INCENTIVE MECHANISMS AND THE PROVISION OF PUBLIC GOODS: TESTING ALTERNATIVE FRAMEWORKS TO SUPPLY ECOSYSTEM RESTORATION

BY

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ABSTRACT

This research examines a practical method to implement an individualized pricing approach to public good provision, grounded in Lindahl's marginal benefit theory. We focus on ecosystem valuation and market approaches that have potential to provide public goods, examining the potential to generate revenues for public goods from consumers. While willingness-to-pay measurement techniques have been used to assess preferences for many environmental goods, this research goes a step further to explore real money auctions that generate revenues sufficient to pay for restoration activities. We compare field experiments conducted in coastal Virginia with induced-value laboratory experiments in order to evaluate the performance of auction mechanisms in generating revenues relative to potential (Hicksian) willingness to pay for marginal increments in public goods.

Induced-value lab experiments allow for a test of the mechanisms in a controlled, experimental economics laboratory environment, examining how individuals respond to the incentives without the possible bias associated with preconceived notions about the specific public good's environmental or social impacts. The design of the induced-value experiment follows the literature testing mechanisms intended to fund public goods. In the laboratory experiments, groups of 8 to 14 participants are assembled and asked to make a series of decisions regarding how much money they are willing to allocate, on a per-unit basis, towards provision of incremental units of a public good. The auction process asks participants to report a marginal bid curve and the lab experiment allows a test of how well the marginal bids track the participants' marginal willingness to pay.

The field execution of this experiment involves residents of Virginia's eastern shore and local public goods. This application involves half-acre increments of ecosystem restoration for sea grass habitat in coastal lagoons, plantings for migratory bird habitat, and, in some auctions, clam-based increments of water quality services, defined as delaying the harvest of clams for six months beyond normal harvest by an existing aquaculture firm. To perform these tasks, participants are provided a budget, between $90 and $150. The auctioneer describes for participants the ecosystem services that may result from additional ecosystem restoration associated with each activity. The actual levels of ecosystem restoration provided are based on aggregate offers reaching a pre-determined (but unknown to the participants) provision point, or cost of implementing the project. The auction process considers offers to pay for and costs to deliver each unit in the sequence. In this way the auction process aggregates participants' willingness to pay (offers) on a given level of restoration and balances aggregate marginal payment with marginal cost for any level of restoration provided.

Data from the field experiment, allow us to compare auction prices offered to estimates of marginal Hicksian willingness to pay derived from a baseline choice experiment that employs an incentive compatible, majority vote mechanism and actual (not hypothetical) money payments. A conditional logit model, rooted in McFadden's choice theory, is used to examine the trade-offs between ecosystem restoration activities to estimate willingness to pay.

In both lab and field settings, we find offers are consistent with decreasing marginal benefits, with higher bids on earlier units. There are some differences across individual incentive mechanisms (involving rules for rebates of excess funds) that we will explore. Additionally, participants contribute enough funds to supply, on average, multiple units of ecosystem restoration. Thus, individualized pricing for each activity supports the potential that Lindahl-inspired methods can generate revenues to fund public goods, at least when implemented with rebate mechanisms such as those found in the experimental literature.

The study is intended to initiate development of new approaches for financing public goods, beyond government and philanthropic efforts. Individualized pricing based on the Lindahl approach has long been considered impractical in microeconomics. This study initiates a direct test of this long-held (90-year) assumption. Our results indicate that participants make decisions consistent with the desirable theoretical properties of Lindahl's framework, while simultaneously generating adequate funds to provide the public goods. The methods explored in this study may be most appropriate for localized public goods, but there is potential to adapt such incentive mechanisms for use in combination with existing programs by which government pays landowners for ecosystem services. Auction methods could serve as an alternative (or complementary approach) to stated preference methods as a means for guiding the investment of public funds for ecosystem services.

