats produce statistically different preference functions. We further examined participants' responses from the twelve choice tasks (or the repeated survey format) to investigate whether these responses suggest any form of order effects discussed in the stated preference literature in terms of participants' cost sensitivity across the sequence. Analysis of responses from repeated choice format suggests evidence of precedent-dependent order effect relating to a potential to retain higher *net surplus* from the *most-valued* alternative in the current task relative to the same in the preceding task may induce participants to be less sensitive to cost and thus appear to have a higher WTP across the sequence in our application using trichotomous choice tasks.

The paper is organized as follows. Section 2.3 discuses the theoretical framework of random utility model (RUM) to model participants' choices for protecting forested wetland parcels. Section 2.4 details identification of relevant attributes, experimental design of forested wetland parcels, and implementation of a stated preference survey developed in this study. Section 2.5 presents the results of hypothesis tests. Section 2.6 concludes the paper by discussing the implications of our results.

2.3 The conceptual model

Following standard practice, we employ a random utility model or the RUM framework (McFadden, 1974) to model survey participants' choices for conserving wooded wetland parcels. The RUM assumes that participants' choice is dictated by the maximization of the utility. The utility that participant n receives from alternative j in choice task t can be represented by: $U_{njt}=V(\beta, X_{njt})+\varepsilon_{njt}$, where $V(\beta, X_{njt})$ represents the observed portion of utility estimated from a vector of attributes of wetland parcels (X_{njt}) with a vector of parameters to be estimated, β, and where ε_{njt} represents the portion of utility unobserved or unknown from the researcher's perspective and is assumed to be an *iid* type 1 extreme value. Given these assumptions, the probability that participant n chooses alternative j in choice task t is given by the following logit specification:

(1) $$P_{njt}=exp(\lambda V_{njt}) / \Sigma_{j'} exp(\lambda V_{nj't})$$

where λ is a scale parameter and is inversely proportional to the error variance, σ_ε^2 ($\lambda=\pi/\sqrt{[6\sigma_\varepsilon^2]}$). Since the preference parameter vector, β, and the scale parameter, λ, cannot be identified simultaneously, the scale parameter is often normalized to 1 for identification purpose. The assumption of a constant error variance across individuals could mislead the results of hypothesis tests while comparing preferences across subsamples of participants because the preference vectors, β, are confounded by the corresponding scale parameters. A heteroskedastic conditional logit model (DeShazo & Fermo, 2002; Hensher, Louviere, & Swait, 1998) allows one to estimate the scale parameter as a function of participant-specific characteristics, and thus allows us to compare both preference vectors as well as the scale parameters across different subsamples of participants. Moreover, estimated scale parameters provide us with an indication of uncertainty in responses, in addition to the effect of all unobserved factors or variables, across the two response formats.

Our comparison of preferences and the scale parameters between the two response formats is limited to an estimation of a heteroskedastic conditional logit model because two choice observations from each survey participant may not allow us to discover statistically different random parameters under our two choice task survey format (Rose, Hess, Bliemer, & Daly, 2011). However, we will utilize a mixed logit model to further explore the responses under our repeated response format involving twelve choice tasks.

2.3.1 Hypothesis tests regarding survey formats

DCE studies using the repeated choice format assume that participants' preferences do not change or are stable across the choice tasks in the sequence. Therefore, our first hypothesis is related to examining a set of marginal utility parameters to compare underlying utility functions, scale parameters, and mWTP estimates for attributes across the two survey formats. We formally express the hypothesis as follows:

Hypothesis 1: A set of marginal utility parameters, β, is not significantly altered by the repeated response format.

H_O: $\beta^{Choice2} = \beta^{Choice12}$ and H_A: $\beta^{Choice2} \neq \beta^{Choice12}$

where β^{C} represents a set of marginal utility parameters estimated from a subsample facing two choice tasks (C=Choice2) and a different subsample facing twelve choice tasks (C= Choice12).

In order to test **Hypothesis 1**, we will conduct a Likelihood Ratio (LR) test by imposing restrictions implied by the null hypothesis (H_O) examine whether the restrictions are true. Additionally, we will compare the scale parameter estimates to examine underlying error variances across the survey formats, i.e., **Hypothesis 1a:** test $\lambda_{Choice12} / \lambda_{Choice2}=1$, where the scale parameter (λ_C) for a subsample facing two choices (C=Choice2) is normalized to 1 and the scale parameter for a different subsample facing twelve choice tasks (C=Choice12) is estimated relative to 1 for identification purpose. Therefore, the test of scale parameters between the subsamples is whether the ratio of scale parameters (or the relative values) is equivalent to 1.

Hypothesis 2: Marginal willingness to pay (mWTP) values for wetland attributes are not significantly affected by the repeated survey format.

H_O: $mWTP^{Choice2} = mWTP^{Choice12}$ and H_A: $mWTP^{Choice2} \neq mWTP^{Choice12}$

where $mWTP^C_X$ represents marginal willingness to pay for an attribute X defined as the ratio of the marginal utility of an attribute X (β_X) and the marginal utility of income ($-\beta_{Cost}$) or $(-1)*(\beta_X / \beta_{Cost})$, using coefficients estimated from a subsample facing two choice tasks (C=Choice2) and a different subsample facing twelve choice tasks (C= Choice12).

In order to test **Hypothesis 2**, we will conduct a series of pair-wise Wald tests of equality of mWTP estimates for wetland attributes across the two choice formats.

2.3.2 Exploring order effects under repeated choice format

Given that **Hypothesis 1** and **2** above are rejected, we will further examine responses from the repeated survey format. We will estimate a mixed logit model to examine both forms of orders effects, *position-dependent* and *precedent-dependent* effects, under the repeated survey format involving twelve choice tasks. We will specifically examine these effects by creating a set of variables or interactions representing the corresponding type and examining whether these variables alter marginal utility of cost to participants (and thus mWTP) as well as the utility of the status quo option across the sequence. The actual empirical model estimated to examine these effects will be discussed later.

2.4 Empirical application

2.4.1 Wetland survey design and implementation

We examined the hypotheses regarding preferences across alternative survey formats using stated preference (SP) data to assess values of forested wetlands in Rhode Island, USA. The SP data utilized in this paper were part of a larger study involving both hypothetical and real-money choices (Newell, 2003; Newell & Swallow, 2013), but the present study utilizes responses only from hypothetical choices of wooded wetland parcels. Details about the original study can be found in (Newell, 2003). Responses from the 12-choice format have not previously been analyzed.

Personal interviews and a total of eight focus groups (Johnston et al., 1995) with the members of Wood Pawcatuck Watershed Association, several school parents' organizations, and members of the general public were conducted during the process of identifying relevant attributes to describe various aspects of conserving wooded wetland parcels (Newell, 2003). These focus groups and personal interviews were primarily concentrated on learning Rhode Island residents' attitudes and views towards different dimensions of forested wetlands and other natural resources in general. These discussions also helped to develop, pretest, and revise the survey instrument in terms of clarity of instructions and presentation as well as comprehensiveness of the content of the survey.

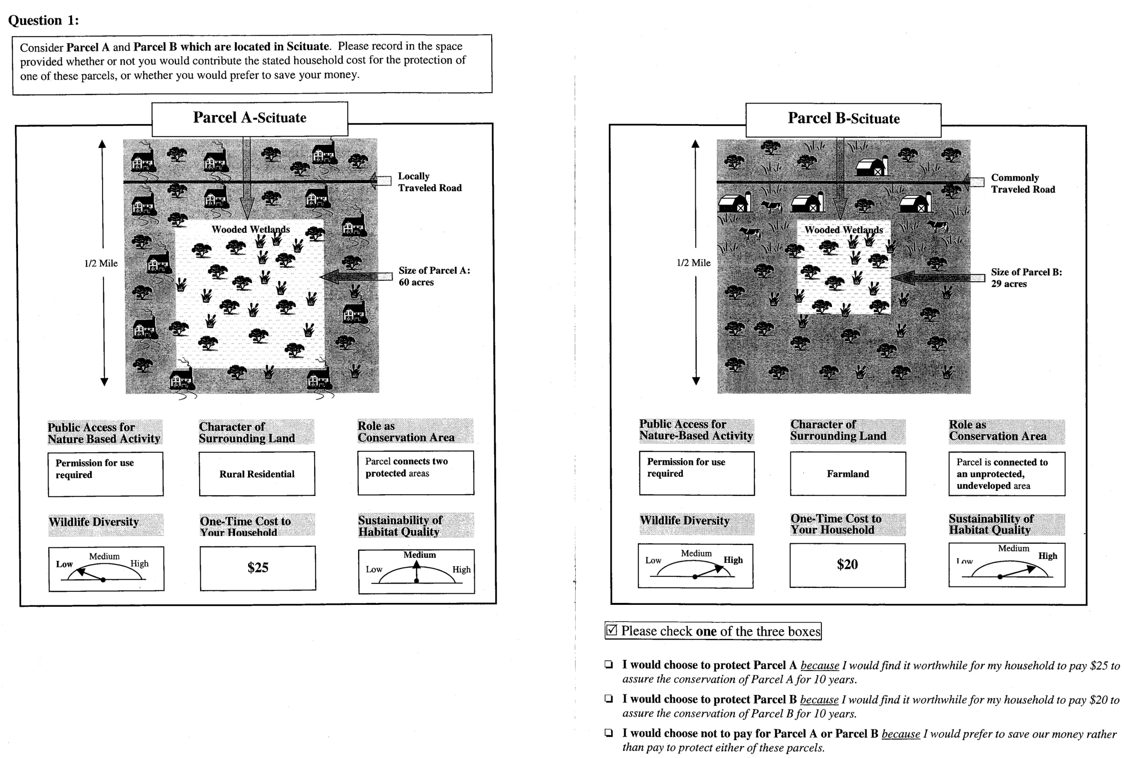
Table 2.1 presents identified attributes of forested wetland parcels that were considered to be relevant by conservation biologists, local residents and the focus group participants, including type of road passing by a wetland parcel, character of surrounding land, level of wildlife diversity, level of public access, sustainability of habitat quality, role of parcel as conservation area, size of parcel (acres) and one-time cost ($) to participants to protect a wetland parcel for a ten-year period. An example choice task is presented in Figure 2.1.

Table 2.1 Wetland parcel attributes and levels

Attribute	Variable and description
Type of road	**Common_Road**: An effects-coded variable equals **1** for a commonly travelled road adjacent to the wetland parcel, equals **-1** for a locally traveled road; and equals **0** otherwise. **Heavy_Road**: An effects-coded variable equals **1** for a heavily travelled road adjacent to the wetland parcel, equals **-1** for a locally traveled road; and equals **0** otherwise.
Character of surrounding land	**Woodland:** An effects-coded variable equals **1** if the wetland parcel is surrounded by woodland, equals **-1** if the parcel is surrounded by rural residential land; and equals **0** otherwise. **Farmland:** An effects-coded variable equals **1** if the wetland parcel is surrounded by farmland, equals **-1** if the parcel is surrounded by rural residential land; and equals **0** otherwise.
Wildlife diversity	**Medium_WLDiversity:** An effects-coded variable equals **1** if the wildlife diversity of the parcel is medium, equals **-1** if the diversity is low; and equals **0** otherwise. **High_WLDiversity:** An effects-coded variable equals **1** if the wildlife diversity of the parcel is high, equals **-1** if the diversity is low; and equals **0** otherwise.
Public access	**Limited_Access:** An effects-coded variable equals **1** if limited public access to the parcel is allowed, equals **-1** if no public access is allowed; and equals **0** otherwise. **Full_Access:** An effects-coded variable equals **1** if full public access is allowed to the parcel, equals **-1** if no public access is allowed; and equals **0** otherwise.
Sustainability of habitat quality	**Medium_Sustain:** An effects-coded variable equals **1** if the parcel sustains medium level of habitat quality, equals **-1** if the parcel sustains low level of habitat quality; and equals **0** otherwise. **High_Sustain:** An effects-coded variable equals **1** if the parcel sustains high level of habitat quality, equals **-1** if the parcel sustains low level of habitat quality; and equals

	0 otherwise.
Role as conservation area	**Expands:** An effects-coded variable equals **1** if the parcel expands an existing protected areas, equals **-1** if the parcel is isolated from other protected areas; and equals **0** otherwise. **Connects:** An effects-coded variable equals **1** if the parcel connects two protected areas, equals **-1** if the parcel is isolated from other protected areas; and equals **0** otherwise.
Size of parcel	**Size:** The size of wetland parcels (in acres)- 29 acres, 45 acres and 60 acres
One-time cost to participant's household	**Cost:** One-time payment that participant's household is required to make for the conservation of wetland parcel for a 10-year period- \$5, \$10, \$15, \$20, \$25 and \$30.
Status quo option	**SQ:** A dummy variable equals **1** for the status quo option or "conserve neither parcel", and equals **0** for a parcel (Parcel A or Parcel B).

Figure 2.1 An example choice task of forested wetland protection



StatDesign Inc.[18] provided a fractional factorial design of choice tasks by combining levels of eight wetland parcel attributes (see Table 2.1). The fractional factorial design of the attribute combinations produced a total of 36 choice tasks. Each choice task consisted of two wetland parcels that differ in the levels of the eight attributes. Participants were asked to evaluate the attributes of the two parcels and indicate their most preferred parcel: Parcel A or Parcel B or "Neither parcel," making each choice task a trichotomous valuation scenario.

In order to examine whether the survey format or sequence length affected modeling of preferences and values, the researchers created two wetland survey booklets entitled "Are Rhode Island's Wetlands Valuable?". The first survey booklet consisted of two different choice tasks (Choice2 subsample), and the second survey booklet consisted of a series of twelve different choice tasks (Choice12 subsample), from the same pool of original 36 choice tasks produced by the fractional factorial design. The two choice tasks were chosen from the pool of 36 choice tasks such that the first choice task was picked at an interval of five choice tasks relative to the second choice task. For example, if the first choice task is the 6th in the pool of 36 tasks, then the second choice task was 1st from the pool of 36 tasks. This was to ensure that the two choice tasks were different in the survey booklet. The fractional factorial design produced 36 choice tasks that were then efficiently blocked into three sets of twelve choice tasks. That is the first set consists of choice tasks 1st through 12th; the second set consists of choice tasks 13th through 24th; and the third set consists of choice tasks

[18] We are indebted to Don A. Anderson of Evergreen, CO, who created the design and suggested the 12-choice format be implemented.

25th through 36th. Each participant was then randomly assigned to one of the three sets. Except for the number of choice tasks faced by participants in the two survey booklets, both surveys consisted otherwise of the exact same information on the purpose of the survey and the benefits of protecting forested wetlands and the questions regarding their socio-demographic characteristics.

The researchers employed the Dillman method (Dillman, 1978) to distribute the surveys to randomly-drawn residents of the towns of North Smithfield and Scituate, Rhode Island, USA, in the summer of 2000. The Dillman method, as applied in this study, involved sending a cover letter, the survey and a $1 coin as financial token of appreciation. For non-respondents, additional mailings were sent, including a reminder postcard, followed by a letter with a replacement survey, a second reminder postcard, plus a letter with a final post card asking non-respondents about their basic (age, gender, and education as described below) socio-demographic information.

2.4.2 Descriptive statistics about survey participants

A total of 1000 surveys involving two choice tasks were mailed out and 402 were returned of the 906 surveys actually delivered, registering a response rate of 44.37%. A total of 200 surveys involving twelve choice tasks were mailed out and 82 surveys were returned of 180 deliverables providing a response rate of 45.56%. Table 2.2 reports summary statistics for the available socio-demographic characteristics of participants in the two subsamples. A chi-squared test of independence for categorical variables suggests the two subsamples have statistically similar proportions of male and female participants (see Table 2.2), but the subsamples who faced a series of twelve choice tasks had significantly higher proportion of participants with a college degree or higher than the participants who faced only two choice tasks (see Table 2.2). Two-sample t-test shows that the mean age of the participants across the subsamples is statistically equivalent (see Table 2.2).

Table 2.2 Participants' characteristics across the choice formats

Variables	Description	Choice formats		
		Two choice tasks (Choice2)	Twelve choice tasks (Choice12)	Pearson $\chi 2$, 1df (p)
		Sample mean (SD)	Sample mean (SD)	
Male	=1 if participant is male; 0 otherwise.	0.68 (0.47)	0.67 (0.47)	0.066 (0.7973)
College	=1 if participant has a college degree or higher; 0 otherwise.	0.75 (0.43)	0.87 (0.34)	4.922 (0.0265)
Age	Age of participants	48.95 (13.64)	48.99 (12.19)	0.0268[a] (0.9786)

[a]Two sample t-stat, 482 df, (p-value)

2.5 Results

2.5.1 Empirical model specification for hypothesis tests regarding choice formats

We assume the indirect utility (V_{njt}) is a linear function of the attributes of wetland parcels (X_{njt}) including the cost to buy the parcel[19] for conservation ($Cost_{njt}$), as well as participant-specific socio-demographic characteristics (Z_n). The indirect utility function can be expressed as follows:

[19] The survey asked about paying the cost to secure a 10-year easement preventing development; this restriction was related to the broader purpose of the study, such as described in (Newell & Swallow, 2013).

(2) $V_{njt}=\beta_{SQ}SQ_j+\beta_X X_{njt}+\beta_{Cost}Cost_{njt}+\beta_{ZSQ}Z_n\bullet SQ_j$

$+(\beta_{SQC12}SQ_j+\beta_{XC12}X_{njt}+\beta_{CostC12}Cost_{njt}+\beta_{ZSQC12}Z_n\bullet SQ_j)\bullet Choice12,$

where[20] β_{SQ} , β_{SQC12} represent the coefficients measuring the utility of the status quo option (SQ_j) across the choice formats as captured by dummy variable Choice12 for which 1 indicates the 12-choice presentation, and 0 indicates the 2-choice presentation; β_X represent the coefficients measuring the marginal utility of the non-monetary attributes of wetland parcels (X_{njt}) in the 2-choice format and, when Choice12 =1, the addition of β_{XC12} captures any addition to the marginal utility due to the 12-choice format; similarly β_{Cost}, $\beta_{CostC12}$ together represent the marginal utility of cost to participants ($Cost_{njt}$), often known as the negative of the marginal utility of income, across the survey formats (Choice12=1,0); β_{ZSQ}, β_{ZSQC12} represent the coefficients adjusting the utility of the status quo option due to participant-specific socio-demographic characteristics (Z_n) across the survey formats (Choice12=1,0); SQ_j represents a dummy variable taking a value of 1 for the status quo option, or the "Neither Parcel" alternative, and the value of 0 for a wetland parcel (Parcel A or Parcel B); X_{njt} represents the vector of non-monetary attributes of wooded wetland parcels (Table 2.1) and the cost to the participant to buy the parcels ($Cost_{njt}$); Z_n represents the vector of participants' socio-demographic characteristics[21].

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[20] Note that in Eq. (2), parameters β_n relates to the marginal utilities for the 2-Choice format (Choice12=0) while ($\beta_n+\beta_{nC12}$) gives the marginal utilities for the 12-Choice format (Choice12=1).

[21] Since participants who faced a series of twelve choice tasks had significantly higher proportion of participants with a college degree or higher than the participants who

2.5.2 Hypothesis test results regarding the choice formats

We estimated a heteroskedastic conditional logit model of the utility specification presented in equation (2) using the pooled data from both survey formats. In order to test **Hypothesis 1**, we conducted a LR test by imposing restrictions on a set of the utility parameters, including the utility of the status quo option, the marginal utility parameters of the attributes of wetland parcels, and the marginal utility of income. The LR test[22] suggests that the two survey formats produce statistically different underlying preference functions (LR Test: $\beta_{SQC12}=\beta_{XC12}=\beta_{CostC12}=0$; $\chi 2=60.43$, 15 df, $p<0.0001$). We also examined whether the two choice formats produce statistically different estimates of the scale parameters representing uncertainty or randomness in responses across the formats. The LR test[23] suggests that the scale parameter is

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faced only two choice (see Table 2.2), we examined, in our preliminary models not discussed here, whether this difference in education level could affect the potential difference in estimated preference functions across the survey formats (Choice12=1,0) and found that the effect on wetland attributes was not statistically significant and thus excluded from further consideration ($\chi 2=14.1758$, 15 df, $p=0.5122$).

[22] The LR test statistic was calculated as $2*(LL_U-LL_R)$ with 15 df, is asymptotically chi-square distributed. LL_U is the log-likelihood value of the unrestricted model specified in Eq. (2) and reported in Table 2.3 and LL_R is the log-likelihood value of the restricted model after imposing a set of restrictions ($\beta_{SQC12}=\beta_{XC12}=\beta_{CostC12}=0$) estimated using the pooled dataset from both survey formats.

[23] The LR test statistic was calculated as $2*(LL_{VS}-LL_{ES})$ with 1df is asymptotically chi-square distributed. LL_{VS} is the log-likelihood value of the pooled model allowing

significantly lower (or, equivalently, shows higher error variances, and thus higher uncertainty or randomness, in choices) for the subsample that faced only two choice tasks (**Hypothesis 1a**- LR Test: [$\lambda_{Choice12}$ / $\lambda_{Choice2}$]=1; $\chi 2$=17.23, 1 df, p<0.0001).

The heteroskedastic conditional logit model results of the utility specification in Eq. (2) estimated using the pooled data from both response formats are reported in Table 2.3. These results suggest that the marginal utility parameters for variables representing wetland parcel surrounded by woodland, medium level of wildlife diversity, high level of sustainability of habitat quality, wetland parcel connecting two protected areas, the size of the parcel and the marginal utility of the cost to participants are statistically different across the survey formats (see Table 2.3).