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CHAPTER 1: INTRODUCTION

1.0 Statement of the Problem

A fundamental problem faced by economists and others in society is how to value and provide public goods. Public goods are persistently undervalued because they are non-excludable. Providers are unable to exclude beneficiaries who do not pay for the cost of provision, creating the opportunity for individuals to "free ride" on those who do pay. Erik Lindahl first proposed a system to finance public goods via individualized pricing in 1919, based on setting an individuals' marginal cost (i.e., marginal price) equal to the marginal benefit they receive from provision of the good (Lindahl 1919, Mas Collel 2002, Nicholson 2005), thus establishing one level of the good with many individualized prices. Lindahl's approach sums the individualized prices of each person to balance against the actual marginal cost of providing the good. While, theoretically, Lindahl's approach can reach a Pareto optimal level of public good provision, if each individual were to reveal their full marginal value (Groves and Ledyard 1977, Walker 1981), it has been thought to be near impossible to garner offers sufficient to provide for the Pareto optimal quantity of public goods in actuality (Nicholson 2005).

Increased demands on our natural resources, due to increased development and population growth, limit society's access to well-functioning ecosystems and diminish the secondary services, or ecosystem services, a healthy ecosystem provides (Daily 1997; Lugo 2008). The Millennium Ecosystem Assessment (2005) categorizes these ecosystem services broadly as provisioning, regulating, supporting and cultural services.[1]

While these goods and services may take on many different functions, from clean water to adequate fish habitat to scenic vistas, many of them also lack well-established markets, leaving such goods undervalued in society. While ecosystem services encompass many forms, this study focuses on a subset of services, such as submerged aquatic vegetation (SAV), that provide habitat for fish and shellfish. Some of these services benefit individuals directly, such as when an individual personally harvests and consumes shellfish for recreation and food. Other services are less easily classified, such as habitat support services that not only provide for recreational consumption of shell fishing but also support water clarity by preventing sediment suspension and coastal erosion control (Orth et al 2005).

The seminal work of Krutilla (1967) is often attributed with stimulating economists in recent decades to recognize many ecosystem services as public goods, which benefit many people simultaneously, including individuals who benefit without paying towards the costs of provision. Yet a challenge faced by economists, policy-makers and others concerns how to link the value of such public goods to people and integrate these values into the economy. While few to no markets[2] exist for ecosystem

[1]The Millennium Ecosystem Assessment defines them as: provisioning services are products obtained from ecosystems (e.g. food, fresh water), regulating services are the benefits obtained from the regulation of ecosystems (e.g. climate regulation, water purification), supporting services are those necessary for the production of all other ecosystem services (e.g. nutrient cycling) and cultural services are the non-material benefits obtained from ecosystems (e.g. eco-tourism, spiritual or aesthetic services).
[2] By markets we mean free, private markets, excluding philanthropic transactions.

restoration that provide public goods and are not traditional commodities, such as habitat services provided by healthy sea grass beds or water quality benefits associated with clam populations filtering water, consumer preferences can provide insight to managers and policy-makers on how to prioritize limited funding and make trade-offs between restoration priorities.

This study, motivated by Lindahl's approach, will explore ways to generate revenues for such public goods via exploring individual willingness to pay for specific ecosystem restoration activities and auction methods by which such willingness to pay might be translated into revenues. Results and insights into such preferences and valuations are potentially useful for private enterprises looking to establish new markets, philanthropic organizations who regularly solicit voluntary contributions from the public, and policy makers looking to establish a better balance between the public value of environmental quality and the alternative uses of environmental resources.

The goals of this project include:

(1) To establish an individualized-price experimental auction scenario, grounded in Lindahl's theory of marginal benefit pricing for public goods;

   a. To evaluate if the individualized pricing experimental auction can, in practice, mitigate free-riding or cheap-riding ;

(2) To establish an incentive compatible scenario that evaluates the Hicksian willingness-to-pay for alternative ecosystem restoration activities to compare to the individualized pricing experimental auction;

(3) To examine the trade-offs that individuals make under different economic payment rules (incentive mechanisms), including

    a. Truthful revelation; and

    b. Efficiency.

1.1 Approach

This body of research examines a new auction process, inspired by Lindahl's idea of marginal benefit pricing, in conjunction with economic payment rules or mechanisms to elicit individuals' private values for environmental goods and the potential to provide these public goods. An individualized pricing experimental auction (IPA) approach[3], grounded in marginal benefit theory and motivated by Lindahl's framework for public goods (Lindahl 1919, Musgrave & Peacock 1958), generates offers on incremental units of the public good, at the margin. We evaluate the marginal offers under the IPA framework for incremental levels of the public good, using econometrics to estimate our specified function relative to marginal changes in provision. We do this comparison to evaluate estimates of marginal willingness to pay

[3] The IPA process is subject to a pending patent application, and within that application, the process described here is the forward version. Swallow, Smith, and Anderson 2008 "Revenue Raising Auction Processes for Public Goods," Provisional Patent Application 61/120,573 filed 12/10/08. Sponsored by NSF, grant No DEB0621014.

under our new approach with those under a known incentive compatible approach that should (in theory) produce offers consistent with full, Hicksian value.[4]

Economic incentive mechanisms applied to the IPA framework can help mitigate free-riding. We evaluate how the IPA works in a laboratory setting and the impact of selected incentive mechanisms on both provision and demand revelation. Previous research in the experimental economics literature has shown that individuals will increase donations to a public good project if the payment rules reduce the incentives for individuals to 'free ride' (benefit without paying towards the cost of provision) on the contributions of others (Isaac et al. 1989; Bagnoli and Lipman 1989; Davis and Holt 1993; Ledyard 1995; Holt 2007). Additionally, individuals contribute more towards a project if there is a provision point and money back guarantee. Under these conditions, the public good is supplied only if a pre-specified amount of money (the provision point) is raised, and participants receive their money back if the market fails to raise that amount (Bagnoli and McKee 1991, Marks and Croson 1998, Cadsby and Maynes 1999, Poe et al. 2002, Das 2007, Spencer et al. 2009). We adopt several variations of these incentive mechanisms in the IPA model, to assess whether decision-making changes with alternative rules for settling the auction with respect to marginal units.

[4] IPA offers do not necessarily reflect true marginal WTP since the IPA is not incentive compatible and the offers are thus not representing the true Hicksian value, but for simplicity for the remainder of this document we will use Mθ notation when referring to marginal offers produced under the IPA and mWTP to refer to Hicksian offers produced under the choice experiment.

We then evaluate the IPA in a field setting to see how the framework is operating and compare these marginal offers (Mθ) with those estimated from an incentive compatible scenario that, in principle, establishes willingness to pay (WTP). Offers established under an incentive-compatible choice are consistent with truthfully revealing the full value (full willingness to pay (WTP)) for the alternative that an individual prefers most. For example, in a choice among two alternative sets of restoration activities and required payments from the individual, a voting institution with majority rule is incentive compatible because each participant's best strategy is to vote for the alternative that he or she would most prefer to see implemented (Hoehn and Randall 1987, Bagnoli and Lipman 1989).

In recent years, economists have created a rich literature on valuing environmental goods and services through choice experiments (Hanley et al. 1998, Opaluch et al. 1993, Adamowicz et al. 1994, Adamowicz et al. 1998, Johnston et al. 2002, List et al. 2006, Carlsson and Martinsson 2001, Carlsson et al. 2003). The valuation experiments constructed here ask individual participants to make commitments, with real money, choosing between bundles of ecosystem restoration that vary in acreage and cost. Hereafter, we refer to this valuation experiment as the 'choice experiment' but unlike studies involving stated preferences our choice experiments always involve real goods and real dollar payments, *not* hypothetical payments; we therefore use the acronym CE^R to emphasize the real money component of this choice experiment. Under the specified rules of trade, particularly a dichotomous choice vote, an individual is always best off if they make choices consistent with the full value they place on the alternatives. In a laboratory setting, Carlsson and Martinsson (2001) provide a precedent for using this type of choice experiment for actual provision of public goods.

We evaluate the offers from the incentive compatible CE^R approach and the IPA to assess estimates of $M\theta$ against true mWTP. The CE^R provides estimates of WTP, which we can then compare, at the margin, to the offers ($M\theta$) from the IPA. This allows us to measure how the IPA is operating in terms of its effectiveness at generating offers consistent with mWTP. If the marginal offers under an IPA process are close to estimated mWTP based on a CE^R involving real choices in an incentive compatible setting, then the IPA may be viewed as promising as a practical approach to identifying Lindahl's individual, marginal-benefit prices. Integrating an individualized pricing framework (IPA) into the public goods research agenda has the potential for generating more effective institutions to integrate public goods into market based choices for environmental restoration activities, including the services that well-functioning ecosystems provide.