Table 2.3 Heteroskedastic conditional logit model results

Variable (n)	**Coefficient (se) [p-value]**
Base Parameters (β_n) when Choice12=0	
Status quo (SQ)	-0.5113 (0.6492) [0.431]
Common_Road	.0216 (0.0775) [0.780]
Heavy_Road	-0.1072 (0.0776) [0.167]
Woodland	0.3418 (0.0803) [0.0001]
Farmland	-0.0037 (0.0804) [0.963]
Medum_WLDiversity	0.0128 (0.0649) [0.843]
High_WLDiversity	0.3767 (0.0644) [0.0001]
Limited_Access	-0.0311 (0.0749) [0.678]
Full_Access	0.3141 (0.0802) [0.0001]
Medium_Sustain	0.1337 (0.0676) [0.048]
High_Sustain	0.1746 (0.0699) [0.012]
Expands	-0.0253 (0.0765) [0.740]
Connects	0.0535 (0.0742) [0.471]
Size	0.0218 (0.0046) [0.0001]
Cost	-0.0119 (0.0055) [0.031]

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varying scale parameters across the choice formats and LL_{ES} is the log-likelihood value of the pooled model assuming equal scale parameters in both response formats.

Male•SQ	0.3067 (0.2633) [0.244]
Age•SQ	0.0178 (0.0094) [0.059]
College•SQ	-0.3633 (0.2748) [0.186]
Additions to Base Parameters (β_{nC12}) when Choice12=1	
SQ•Choice12	1.6184 (1.2447) [0.194]
SQ•Choice12	1.6184 (1.2447) [0.194]
Common_Road•Choice12	0.1137 (0.1007) [0.259]
Heavy_Road•Choice12	0.1139 (0.1019) [0.264]
Woodland•Choice12	-0.2896 (0.1173) [0.014]
Farmland•Choice12	0.0256 (0.1173) [0.827]
Medium_WLDiversity•Choice12	0.2097 (0.0921) [0.023]
High_WLDiversity•Choice12	-0.0394 (0.0988) [0.690]
Limited_Access•Choice12	0.1235 (0.1046) [0.238]
Full_Access•Choice12	-0.0851 (0.1275) [0.504]
Medium_Sustain•Choice12	0.1261 (0.0900) [0.161]
High_Sustain•Choice12	0.3637 (0.0981) [0.0001]
Expands•Choice12	-0.1319 (0.1043) [0.206]
Connects•Choice12	0.2685 (0.1046) [0.010]
Size•Choice12	-0.0106 (0.0059) [0.076]
Cost•Choice12	-0.0176 (0.0092 [0.056]
Male•SQ•Choice12	-0.5512 (0.4677) [0.239]
Age•SQ•Choice12	-0.0259 (0.0182 [0.153]
College•SQ•Choice12	-0.6752 (0.6146 [0.272]
Model statistics	
Log-likelihood value	-1682.465
AIC	3436.93
BIC	3673.429
Number of parameters	36
Wald $\chi 2$, 36 df (p)	258.46 (p<0.0001)
Number of choices	1756
Number of participants	484
Relative scale parameter ($\lambda_{\text{Choice12}}/ \lambda_{\text{Choice2}}$)	1.8484 (p<0.0001)
Pseudo R^2	0.1279

In order to test **Hypothesis 2,** we conducted a series of pair-wise Wald tests of equality of mWTP values for wetland attributes using estimates from the heteroskedastic conditional logit model presented in Table 2.3 across the response formats. mWTP estimates and results of the Wald tests are reported in Table 2.4. The test results suggest a very weak statistical significance on the difference of mWTP estimates across the survey formats when examined individually; the mWTP estimate is statistically different (at the 10% level) for only one of thirteen variables across the response formats. A Wald test for only the variables, whose marginal utility coefficients for the 12-choice presentations were significantly different (see Table 2.3) suggests a statistically different mWTP estimates across the survey formats ($\chi 2$=21.56, 9 df, p= 0.0104). However, that test is biased in favor of rejecting the null, and this result did not hold when we conducted a Wald test of equality of mWTP estimates for all thirteen variables ($\chi 2$= 25.69, 25 df, p= 0.4245).

Table 2.4 Marginal WTP for wetland attributes across the survey formats

Variables[a]	Choice formats		Wald test p-value[c]
	Two choice tasks (Choice12=0)[b]	Twelve choice tasks (Choice12=1)[b]	
Common_Road	-5.38 (-27.09, 16.33)	9.40* (-0.39, 19.20)	0.2238
Heavy_Road	-16.22 (-41.59, 9.15)	5.04 (-3.53, 13.62)	0.1196
Woodland	57.21* (-0.18, 114.59)	4.28 (-5.45, 14.01)	0.0747
Farmland	28.14 (-5.64, 61.93)	3.26 (-6.66, 13.17)	0.1660
Medium_WDiversity	33.85* (-1.94, 69.65	26.52*** (12.35, 40.69)	0.7089
High_WDiversity	64.47** (2.64, 126.29)	30.41*** (14.46, 46.35)	0.2958
Limited_Access	21.19 (-8.07, 50.46)	14.02** (2.97, 25.08)	0.6534
Full_Access	50.24** (0.48, 99.99)	18.66*** (6.26, 31.05)	0.2274
Medium_Sustain	37.19* (-1.04, 75.42)	35.86*** (17.14, 54.59)	0.9512
High_Sustain	40.64* (-1.11, 82.39)	45.30*** (23.36, 67.24)	0.8463
Expands	0.24	0.25	0.9994

	(-22.06, 22.54)	(-7.33, 7.82)	
Connects	6.87 (-15.47, 29.22)	16.49*** (5.33, 27.66)	0.4503
Size	1.84* (-0.01, 3.69)	0.38** (0.06, 0.69)	0.1285

[a]mWTP for a continuous variable (Size) is simply calculated as the ratio of marginal utility of that variable and the marginal utility of the income (negative of β_{Cost}). For effects-coded variables, mWTP is calculated as an addition to WTP for a wetland parcel when the indicated level of the attribute is added relative to the base level of the corresponding attribute, *ceteris paribus.*

[b]95% confidence intervals (CIs) of mWTP estimates are reported in parentheses.

[c]P-values from the pair-wise Wald test of equality of mWTP estimates across the subsamples (Choice12=1,0), i.e., H_O: $mWTP_X^{Choice2} = mWTP_X^{Choice12}$, where $mWTP_X^{Choice2}$ is mWTP for an attribute X for the subsample of participants that faced two choice tasks (Choice12=0) and $mWTP_X^{Choice12}$ is mWTP for an attribute X for the subsample of participants that faced a series of twelve choice tasks (Choice12=1).

Three, two and one asterisk(s) (***, ** and *) indicate significantly different from zero at the 1%, 5% and 10% levels respectively.

2.5.3 Order effects in repeated response survey format

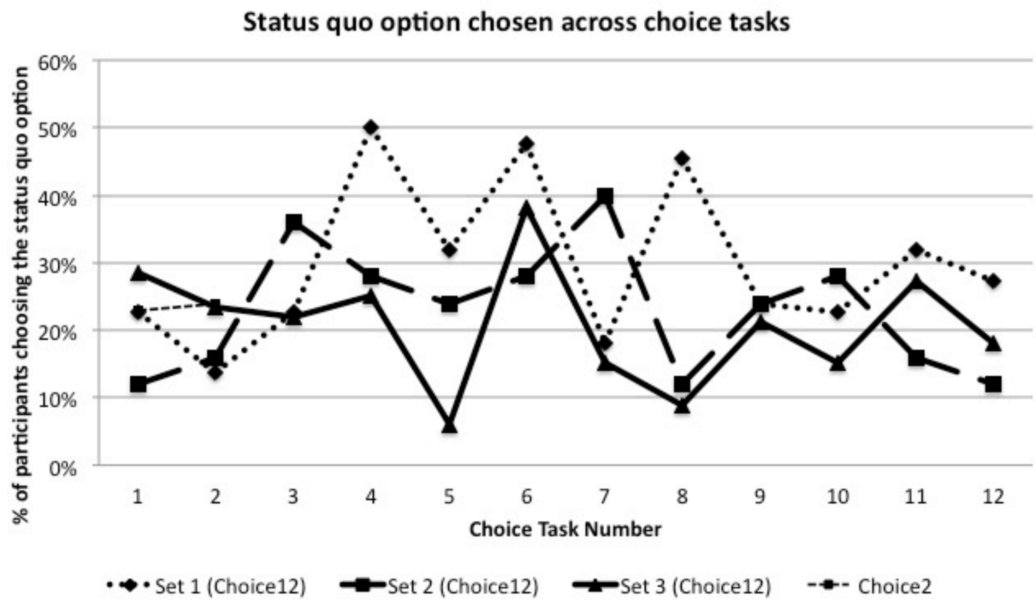
Hypothesis test results regarding the alternative survey formats above suggested that the two formats produced statistically different underlying preference functions. However, our results of pair-wise Wald tests of mWTP estimates for the variables did not show statistical difference across the response formats. Therefore, we now examine responses from the repeated response format or the DCE involving twelve choice tasks to explore the pattern of participants' preferences implied across the sequence of the repeated tasks if we maintain the presumption that individuals' responses are consistent with utility maximization.

We will examine both forms of order effects, position-dependent and precedent-dependent, by creating a set of variables or interactions representing the corresponding effect-type and examining their significance to alter the marginal utility of income as well as their effect on the utility of the status quo option across the sequence. We focus our analysis of *order effects* in terms of the effect on the marginal utility of income which then translates to the effect on marginal willingness to pay (mWTP) and the effect on the utility of the status quo option which will translate to the effect on total WTP values for an alternative relative to the status quo option. Prior research has focused on carefully designed, dichotomous choice with few attributes. This focus allows researchers to identify choice sequences providing scenarios that increase (or decrease) utility from one question to the next. But existing studies have not adequately explored whether precedent-dependent effects might arise in a complex choice experiments that are more typical of modern applications. Yet such applied surveys do not allow researchers as much flexibility in designing a survey with choice sequences for which trends in utility can be expected to be known with high confidence a priori. We address this limitation by using out 2-Choicesurvey data to create an independent means to identify the trends in utility offered in a sequence of choice questions.

2.5.3.1 Variables to examine position-dependent order effects

As already mentioned, 3 sets of 12 choices tasks were created from our experimental design procedure from the pool of 36 choice tasks. First we examined the percentages of participants choosing the status quo option along the sequence of 12 choice tasks. Figure 2.2 shows these results by a graphical representation. Figure 2.2 also shows the percentages of participants choosing the status quo option in the 2-choice presentation and these are within the ranges of the values from the three sets under the 12-choice presentation. Observations from Figure 2.2 suggest that percentages of participants choosing the status quo option are consistent in initial tasks (Task # 1- Task #3) as well as later tasks (Task # 9 – Task #12) between the sets. However, there exists some variation in the responses with respect to the choice of the status quo option in the middle tasks (Task #4 -Task # 8). This observation suggests that we consider a step-wise, discrete group of choice tasks to examine participants' responses along the sequence, which we examine in the following section.

Figure 2.2 Pattern of the choice of the status quo option across tasks between sets



In order to examine whether these discrete group of choice tasks impact the marginal utility of income as well as the utility of the status quo option across the sequence, we created two dummy variables: Position4_8 = 1 for the choice tasks occurring in the 4th through 8th position in the sequence and Position9_12 = 1 for the choice tasks occurring in the 9th through 12th position in the sequence, with zero indicating otherwise respectively. We included interaction terms in the utility specification by interacting these dummy variables (Position4_8 and Position9_12) with the cost attribute ($Cost_{njt}$; Table 2.1) and also with the dummy variable representing the status quo option (SQ_j; Table 2.1) to examine the position-dependent order effects on the cost sensitivity (and thus mWTP) as well as the effect on the status quo utility (and thus total WTP) across the sequence.

2.5.3.2 Variables to examine precedent-dependent order effects

In order to examine whether participants' responses in the current choice task were affected by the type (or nature) of alternatives that appear in the preceding choice tasks, collectively termed as *precedent-dependent order effects*, we created a continuous variable that represents the proportion (or the rate) at which the status quo option was chosen in the preceding choice task as predicted using the responses from the Choice2 subsample data. In order to create this variable, we first estimated a conditional logit model using the utility specification represented in Eq. (2) using the responses from the Choice2 subsample only (so the interaction terms involving Choice12 in Eq. (2) were absent). The estimation results are presented in Manuscript 2- Appendix B1. Then we predicted the probabilities of each alternative being chosen using the estimates from this conditional logit model[24]. The predicted probability for the status quo option was averaged across the participants in the Choice2 subsample, producing the predicted probability of the status quo option for each of 36 choice tasks. This newly created variable "PrevSQChosen" consists of zeros for the first choice task and the estimated probability of the status quo option being chosen in the preceding choice task predicted from the Choice2 subsample model for the subsequent choice tasks in the sequence. This variable is then interacted with the cost variable ($Cost_{njt}$; Table 2.1) as well as with the dummy variable for the status quo option (SQ_j; Table 2.1) to examine its impact on the marginal utility of income (and thus mWTP) and the utility of the status quo option (and thus total WTP).

[24] Accordingly, we used Eq. (1) with the scale parameter normalized to one.

Next, we also created a dummy variable that takes a value of 1 if a *net surplus* value, the difference between the *predicted* willingness to pay for the *most-valued*[25] wetland parcel and the actual cost asked of respondents to buy that parcel in the choice task, is higher in the current choice task relative to the preceding task, and zero otherwise. In order to generate the net surplus value for the most-valued alternative, we used the coefficient estimates from the conditional logit model of the utility specification in Eq. (2) using the responses from the Choice2 subsample only; these coefficients were used to calculate the total utility of the non-status quo alternative and the utility of the status quo option. We then used these utility values (see Manuscript 2-Appendix B) to estimate total WTP[26] values for an alternative relative to the status quo option for each participant for the Choice12 subsample participants using their socio-demographic characteristics. This process provided total WTP value estimates for each non-status quo alternative (Parcel A and Parcel B) for each participant for the 12 choice tasks she or he faced. Then we calculated the difference between the

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[25] Since we are asking participants to state their most preferred alternative in a task, it is certainly relevant for participants to think about the net surplus value they could retain by choosing their most preferred alternative and change in that surplus across the tasks may affect their responses across the sequence.

[26] Total WTP for an alternative wetland parcel relative to the status quo was calculated as -1*[U(Alternative)-U(totalSQ)]/β_{Cost}, where U(Alternative) is the total utility for a non-status quo alternative, U(totalSQ) is the total utility of the status quo option (the β_{SQ} adjusted by β_{ZSQ} using participants socio-demographic profiles) and β_{Cost} is the marginal utility of the cost to participants, using the coefficient estimates from the conditional logit model of utility specification in Eq. (2) using the Choice2 subsample data only (see Manuscript 2-Appendix B).

estimated total WTP value for an alternative parcel and the corresponding amount of money participants were asked to pay for that alternative, providing us with the net surplus value for each non-status quo alternative. We then compared the net surplus value for the most-valued alternative in each choice task across the sequence to determine whether the potential surplus value in the current choice task is increasing or decreasing relative to the preceding choice task. We created a dummy variable "IncrSurplus", which takes the value 1 if the net surplus for the most-valued alternative in current choice tasks is increasing relative to the corresponding value in the preceding choice task, and the value of 0 otherwise. For the first choice task, this variable will take a value of zero. This newly created dummy variable is then interacted with the cost variable ($Cost_{njt}$; Table 2.1) as well as with the dummy variable for the status quo option (SQ_j; Table 2.1) to examine their impact on the marginal utility of income (and thus mWTP) and the utility of the status quo option (and thus total WTP).

2.5.3.3 Empirical model estimation and the LR tests

We estimated a panel mixed logit model (Train, 2003; Revelt & Train, 1998; Train, 1998)[27] assuming a linear utility function using the choices from the survey response

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[27] The *mixlogit* module in Stata (Hole, 2007) was employed to estimate panel mixed logit model using "id (*participant id*)" option to adjust for the potential non-independence of responses to 12 choice tasks from a survey participant. Only non-monetary attributes of wetland parcels (X_{njt}) and cost to participants ($Cost_{njt}$) were specified as normally distributed random variables. All the other variables and interactions were modeled as fixed parameters.

format involving twelve choice tasks only. In order to examine the significance of a set of variables representing corresponding order effects, we first estimated an unrestricted model defined below and tested the parameter restrictions of interest against the unrestricted model. Thus, we defined:

(3) $V_{njt}=\beta_{SQ}SQ_j + \beta_{ZSQ}Z_n\bullet SQ_j + \beta_X X_{njt}+\beta_{Cost}Cost_{njt}$

$+(\beta_{Cost\_P48}Position4\_8+\beta_{Cost\_P912}Position9\_12$

$+\beta_{Cost\_PrevSQ}PrevSQChosen+\beta_{Cost\_IncrSurplus}IncrSurplus)\bullet Cost_{njt}$

$+(\beta_{SQ\_P48}Position4\_8+\beta_{SQ\_P912}Position9\_12$

$+\beta_{SQ\_PrevSQ}PrevSQChosen+\beta_{SQ\_IncrSurplus}IncrSurplus)\bullet SQ_j$

where β_{SQ}, β_{ZSQ} represent the coefficients measuring the utility of the status quo option (SQ_j) and adjusting the utility of the status quo option due to participant-specific socio-demographic characteristics (Z_n); β_X represent the coefficients measuring the marginal utility of the non-monetary attributes of wetland parcels (X_{njt}); β_{Cost} represents the marginal utility of cost to participants ($Cost_{njt}$), often known as the negative of the marginal utility of income; β_{Cost_P48}, β_{Cost_P912} represent the coefficients adjusting the marginal utility of cost to participants due to position-specific dummy variables, Position4_8 and Position9_12 respectively; β_{SQ_P48}, β_{SQ_P912} represent the coefficients adjusting the marginal utility of the status quo due to position-dependent variables, Position4_8 and Position9_12 respectively; β_{Cost_PrevSQ}, $\beta_{Cost\_IncrSurplus}$ represent the coefficients adjusting the marginal utility of cost to participants due to precedent-dependent variables, PrevSQChosen and IncrSurplus respectively; β_{SQ_PrevSQ}, $\beta_{SQ\_IncrSurplus}$ represent the coefficients adjusting the marginal utility of the status quo due to precedent-dependent variables, PrevSQChosen and IncrSurplus respectively.

Estimation results of a panel mixed logit model of the utility specification represented in Eq. (3) are presented in Table 2.5. This is the unrestricted model against which a set of parameter restrictions was tested to examine significance of the variables representing the corresponding order and precedent-dependent effects. The LR test suggests that the interactions representing position-dependent order effects are not statistically different from zero (LR Test: $\beta_{Cost\_P48}=\beta_{Cost\_P912}=\beta_{SQ\_P48}=\beta_{SQ\_P912}=0$; $\chi 2=4.4446$, 4 df, p=0.3492). Next, we conducted a LR by imposing restrictions on the interactions involving the precedent-dependent order effects and found a weak statistical significance (LR Test:$\beta_{Cost\_PrevSQ}=\beta_{Cost\_IncrSurplus}=\beta_{SQ\_PrevSQ}=\beta_{SQ\_IncrSurplus}=0$; $\chi 2=7.5036$, 4 df, p=0.1116). This weak significance is mostly resulted from the relatively stronger significance of the interaction of the precedent-dependent variable IncrSurplus with the cost variable and the status quo option (LR Test: $\beta_{Cost\_IncrSurplus}=\beta_{SQ\_IncrSurplus}=0$; $\chi 2=4.8884$, 2 df, p=0.0868).

Table 2.5 Panel mixed logit model results from repeated survey format

Variable	**Coefficient (se) [p-value]**	**Std. Dev. (se of Std. Dev.) [p-value]**
Non-random parameters		
SQ	0.5818 (1.2916) [0.652]	N/A
Male•SQ	-0.2006 (0.4906) [0.683]	N/A
Age•SQ	-0.0313 (0.0210) [0.137]	N/A
College•SQ	-0.4131 (0.6151) [0.502]	N/A
Position4_8•SQ	0.1884 (0.5166) [0.715]	N/A
Position4_8•Cost	-0.0247 (0.0239) [0.303]	N/A
Position9_12•SQ	0.4541 (0.5709) [0.426]	N/A
Position9_12•Cost	0.0107 (0.0243) [0.658]	N/A

PrevSQChosen•SQ	-1.6687 (2.7676) [0.547]	N/A
PrevSQChosen•Cost	-0.1567 (0.1404) [0.265]	N/A
IncrSurplus•SQ	0.7473 (0.5799) [0.198]	N/A
IncrSurplus•Cost	0.0677 (0.0269) [0.012]	N/A
Random parameters		
Common_Road (n)	0.0754 (0.1303) [0.563]	0.1445 (0.3374) [0.668]
Heavy_Road (n)	0.2358 (0.1333) [0.077]	0.1942 (0.2937) [0.508]
Woodland (n)	0.1573 (0.1486) [0.290]	0.4089 (0.2009) [0.042]
Farmland (n)	-0.0462 (0.1474) [0.754]	0.6043 (0.1692) [0.0001]
Medium_WDiversity (n)	0.3495 (0.1198) [0.004]	0.2371 (0.1940) [0.222]
High_WDiversity (n)	0.6904 (0.1500) [0.0001]	-0.5653 (0.1297) [0.0001]
Limited_Access (n)	0.0521 (0.1344) [0.698]	-0.2570 (0.2732) [0.347]
Full_Access (n)	0.4569 (0.1771) [0.010]	0.9598 (0.1772) [0.0001]
Medium_Sustain (n)	0.2162 (0.1190) [0.069]	0.3483 (0.1675) [0.038]
High_Sustain (n)	1.1284 (0.1582) [0.0001]	0.3207 (0.1980) [0.105]
Expands (n)	-0.2594 (0.1195) [0.030]	-0.1604 (0.1986) [0.419]
Connects (n)	0.6457 (0.1377) [0.0001]	0.4725 (0.1698) [0.005]
Size (n)	0.0179 (0.0088) [0.043]	0.0493 (0.0071) [0.0001]
Cost (n)	-0.0609 (0.0277) [0.028]	0.1221 (0.0201) [0.0001]
Model statistics		
Number of observations	2880	
Number of participants	82	
Log-likelihood (LL)	-703.56108	
Number of parameters	40	
AIC	1487.122	
BIC	1725.744	
LR(χ2), 14 df (p)	366.35 (p<0.0001)	

Table 2.5 presents estimation results of the panel mixed logit model represented in Eq. (3) using the responses only from the repeated response survey format involving twelve choice tasks. Results show that the mean coefficient estimates for most of wetland attribute variables, assumed to be normally distributed, are statistically significant except for a few variables (namely the variable representing type of road as Common_Road, character of surrounding land- Woodland, Farmland, and variable representing a limited public access- Limited_Access) (see Table 2.5). All of the non-monetary wetland attribute variables (random) whose mean coefficient

estimates are statistically significant have a positive impact on participants' utility except for the variable that represents the role of the wetland parcel as expanding an existing protected areas (see Table 2.5), *ceteris paribus*. Statistically significant estimates of standard deviation (SD) for most of the wetland attributes suggest heterogeneity in preferences in relation the corresponding attributes. Results also show that none of parameters for the fixed variables and interactions are statistically significant except for a positive and significant estimate for the interaction of the cost variable with IncrSurplus- the variable representing precedent-dependent effect (see Table 2.5). This positive coefficient estimate indicates that participants who could have a higher *predicted* net surplus value for the most-valued alternative in the current task relative to the preceding task are less cost sensitive than on average and thus have a higher WTP than on average, everything else being fixed.