1.2 Methodology and Procedures

This research includes three broad tasks: (1) examine the IPA framework with specific incentive mechanisms in an experimental laboratory environment; (2) develop an incentive compatible method to estimate individual's willingness to pay for specific ecosystem restoration activities; and (3) examine the IPA for application to public goods relevant to ecosystems in the Virginia Coastal Reserve study area. The field experiments of this study involve an application to create auction markets for restoration of coastal habitats, including sea grass (specifically eelgrass, *Zostera marina*), migratory bird habitat, and clams filtering nutrients from water in coastal lagoons.

This research will involve several tasks to support the objectives above, and these are described as follows: Task 1 allows mechanisms to be tested in a controlled, experimental economics laboratory environment, examining how individuals respond to the incentives without the possible bias associated with preconceived notions about the specific environmental goods or social impacts. Task 2 will examine the trade-offs between each restoration activity (or public good) made by local residents benefiting from these goods. This task also allows for a baseline willingness-to-pay estimation in an incentive compatible environment that can be compared against other, newer, mechanisms (Task 3). Task 3 examines the marginal offers by residents for a subset of specific local public goods, under the incentive mechanisms examined in Task 2. Tasks 1, 2 and 3 together, allow for an assessment of the performance of the IPA against an economic estimate of residents' values for incremental units (acres) of sea grass restoration, bird habitat restoration, and clam restoration.

1.3 Study Population[5]

Two distinct groups of individuals comprise the study population of this research:

1. University of Rhode Island undergraduate[6] and graduate students: This population did partake in lab experiments designed to examine the properties of the incentive mechanisms mentioned above. In accordance with the Institutional Review Board protocols on research involving human subjects, participants were recruited though an existing URI Policy Simulation Lab email recruitment list.

2. Local Residents of Accomack and Northampton Counties, Virginia: Recruitment for both the year one and year two (2008, 2009) was accomplished through local environmental groups, including Citizens for a Better Eastern Shore, Master Gardeners, Master Naturalists, and similar groups.

1.4 Dissertation Outline

Chapter 2 provides background on the Lindahl-inspired approach and how we integrate incentive mechanisms into the IPA framework. Chapter 3 introduces the IPA framework in the lab, allowing for a test of demand revelation and efficiency. Chapter

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[5] All protocols for human subjects follow the Institutional Review Board (IRB) Policies and Procedures as outlined in HU0809-013.

[6] One session of induced value experiments did take place at Newbury College in an undergraduate economics class with a URI graduate student instructor.

4 includes the background on both years of the field experiment that develops the incentive compatible choice experiment (CE^R) and the individualized price experimental auction (IPA), results of each approach are presented. Chapter 5 compares the results of the two experiments (CE^R and IPA) and evaluates the IPA estimates against those from the incentive compatible CE^R. Finally, Chapter 6 identifies some of the challenges in this research and discusses potential avenues for future research. Appendices provide samples of both the laboratory and field experiments.

Chapter 2: EVOLUTION OF THE IPA

2.0 Overview

This chapter provides a brief overview of some of the literature and the process that contributed to our newly developed auction process, the IPA. In order to introduce the concept of Lindahl's system of public good pricing, we review the public good problem, efficient provision and provide an introductory review of the literature on approaches to overcome free riding, particularly focused on more recent experimental economics literature examining methods to encourage the supply (or to reduce under supply) of public goods. We examine scenario's that could impact the Nash equilibria and potential for Pareto optimal allocations. In the next chapter, we present the laboratory execution of the auction process that incorporates incentives for participants to reveal their demand and that attempts to solicit offers that enable the implementation of Lindahl pricing for pragmatic application to provision of public goods.

2.1 Introduction

A fundamental problem faced by economists and others in society is how to value and provide public goods. A common definition of a public good, following Samuelson (1954), is a good which all people enjoy in common, in non-rival fashion, such that each individual's consumption of the good does not result in a reduction of any other individual's consumption of that good. Public goods are generally non-excludable, such that anyone may use them while not paying towards the cost of providing them, so that providers cannot require beneficiaries to pay for costs of provision, which often results in the under-provision of these valuable goods. Without the usual market system in place, we lack accurate information on consumer's values. If information is obtained that accurately represents how much a group values a particular public good (or set of public goods), a level of provision might be established that accurately reflects how much members of society value them. This idea, of establishing an efficient level of the public good and finding a way to get consumers to pay for it, has challenged economists for more than a century.