2.6 Conclusions and implications

In this paper, we examined whether alternative survey formats, i.e., a survey format involving two choice tasks compared to the survey format involving a series of twelve choice tasks, yield statistically equivalent choice outcomes. In particular, we examined whether a set of utility parameters, scale parameters and marginal WTP estimates differ across the response formats. Our application involved a SP survey of trichotomous choices for protecting wooded wetlands in Rhode Island, USA. Our results suggest that the survey format or sequence length results in statistically different marginal utility parameters for some attributes as well as the significantly different scale parameters. A significantly lower scale parameter for the subsample that faced only two choice tasks indicates higher error variance or increased uncertainty or randomness in the two-choice sequence compared to the variance for the subsample that faced a series of twelve choice tasks. Nonetheless, we found only a weak statistical difference of mWTP estimates across the survey formats when compared individually, but found no difference when compared jointly.

We further examined the responses under the repeated response format to explore any form of order effects discussed in the literature. Particularly, we examined position-dependent as well as precedent-dependent order effects by generating a set of variables or interaction terms representing the corresponding effect type and their effect on the marginal utility of cost to participants (and thus marginal WTP) as well as on the utility of the status quo option (and thus total WTP) across the sequence. Our results suggest evidence of a precedent-dependent effect relating to a potential to retain higher *net surplus* from the *most-valued* alternative in the current task relative to the *most-valued* alternative in the preceding task may induce participants to be less cost-sensitive and thus appear to have a higher WTP due to the precedent-dependent effect.

Our application using trichotomous choice format of wetland parcel preservation provides evidence of precedent-dependent effects. A recent study by Scheufele & Bennett (2012), using repeated binary discrete choice experiments, examined whether *strategic opportunities* provided by the order in which choice sets are presented affect choice decisions and found evidence of such effects in terms of participants' increased cost sensitivity and thus lowering estimated willingness to pay (WTP) estimates if the same or similar level of provision was offered in the previous choice task at a lower cost than if it was not. However, they found that the cost sensitivity and thus WTP remains unaffected if the same or similar level of provision was offered in the previous choice task at a higher cost. Their results also indicate that the cost sensitivity increases (and WTP decreases) as participants progress through the sequence of choice tasks. There is also a large number of studies which documented order effects of precedent-dependent type, such as *starting task effects* (Bateman, Day, Dupont, & Georgiou, 2009; Herriges & Shogren, 1996; Ladenburg & Olsen, 2008) or *reference effects* (Isoni, 2011; Mazumdar, Raj, & Sinha, 2005). There are also studies that documented order effects of position-dependent type such as *learning effects* (Braga & Starmer, 2005; Plott, 1993) or *fatigue effects* (Bradley & Daly, 1994; Savage & Waldman, 2008). Our results, however, did not display any evidence of position-dependent order effects. Advanced awareness (or disclosure because participants were able to see the repeated choice tasks in a printed survey booklet mailed to them) of the repeated format may have mitigated these position-dependent orders effects in our application, consistent with the conclusions by Bateman et al. (2004) and Scheufele & Bennett (2013).

We also note one important observation from the previous studies, however, that these studies differ substantially in terms of number of choice tasks, choice context, experimental design as well as empirical models to estimate preference parameters and scale parameters. These differences between the studies could have contributed to different results in terms of whether and how these order effects are observed in those studies. Nonetheless, it may be worth deeper exploration of orders effects- both position-dependent as well as precedent-dependent in multinomial response formats. Since our application involved only two lengths of choice tasks, we could not test the idea of learning effect in relation to fatigue effect across the sequence which we could have done if we had more survey length subsamples such as surveys involving four, six or eight choice tasks. Future research could also investigate the type of strategic responses or other biases in terms of latent class modeling to learn about these behavioral phenomena across the classes of participants represented by their distinct preference functions.

Our results, however, are consistent with the idea that may not be readily influenced by position-dependent effects once analysts account for heteroscedasticity. However, our evidence that precedent-dependent effects, linked to the potential that a sequence of choice questions could offer increasing (or decreasing) net benefits influences estimates of the marginal utility of income raises concern about the validity of WTP estimates. Survey respondents might view a sequence to which net benefits tend to increase as one offering "good deal", whether this situation triggers a strategic behavior of respondents seeking to signal a demand for increasing surplus or avoiding "bad deals" may not be resolved by this one study. But the effect found here would tend to increase estimates of WTP. Future research may be needed to identify whether it is this increased WTP estimate that is or is not closer to true WTP.

2.7 Manuscript 2 References

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R., & Schuman, H. (1999). *Report of the NOAA panel on contingent valuation* (Federal Register No. 58) (pp. 4601–4614).

Bateman, I. J., Cole, M., Cooper, P., Georgiou, S., Hadley, D., & Poe, G. L. (2004). On visible choice sets and scope sensitivity. *Journal of Environmental Economics and Management*, *47*(1), 71–93.

Bateman, I. J., Day, B. H., Dupont, D. P., & Georgiou, S. (2009). Procedural invariance testing of the one-and-one-half-bound dichotomous choice elicitation method. *Review of Economics and Statistics*, *91*(4), 806–820.

Bradley, M., & Daly, A. (1994). Use of the logit scaling approach to test for rank-order and fatigue effects in stated preference data. *Transportation*, *21*(2), 167–184.

Braga, J., & Starmer, C. (2005). Preference anomalies, preference elicitation and the discovered preference hypothesis. *Environmental and Resource Economics*, *32*(1), 55–89.

Carson, R. T., & Groves, T. (2007). Incentive and informational properties of preference questions. *Environmental and Resource Economics*, *37*(1), 181–210.

Day, B., Bateman, I. J., Carson, R. T., Dupont, D., Louviere, J. J., Morimoto, S., Scarpa, R., & Wang, P. (2012). Ordering effects and choice set awareness in repeat-response stated preference studies. *Journal of Environmental Economics and Management*, *63*(1), 73–91.

DeShazo, J. R., & Fermo, G. (2002). Designing choice sets for stated preference methods: The effects of complexity on choice consistency. *Journal of Environmental Economics and Management*, *44*(1), 123–143.

Dillman, D. A. (1978). *Mail and Telephone Surveys. The Total Design Method*. John Wiley & Sons, New York, NY.

Farquharson, R. (1969). *Theory of voting*. Yale University Press, New Haven.

Gibbard, A. (1973). Manipulation of voting schemes: A general result. *Econometrica*, *41*(4), 587–601.

Hensher, D., Louviere, J., & Swait, J. (1998). Combining sources of preference data. *Journal of Econometrics*, *89*(1–2), 197–221.

Herriges, J. A., & Shogren, J. F. (1996). Starting point bias in dichotomous choice valuation with follow-up questioning. *Journal of Environmental Economics and Management*, *30*(1), 112–131.

Hole, A. R. (2007). Fitting mixed logit models by using maximum simulated likelihood. *Stata Journal*, *7*(3), 388–401.

Isoni, A. (2011). The willingness-to-accept/willingness-to-pay disparity in repeated markets: loss aversion or “bad-deal” aversion? *Theory and Decision*, *71*(3), 409–430.

Johnston, R. J., Weaver, T. F., Smith, L. A., & Swallow, S. K. (1995). Contingent valuation focus groups: Insights from ethnographic interview techniques. *Agricultural and Resource Economics Review*, *24*(1).

Ladenburg, J., & Olsen, S. B. (2008). Gender-specific starting point bias in choice experiments: Evidence from an empirical study. *Journal of Environmental Economics and Management*, *56*(3), 275–285.

Manuscript 1. *Consequential cash choice experiments and restoration of NROC's ecosystem: Do the provision rules matter?*

Mazumdar, T., Raj, S. P., & Sinha, I. (2005). Reference price research: Review and propositions. *Journal of Marketing*, *69*(4), 84–102.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. *In Frontiers in Econometrics*. Academic Press.

Moulin, H. (1994). Social choice. In *Handbook of game theory with economic applications*. North-Holland, Amsterdam.

Newell, L. W. (2003). *Analyzing public preferences and valuations for forested wetlands in RI: Comparison of real-money and hypothetical survey presentations* (PhD Dissertation). University of Rhode Island, Kingston, RI.

Newell, L. W., & Swallow, S. K. (2013). Real-payment choice experiments: Valuing forested wetlands and spatial attributes within a landscape context. *Ecological Economics*, *92*, 37–47.

Plott, C. R. (1993). *Rational Individual Behavior in Markets and Social Choice Processes* (Working Paper No. 862). California Institute of Technology, Division of the Humanities and Social Sciences.

Revelt, D., & Train, K. (1998). Mixed logit with repeated choices: households' choices of appliance efficiency level. *The Review of Economics and Statistics*, *80*(4), 647–657.

Rose, J. M., Hess, S., Bliemer, M. C. J., & Daly, A. (2011). The Impact of varying the number of repeated choice observations on the mixed multinomial logit model. Presented at the Transportation Research Board 90th Annual Meeting.

Satterthwaite, M. A. (1975). Strategy-proofness and Arrow's conditions: Existence and correspondence theorems for voting procedures and social welfare functions. *Journal of Economic Theory*, *10*(2), 187–217.

Savage, S. J., & Waldman, D. M. (2008). Learning and fatigue during choice experiments: A comparison of online and mail survey modes. *Journal of Applied Econometrics*, *23*(3), 351–371.

Scheufele, G., & Bennett, J. (2012). Response strategies and learning in discrete choice experiments. *Environmental and Resource Economics*, *52*(3), 435–453.

Scheufele, G., & Bennett, J. (2013). Effects of alternative elicitation formats in discrete choice experiments. *Australian Journal of Agricultural and Resource Economics*, *57*(2), 214–233.

Train, K. (2003). *Discrete Choice Methods with Simulation*. Cambridge University Press.

Train, K. E. (1998). Recreation demand models with taste differences over people. *Land Economics*, *74*(2), 230–239.

Vossler, C. A., Doyon, M., & Rondeau, D. (2012). Truth in consequentiality: Theory and field evidence on discrete choice experiments. *American Economic Journal: Microeconomics*, *4*(4), 145–171.

MANUSCRIPT 2–APPENDIX B

This appendix provides the estimation results of the conditional logit model of the utility specification in Eq. (3) using the responses from the survey involving only two choice tasks, so that the interaction terms involving Choice12 were absent.

B1. Conditional logit model results from Choice2 subsample

Variable	**Coefficient (se) [p-value]**
Status quo (SQ)	-0.5113 (0.6492) [0.431]
Common_Road	.0216 (0.0775) [0.780]
Heavy_Road	-0.1072 (0.0776) [0.167]
Woodland	0.3418 (0.0803) [0.0001]
Farmland	-0.0037 (0.0804) [0.963]
Medum_WLDiversity	0.0128 (0.0649) [0.843]
High_WLDiversity	0.3767 (0.0644) [0.0001]
Limited_Access	-0.0311 (0.0749) [0.678]
Full_Access	0.3141 (0.0802) [0.0001]
Medium_Sustain	0.1337 (0.0676) [0.048]
High_Sustain	0.1746 (0.0699) [0.012]
Expands	-0.0253 (0.0765) [0.740]
Connects	0.0535 (0.0742) [0.471]
Size	0.0218 (0.0046) [0.0001]
Cost	-0.0119 (0.0055) [0.031]
Male•SQ	0.3067 (0.2633) [0.244]
Age•SQ	0.0178 (0.0094) [0.059]
College•SQ	-0.3633 (0.2748) [0.186]
Model statistics	
Number of observations	2388
Number of participants	402
Log-likelihood value	-791.8468
AIC	1619.69
BIC	1723.70
Wald $\chi 2$, 18 df (p)	109.45 ($p<0.0001$)
Pseudo R^2	0.0945

MANUSCRIPT 3

DOES LINDAHL-INSPIRED INDIVIDUALIZED PRICE AUCTION (IPA) GENERATE HIGHER OFFERS THAN A VOLUNTARY DONATION ELICITATION? A REAL-MONEY FIELD EXPERIMENT ON ECOSYSTEM-SERVICE PUBLIC GOODS

Prepared for submission to mainstream journal of environmental and natural resource economics

3.1 Abstract

Benefits from provision of public goods cannot be made exclusive. This non-exclusive characteristic of the public goods naturally creates an incentive for individuals to 'free-ride' on others' contribution, resulting persistently in under-provision of such goods. Some individuals still contribute towards the private provision of such public goods despite the well-known free-rider problem in both laboratory experiments as well as actual fund-raising efforts. One relatively pragmatic public good institution, that may mitigate the 'free-riding' behavior, is an individualized price auction (IPA) motivated by Lindahl's framework for public goods. We solicit individualized offers for multiple successive units or a range of quantities (or units) of the good under the IPA approach. These multiple successive offers generated from the IPA approach are then empirically compared against the corresponding offers generated from a voluntary donation institution, both incorporating the incentive mechanisms from experimental economics literature including a provision point (PP) with a money back guarantee (MBG) and proportional rebate (PR) of any excess funds beyond the PP. Using a split sample approach in a field experiment setting, we ask participants to contribute real dollars towards public good projects focused on water quality improvements resulting from implementing best manure management practices in local livestock farms in their local watershed system. Our results suggest that participants under the voluntary donation approach made higher offers, on average, than those under the IPA. Even though individuals' average offers were approximately constant across the available range of improvements (or quantities of the good) in water quality under both institutions, we discovered a statistically different pattern of offers. Results from a two-limit tobit model further suggest a statistically significant effect of participants' socio-demographic profiles on the expected total offers for the public good across the two public good institutions.

Key words: Public good provision, individualized price auction, proportional rebate, provision point, voluntary donation, best manure management practice, water quality

3.2 Introduction

Valuing public goods and their efficient provision have posed a fundamental challenge to both economists and fundraisers because the providers of public goods cannot exclude potential beneficiaries who do not pay toward the cost of provision. Thus public goods naturally create an economic incentive for individuals to "free-ride" on others' contributions. The game-theoretic prediction in a public good experiment is that contributing nothing may be a dominant strategy for an individual (Ledyard, 1995), no matter how much the others contribute. The total free rider prediction seems evidently not true in previous public good experiments. Existence of the "free rider problem" obviously cannot be denied in these experiments, but it is also true that a change in public good institutions, under which individuals contribute to provide these goods, may mitigate the free rider problem. Without any additional change in institutional structure, for example, a voluntary donation approach will not produce the Pareto[28] optimal level of public good provision. But it may be possible to create a Pareto improvement by changing the institutional structure, and thus the incentive structure, under which individuals make contributions (Groves & Ledyard, 1977; Ledyard & Palfrey, 1994).

One promising and relatively more pragmatic institutional structure is a public good auction approach developed by (Swallow, Smith, & Anderson, 2013), hereafter referred to as the individualized price auction (IPA)[29], which is motivated by Lindahl's

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[28] Pareto optimal, also known as Pareto efficient, outcome is a state of allocation of a public good in which it is not possible to make any individual better off without making at least one individual worse off.

[29] The IPA is patented business process, patent number US 8,429,023 B2 sponsored by

framework for public goods (Lindahl, 1919). Lindahl's equilibrium (Lindahl, 1919; Samuelson, 1954, 1955) is an efficient equilibrium for public goods and the IPA approach, motivated by this framework, can reach a Pareto optimal level of public good provision theoretically if each individual were to contribute their full marginal value on each unit of the good (Groves & Ledyard, 1977; Walker, 1981) However, economic consensus has long held that it may be impossible to generate enough funding for the Pareto optimal level of public goods in real situations (Nicholson, 2005). This consensus among economists has not been well tested in empirical framework except Smith & Swallow (2013) and Smith (2012). One of the simple institutions most tested in laboratory public good experiments is a voluntary contribution mechanism (VCM). Our study empirically compares the revenue generation potential of the IPA approach compared to voluntary contribution mechanism (VCM) with the provision point (PP) and a money back guarantee (MBG) and the proportional rebate (PR) incentive mechanisms.

We employed a split sample design to compare offers under these two public good institutions. We utilized a field application in which participants contributed real dollars towards implementing manure management projects in their local watershed. Our results suggest that higher offers, on average, are realized under the voluntary donation approach than those under the IPA, although average contributions remain approximately constant for the available range of improvements in water quality (or units of the good) across the public good treatments. Our results also suggest

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heterogeneous contributions across socio-demographic profiles of participants between the public good treatments.

In previous experimental studies of the voluntary donation elicitation, participants have been provided with an endowment of experimental dollars and are asked to voluntarily provide some of the endowment towards the provision of the public good. Participants receive benefits the public good provides net of the cost they voluntarily paid. Under this institution, the Pareto optimal level of provision results when all participants contribute their full endowment (Davis & Holt, 1993), but the dominant strategy for an individual is to contribute nothing, producing a non-cooperative equilibrium that is not a Pareto optimal level (Ledyard, 1995). However, experimental evidence also suggests that many participants contribute to the public good, usually 40-60% of endowed experimental dollars, although, conditional on everyone else's contribution, one individual could maximize his or her payoffs by contributing nothing (Dawes & Thaler, 1988). Economists have incorporated various incentive mechanisms into the voluntary donation institution to mitigate "free-riding" behavior. One important modification is a provision point or a threshold, i.e., minimum amount of money required to implement the public good (Bagnoli & Lipman, 1989; Bagnoli & Mckee, 1991). It is found to induce participants to make higher offers than occurs without the provision point (Bagnoli & Mckee, 1991; Suleiman & Rapoport, 1992; Rondeau, Schulze, & Poe, 1999; Rondeau, Poe, & Schulze, 2005). Under the provision point mechanism, "free-riding" is no longer a dominant strategy. Furthermore, a money back guarantee (MBG) ensures participants that their offers will be returned if the group is unable to meet the pre-determined provision point. A MBG has been found to generate higher offers than the experiments without the MBG (Isaac, Schmidtz, & Walker, 1989; Rapoport & Eshed-Levy, 1989; Marks & Croson, 1998; Cadsby & Maynes, 1999; Spencer, Swallow, Shogren, & List, 2009). In case of the excess funds beyond the provision point, a proportional rebate (PR) rule, which returns excess funds to the participants in proportion to their original offer, imposes a weaker marginal penalty for over-contributions than does a mechanism without a rebate (Marks & Croson, 1998) and thus has been found to garner higher offers (or at least no lower offers) when used with a provision point and a MBG (Marks & Croson, 1998; Rondeau, Schulze, & Poe, 1999; Poe, Clark, Rondeau, & Schulze, 2002; Spencer et al., 2009). These previous public goods experiments employing a voluntary donation elicitation with the incentive mechanisms solicit participants' offers for a single unit of the public good.

A long-held consensus among economists that it may be impossible to raise enough revenues for efficient provision of public goods has been put into an empirical test recently by Smith & Swallow (2013) and Smith (2012) by developing a public good auction approach- the IPA. The IPA approach solicits offers on successive cumulative units of a public good. For each unit of the good, the IPA establishes many individualized prices, one for each participant. An equilibrium quantity of the good, for a group of individuals, is determined based on the last unit of the good for which the aggregate offers from all individuals on that unit covers or exceeds the delivery cost of that unit (Smith & Swallow, 2013). A chief motivation of the IPA is that the auctioneer evaluates bids sequentially, so that bidders know in advance that bids on each unit must be sufficient to provide that unit in order for the auctioneer to move on to evaluate bids on the subsequent unit, while the payment will be determined by bids on that last unit provided. This conditional bid evaluation process may encourage participants to offer a sequence of non-increasing bids in hopes of building an excess of benefits over costs as the auction delivers a higher number of units. In theory, the IPA approach can reach the optimal level of public good provision if each individual offers his or her full marginal value on each unit. In this study, we employed the IPA approach by incorporating the provision point (PP) with a money back guarantee (MBG) and the proportional rebate (PR) of the excess funds, if any, beyond the PP.

There exists almost no empirical study examining the empirical performance of Lindahl's framework for provision of public goods in experimental settings except Smith & Swallow (2013) and Smith (2012). Smith (2012) explored the feasibility of implementing the IPA using incentive mechanisms – proportional rebate (PR) and pivotal mechanism (PM)[30] - by eliciting offers on successive units of the public good, thus obtaining individual marginal offer curves. Employing a split-sample design, she used laboratory experiments to explore the IPA and also compared the results using field experimental settings involving actual implementation of public goods with real contribution to pay for provision. Her results suggest that participants were making

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[30] The pivotal mechanism (PM) is adapted from the Vickrey-Groves-Clarke mechanism, which employs a provision point (PP) to provide the marginal unit of a public good if the sum of the groups' contributions covers the delivery cost of the public good. In this case, a participant is considered to be pivotal on the marginal unit if the public good cannot be provided without his or her contribution. Also, participants who are considered to be pivotal will pay only the contribution required to meet the provision point.

offers consistent with decreasing marginal benefits for additional units of the good. The IPA may perform better than many public good experiments seen in the literature in terms of higher average proportion of induced value offered in the first unit of the good in the IPA (Smith, 2013) relative to one-shot single-unit induced value experiment. She also compared the marginal offers (or estimates) elicited from the IPA with the marginal values (i.e., marginal willingness to pay or mWTP) estimated from a discrete choice experiment (DCE) involving binary choices with the incentive-compatible majority provision rule. This comparison suggested that the marginal estimates from the IPA are not statistically different from the mWTP estimates from the DCE, which supports the promising result in favor of the IPA process. Yet, the empirical performance of the IPA process for the private provision of public goods still remains inadequately understood.

This study empirically compares the performance of the IPA approach in terms of revenue generation potential relative to a voluntary donation elicitation for private provision of public goods in a framed field experiment (Harrison & List, 2004; List, 2008). Unlike most previous public good experiments, our study elicits participants' offers on successive and non-uniform discrete units of a public good by employing the IPA process. The marginal offers on the successive non-uniform discrete units of the good elicited under the IPA approach are empirically compared to the donations elicited under a voluntary donation when both approaches use the PP with a MBG and the PR of any excess funds beyond the PP. Employing a split sample approach, this study utilizes a field application where participants contributed real dollars to provide an ecosystem service regarding water quality in their local watershed system through improved manure management practices in local livestock farms.

This paper is organized as follows. Section 3.3 outlines the theoretical framework. Section 3.4 described the field experimental design and procedures. Section 3.5 reports the results and section 3.6 discusses the conclusions and implications of the results.

3.3 The conceptual model

Consider a problem of delivering multiple units of a public good, but when these units are only available in discrete packages. This situation could apply to protection of water quality by implementing manure management on farms of various sizes. Then consider raising funds for the public good by soliciting donations. Rather than open-ended donations, we take a more structured approach of requesting donations for a task, where each task j adds q_j units of public good to the preceding task, for an accumulated provision of Q_j in task j, which incorporates all the q_k for k <= j ($Q_j=\Sigma_j q_j$). We will empirically examine the solicitation of donations through a sequence of donation tasks, numbering J', as compared to a sequence of the IPA tasks, numbering J = 2J', covering the same range of total units ($Q_{J'} = Q_J$) using the more structured IPA approach.

Now, consider a group of N field experiment participants. Each individual participant i is provided with a fixed personal budget (B). Each auction participant is asked to offer his or her contribution for a collection of units of a public good Q_j in task j. A task j included a collection of units of a public good and the number of units of the good offered in a task is based on a discrete project that providers can deliver. Therefore, each task consists of non-uniform discrete collection of units of the good. Participants are asked to make offers for multiple tasks, j=1,2,3, …, J.

Under the IPA approach, participants choose a "contribution per unit" to buy all the units included in a particular task, multiplying the "contribution per unit" offer with the total units included in that task equals the total offer for that task. Participants faced two types of constraints regarding their decisions to contribute to a particular task under the IPA process: (i) their total offer in a task cannot exceed the fixed personal budget B and (ii) they could only offer the same or less "contribution per unit" in the subsequent tasks than in the preceding task. Unlike other public goods institutions examined in a majority of previous experiments, the IPA process in our experiments elicited participants' offers on successive non-uniform discrete collection of units of the public good, thus producing a total of J offers on the corresponding J tasks.

Under the voluntary donation approach, participants choose a lump-sum amount to offer, any amount between $0 and the fixed personal budget B, for all the units of the good included in a particular task. Participants faced only one constraint regarding their decisions to contribute to a particular task, i.e., the lump-sum amount of donation for a particular task cannot exceed the fixed budget B. Moreover, J tasks presented to IPA participants were reduced to J' (=J/2) by merging successive pairs of tasks under IPA to create tasks under the voluntary donation approach. This merging of successive pairs of tasks allows a comparison of the IPA to a multi-unit ordinary donations approach. While the IPA approach looks at discrete lumps of units, based on price per unit that can be delivered (but the units had to be delivered in packages corresponding to on-farm projects), the donations approach just asks for money that will be used to carry out as many projects as possible to deliver as many units within a given range as possible. Unlike previous experiments using the voluntary donation approach, our field experiment participants made a total of J' lump-sum amounts of donations to be used for the corresponding J' non-uniform discrete sets of units of the public good to go as far as possible delivering units within a particular range covered in the task. Thus, like common philanthropic donation, payment was not tied to specific quantity delivered, except that delivery of within the range of a given tasked assured delivery of all units from the preceding task.

We employed a provision point (PP) mechanism with the MBG, if no units of the public good are provided, and proportional rebate (PR) of any excess funds beyond the PP from offers that apply to the units of the delivered task. The PP mechanism requires that the sum of the offers from all participants in a particular task equal or exceed the delivery cost of providing the units of the public good in that task. Since each participant makes an offer for each task for a total of J IPA tasks (or J' Donation tasks), there will also be the corresponding J (or J') number of provision points or one provision point for each task, denoted by PP_j. The implemented level of the public good will be the task, hereafter referred to as a *binding task*, for which the sum of offers from all participants is equal to or exceeds the corresponding provision point PP_j. If no bundle of units of the good is provided i.e., no PP_j is met, the MBG ensures that participants would receive their fixed budget B back. If a set of units of the good, the units of the good in some task j, are provided and result in excess funds collected (based on offers for task j) beyond the corresponding provision point PP_j, participants would receive the excess funds back in a rebate. The rebate amount will be in proportion to their total offer in the *binding task* j, as defined by the PR rule.

The payoff function for participant i in the field experiment based on the PR rule is given by the following expression:

(1) $\Pi_{ij*}=(B-O_{ij*})+V_{ij*}+ (O_{ij*}/\Sigma_i O_{ij*}) (\Sigma_i O_{ij*}-PP_{j*})$ for $j\{1,\ldots,J\}$, $j^*=\max\{j| \Sigma_i O_{ij}\geq PP_j$ for all $j\leq j^*$

$\Pi_{ij}=B$ only if max j with $\Sigma_i O_{ij}\geq PP_j$ does not exist for $j\geq 1$.

where Π_{ij} gives the earning for a participant i in the experiment which is equal to their budget net of the total offer in the *binding task* j ($B-O_{ij}$) plus the (monetized) benefits of the units of the good to participant i denoted by V_{ij} and any rebate in proportion to the original total offer O_{ij} in the *binding task* j beyond the PP_j given by last term in the first line of Eq. (1). Since the MBG feature is included in our experiments, participants receive their full budget B if no collection of units of the good is provided, as given by the second line of Eq. (1) above.

As discussed and illustrated graphically in Swallow (2013), Smith & Swallow (2013) and Smith (2012), participants in the IPA framework may have a unilateral incentive to make offers reflecting their marginal value in an expectation to retain added surplus value if the auction settles on later units. Moreover, the IPA approach asks participants about their "price per unit" offer trying to mimic a familiar market purchasing decisions, although they were asked about the public good. In sum, the IPA approach constituted a framework to induce participants to think in a more structured way to decide on their contribution for the public good. A voluntary donation elicitation, on the other hand, asks participants about their lump-sum amount of donation for units of the good, which is a less-structured framework for public goods. Unlike previous public good experiments employing a voluntary donation approach, our field experiments asked a series of donations for the corresponding successive non-uniform discrete set of units of the good. Although none of the public good institutions in our field experiments is theoretically incentive-compatible, incentives embedded in the IPA approach from Lindahl's framework for public goods may suggest that the IPA may garner higher offers than the voluntary donation elicitation.

3.4 A field application to water quality ecosystem service in local watershed

3.4.1 Study background and area

This study was part of a larger project that aimed to demonstrate a market-like process for delivery of ecosystem services by bringing together both sides of the market, i.e., the suppliers of ecosystem services and the potential consumer beneficiaries from provision of such services (Uchida et al., 2014). In the larger part of the project, a spatially-explicit watershed simulation model was developed using the Soil and Water Assessment Tool (SWAT)[31] to model the relationship between the manure management decisions on local livestock farms within a watershed and the change in

[31] SWAT is a watershed hydrological transport model developed to quantify the impact of land management practices on water, sediment, and agricultural chemicals using components like weather hydrology, soil temperature and properties, plant growth, nutrients, pesticides, bacteria and pathogens and land management (Arnold et al., 2012).

phosphorus loadings (kg P reduced per year for 20 years) into the Scituate Reservoir waters in Rhode Island, USA.

Phosphorus is a naturally occurring nutrient that helps plants grow. The natural environment in a watershed system can absorb and use phosphorus without pushing the natural function of the ecosystem outside its normal character. However, human actions also contribute phosphorous to the watershed system via various activities, and thus human actions can push the natural system to that threshold or beyond. One such prominent, human-induced source of phosphorous to the watershed system is pastureland where livestock are raised. A recent limnological study documents evidence of phosphorus-driven eutrophication and algal blooms in some portions of the reservoir system (ESS Group, Inc., 2011). One way to reduce phosphorus loadings from human-induced sources into the reservoir water is to implement manure management practices in local livestock farms, which may prevent leaching phosphorous from livestock manure by rainwater which drains to the nearest water bodies and ultimately to the reservoir system.

We collaborated with local conservation groups, focus group participants and mailings to identify livestock owners who could voluntarily agree to participate in our supply side field experiment. Best manure management practices in our project involved two types of practices: i) building a manure pad to store livestock manure instead of piling manure in nearby woods leaving it exposed to rain; and ii) installing a gutter system to redirect rain water off the manure piles to a safer outlet. Phosphorus prevented from entering the water bodies through the manure management practices reduces the excessive growth of plants, thereby reducing the algal bloom events and thus prevents the surface water quality from deteriorating. In order to derive a supply curve for improved water quality, Uchida et al. (2014) conducted a reverse auction process to solicit bids for payments from local livestock owners to implement best manure management practices on their farms in exchange for compensation.

The major objective of the present study is to bring the demand-side dimension, meaning potential consumer beneficiaries' values in terms of willingness-to-contribute for improved water quality, into a market-like process for improved water quality. In order to do so, we conducted field experiments to ask local resident-volunteers how much they would be willing to contribute for water quality improvements in their watershed system. We conducted these demand-side field experiments in the context of the Scituate reservoir system, which supplies drinking water to residents of the city of Providence and surrounding suburb communities in Rhode Island, USA. The reservoir system is composed of six interlinked sub-watersheds. The town of Scituate constitutes the major part of the watershed system including some portions of the towns of Foster and Glocester, Rhode Island, USA. The reservoir system does not serve drinking water to the residents of these towns directly, but the residents are known to enjoy recreating in the watershed. Furthermore, many resident volunteers, who participated in our focus group discussions, expressed their sense of being responsible 'stewards' of the watershed. Some also considered a potential hydrologic linkage between surface water quality and ground water sources that provide their own household with drinking water.

3.4.2 The public good

Many ecosystem services, like improved water quality in our study, are public goods because the providers (or local livestock owners) of these services cannot require potential beneficiaries to pay for these services. The consumer beneficiaries of improved water quality in a local watershed system may enjoy the benefits without having to pay for those benefits. Therefore, the public good in our field experiment is the improvement or protection of water quality in the local watershed system, with the unit of the good described as the phosphorus reduction at the reservoir that would have resulted from a proportional number of tons of cow manure prevented from entering the reservoir directly. Tons of cow manure prevented from entering the reservoir represents the units of the good (affecting water quality); these units were chosen to present water quality improvements in more familiar terms to the field experiment participants as potential donors.

3.4.3 Field experiment participants

A commercial marketing company, Lighthouse Consulting Group, recruited participants for our field experiments. Participants for the experiment were adult citizens living in one of the towns of Scituate, Foster and Glocester in Rhode Island, USA and were contacted through posting invitation flyers to the town email listserv, town websites, local newsletters, and on-the-ground distribution, as well as posters in local public places. Contacted individuals were asked to sign up for one of the available nights and were offered a $50 participation fee.

3.4.4 Experimental procedures

Participants were gathered in a local community building of the town of Scituate to participate in a 2-hour session titled "Water Quality Decision-Making Workshop". A total of three sessions were conducted among which two involved the IPA treatment and the remaining one involved the voluntary donation treatment. Each participant took part in only one of the three sessions. Participants were requested to avoid talking to their friends or neighbors about the workshop and were told multiple sessions would be held during a 2-week period. Each session was led by the same experiment moderator and involved the same set of experimental procedures to keep information provided to participants across the sessions as similar as possible. The only difference between the treatments was the description of the corresponding treatment. To summarize, each session involved the following steps.

3.4.4.1 Background presentation

The experiment moderator[32] began each session with a scripted PowerPoint presentation to provide participants with information on the linkages between manure management practices in local livestock farms, phosphorus and the implications for the water quality of the reservoir system. The presentation involved illustrations using example photographs of water bodies affected by excessive phosphorus loadings, as

[32] The authors gratefully acknowledge the excellent moderation of the field experiments by Carrie A. Gill, Graduate Research Assistant at the Department of Environmental and Natural Resource Economics (ENRE), University of Rhode Island, Kingston, Rhode Island, USA (see Manuscript 3-Appendix C2 for additional details).

well as structures to be installed, if implemented, as best manure management practices. After the background presentation on manure management, phosphorus and water quality, participants were told that each would receive $100, in addition to the $50 participant fee, with which they could decide between contributing to a collective fund to pay for implementing on-farm manure management projects or to take some money home to spend on other priorities. A brief question-answer session was allowed at the end of the presentation and the moderator carefully answered questions raised to maintain neutrality of the information given to the participants, without leading them in any direction.

3.4.4.2 Survey instrument

Each participant was provided with a survey packet that consisted of a survey booklet (see Manuscript 3-Appendix C3) and an official envelope of University of Rhode Island, Department of Environmental and Natural Resource Economics (ENRE). Before participants started making decisions on contributions toward on-farm manure management projects, each participant was asked to write their home address on a mailing envelope so that the research team could send the remaining portion of their $100, if any, to participants based on the outcome of the workshops at the end of all sessions to be held in a 2-week period (October 28- November, 12, 2014). The survey booklet was developed to solicit participants' contributions or offers for on-farm manure management projects. The booklet contained written instructions for soliciting participants' offers and the experiment moderator read these instructions aloud, along with the participants. Participants were provided with a form soliciting their offers for the manure management projects; in the IPA they made six offers (J=6), while in the donations workshop, participants made three offers (J'=3).

In the IPA workshop (treatment group), participants were asked to evaluate a series of six "tasks" representing a set of on-farm manure management projects. Two or more on-farm projects from participating livestock owners were combined[33], by preserving the ranking of the projects in terms of cost per kg of P reduced per year for 20 years so that the most cost-efficient projects appear first in the sequence and the least cost-efficient at the end, to form these tasks. IPA participants were asked to make a "price per ton" offer for manure management projects, multiplying with the tons of cow manure managed by a given task to obtain the total offer for that project in the first task. The second task included the manure management from the first task (q_1) and an additional increment (q_2), that could be delivered at the second cheapest cost per kg P reduced per year for 20 years, by combining tons of cow manure prevented from both the tasks, (so task 2 would deliver a total of $Q_2 = q_1 + q_2$ kg reduction in P loadings) and so on to define tasks 3 through 6 for the IPA. Participants were instructed that their total contribution or offer in each task was not allowed to exceed

[33]A farmer or provider of improved water quality implements a fixed-impact project and these are ordered by cost per kg of phosphorus loading to the reservoir. In practice, we sometimes merged two or more on-farm projects into one discrete on-farm project, but the main idea for the economics is that the q_j increments were fixed by the technology of on-farm manure management, which was tied to farm or livestock-herd size and location in the watershed and its hydrologic connectivity to loadings as modeled by SWAT.

their fixed budget of \$100.[34] In the subsequent tasks, participants were only allowed to make equal or less “price per ton” offers on the preceding task.[35] Participants were provided with a chart to help calculate their total offer corresponding to the chosen “price per ton” value in an increment of 10 cents in all tasks (see Figure 3.1).

Figure 3.1 An example task under Individualized Price Auction (IPA)

Task 1:

This task includes one water quality project, which would reduce phosphorus in ***15.70 tons of cow manure per year*** from entering the reservoir. For this task, you have a budget of \$100. Your total contribution cannot be greater than \$100. Please write down your per-ton contribution and the total contribution for the project at the bottom of the page or you may just circle the pre-calculated row.

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
\$0.00	15.70	\$0.00	\$100.00
\$0.50	15.70	\$7.85	\$92.15
\$1.00	15.70	\$15.70	\$84.30
\$1.50	15.70	\$23.55	\$76.45
\$2.00	15.70	\$31.40	\$68.60
\$2.50	15.70	\$39.25	\$60.75
\$3.00	15.70	\$47.10	\$52.90
\$3.50	15.70	\$54.95	\$45.05
\$4.00	15.70	\$62.80	\$37.20
\$4.50	15.70	\$70.65	\$29.35
\$5.00	15.70	\$78.50	\$21.50
\$5.50	15.70	\$86.35	\$13.65
\$6.00	15.70	\$94.20	\$5.80
\$6.40	15.70	~\$100.00	~\$0.00

I would pay **\$** _________ ***per ton*** to reduce phosphorus in ***15.70 tons of cow manure per year*** from entering the reservoir. My total contribution is **\$**__________ and I would take home **\$**__________ (which is **\$100 *minus your total contribution)*** if the projects in this task were implemented.

In the voluntary donation workshop (treatment group), participants were asked to evaluate a series of three “tasks” consisting of the same set of on-farm manure

[34] This limited contributions to funds by the researchers, in compliance with IRB approved protocol for research involving human subjects.

[35] Participants were explicitly instructed to make non-increasing bids.

management projects as in the IPA workshop. However, as previously described, two successive IPA “tasks” were simply merged to construct one donation “task”, thus producing a total of three donation “tasks” from the six IPA “tasks”. Participants were asked to make a lump-sum donation amount to contribute toward implementing the greatest possible number of on-farm projects included in a particular “task” and the total donation was not allowed to exceed their fixed budget of $100 in each of the three tasks.

The survey booklet also contained a set of follow-up questions asking participants about how they responded to the “tasks” as well as their general opinion on various statements about the water quality issues in the surrounding communities and local livestock farms using 7-point scale Likert-scale questions from “Strongly Agree” to “Strongly Disagree” Finally, the survey booklet contained questions soliciting socio-demographic characteristics of participants.

3.4.4.3 Outcome of the workshops

Participants were told, on the day of their workshop, that the outcome would be determined after collecting survey responses from all three sessions. All survey responses were collected from all three sessions and gathered at the University of Rhode Island. Then the research team evaluated the aggregate offers in a particular task from all participants from all three sessions against the cost of delivering the on-farm manure management projects in that task. Offers in the donations task 1 could be applied in aggregate to supplement offers from IPA task 1. If the aggregate amount exceeded the cost of providing IPA task 1, we proceeded to evaluate IPA task 2 using offers from IPA task 2 and combining this money again with offers from donation task 1. Similarly, in evaluating IPA task 3 and, subsequently, IPA task 4, we applied offers from donations task 2. We continued this bid evaluation process until we found a task in which aggregate offers were not enough to cover the cost(s) of the project(s) in that task. In our field experiments, aggregate offers, evaluated by the process described above, for IPA task 3 were not enough to cover the cost(s) of the project(s) included in that task. Therefore, IPA task 2 (or the corresponding donation task 1) was determined as the *binding task*, and the on-farm manure management projects included in that task would be implemented. Participants' actual payments for the corresponding on-farm manure management projects ($100 minus total offer in the *binding task*) plus any rebate amount would also be calculated based on their total offers or donations in the *binding task*.

3.5 Results

3.5.1 Descriptive statistics about experiment participants

Table 3.1 presents the descriptive statistics about the participants across the public good treatments. Continuous variables discussed at the bottom of Table 3.1 (except Age, Resident (Years) and Income) were constructed using factor analysis approach (Milan & Whittaker, 1995). We utilized participants' responses to attitude statements about their views and opinions regarding local livestock farms, water quality and quality of life on a 7-point Likert scale to construct continuous factor score variables by employing a principal component factor (PCF) with *varimax* rotation method. The rotated factor loadings on each statement presented in Table 3.2 are then used to convert Likert scale responses to "standardized scores" for individual participants by the regressions scores method (Milan & Whittaker, 1995) in Stata statistical package. A participant who has a high value for Factor One tends to represent the belief that local livestock farms should adopt farming practices to reduce nutrient inputs like phosphorus to water bodies affecting the water quality; they would be willing to support these farmers; and manure management operations in local livestock farms should be regulated to improve water quality. Factor Two tends to indicate that a participant with a high value for this factor is concerned about water quality in lakes and streams near their home because they value water quality even if they do not directly use lakes and streams and they believe local livestock farmers in their neighborhood are good stewards of the land. A high value for Factor Three for a participant seems to suggest the belief that local farms face difficult competition to survive in a modern economy and they should receive financial and technical assistance to be better environmental stewards. A participant who displays a high value for Factor Four seems to be concerned about the water quality in lakes and streams for recreational activities such as swimming, fishing, or boating and doesn't believe that the homes that actually drink Scituate reservoir water should pay the costs of manure management.