Public goods are persistently undervalued because they are non-excludable. Providers are unable to exclude beneficiaries who do not pay for the cost of provision, creating the opportunity for individuals to "free ride" on those who do pay. The non-excludable nature of public goods motivates effort to find better approaches for determining the appropriate level of production while simultaneously setting a price (or set of prices) that will lead to provision of the good. Lindahl first proposed a system for individualized pricing of public goods in 1919, based on an individuals' marginal payment being equal to the marginal benefit they receive from provision of the last unit of the good (Lindahl 1919, Musgrave and Peacock 1958, Walker 1981, Nicholson 2005). Balancing the sum of these payments against the cost of delivery, at the margin, establishes one level of the good with many individualized prices.

Lindahl's approach does several things. First, by establishing a framework that allows people to pay individualized prices, the approach sets a price to the individual no higher than the individual's marginal benefit. Theoretically, Lindahl's approach can reach a Pareto optimal level of public good provision[7], if each individual were to reveal their full marginal value (Groves and Ledyard 1977). This framework can create an incentive for individuals to pay their marginal benefit since the price reflects the benefit they personally will receive if the good is provided and that price can assure some surplus benefit is retained on infra-marginal units.[8] Second, setting the production of the public good at a level where the sum of the marginal prices is balanced against the marginal cost establishes a Pareto optimal level of provision, if each individual does reveal his or her full marginal value (Samuelson 1954). Nonetheless, many economists believe it is impractical to elicit offers that reflect an individual's full value for the marginal unit so that the sum of the marginal benefits can be balanced against the marginal cost of production on the marginal unit (Nicholson 2005, Mas Collel 1995). We have found no empirical research regarding any process designed to elicit marginal values as Lindahl considered.

2.2 Efficient Provision

Pareto optimality (also referred to as Pareto efficiency) is a standard often used in economics that describes a situation where no further improvements to society's well-being can be made through a re-allocation of resources that makes at least one person better off without making someone else worse off. If resources are *not* allocated in a Pareto efficient manner, then it would be possible through re-allocation to provide more of some good(s) to at least one person, making that person better off, without

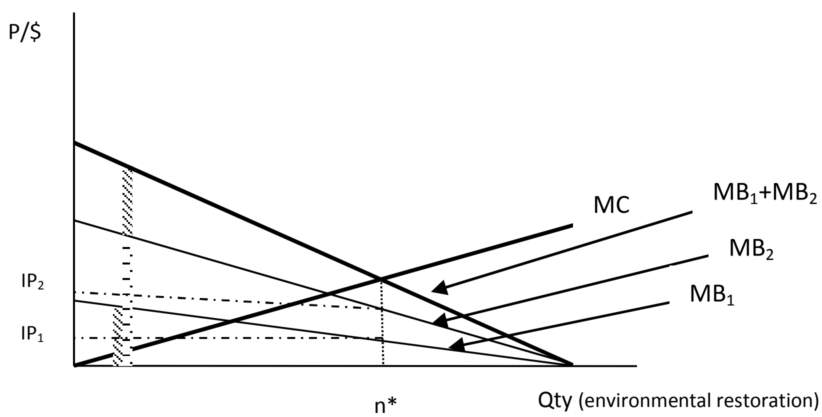
[7] Under a Lindahl equilibrium it is never in a participants' best interest to not participate, that is, no one is worse off in equilibrium than they were at the initial starting point, at which there is zero provision.
[8] This assumes diminishing marginal willingness to pay.

making any other person feel less well off. If all members of society who enjoy a public good are paying an individualized price equal to the marginal benefit they each receive at the quantity provided, and if the sum of these marginal payments is balanced against marginal delivery cost, then no individual can be made better off, such as by paying less and retaining more surplus benefits, without making another individual worse off. If one individual paid less, either someone else would have to pay more to make up the deficit at the margin, or the quantity provided would decline below the Pareto efficient level such that the collective benefit of the lost unit(s) exceeds the (marginal) cost of their provision. The Lindahl equilibrium is then Pareto optimal, generating a level of provision that is efficient if each individual reveals and pays their true marginal value.