Table 3.1 Descriptive statistics of participants across public good treatments

Categorical variables	Description	Public goods treatments		
		Voluntary donation (N=30)	Combined IPA (N=69)	Pearson χ2, 1df (p)
		Sample Mean (SD)	Sample Mean (SD)	
Male	1 if a participant is male; 0 otherwise	0.43 (0.50)	0.42 (0.49)	0.0146 (0.904)
Livestock owner	1 if a participant owns a livestock; 0 otherwise	0.07 (0.26)	0.14 (0.35)	1.0964 (0.295)
Home owner	1 if a participant owns a home; 0 otherwise	0.83 (0.38)	0.88 (0.32)	0.4716 (0.492)
Lawn-fertilizer user	1 if a participant fertilizes their lawn and garden; 0 otherwise	0.65 (0.49)	0.52 (0.50)	1.2642 (0.261)
Member	1 if a participant is currently affiliated to any environmental groups or causes; 0 otherwise	0.13 (0.35)	0.22 (0.42)	1.0140 (0.314)
Graduate degree	1 if a participant has a graduate degree; 0 otherwise	0.13 (0.35)	0.22 (0.42)	0.9526 (0.329)
Lakes visitor	1 if a participant visited freshwater lakes or steams either for personal enjoyment or recreations in the past 12 months; 0 otherwise	0.83 (0.38)	0.79 (0.41)	0.1770 (0.674)
Donate	1 if a participant donated to environmental causes or groups in the past 12 months; 0 otherwise	0.37 (0.49)	0.26 (0.44)	1.1299 (0.288)
Volunteer	1 if a participant volunteered in environmental projects or causes in the past 12 months; 0 otherwise	0.40 (0.49)	0.28 (0.45)	1.5102 (0.219)
Continuous variables	**Description**	**Sample Mean (SD)**	**Sample Mean (SD)**	**t-stat, df (p)**
Age	Age of participant in years	50.68 (13.81)	48.38 (16.42)	0.6724, 97 df (0.5029)
Resident	Number of years a	19.89	23.96	1.1657, 97

(Years)	participant lived in or around towns of Scituate, Foster or Glocester	(15.11)	(16.29)	df (0.2466)
Income	Participant's total household income (in '000 dollars)	84,913.29 (46,456.98)	65,624.50 (41,427.89)	2.0022, 91 df (0.0482)
"Support and Regulate Farms" (Factor One)	A continuous factor score indicating attitude that local livestock farms should be required to adopt farming practices to reduce degradation of water quality and livestock operations should be regulated.	0.05 (0.92)	-0.02 (1.03)	0.3283, 92 df (0.7434)
"Good Stewardship" (Factor Two)	A continuous factor score indicating pro-attitude toward protecting water quality in lakes and streams to affect the quality of life, local livestock farms are good stewards and value water quality even without using directly.	-0.05 (1.16)	0.02 (0.93)	0.3258, 92 df (0.7454)
"Assist Farms" (Factor Three)	A continuous factor score indicating a belief that local farms face difficult competition to survive in a modern economy and should receive financial and technical assistance.	0.33 (1.26)	-0.13 (0.85)	2.0348, 92 df (0.0448)
"Water quality for Recreation" (Factor Four)	A continuous factor score indicating a pro-attitude for water quality for recreational activities such as swimming, fishing or boating.	0.36 (1.12)	-0.15 (0.92)	2.2797, 92 df (0.0249)

Firstly, we compared the socio-demographic profiles of participants across the two IPA sessions using a chi-squared test of independence for categorical variables and a two-sample t-test for continuous variables and found no significant difference for all demographic characteristics presented in Table 3.1 (see Manuscript 3-Appendix C1). Thus the two IPA session data were combined. Then we also compared socio-demographic profiles of participants under this combined IPA participant-sample with those of the voluntary donation using a chi-squared test of independence for categorical variables and a two-sample t-test of mean values of continuous variables. The test results suggest that the subsamples (the combined IPA and the voluntary donation) are not significantly different from each other in terms of socio-demographic characteristics except participants in the voluntary donation treatment had significantly higher income (at the 5% level of significance) and statistically higher and positive average score (at the 5% level of significance) for the factor variables "Assist Farms" and "Water Quality for Recreation" than the participants in the IPA treatment.

Table 3.2 Varimax rotated factor loadings of Likert-scale statements

Statements[a]	**Factor One "Support and Regulate Farms"**	**Factor Two "Good Stewardship"**	**Factor Three "Assist Farms"**	**Factor Four "Water Quality for Recreation"**
The quality of water in lakes and streams near my home affects my quality of life.	0.4811	**0.6296**	-0.0211	0.2019
I am concerned about water quality in lakes and streams near my home.	0.3519	**0.7492**	0.1821	0.1900
I am concerned about water quality in lakes and streams near my home because they are used for recreation, such as swimming, fishing, or	0.1438	0.0695	0.1685	**0.8219**

boating.				
I value water quality in lakes and streams near my home even if I do not use them.	0.4231	**0.6718**	0.0649	0.0751
I believe local livestock farms affect water quality of lakes and streams near my home.	**0.7791**	0.2727	0.0276	-0.0095
I believe local livestock farms are a significant source of nutrients like phosphorus, which adversely affects water quality in lakes and streams near my home.	**0.8586**	0.1409	0.0714	0.0625
Livestock farms should adopt farming practices that reduce the amount of nutrients like phosphorus from entering lakes and streams near my home.	**0.8305**	0.1566	0.1424	0.0198
Livestock farmers in my neighborhood are good stewards of the land.	-0.2489	**0.6268**	0.2592	-0.2221
I would be willing to support local livestock farmers that improve their farming practices in order to improve water quality.	**0.4780**	0.4251	0.3563	0.0198
Local livestock farmers should receive financial and technical assistance so that they can be better environmental stewards.	0.2036	0.1211	**0.7917**	0.0864
I believe local farms face difficult competition to survive in a modern economy.	-0.0289	0.4099	**0.6589**	0.1621
I believe homes that actually drink Scituate Reservoir water should pay the costs of manure management.	0.2579	-0.3408	0.4776	**-0.5262**

I believe manure management operations in local livestock farms should be regulated.	**0.6271**	-0.0792	0.3509	0.3754
Eigen Value	4.8291	1.5817	1.2955	1.0485

[a]Survey participants rated each statement using a seven-point Likert-scale varying from Strongly Agree (1) to Strongly Disagree (7). Numbers in bold represent *varimax* rotated highest factor loading (normalized to mean 0 and SD 1) for a given statement indicating agreement for positive coefficient and vice versa. Total variation explained by the four factors is 67.34%.

3.5.2 Participants' contributions across the tasks

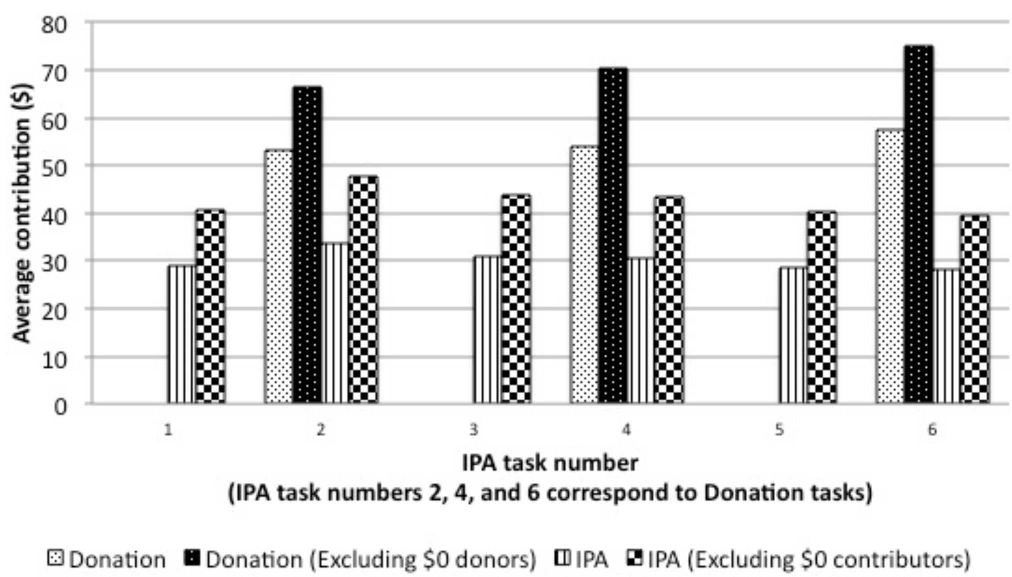
We first examined participants' average contribution across the tasks under the two public good treatments. Participants in the donations-based Workshop donated, on average, about \$53 in the first task and about \$58 in the third task. These average donations are higher after excluding \$0 donors, ranging from \$66 in the first task to \$75 in the sixth task and are in increasing order, although statistically insignificant, across the tasks. Likewise, participants in the IPA-based Workshop contributed, on average, about \$29 in the first task, slightly increased the mean contributions in the second task and then decreased in the subsequent tasks to \$28 in the sixth task. After excluding \$0 contributors, the pattern of average contributions across tasks in the IPA workshops remains the same, but higher in magnitude, ranging from \$41 in the first task to \$39 in the sixth task. Two-sample t-test results[36] suggest that the average

[36] Since the even-numbered IPA tasks correspond to equivalent Donation tasks, we compared mean contributions between Donation task 1 and IPA task 2 (t-stat= 2.4029, 97 df, p= 0.0182), Donation task 2 and IPA task 4 (t-stat= 2.9332, 97 df, p=0.0042), and Donation task 3 and IPA task 6 (t-stat=3.6238, 97 df, p=0.0005).

donations from donations-based Workshop are significantly higher than the mean contributions from the IPA workshops. These results remain unchanged[37] after excluding $0 contributors.

Figure 3.2 shows the average contribution across tasks in both donations-based and IPA-based workshops. These results suggest that the average contributions tended to be relatively constant, although there is a slight increase across the three successive tasks in donations-based Workshops, while average offers from participants in the IPA-based Workshop showed a slight decrease across the six successive tasks; these trends, however, are not statistically significant.

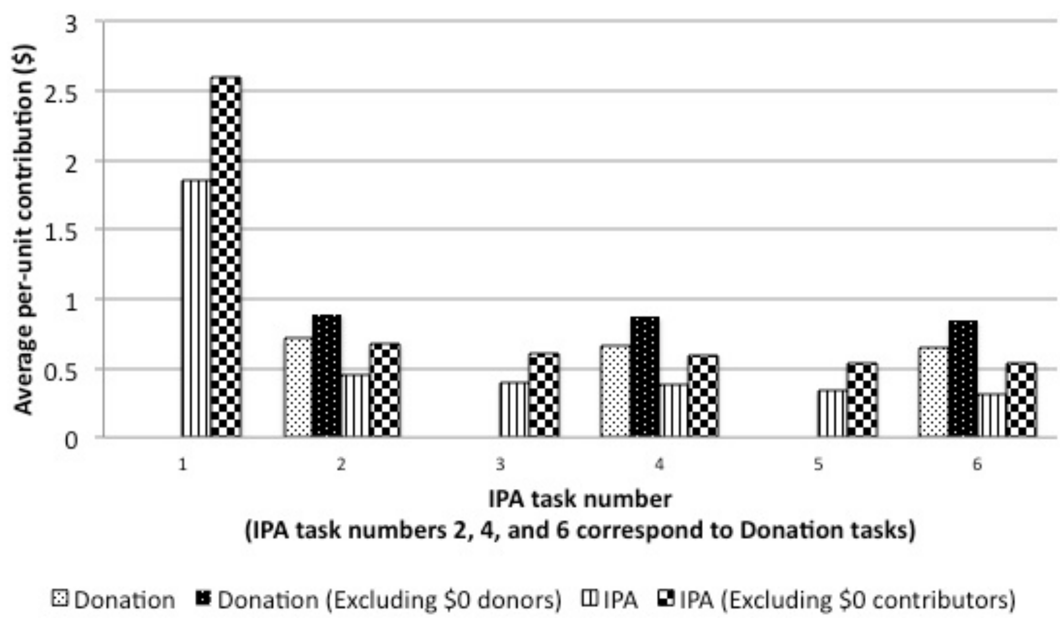
Figure 3.2 Average contribution across tasks



[37] Test results after excluding $0 contributors are as follows: Donation task 1 and IPA task 2 (t-stat=1.9830, 62 df, p= 0.0518), Donation task 2 and IPA task 4 (t-stat= 2.6574, 62 df, p=0.0042), and Donation task 3 and IPA task 6 (t-stat= 3.2609, 62 df, p= 0.0018).

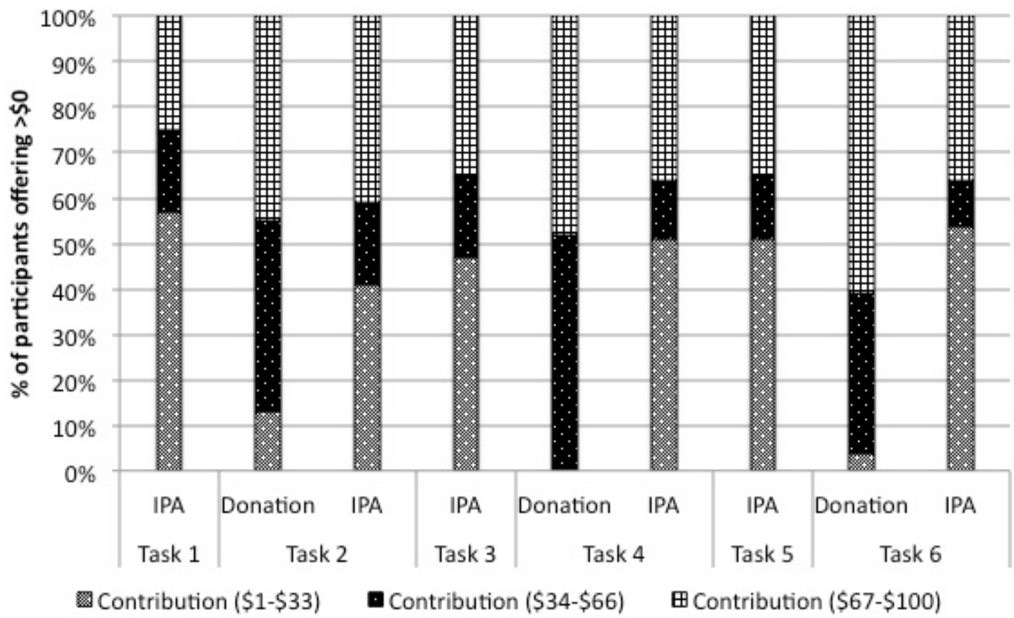
Moreover, we examined mean values of “Per unit” contribution across the tasks. “Per unit” contributions are always significantly higher across the tasks in donations-based workshops relative to the IPA-based workshops. “Per unit” contributions sharply decreased, in both treatment groups, after the first task and remain constant in the subsequent tasks as represented in Figure 3.3. This is because the tons of cow manure managed sharply increased from IPA task 1 to task 2 (from about 16 to 75 tons), but mean values of total contribution across the tasks were approximately constant.

Figure 3.3 Average "per-unit" contribution across tasks



We also examined the proportion of participants contributing $1-33, $34-66 and $67-100, between the two Workshop-types, and found a statistically significant difference on the proportions across the treatments.[38] These results are shown graphically in Figure 3.4.

Figure 3.4 Amount of contribution

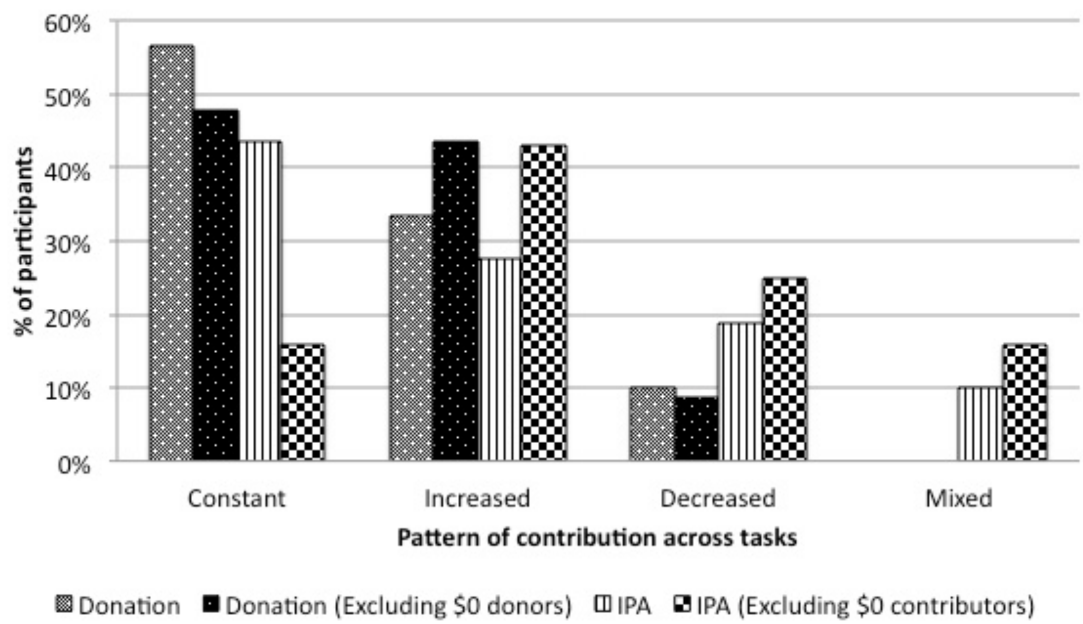


We further examined whether participants follow a particular pattern of contribution across the tasks, classifying each participant as having made a constant offer across tasks, increased their offer on successive tasks, decreased their offer, or exhibited a mixed pattern (sometimes increasing their offer between tasks and other times decreasing their offer) (Figure 3.5). Participants in the donations-based

[38] Since the even-numbered IPA tasks correspond to equivalent Donation tasks, we compared the number of participants contributing an amount within a selected range between Donation task 1 and IPA task 2 (Pearson $\chi2=7.853$, 2 df, $p= 0.0197$), Donation task 2 and IPA task 4 (Pearson $\chi2=20.342$, 2 df, $p<0.0001$), and Donation task 3 and IPA task 6 (Pearson $\chi2=16.809$, 2 df, $p<0.0001$).

Workshop were more likely to exhibit a constant or increasing pattern in their offers (Pearson $\chi2$=11.456, df 3, p=0.0095; Figure 5).[39]

Figure 3.5 Pattern of contribution across tasks



Although participants had an overall different pattern of contribution across tasks, both public good treatments produce constant contributions for a range of improvement in water quality. Participants' total contributions in the first task were not significantly different from the total contributions in the subsequent tasks in both

[39] We only considered even-numbered IPA tasks and the corresponding Donation tasks to examine the pattern of contribution across the tasks. The significance disappears when we included participants who donated $0 (23% in donations workshop) or contributed $0 (36% in combined IPA session) for all of the three even-numbered IPA tasks (Task 2, 4, and 6) and the corresponding Donation tasks (Pearson $\chi2$=5.061, df 3, p=0.1674; Figure 3.5)

treatment groups, implying that the rule requiring "contribution per unit" in successive tasks to be less than or equal to the "contribution per unit" in the preceding task in the IPA treatment may not have influenced the contributions.

3.5.3 Two-limit tobit regression model results

Since the participants were only allowed to choose a total offer amount between $0 and $100, we estimated a two-limit tobit regression (Tobin, 1958; Long, 1997; Davidson & MacKinnon, 2003; Maddala & Lahiri, 2010; Cameron & Trivedi, 2010; Wooldridge, 2012) to model participants' total offers as a linear function of tons of cow manure managed (or equivalently quantities or units of the public good) and a set of socio-demographic variables. Both the quantities of the good and the set of socio-demographic characteristics were allowed to vary across the subsamples (the combined IPA and the voluntary donation) to examine the effect of these variables on the expected total offers across the treatments. The empirical model[40] employed in the Tobit regression model is given by:

(2) $O_{ij} = \alpha + \alpha_{IPA}IPA + (\beta + \beta_{IPA} \bullet IPA) \bullet Q_j + (\delta + \delta_{IPA} \bullet IPA) \bullet Z_i$,

where O_{ij} is the total offer by participant i in task j in which certain tons of cow manure are prevented from entering the reservoir water by on-farm manure management projects, denoted by Q_j (or equivalently total units of the good provided in reduction of kg P loadings); αs represent the intercept terms for the two treatments; βs represent the slopes of the tons of cow manure managed (or the quantities or units

[40] We used a "vce (cluster)" option in Stata packages to estimate standard errors to account for non-independent offers from a single participant.

of the public good); δs represent coefficients measuring the effect of participant-specific characteristics (Z_i) on the total offers; IPA is a dummy variable taking a value of 1 for participants under the IPA approach and the value of 0 for participants under voluntary donation approach.

Table 3.3 reports the estimation results of the empirical two-limit tobit model described in equation (2). Model 1 utilizes observations on each participant from all six tasks from the IPA treatment and all three tasks from the donation treatment, whereas Model 2 utilizes observations on each participant excluding IPA tasks 1 and 2 and the corresponding Donation task 1. We first estimated an unrestricted model using the pooled data (combined IPA and Donation Workshops) of the specification represented in Eq. (2) above and conducted a series of Likelihood Ratio (LR) tests to examine the significance of parameter estimates. A LR test suggests that a set of regression coefficients estimated from the Donation treatment is statistically different from the corresponding estimates from the IPA treatment (LR Test: $\alpha_{IPA}=\beta_{IPA}=\delta_{IPA}=0$; $\chi2=123.2408$, 10 df, $p<0.0001$ using Model 1 data, and $\chi2=87.2641$, 10 df, $p<0.0001$ using Model 2 data). These significantly different estimates are the result of the effect of socio-demographics and environmental attitude variables on the expected contributions across the treatments (LR Test: $\delta_{IPA}=0$; $\chi2=96.7984$, 8 df, $p<0.0001$ using Model 1 data, and $\chi2=72.2697$, 8 df, $p<0.0001$ using Model 2 data). The Donation and IPA treatments have statistically equivalent coefficients on the quantities of cow manure managed (LR Test: $\beta_{IPA}=0$; $\chi2=0.2034$, 1 df, $p=0.6519$ using Model 1 data, and $\chi2=0.1448$, 1 df, $p=0.7036$ using Model 2 data), meaning expected contributions tend to be constant for a range of tons of cow manure managed by on-farm manure management projects, *ceteris paribus*. The intercept term, that is expected contribution when all other variables are evaluated at 0, in Model 1 for donation treatment is positive and significantly higher than the intercept term for the IPA (which is statistically equivalent to 0; see Table 3.3). However, this significance of the intercept term for donation treatment disappears in Model 2 which utilized participants' offers by excluding the observations from IPA tasks 1 and 2 and the corresponding Donation task 1.

Table 3. 3 Two-limit Tobit model results

Model 1		**Model 2**	
Variable	**Coefficient (se)**	**Variable**	**Coefficient (se)**
Donation		**Donation**	
Intercept (α)	87.6455** (35.6971)	Intercept (α)	51.0924 (49.7455)
Quantity (β)	-0.061085 (0.09022)	Quantity (β)	0.3303 (0.3455)
Socio-demographics (δ)		*Socio-demographics (δ)*	
Lawn-fertilizer user	-41.2058* (21.1998)	Lawn-fertilizer user	-42.5594* (25.144)
Member	34.2613 (38.3443)	Member	45.0304 (39.2665)
Lakes visitor	-29.80505 (26.4775)	Lakes visitor	-39.4927 (35.1467)
Donate	-22.7804 (18.4909)	Donate	-23.5887 (19.0661)
Volunteer	-45.9575** (20.4231)	Volunteer	-53.5137*** (19.8988)
Income	0.0004819 (0.0003182)	Income	0.0006166* (0.0003742)
"Support and Regulate Farms"	-53.5092*** (14.2463)	"Support and Regulate Farms"	-56.8636*** (16.1375)
"Good Stewardship"	-11.1662* (5.7645)	"Good Stewardship"	-14.6913** (7.3543)
IPA		**IPA**	
Intercept ($\alpha + \alpha_{IPA}$)	1.0685 (20.2063)	Intercept ($\alpha + \alpha_{IPA}$)	20.0294 (24.3240)

Quantity ($\beta + \beta_{IPA}$)	0.02243 (0.04287)	Quantity ($\beta + \beta_{IPA}$)	-0.2134 (0.1878)
Socio-demographics ($\delta + \delta_{IPA}$)		*Socio-demographics ($\delta + \delta_{IPA}$)*	
Lawn-fertilizer user	-34.5038*** (13.0819)	Lawn-fertilizer user	-35.5039*** (13.4867)
Member	-36.01815* (19.6696)	Member	-38.7542* (19.9292)
Lakes visitor	33.42931** (16.8636)	Lakes visitor	33.4078* (17.7317)
Donate	38.0785** (18.2499)	Donate	40.5951** (18.5147)
Volunteer	-5.4388 (16.1173)	Volunteer	-1.6875 (16.7685)
Income	0.0001973 (0.0001413)	Income	0.0001867 (0.0001432)
"Support and Regulate Farms"	-18.4831*** (7.1565)	"Support and Regulate Farms"	-17.9655** (7.2775)
"Good Stewardship"	-34.0249*** (8.7719)	"Good Stewardship"	-34.2368*** (9.0543)
Model statistics Log pseudolikelihood = -1405.6484 Number of observations: 468 Number of participants: 78 F (19, 449) = 4.48, p-value <0.0001 Pseudo R^2 = 0.1145 Sigma: 40.70765[a]		**Model statistics** Log pseudolikelihood = -920.63103 Number of observations: 312 Number of participants: 78 F (19, 293) = 4.12, p-value <0.0001 Pseudo R^2 = 0.1186 Sigma: 41.04164 [a]	

[a]"Sigma" is the estimated standard error of the regression and is comparable to the root mean squared error that would be obtained in an Ordinary Least Squares (OLS) regression.

The estimation results presented in Table 3.3 clearly suggest that participants' socio-demographic characteristics and environmental attitude variables significantly affected expected total contributions for water quality improvements and there also exists heterogeneity in expected total contributions based on participants' socio-demographic profiles across the public good treatments. Participants who fertilize their lawn and garden significantly decreased their expected total contribution compared to the participants who do not fertilize their lawn; the direction and magnitude of effect is the same in both public good treatments, all other things holding fixed. Likewise, participants who would be willing to support local farms to adopt best farming practices and would favor regulating manure management operations in the farms ("Support and Regulate Farms) as well as those who are generally concerned about water quality in their neighborhood and view local farmers as good stewards of the land ("Good Stewardship") tended to contribute less (significant effect in both treatments groups), *ceteris paribus*. Furthermore, participants who are currently affiliated with any environmental groups or causes (significant effect in the IPA group only) as well as those who volunteer in environmental projects or causes (significant effect in Donation groups only) showed a significant reduction in the expected total contribution, all other things remaining unchanged. However, participants who visited freshwater lakes or steams either for personal enjoyment or recreation or who donate to environmental groups or causes, significantly increased their contribution; both effects are significant in IPA group only.

3.5.4 Additional analysis

Table 3.4 presents participants' responses to follow up questions regarding how they responded to contribution-allocation tasks for on-farm manure management projects. We conducted a chi-squared test of independence between participants' responses to the degree of agreement to qualitative statements between the two public good treatments and found no significant difference except for the fourth statement (Table 3.4; $\chi2=8.7208$, df=4, p=0.0685). This suggests a significantly different pattern of responses to the statement asking participants whether they thought that their contribution would be sufficient to implement the projects; a higher percentage of participants under donation (about 52%) than those under the IPA (about 28%) were neutral and a higher percentage of participants under IPA (about 33%) than those under the donation (about 14%) disagreed with this statement. Although we do not have any measures to examine whether their responses were truthful or not, the results suggested that higher percentages of IPA participants were more skeptical about whether their contributions would be sufficient to implement the on-farm manure management projects than the participants under voluntary donation.

Table 3. 4 Participants' responses to follow up questions on tasks

Statements	Degree to which participants agree or disagree with following statements [% Donation participants] {% IPA participants}				
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)
(1) The decisions were difficult.	[3.45] {11.76}	[44.83] {29.41}	[31.03] {30.88}	[17.24] {23.53}	[3.45] {4.41}
(2) The decisions were relevant to my concerns about water quality in lakes and rivers in my neighborhood.	[13.79] {21.21}	[55.17] {46.97}	[17.24] {15.15}	[13.79] {15.15}	[0.00] {1.52}
(3) My decisions were influenced by my perception about what others in the room would do.	[3.33] {1.47}	[6.67] {4.41}	[6.67] {2.94}	[73.33] {79.41}	[10.00] {11.76}
(4) My donation would be sufficient to implement the water quality projects listed in each task.	[13.79] {5.97}	[20.69] {32.84}	[51.72] {28.36}	[13.79] {28.36}	[0.00] {4.48}
(5) I was trying to keep my total donation near a constant value of the budget ($100).	[10.34] {10.29}	[27.59] {23.53}	[27.59] {27.94}	[31.03] {35.29}	[3.45] {2.94}

(6) I was trying to keep my total donation near a certain percentage of the budget ($100).	[13.79] {14.71}	[31.03] {30.88}	[20.69] {20.59}	[31.03] {29.41}	[3.45] {4.41}

3.6 Conclusions and implications

The well-known free-rider problem persistently results in under-valuation and thus under-provision of public goods in both laboratory experiments and fund-raising efforts in the field. Economists have been testing various public good institutions to identify institutions that may mitigate free-riding behavior pervasive in these experimental settings. One relatively pragmatic institution is a newly established individualized price auction (IPA) motivated by Lindahl's framework for public goods. Empirical performance of the IPA process in generating revenues for private provision of public goods has not been well tested except Smith & Swallow (2013). Our field experiments implemented the newly established individualized price auction (IPA) to solicit offers on multiple successive and non-uniform sets of units of the public good incorporating incentive mechanisms from experimental economics literature such as the provision point (PP) with a money back guarantee (MBG) and proportional rebate (PR) of any excess contributions beyond the PP to mitigate free-riding behavior. Contributions generated under this IPA approach were then compared with the contributions generated under a less-structured voluntary donation elicitation. Employing a spilt sample approach, we asked participants in a framed field experiment to pay real dollars into a collective fund, which would be used to pay livestock owners to implement on-farm manure management projects. Under both public good institutions, participants were asked to make an offer on successive units of the public good, a lump-sum amount under the donation approach and "price per unit" offer under the IPA. Our results suggest that participants under the voluntary donation approach made higher total offer, on average, than participants under the IPA. However, total contributions across the tasks were statistically equivalent within both treatment groups, suggesting that participants' contributions were constant across a range of water quality improvements (or quantities of the public good). Moreover, we modeled participants' total contributions as a linear function of the tons of cow manure managed (or quantities of the public good) and a set of socio-demographic characteristics and discovered statistically significant heterogeneous effect of participants' characteristics on the total contributions between the treatment groups.

Our results contrast with the expectations that the IPA approach might garner relatively higher contributions than the traditional voluntary donations. While neither approach is incentive compatible, Smith (2012) previously showed that marginal value estimates obtained from the IPA approach may be consistent with marginal willingness to pay (mWTP) estimated from a discrete choice experiment involving binary choices that bear direct financial consequences under an incentive-compatible provision rule. Our field experiments produced higher contributions, on average, from the less-structured donation approach relative to the more-structured IPA. The simpler, more straightforward Donations worked better in this field setting. This may be because there was a lot for participants to understand about phosphorus, manure-management on farms, and water quality outcomes in addition to the rules (for example, participants had to make non-increasing offers in the subsequent tasks) of the

IPA approach. Moreover, our field experiments produced statistically equivalent average contributions for a range of quantities (or units of the good) across the tasks. This may be due to the fact that the magnitude of tons of cow manure managed changed very little between tasks, except from IPA task 1 to IPA task 2 where tons of cow manure managed sharply increased from about 16 tons to 75 tons. These small increments from one task to the next would imply small changes in protection of water quality in the reservoir. Participants may have concluded there was a large potential for variation in impact such that they just decided a relatively constant contribution was likely enough to have a measurable impact with little change in impact. Or perhaps the changes in ranges across the tasks were just not big enough to matter in the scope of the $100 budget. Although the experiment moderator clearly described the linkages between phosphorus in the watershed system, manure management, and the ultimate impact on water quality, a "loosely" defined public good "product" may have influenced participants' contributions. Uncertainty associated with the complex natural process about phosphorus and its connection with the actual impact on water quality may have also impacted participants' thought process while making contributions, but we do not have any measures to identify whether this uncertainty played a role in our field experiment.

The two-limit tobit regression results suggest that there exists statistically significant heterogeneity in expected total contribution across the socio-demographic and environmental attitude profiles of the participants between the two public good institutions. For example, members of environmental groups (statistically significant effect in IPA group only) and volunteers in environmental groups or causes (statistically significant effect in Donation group only) tended to contribute less. This may mean environmental groups were not favorably inclined to the IPA approach raising money in a manner that is more like a common commodity; and volunteers may feel that they have already contributed through their time. Likewise, participants who would be willing to support local farms to adopt farming practices and would favor regulating manure management practices in the farms, and who are generally concerned about the water quality and view local farmers in their neighborhood as good stewards of the land seemed to make lower offers under both approaches. However, participants who visit lakes or streams for recreational activities and who donate to environmental groups or causes offered higher contributions (significant effect in the IPA group only). Overall, these results suggest that participants in the two public good institutions responded differently to offer solicitations for improved water quality, and the institutions themselves appear to have influenced their response. This result might signal heterogeneity in how people will react under novel markets for ecosystem services, suggesting research will be needed to better understand for which groups novel approaches will best mitigate free-riding behavior. The result is analogous to Kafle et al.'s (2014) results regarding whether supplemental government funding stimulates crowding in or crowding out of contributions to watershed management.

One speculation the authors may put forward is that participants in donations-based Workshop may be motivated by personal 'altruistic' interest or simply social motivations for doing 'good things' for the surrounding environment in the neighborhood and may have donated without particular regard for the quantity of manure management. However, participants in the IPA-based Workshops may be making decisions more thoughtfully because they were put into a framed mindset of a regular 'market purchasing situation' by asking the "price per unit" offer. Our IPA experiment asked participants to consider "Price per unit" first and then allowing them to evaluate the total contribution in a task. Future studies may explore whether asking participants a maximum total offer they would be willing to contribute and then allowing then to see the corresponding "price per unit" that the maximum contribution implied could garner higher offers.

Finally, we note that our study is an example of research to develop novel approach that may (or may not) improve the potential for integration of donor-beneficiaries in future (and evolving) markets for ecosystem services. As such, we encourage others to pursue such topics, noting its consistency with Portney's (2004) obligation of the "policy economist", to contribute directly to creation of potential policy (or market-based) alternatives.

3.7 Manuscript 3 References

Arnold, J. G., Moriasi, D. N., Gassman, P. W., Abbaspour, K. C., White, M. J., Srinivasan, R., & Jha, M. (2012). SWAT: Model use, calibration, and validation, *55*(4), 1491–1508.

Bagnoli, M., & Lipman, B. L. (1989). Provision of public goods: Fully implementing the core through private contributions. *Review of Economic Studies*, *56*(4), 583–601.

Bagnoli, M., & Mckee, M. (1991). Voluntary contribution games: Efficient private provision of public goods. *Economic Inquiry*, *29*(2), 351–366.

Cadsby, C. B., & Maynes, E. (1999). Voluntary provision of threshold public goods with continuous contributions: Experimental evidence. *Journal of Public Economics*, *71*(1), 53–73.

Cameron, A. C., & Trivedi, P. K. (2010). *Microeconometrics Using Stata*. Stata Press.

Davidson, R., & MacKinnon, J. G. (2003). *Econometric Theory and Methods*. New York: Oxford University Press.

Davis, D. D., & Holt, C. A. (1993). *Experimental economics*. Princeton University Press.

Dawes, R. M., & Thaler, R. H. (1988). Anomalies: Cooperation. *Journal of Economic Perspectives*, *2*(3), 187–97.

ESS Group, Inc. (2011). *Regulating reservoir limnological study and recommendation* (Project No. P282-000). ESS Group, Inc., East Providence, Rhode Island.

Groves, T., & Ledyard, J. (1977). Optimal allocation of public goods: A solution to the “free rider” problem. *Econometrica*, *45*(4), 783.

Harrison, G., & List, J. (2004). Field experiments. *Journal of Economic Literature*, *42*(4), 1009–1055.

Isaac, R. M., Schmidtz, D., & Walker, J. M. (1989). The assurance problem in a laboratory market. *Public Choice*, *62*(3), 217–236.

Kafle, A., Swallow, S. K., Smith, E. C. (2014). Does public funding affect preferred tradeoffs and crowd-in or crowd-out willingness to pay? A watershed management case. *Environmental and Resource Economics*, Forthcoming.

Ledyard, J. O. (1995). Public goods: A survey of experimental research. In *The Handbook of Experimental Economics*. Princeton, NJ: Princeton University Press.

Ledyard, J. O., & Palfrey, T. R. (1994). Voting and lottery drafts as efficient public goods mechanisms. *Review of Economic Studies*, *61*(2), 327–55.

Lindahl, E. (1919). Die Gerechtigkeit der Besteuring. Lund: Gleerup. [English translation:Just taxation – a positive solution]. In *Classics in the Theory of* Public Finance. London: MacMillan.

List, J. (2008). Introduction to field experiments in economics with applications to the economics of charity. *Experimental Economics*, *11*:203–212.

Long, J. S. (1997). *Regression Models for Categorical and Limited Dependent Variables* (1 edition.). Thousand Oaks: SAGE Publications, Inc.

Maddala, G. S., & Lahiri, K. (2010). *Introduction to Econometrics* (4th ed.).

Marks, M., & Croson, R. (1998). Alternative rebate rules in the provision of a threshold public good: An experimental investigation. *Journal of Public Economics*, *67*(2), 195–220.

Milan, L., & Whittaker, J. (1995). Application of the parametric bootstrap to models that incorporate a singular value decomposition. *Applied Statistics*, *44*(1), 31.

Nicholson, W. (2005). *Microeconomic theory: Basic principles and extensions* (9th ed.). Cincinnati, OH: South-Western College Publishing.

Poe, G. L., Clark, J. E., Rondeau, D., & Schulze, W. D. (2002). Provision point mechanisms and field validity tests of contingent valuation. *Environmental and Resource Economics*, *23*(1), 105–131.

Portney, P. (2004). The obligations of a policy economist. *Agricultural and Resource Economics Review*, *33*(2): 159–161.

Rapoport, A., & Eshed-Levy, D. (1989). Provision of step-level public goods: Effects of greed and fear of being gypped. *Organizational Behavior and Human Decision Processes*, *44*(3), 325–344.

Rondeau, D., Schulze, W. D., & Poe, G. L. (1999). Voluntary revelation of the demand for public goods using a provision point mechanism. *Journal of Public Economics*, *72*(3), 455–470.

Rondeau, D., Poe, G. L., & Schulze, W. D. (2005). VCM or PPM? A comparison of the performance of the two public goods mechanisms. *Journal of Public Economics*, *89*(8), 1581–1592.

Samuelson, P. (1954). The pure theory of public expenditures. *Review of Economics and Statistics*, *36*(4), 387–389.

Samuelson, P. (1955). Diagrammatic exposition of a theory of public expenditure. *Review of Economics and Statistics*, *37*(4), 350–356.

Smith, E. C. (2012). *Incentive mechanisms and the provision of public goods: Testing alternative frameworks to supply ecosystem services* (PhD Dissertation). University of Rhode Island, Kingston, RI.

Smith, E. C., & Swallow, S. K. (2013). Lindahl pricing for public goods and experimental auctions for the environment. In, Jason Shogren (ed.) *Encyclopedia of Energy, Natural Resource, and Environmental Economics*, volume 3, pp. 45-51. Amsterdam: Elsevier.

Spencer, M. A., Swallow, S. K., Shogren, J. F., & List, J. A. (2009). Rebate rules in threshold public good provision. *Journal of Public Economics*, *93*(5–6), 798–806.

Swallow, S. K. (2013). Demand-side value for ecosystem services and implications for innovative markets: Experimental perspectives on the possibility of private markets for public goods. *Agricultural and Resource Economics Review*, *42*(1):

Swallow, S. K., Smith, E. C. & Anderson, C. M. (2013). Revenue raising auction processes for public goods," Patent No.: US 8,429,023 B2. Date of Patent Apr. 23, 2013. Patent Application 12/653,125 filed December 8, 2009 Associated with NSF grant No DEB0621014 (LTER-VCR) (USPTO Allowance issued 1/16/2013).

Tobin, J. (1958). Estimation of Relationships for Limited Dependent Variables. *Econometrica*, *26*(1), 24.

Uchida, E., Swallow, S. K., Gold, A., Opaluch, J., Kafle, A., Merrill, N., Michaud, C., Gill, C. A. (2014). Integrating hydrology and economics in environmental decision making for improved water quality. Department of Environmental and Natural Resource Economics (ENRE), University of Rhode Island, Kingston, RI.

Walker, M. (1981). A simple incentive compatible scheme for attaining Lindahl allocations. *Econometrica*, *49*(1), 65.

Wooldridge, J. M. (2012). *Introductory econometrics: a modern approach*. Mason, Ohio: South-Western Cengage Learning.

MANUSCRIPT 3 – APPENDIX C

This appendix provides additional information on participants' socio-demographic profiles across the two IPA sessions, background presentation for experiment participants and a sample survey booklet.

C1. Participants' socio-demographic profiles across the two IPA sessions

The following table presents the descriptive statistics about participants across the two IPA sessions.

Descriptive statistics of participants across public good treatments

Categorical variables	Description	IPA sessions		
		IPA session 1 (N=26)	IPA session 2 (N=43)	Pearson χ2, 1df (p)
		Sample Mean (SD)	Sample Mean (SD)	
Male	1 if a participant is male; 0 otherwise	0.31 (0.47)	0.49 (0.510	2.1710 (0.141)
Livestock owner	1 if a participant owns a livestock; 0 otherwise	0.08) (0.27)	0.19 (0.39)	1.5570 (0.212)
Home owner	1 if a participant owns a home; 0 otherwise	0.81 (0.40)	0.93 (0.26)	2.3737 (0.123)
Lawn-fertilizer user	1 if a participant fertilizes their lawn and garden; 0 otherwise	0.42 (0.50)	0.59 (0.49)	1.7843 (0.182)
Member	1 if a participant is currently affiliated to any environmental groups or causes; 0 otherwise	0.27 (0.45)	0.19 (0.39)	0.5793 (0.447)
Graduate degree	1 if a participant has a graduate degree; 0 otherwise	0.23 (0.43)	0.21 (0.41)	0.0439 (0.834)
Lakes visitor	1 if a participant visited freshwater lakes or steams either for personal enjoyment or recreations in the past 12 months; 0	0.88 (0.33)	0.74 (0.44)	1.9757 (0.160)

	otherwise			
Donate	1 if a participant donated to environmental causes or groups in the past 12 months; 0 otherwise	0.19 (0.40)	0.30 (0.46)	1.0171 (0.313)
Volunteer	1 if a participant volunteered in environmental projects or causes in the past 12 months; 0 otherwise	0.27 (0.45)	0.28 (0.45)	0.0079 (0.929)
Continuous variables	**Description**	**Sample Mean (SD)**	**Sample Mean (SD)**	**t-stat, df (p)**
Age	Age of participant in years	46.35 (14.79)	49.60 (17.39)	0.7965, 67 df (0.4285)
Resident (Years)	Number of years a participant lived in or around towns of Scituate, Foster or Glocester	18.21 (14.81)	27.43 (16.32)	2.3520, 67 df (0.0216)
Income	Participant's total household income (in '000 dollars)	62,499.50 45,276.93	67,762.66 39,058.99	0.4962, 62 df (0.6215)
"Support and Regulate Farms"	A continuous factor score indicating attitude that local livestock farms should be required to adopt farming practices to reduce degradation of water quality and livestock operations should be regulated.	-0.19 (0.99)	0.08 (1.06)	1.0563, 65 df (0.2947)
"Good Stewardship"	A continuous factor score indicating pro-attitude toward protecting water quality in lakes and streams to affect the quality of life, local livestock farms are good stewards and value water quality even without using directly.	0.18 (1.02)	-0.08 (0.87)	1.1273, 65 df (0.2638)
"Assist Farms"	A continuous factor score indicating a belief that local farms face difficult competition to survive in a modern economy and	0.03 (0.94)	-0.23 (0.78)	1.2552, 65 df (0.2139)

	should receive financial and technical assistance.			
"Water quality for Recreation"	A continuous factor score indicating a pro-attitude for water quality for recreational activities such as swimming, fishing or boating.	-0.16 (0.93)	-0.13 (0.92)	0.1239, 65 df (0.9017)

C2. Background presentation slides and the core scripts

I gratefully acknowledge an excellent moderation of all the field experiments as well as the receipt of the presentation slides and the written scripts included below by Carrie A. Gill, graduate research assistant at the department of Environmental and Natural Resource Economics, University of Rhode Island. The example presentation slides and the scripts were used for the IPA based workshops. For Donation workshop, the information and content of the survey were exactly same except the description of Donation treatment and necessary corrections accordingly.

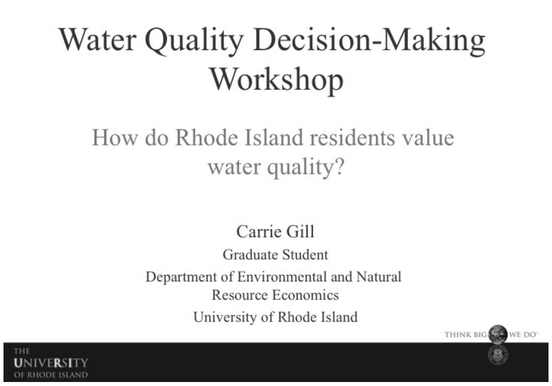
Background (by Carrie A. Gill, Dept of ENRE, URI)

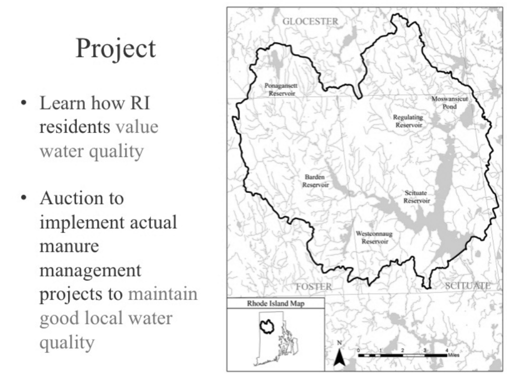
Each session began with a scripted PowerPoint presentation that was designed to give participants a common review and understanding of the linkages between P, manure management, and water quality. This presentation used simple illustrations and clear language, including photographs of a range of potential manure management projects. We were careful about differences in connotation and denotation for our word choices and directly addressed preconceptions and nuances. To ensure understanding, the presenter addressed questions from participants prior to explaining instructions soliciting individuals' donations or contributions to pay for on-farm manure management projects.

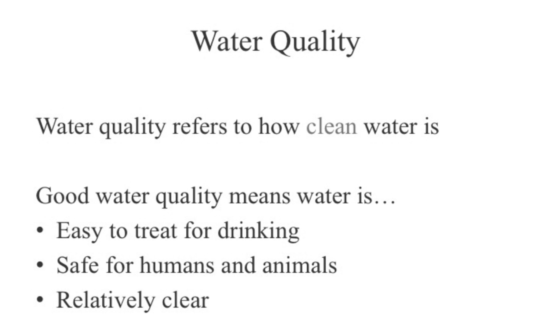
In addition to the PowerPoint presentation, participants were provided with a booklet to review as instructed by the moderator. This booklet contained written instructions for soliciting voluntary contributions under the approach used for that Workshop (IPA or donations), and these instructions were reviewed orally by the moderator as well. The booklet also included a form soliciting offers of contributions; in the IPA workshops individuals made six offers, while in the donations workshops individuals made three offers. Finally, the booklet included a follow-up survey soliciting socio-demographic characteristics of the individual.

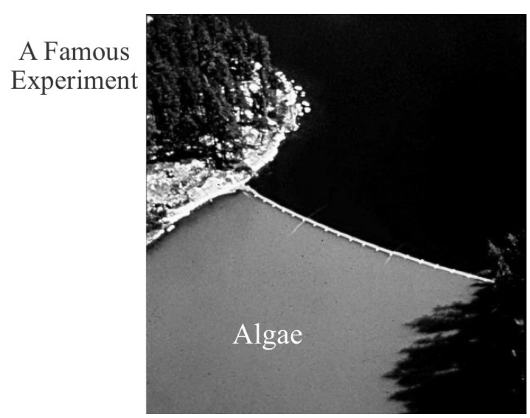
All participants were told that there were other Workshops being held in a 2-week period (Oct. 28 – Nov. 12, 2013) and results would be determined by the combined choices of participants in these Workshops.

Presentation slides (by Carrie A. Gill, Dept of ENRE, URI)

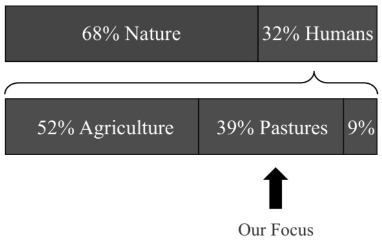




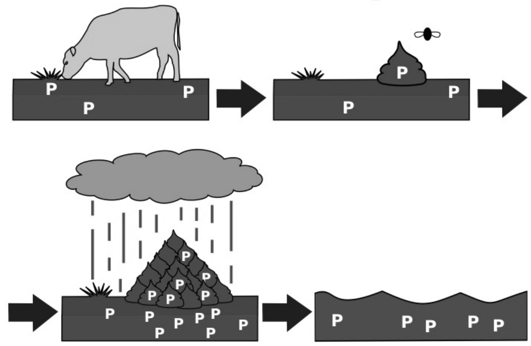




Phosphorus Sources



Manure Contains Phosphorus



Reducing Phosphorus through Manure Management

1. Proper storage of animal manure

Current Practice

Concrete Pads

Reducing Phosphorus through Manure Management

1. Proper storage of animal manure
2. Redirecting rain water off animal sheds

Gutter Systems

We want to know *your* values about water quality.

Water Quality Auction Instructions

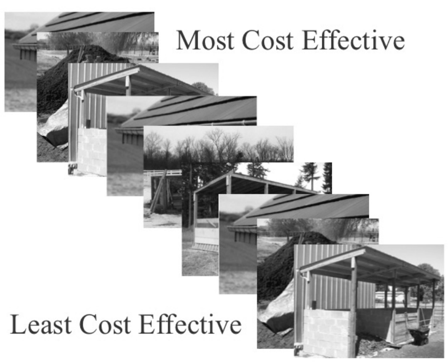
If I took $100 home, I likely would spend it on ____.

If I were to donate part of this money to a non-profit group, I would consider the group

____.

Note: This is NOT a real bill. This was used for illustration purpose only.

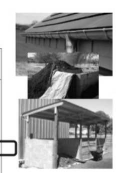
Most Cost Effective



Least Cost Effective

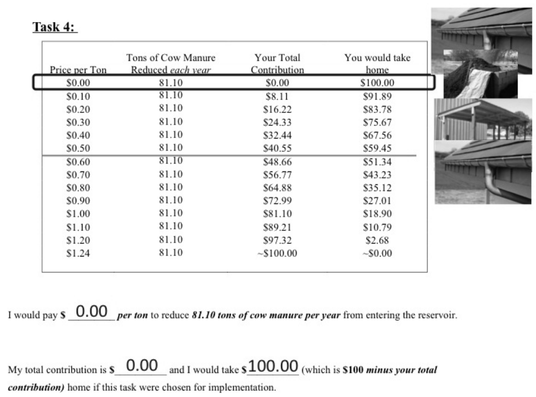
Task 3:

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	77.90	$0.00	$100.00
$0.10	77.90	$7.79	$92.21
$0.20	77.90	$15.58	$84.42
$0.30	77.90	$23.37	$76.63
$0.40	77.90	$31.16	$68.84
$0.50	77.90	$38.95	$61.05
$0.60	77.90	$46.74	$53.26
$0.70	77.90	$54.53	$45.47
$0.80	77.90	$62.32	$37.68
$0.90	77.90	$70.11	$29.89
$1.00	77.90	$77.90	$22.10
$1.10	77.90	$85.69	$14.31
$1.20	77.90	$93.48	$6.52
$1.29	77.90	~$100.00	~$0.00



I would pay $ 0.50 ***per ton*** to reduce ***77.90 tons of cow manure per year*** from entering the reservoir.

My total contribution is **$** 38.95 and I would take **$** 61.05 (which is **$100 *minus your total contribution)*** home if this task were chosen for implementation.

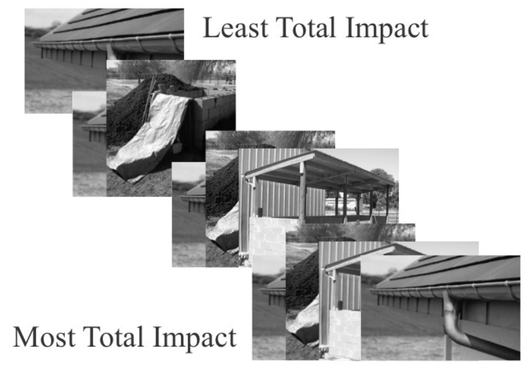


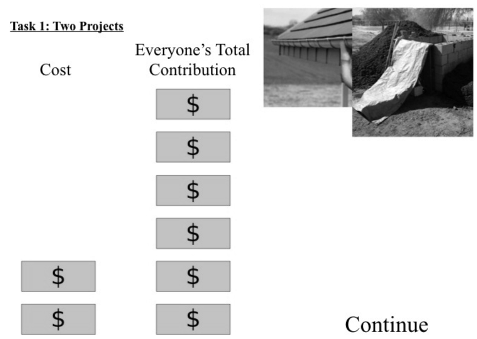
Task 4:

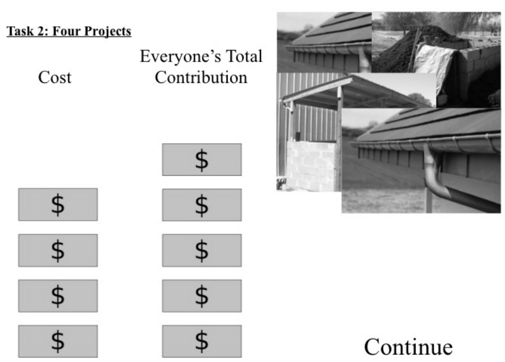
Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	81.10	$0.00	$100.00
$0.10	81.10	$8.11	$91.89
$0.20	81.10	$16.22	$83.78
$0.30	81.10	$24.33	$75.67
$0.40	81.10	$32.44	$67.56
$0.50	81.10	$40.55	$59.45
$0.60	81.10	$48.66	$51.34
$0.70	81.10	$56.77	$43.23
$0.80	81.10	$64.88	$35.12
$0.90	81.10	$72.99	$27.01
$1.00	81.10	$81.10	$18.90
$1.10	81.10	$89.21	$10.79
$1.20	81.10	$97.32	$2.68
$1.24	81.10	~$100.00	~$0.00

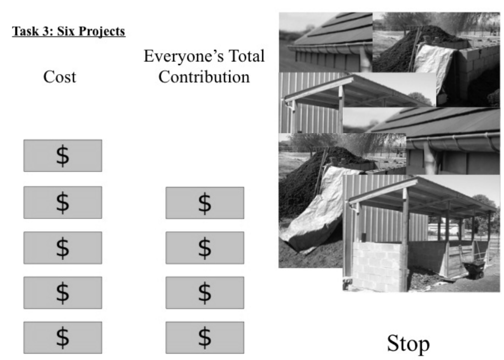
I would pay $ 0.00 ***per ton*** to reduce ***81.10 tons of cow manure per year*** from entering the reservoir.

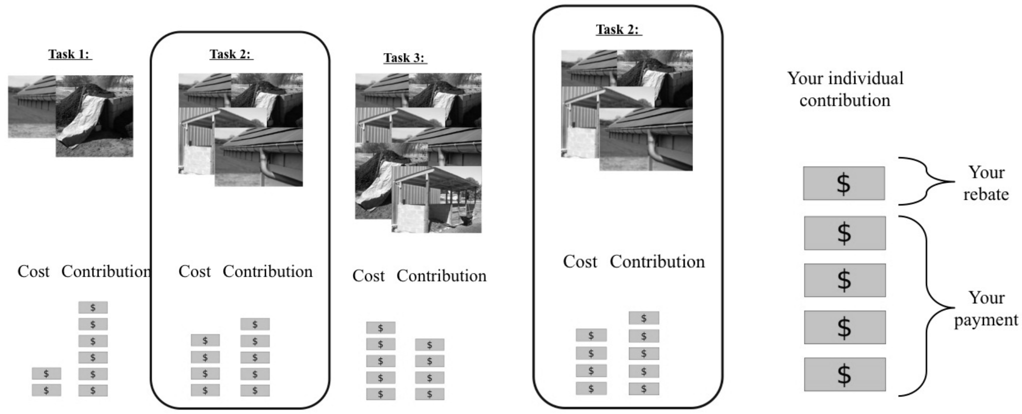
My total contribution is **$** 0.00 and I would take **$** 100.00 (which is **$100 *minus your total contribution)*** home if this task were chosen for implementation.

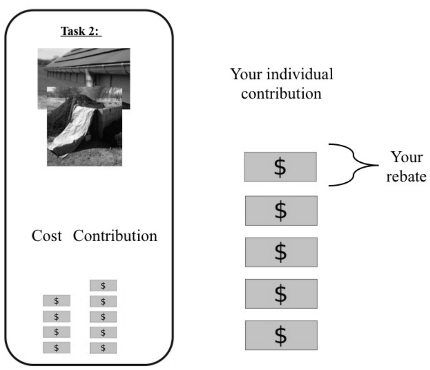


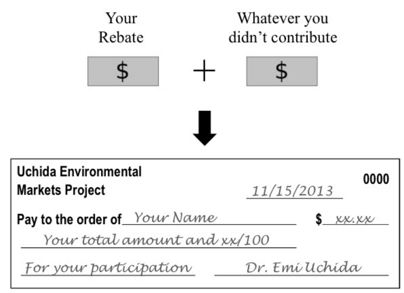












Presentation script (by Carrie A. Gill, Dept of ENRE, URI)

Our project aims to learn how RI residents who live or work in the Scituate Reservoir area, like you, value water quality. In order to figure that out, we're going to hold an economic auction to implement *actual* manure management projects in the Scituate Reservoir watershed that will maintain good local water quality.

When we talk about water quality, we're referring to how clean the water is. Clean water is easy to treat to turn it into safe drinking water. It's safe for you, your children, and your pets to come into contact with. And its aesthetically pleasing.

One reason why water quality may be bad is phosphorus. You might recognize phosphorus from bags of fertilizer that you use on your lawn and garden. Phosphorus is a nutrient, which means it's essential for plants to grow. However, too much phosphorus means lots of growth.

A while ago, a group of scientists performed an experiment in a lake in a freshwater Canada. They divided the lake in half and added phosphorus to one side. The additional phosphorus caused little plants to grow in the water. We know these plants as algae. One additional pound of phosphorus in a freshwater lake will cause

300 to 500 pounds of wet algae to grow. While algae are natural, too much algae means that water is difficult to treat, could be unsafe or toxic for contact, and becomes murky. In other words, too much phosphorus means too much algae, which in turn means poor water quality.

You may have seen the impact of algae in water bodies around RI. For example, signs that warn against swimming and fishing, or news stories warning about toxic algae blooms.

In the Scituate Reservoir System, 68% of phosphorus in the Scituate Reservoir System is from naturally occurring, uncontrollable sources. The other 32% is from human sources. This includes agriculture and crops, livestock that graze on pastures, and residential sources like garden fertilizer and septic systems. Our project is only focusing on the phosphorus that comes from pastures.

Livestock like cows graze on pasture. What they eat contains phosphorus. And as you know, what goes in must come out, and that contains phosphorus, too. One ton of manure contains about 5 pounds of phosphorus. An average cow produces about 80 pounds of manure every day. That adds up to 15 tons per year per cow. When manure is scattered over the land, the plants can use the phosphorus in it to grow. However, the common practice is for livestock owners to make big manure piles. The plants around the big manure piles can't use all the phosphorus in the manure. And, when it rains, this excess phosphorus washes into the soil and surface water and makes its way through streams and rivers into the reservoir water. And why is excess phosphorus bad for water quality? Because it causes too much algae to grow.

We can reduce the phosphorus that enters the reservoir water through better manure management on local livestock farms. There are two ways. First, we can store animal manure properly. Like I mentioned, the current practice is for livestock owners to gather manure into a big pile. There are no regulations governing this practice. However, big manure piles lead to excess phosphorus in reservoir water. A better way to store manure is on a concrete pad. The concrete acts as a barrier that the phosphorus can't cross between the manure and the soil.

The second good manure management practice is to prevent rainwater from getting on the manure. Practically speaking, this means installing gutters around animal sheds. and places where manure can pile up.

Local livestock owners have reached out to URI because they feel responsible for water quality and want to be better environmental stewards. These livestock owners are your neighbors and friends. Many feel that local farmers are integral to the unique rural and historic culture of the Scituate area.

Being a farmer is hard. It's lots of work and its difficult to make ends meet. The farmers that have reached out to us want to implement concrete pads and gutters but they can't afford the cost, which can range from a couple hundred to a couple thousand dollars. The projects that these farmers want to implement are the projects that we'll see in the auction coming up. There, you'll have the option to contribute some money to getting some, all, or none of these projects *actually* implemented.

All the livestock owners involved in our project are located in the Scituate Reservoir System. Local water scientists have reported that most reservoirs here still have good water quality, while a couple have already shown signs of degradation and algae blooms. Once a water body shows signs of degradation, it gets increasingly difficult and costly to restore back to having good quality. (If asked - this is because feedback systems start, which release even more phosphorus into the water.) The more we can prevent phosphorous from getting into the reservoir--through better manure management, for example--the longer we can prevent the system from degrading, and hence preserve the good water quality.

We want to know how much you'd be willing to contribute to local manure management projects, in order to reduce phosphorus in reservoir water and preserve good water quality. Some people may have other priorities and may not want to contribute any money, while others might be completely indifferent. Still others might consider water quality to be top priority and want to contribute a lot. Some people are in the middle. Whatever your values are, we want to know. There are no right or wrong answers and all of your responses will be kept strictly confidential.

Now, we'll go over how the auction works and then how we choose which projects will actually get implemented. My colleagues and I were talking about how much we're asking of you during this two hours and decided that we needed to compensate you more. So, congratulations, you've earned yourselves another $100 for participating tonight. Imagine opening up your wallet to see a crisp $100 bill in there. Yes, we are actually giving you another $100. Take a second to think about what you're going to use your hard earned money for. On page __ we've provided two fill in the blank sentences. The first states what you will spend your money on (or save it for). The second states what cause or charity you will donate your money to, if you're so inclined. Take a minute to jot down your thoughts.

One thing you can do with your hard earned money is contribute to manure management projects in our auction. We've talked to actual local livestock owners who want to install concrete pads and gutters. Local experts from the Northern Rhode Island Conservation District have visited these farms and have deemed these projects appropriate for reducing phosphorus in the reservoir. These farmers have signed contracts with us promising to implement these projects by the end of next year if there is a big enough contribution from the auction to cover the costs of the projects. *Some, all, or none of these projects will actually be implemented because of your decisions tonight.*

All projects in the auction are projects that the farmers want to implement. If some projects do get implemented, that does *not* mean that all farmers will have to implement these projects, too.

And just because you might contribute something tonight, that does *not* mean that others will be forced to contribute. The images here are representations of the actual projects but they don't show the real thing. And, we're not going to give you most of the details about the actual projects either. That's because we want to know how much you value the reduction in phosphorus from manure management, not how much you'd like to contribute to your neighbor Fred's project down the road.

We've taken all these projects, figured out how much phosphorus from manure they'd reduce, and ranked them from most cost effective to least cost effective. We're going to present them in our auction from most cost effective to least so that you get the *most bang for your buck* out of your contribution. This auction will consist of a series of tasks, which will include one or several projects. In each task, you'll see a table and two fill-in-the-blank sentences. We want to know how much you'd be willing to contribute per ton of cow manure reduction for the project or projects in each task.

This isn't a math test, so the table is here to help you out. You choose how much you want to contribute per ton, and then the table does the math to tell you how much your total contribution would be and how much you'd end up taking home. So your job is to circle the row in the table that best represents what you want to contribute to the project or projects in the task.

The sentences are here to help you understand how much you're contributing. We encourage you to fill in the blanks.

You can contribute a maximum of $100 to each task. This does not change, regardless of how much you contribute in previous tasks. In the end we're only going to choose one task and implement only those projects in that task.

So let's see an example of how this works in practice. The first task includes the most cost effective project, because - remember - we want to get the most bang for your buck. You'll see that this project reduces phosphorus from 15.7 tons of cow manure. You might want to contribute your entire budget - your hard earned $100 - to this project. You might have other things in mind for you $100 and not want to contribute anything. For the sake of this example, let's say you contribute an even $1 per ton. We can write that in our first fill in the blank sentence. Therefore, your total contribution would be $1 per ton times 15.7 tons, or $15.70. That means that you'd be guaranteed to take home $84.30, or your $100 minus your contribution.

The next task includes the same project from task 1 *and* the most cost effective project from the remaining projects. Since we have two projects now, the tons of cow manure reduced has increased. Again, you're considering how to spend your $100. We want to know how much you'd contribute per ton for these two projects. But here's the catch, you can only contribute the same or less per ton as you did in the previous task.

In task 1, we said we'd contribute $1 per ton. That means that in task 2 we can only contribute $1 per ton or less. Can we contribute $1.20? NO!

So let's circle our contribution for this task and fill in the blanks. For this task, we'll contribute $1 per ton again. That means my total contribution is $74.90 and I'd be guaranteed to take home $25.10.

Okay, let's see how this plays out in our next task. Now we have the same two projects from task 2 and the most cost effective project from the remaining projects. You'll see that tons of cow manure has increased again. Remember, our rule is you can only contribute the same or less per ton as the previous task. Last task we contributed $1 per ton. Can we contribute $1.10 here? NO!

Let's say we'll contribute 50 cents per ton here. That makes the total contribution $38.95 and the guaranteed take home $61.05. For the next task, what would be the amount per ton that I must contribute the same or less as? That's right, I must contribute the same or less as the previous task. If in task 3 I contribute 50 cents per ton, in task 4 I must contribute 50 cents per ton or less. Good.

For each project, we know how much the cost is to implement that project. We need to figure out if the total contribution of everyone, including you, everyone around you, and everyone who participates in this workshop over the next two weeks, is enough to cover the costs of the project. So for task 1, there might be a small cost and large contribution. If the total contribution is larger than the cost, then we look at the next task. For task 2, we had two projects, so the cost has gone up. If everyone's total contribution exceeds the cost, then we continue. For task 3, let's say the cost of these projects is not covered by everyone's total contribution. Then we stop.

So we've looked at three tasks. We choose the task that has the most projects and where everyone's total contribution exceeds the costs of the projects. In our example, that would be task 2. These are the projects that are actually going to be implemented.

So if you contributed to this task, what does that mean for you? We're only going to take what we need from you, out of your individual contribution, to implement these projects. You'll get the rest of your contribution back in the form of a rebate. We'll add up your rebate and how much out of your $100 you did not contribute to the chosen task and write you a check. We're going to put this check in the mail in the envelope that you addressed in the beginning of the workshop. If you do not receive something from us within 15 business days of today, even if we do not owe you any money, please contact Dr. Uchida.

C3. A sample survey booklet (IPA workshop)

Water Quality Decision-Making Workshop

Water Quality Project Auction

DEPARTMENT OF
ENVIRONMENTAL & NATURAL RESOURCE ECONOMICS

THE UNIVERSITY OF RHODE ISLAND

Water Quality Project Auction - Instructions
This auction includes several tasks, which ask how much you would pay for a water quality project(s) that would reduce phosphorus in a given amount of cow manure per year from entering the reservoir water.

The goal of each task is to figure out how much you would be willing to contribute to a project that would reduce a given amount of cow manure per year from delivering phosphorus to the reservoir water. We will tell you in the task description how many tons of cow manure per year are prevented from entering the reservoir water if a particular project or set of projects were to be implemented. We will then ask you to write down how much money you would be willing to pay to prevent the phosphorus in each ton of cow manure each year from entering the reservoir water.

We will be giving you $100, which you can either take home or contribute to the projects in each task. This $100 is in addition to your $50 compensation for participating tonight. Even if you contribute all of the $100 to water quality projects, you will still take home $50. Take a minute now to think about how you might spend $100 if you were to take it all home tonight.

If I took $100 home, I likely would spend it on ______________________________.

If I were to donate part of this money to a non-profit group, I would consider the group or cause: (Please write "none" if you don't think you would donate.)

____.

In each task you can contribute some, all, or none of your $100 budget to reduce phosphorus from a given amount of cow manure from entering the reservoir water. You have a budget of $100 for each task, regardless of how much money you contributed in previous tasks. We will figure out how much of the $100 you will actually contribute to water quality projects based on your contribution and contributions by everyone else, as was explained in the presentation. Your contribution in each task will have real consequences - water quality projects will be implemented depending on how much money you and everyone else contribute. Only write down how much you really would be willing to contribute to reduce the given amount of cow manure from entering reservoir water.

How we determine how much money you actually contribute

After you have completed all the tasks, our research team will collect your responses. For each task, we will add up how much *everyone* would be willing to contribute to reduce a given amount of cow manure. *Everyone* includes you, everyone in this session, and everyone in another session on a different date.

We will add up everyone's contribution for the first task to see if you and everyone else contributed enough money in total to cover the cost of the first project. If this total contribution is enough to cover the cost of the first project, then we will consider the second task. We will stop when the total contribution for a task is not enough to cover the costs of the project(s) in that task. The task with the largest number of projects where the total contribution is enough to cover the costs of all projects in that task that will then actually be implemented.

The projects are real projects. **All, some, or none of these projects might be implemented depending on how much money you and everyone else contribute.** Your contribution, along with everyone else's contribution, will actually go to a local large animal owner to pay for a concrete pad or a gutter system.

Your total contribution may not be needed, in total, to cover the costs of the project(s) chosen. **If this is the case**, you will only pay some of your contribution in proportion to how much you were willing to pay. For example, if you were willing to pay $90 in the task that was chosen for implementation but we only required 90% of everyone's total contributions, then you would only pay $81, which is 90% of $90 and you will receive your contribution that is not required as a rebate.

At the end of this session tonight, you will receive $50 cash for your participation. After we determine how many projects can be implemented based on your and everyone's decisions at URI, we will mail you a check for the portion of your $100 budget that you did not contribute to the projects chosen plus any rebate if applicable. If you do not receive a check from the University of Rhode Island within 15 business days from today, please contact Prof. Emi Uchida (emi@uri.edu; 401-874-4586) immediately.

Water Quality Project Auction - Tasks

In this water quality project auction, each task asks how much you would pay to prevent phosphorus in a given amount of cow manure per year from entering the reservoir.

For your information, a 1000-pound cow produces an average of 14.6 tons of cow manure each year.

You have a budget of $100 for each task, regardless of how much money you contributed in previous tasks.

Please consider how much you would be willing to pay to reduce each ton of cow manure in each task. **Please remember** that for each subsequent task, you can only contribute **the same or less per ton** than you contributed in the previous task.

You may circle the pre-calculated row or write down your own per-ton allocation and the total allocation for the project at the bottom of the page.

Task 1:

This task includes one water quality project, which would reduce phosphorus in ***15.70 tons of cow manure per year*** from entering the reservoir.

For this task, you have a budget of $100. Your total contribution cannot be greater than $100.

Please write down your per-ton contribution and the total contribution for the project at the bottom of the page or you may just circle the pre-calculated row.

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	15.70	$0.00	$100.00
$0.50	15.70	$7.85	$92.15
$1.00	15.70	$15.70	$84.30
$1.50	15.70	$23.55	$76.45
$2.00	15.70	$31.40	$68.60
$2.50	15.70	$39.25	$60.75
$3.00	15.70	$47.10	$52.90
$3.50	15.70	$54.95	$45.05
$4.00	15.70	$62.80	$37.20
$4.50	15.70	$70.65	$29.35
$5.00	15.70	$78.50	$21.50
$5.50	15.70	$86.35	$13.65
$6.00	15.70	$94.20	$5.80
$6.40	15.70	~$100.00	~$0.00

I would pay **$** _________ ***per ton*** to reduce phosphorus in ***15.70 tons of cow manure per year*** from entering the reservoir.

My total contribution is **$**__________ and I would take home **$**__________ (which is **$100 *minus your total contribution)*** if the projects in this task were implemented.

<u>Task 2:</u>
This task includes the water quality project from Task 1 and **<u>one additional project</u>**, which would together reduce phosphorus in ***a total of 74.90 tons of cow manure per year*** *(15.70 tons from Task 1 plus 59.20 tons from the additional project)* from entering the reservoir water.

For this task, you have a budget of $100. Your total contribution cannot be greater than $100.

Please write down your per-ton contribution and the total contribution for the project at the bottom of the page or you may just circle the pre-calculated row. *This* ***<u>per-ton</u>*** *value can be the same or less than your per-ton contribution in the previous task, but* ***<u>must not be larger</u>***.

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	74.90	$0.00	$100.00
$0.10	74.90	$7.49	$92.51
$0.20	74.90	$14.98	$85.02
$0.30	74.90	$22.47	$77.53
$0.40	74.90	$29.96	$70.04
$0.50	74.90	$37.45	$62.55
$0.60	74.90	$44.94	$55.06
$0.70	74.90	$52.43	$47.57
$0.80	74.90	$59.92	$40.08
$0.90	74.90	$67.41	$32.59
$1.00	74.90	$74.90	$25.10
$1.10	74.90	$82.39	$17.61
$1.20	74.90	$89.88	$10.12
$1.34	74.90	~$100.00	~$0.00

I would pay **$** _________ ***per ton*** to reduce phosphorus in ***74.90 tons of cow manure per year*** from entering the reservoir.

My total contribution is **$**__________ and I would take home **$**__________ (which is **$100** ***minus your total contribution)*** if the projects in this task were implemented.

Task 3:

This task includes the water quality projects from Task 2 and **one additional project**, which would together reduce phosphorus in ***a total of 77.90 tons of cow manure per year*** *(74.90 tons from Task 2 plus 3.00 tons from the additional project)* from entering the reservoir water.

For this task, you have a budget of $100. Your total contribution cannot be greater than $100.

Please write down your per-ton contribution and the total contribution for the project at the bottom of the page or you may just circle the pre-calculated row. *This **per-ton** value can be the same or less than your per-ton contribution in the previous task, but **must not be larger**.*

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	77.90	$0.00	$100.00
$0.10	77.90	$7.79	$92.21
$0.20	77.90	$15.58	$84.42
$0.30	77.90	$23.37	$76.63
$0.40	77.90	$31.16	$68.84
$0.50	77.90	$38.95	$61.05
$0.60	77.90	$46.74	$53.26
$0.70	77.90	$54.53	$45.47
$0.80	77.90	$62.32	$37.68
$0.90	77.90	$70.11	$29.89
$1.00	77.90	$77.90	$22.10
$1.10	77.90	$85.69	$14.31
$1.20	77.90	$93.48	$6.52
$1.29	77.90	~$100.00	~$0.00

I would pay **$ _________** ***per ton*** to reduce phosphorus in ***77.90 tons of cow manure per year*** from entering the reservoir.

My total contribution is **$__________** and I would take home **$__________** (which is **$100** ***minus your total contribution)*** if the projects in this task were implemented.

<u>Task 4:</u>

This task includes the water quality projects from Task 3 and **<u>one additional project</u>**, which would together reduce phosphorus in ***a total of 81.10 tons of cow manure per year*** *(77.90 tons from Task 3 plus 3.20 tons from the additional project)* from entering the reservoir water.

For this task, you have a budget of $100. Your total contribution cannot be greater than $100.

Please write down your per-ton contribution and the total contribution for the project at the bottom of the page or you may just circle the pre-calculated row. *This **<u>per-ton</u>** value can be the same or less than your per-ton contribution in the previous task, but **<u>must not be larger</u>**.*

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	81.10	$0.00	$100.00
$0.10	81.10	$8.11	$91.89
$0.20	81.10	$16.22	$83.78
$0.30	81.10	$24.33	$75.67
$0.40	81.10	$32.44	$67.56
$0.50	81.10	$40.55	$59.45
$0.60	81.10	$48.66	$51.34
$0.70	81.10	$56.77	$43.23
$0.80	81.10	$64.88	$35.12
$0.90	81.10	$72.99	$27.01
$1.00	81.10	$81.10	$18.90
$1.10	81.10	$89.21	$10.79
$1.20	81.10	$97.32	$2.68
$1.24	81.10	~$100.00	~$0.00

I would pay **$** _________ ***per ton*** to reduce phosphorus in ***81.10 tons of cow manure per year*** from entering the reservoir.

My total contribution is **$**__________ and I would take home **$**__________ (which is **$100 *minus your total contribution)*** if the projects in this task were implemented.

<u>Task 5:</u>

This task includes the water quality projects from Task 4 and **<u>one additional project</u>**, which would together reduce phosphorus in ***a total of 84.90 tons of cow manure per year*** *(81.10 tons from Task 4 plus 3.80 tons from the additional project)* from entering the reservoir water.

For this task, you have a budget of $100. Your total contribution cannot be greater than $100.

Please write down your per-ton contribution and the total contribution for the project at the bottom of the page or you may just circle the pre-calculated row. *This **<u>per-ton</u>** value can be the same or less than your per-ton contribution in the previous task, but **<u>must not be larger</u>**.*

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	84.90	$0.00	$100.00
$0.10	84.90	$8.49	$91.51
$0.20	84.90	$16.98	$83.02
$0.30	84.90	$25.47	$74.53
$0.40	84.90	$33.96	$66.04
$0.50	84.90	$42.45	$57.55
$0.60	84.90	$50.94	$49.06
$0.70	84.90	$59.43	$40.57
$0.80	84.90	$67.92	$32.08
$0.90	84.90	$76.41	$23.59
$1.00	84.90	$84.90	$15.10
$1.10	84.90	$93.39	$6.61
$1.18	84.90	~$100.00	~$0.00

I would pay **$** _________ ***per ton*** to reduce phosphorus in ***84.90 tons of cow manure per year*** from entering the reservoir.

My total contribution is **$**__________ and I would take home **$**__________ (which is **$100** ***minus your total contribution)*** if the projects in this task were implemented.

<u>Task 6:</u>

This task includes the water quality projects from Task 5 and **one additional project**, which would together reduce phosphorus in ***a total of 88.70 tons of cow manure per year (****84.90 tons from Task 5 plus 3.80 tons from the additional project)* from entering the reservoir water.

For this task, you have a budget of $100. Your total contribution cannot be greater than $100.

Please write down your per-ton contribution and the total contribution for the project at the bottom of the page or you may just circle the pre-calculated row. *This* ***per-ton*** *value can be the same or less than your per-ton contribution in the previous task, but* ***must not be larger***.

Price per Ton	Tons of Cow Manure Reduced *each year*	Your Total Contribution	You would take home
$0.00	88.70	$0.00	$100.00
$0.10	88.70	$8.87	$91.13
$0.20	88.70	$17.74	$82.26
$0.30	88.70	$26.61	$73.39
$0.40	88.70	$35.48	$64.52
$0.50	88.70	$44.35	$55.65
$0.60	88.70	$53.22	$46.78
$0.70	88.70	$62.09	$37.91
$0.80	88.70	$70.96	$29.04
$0.90	88.70	$79.83	$20.17
$1.00	88.70	$88.70	$11.30
$1.10	88.70	$97.57	$2.43
$1.13	88.70	~$100.00	~$0.00

I would pay **$** _________ ***per ton*** to reduce phosphorus in ***88.70 tons of cow manure per year*** from entering the reservoir.

My total contribution is **$**__________ and I would take home **$**__________ (which is **$100** ***minus your total contribution)*** if the projects in this task were implemented.

Follow Up Questions

Please indicate by placing an (X) under the appropriate column the degree to which you agree or disagree with each of the statements below.

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The decisions were difficult.					
The decisions were relevant to my concerns about water quality in lakes and rivers in my neighborhood.					
My decisions were influenced by my perception about what others in the room would do.					
My contribution would be sufficient to implement the water quality projects listed in each task.					
I was trying to keep my total contribution near a constant value of the budget ($100).					
I was trying to keep my total contribution near a certain percentage of the budget ($100).					

Your Opinion on Local Farms and Water Quality

Please indicate by placing an (X) under the appropriate column the degree to which you agree or disagree with each of the statements below.

Statements	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
The quality of water in lakes and streams near my home affects my quality of life.							
I am concerned about water quality in lakes and streams near my home.							
I am concerned about water quality in lakes and streams near my home because they are used for recreation, such as swimming, fishing, or boating.							
I value water quality in lakes and streams near my home even if I do not use them.							
I believe local livestock farms affect water quality of lakes and streams near my home.							
I believe local livestock farms are a significant source of nutrients like phosphorus, which adversely affects water quality in lakes and streams near my home.							
Livestock farms should adopt farming practices that reduce the amount of nutrients like phosphorus from entering lakes and streams near my home.							
Livestock farmers in my neighborhood are good stewards of the land.							
I would be willing to support local livestock farmers that improve their farming practices in order to improve water quality.							
Local livestock farmers should receive financial and technical assistance so that they can be better environmental stewards.							
I believe local farms face difficult competition to survive in a modern economy.							
I believe homes that actually drink Scituate Reservoir water should pay the costs of manure management.							
I believe manure management operations in local livestock farms should be regulated.							

Your Background

This section asks about your social and demographic characteristics. Your answers will help us interpret our results and support environmental managers and decision makers. All information you provide will be kept completely confidential.

1. What is your gender? □ Male □ Female

2. What is your age? ____________ years

3. Do you own a livestock(s) or a farm animal(s) (e.g., cows, horse, sheep, goat, pigs, chickens)?

   □ Yes □ No

4. Is your home…
   - □ Owned by you or someone in your household with a mortgage or loan? Include home equity loans.
   - □ Owned by you or someone in your household free and clear (without a mortgage or loan)?
   - □ Rented? *Skip to question 6*
   - □ Occupied without payment of rent? *Skip to question 6*

5. **If you own your home:**

   How many times per year do you fertilize your lawn and garden?

   □ Never □ Once □ Twice □ Three times or more each year

   When do you fertilize your lawn and garden? *Check all the apply*

   □ Never □ Spring □ Summer □ Fall □ Winter

6. When did you move into your home? Month:_________Year: _______

7. How long have you lived in your current town? __________ years

8. What is the highest degree or level of school you have completed?
   - □ Some high school or less
   - □ High school diploma
   - □ GED or alternative credential
   - □ Some college credit, but less than 1 year of college credit
   - □ 1 or more years of college credit, no degree
   - □ Associate's degree (for example: AA or AS)
   - □ Bachelor's degree (for example: BA or BS)
   - □ Master's degree (for example: MA, MS, MEng, MEd, MSW, MBA)
   - □ Professional degree (for example: MD, DDS, DVM, LLB, JD)
   - □ Doctorate degree (for example: PhD, EdD)

9. Have you ever been negatively affected by farming or livestock operations in your neighborhood?

□ Yes □ No

10. Are you currently affiliated with any environmental group or organization?

□ Yes □ No

11. Approximately how many days did you visit freshwater lakes or streams for either personal enjoyment or recreation in the past 12 months? *Please write 0 if you do not visit freshwater lakes or streams for personal enjoyment or recreation.*

__________ days per year

12. Approximately how much did you donate to environmental causes or groups in the past 12 months? *Please write 0 if you do not donate to environmental causes or groups.*

$ __________ per year

13. Approximately how many days did you volunteer in environmental projects or causes in the past 12 months? *Please write 0 if you do not volunteer in environmental projects or causes.*

__________ days per year

14. What was your total household income before taxes in the past 12 months?

□ $24,999 or less
□ $25,000 to $49,999
□ $50,000 to $74,999
□ $75,000 to $99,999
□ $100,000 to $124,999
□ $125,000 to $149,999
□ $150,000 or more

15. Have you ever experienced a failed septic system?

□ Yes □ No

16. Approximately how many times did you test the quality of your home's drinking water in the past 12 months?

□ None □ Once □ Twice □ Three times or more

Please write down any comments you have about the Water Quality Decision-Making Workshop in the space provided.

CONCLUDING REMARKS

The findings of empirical research presented in this dissertation (manuscripts 1 and 2) provide an important insight regarding methodological issues, relating to incentives and the effect on value estimates due to a provision rule as well as consistency of stated preferences across the repeated response format, under a discrete choice experiment method for valuing environmental goods and services. These results may convey important methodological learning to valuation researchers for future consideration while developing such surveys. The preference models developed could be used by local environmental managers to integrate values for the ecosystem restoration projects and wetland preservation into their decision-making processes regarding the environmental policies that affect the use and management of these natural resources. Furthermore, the results from the public good experiments (manuscript 3) could provide useful insights to research analysts regarding potential ways to improve the public good institutions in the future, as well as learning in terms of what may work and what may not, to generate private offers to provide local public goods. Also, the results that the less-structured public good institution performed better than the more-structured institution may emphasize the need to design simple (in terms of implementation) public good institutions. Overall this dissertation research contributes to both DCE literature as well as the public good experiments literature to further our understanding in terms of examining ways to assess better estimates of values for the goods and services that cannot be traded in common commodity markets and important insights towards creating novel markets for the ecosystem services.

In Manuscript 1, I empirically examined whether the value estimates produced by real-money field experiments using a DCE survey with an incentive compatible provision rule were equivalent to the corresponding estimates from the DCE with a non-incentive compatible provision rule, and I found that the value estimates are statistically equivalent. This result is consistent with previous studies examining the provision rules using dichotomous choices, but this study broadens this conclusion for trichotomous choice elicitation which is the most commonly used DCE elicitation format. This result relays an important message to valuation researchers that the absence of theoretically predicted incentive compatibility in trichotomous choice questions may not be a caveat of concern in such stated preference studies generally, as implied by our results finding statistically similar underlying preference functions across the rules. Strategic behavior under a non-incentive compatible rule predicted by theory may not come out sharply in case of novel environmental choice settings which may require higher-order thinking. That is, the absence of incentive compatibility may not be sufficient to lead respondents in DCE's to respond strategically. Our study also utilized an opportunity to combine real, immediately implementable choice scenarios as well as hypothetical scenarios that extended the range of attribute levels covered in real choices and the comparison of preferences across the two suggested that the preferences were statistically equivalent. This may be due to a spillover effect of real scenarios over the hypothetical ones. This result also implied that future DCE studies could utilize this insight and include some real scenarios whenever possible to create a more consequential choice context.

In Manuscript 2, I empirically investigated whether the stated preferences across a series of choice scenarios in a DCE are stable, as the repeated response format could induce incentives that may lead to non-truthful responses as predicted by theory and also backed up by empirical evidence of systematic change in expressed preferences across the sequence of choices. Our comparison of preferences and value estimates under DCE studies involving two choice scenarios and a series of twelve scenarios suggest statistically different underlying preference functions across the two survey length formats. Further exploration of pattern of response across the sequence of choices in the repeated survey format suggests evidence of precedent-dependent effects relating to a potential to retain higher net surplus from the most-valued alternative in the current task relative to the most-valued alternative in the preceding task may induce participants to be less sensitive to cost and thus appear to have a higher WTP across the sequence. Our exploration of precedent-dependent effect in trichotomous choice elicitation involved choice scenarios with more attributes than previously appeared in the literature. Such a result may be problematic for future applications of stated-preference surveys that have assumed the multiple-attributes of a DCE might lead respondents to adopt a truth-telling strategy throughout a sequence of choices. Examining a change in predicted net surplus for the most-valued alternative across the sequence under multinomial response format, I think, is a novel way of looking at increasing or decreasing utility sequence, than previously was employed in dichotomous choice setting with much simpler targeted DCE surveys.

In Manuscript 3, I empirically examined participants' offers to provide ecosystem-service public good elicited under a more-structured public good institution based on Lindahl's framework known as Individualized Price Auction (IPA) relative to a less-structured voluntary donation elicitation employing incentive mechanisms from experimental economics literature, including a provision point (PP) with a money-back guarantee (MBG) and a proportional rebate (PR) of any excess funds beyond the PP. In our framed field experiment setting, a less-structured voluntary donation garnered higher offers compared to the more-structured IPA. This result emphasizes the need to design simple (in terms of implementation) public good institutions to generate private contributions to provide public goods.