Samuelson (1954) proved that the efficient level of provision of the public good is where the sum of individual marginal benefits equals the marginal cost of provision. In a two person world, where each individual pays their marginal benefit, the public good is then provided at an efficient level and individual prices (IP_1 and IP_2, respectively for each person) are established at an equilibrium level of the good (n^*). Figure 1 below illustrates this outcome. If people offer less than their marginal value, the equilibrium quantity produced will be lower than optimal; if people offer more than their marginal value they would be paying above their marginal benefit for the quantity produced. When the sum of marginal benefits equals marginal cost, the consumer's surplus generated becomes a net benefit that individuals would like to obtain and retain; in this way, the Lindahl approach might generate an incentive for individuals to offer a marginal price that is equal to their marginal value which then establishes an equilibrium quantity in society (n*).

***FIGURE 1*: Individualized Prices and Efficient Public Good Provision**

MC = Marginal cost curve
MB_1 = Marginal benefit curve for person 1
MB_2 = Marginal benefit curve for person 2
$MB_1 + MB_2$ = Marginal benefit curve for society (persons 1 & 2)
IP_1 = Individualized price for person 1
IP_2 = Individualized price for person 2



If people do *not* pay a cost that represents their marginal benefit, the public good is not provided at the efficient level. If one individual paid less, either someone else would have to pay more to make up the deficit at the margin, or the quantity provided would decline below the Pareto efficient level such that the collective benefit of the lost unit(s) exceeds the (marginal) cost of their provision. However, Lindahl's equilibrium allows both people to pay an individualized price equal to the marginal benefit they receive if the good is provided (IP_1, IP_2). The sum of the marginal offers results in a

Pareto optimal level[9] of provision, where each person pays an individualized (personal) price and a socially efficient level of the good is provided.

The Lindahl equilibrium is established theoretically, yet to obtain knowledge of individual demand curves in a society (for all private and public goods) is challenging. The incentive, with no other structure in place, is for an individual to lie about their preferences and under-report marginal benefits for the public good and free ride on the payment of others. While the Lindahl equilibrium is not incentive compatible,[10] incorporating incentive mechanisms used in the experimental literature known to alleviate free riding can re-align incentives with values, in practice. Without additional constraints, free riding prevents the Lindahl equilibrium from being a Nash equilibrium, but the provision point changes the set of Nash equilibria. In the next section we introduce components from the experimental research that we integrate into a newly developed auction process to solicit marginal offers, consistent with Lindahl's approach, the individualized price auction (IPA).

2.3 Public Good Experiments

The early public goods literature is largely theoretical, providing important foundations regarding solution concepts and equilibria, yet in many cases disconnected from the practical solutions needed for public good provision. After

[9] For public goods, this condition is often transformed to be the sum of marginal willingness to pay from all beneficiaries equal to the marginal cost of delivery of the last unit. See Appendix A for more information.

[10] A scenario is incentive compatible when one person has no reason to lie about their valuation, thus they offer their marginal benefit on each unit.

introducing some of the theoretical backbone of the efficient public goods literature there is a shift in the literature, to practical applications conducted in experimental settings. Below, we review some of the major findings in the experimental literature, specifically related to efficient provision of public goods. We apply some of these findings to our auction process to create a framework that urges participants to offer their true marginal value in order to test the feasibility of providing Pareto optimal levels of the public good.

Laboratory experiments let us examine, what types of incentive systems can be designed to provide public goods and ameliorate free riding (Bracht et al 2008). Outside the lab, researchers almost never know a person's true value. The lab provides benefits to individual participants in the way of a cash payout that can be 'earned' if the public good is provided. In an experimental economics laboratory researchers often assign a specific value or payoff to each individual if a certain outcome occurs; these values are called induced values. These benefits are often referred to as induced values since the participants' value for the good being provided are those told to them or induced through the laboratory experiment. In the experimental laboratory, induced values allow the researcher to measure how rules altering existing incentives may impact people's responses, compared to responses consistent with their true (induced) value (Smith 1976). The lab provides benefits in the way of cash payout that can be 'earned' if the public good is provided. In this way induced values (also referred to as marginal benefits) are representative of a participant's true value for the good. Decision making behavior by the participants can be measured against these marginal benefits to determine how well the framework for public good provision is operating as a measurement against the true value.

Public good experiments typically ask participants to contribute money (experimental dollars) to a fund that will pay a return to everyone, whether they invest or not, so that this fund represents the public good (non-investors still benefit). One of the simplest, yet most tested, laboratory experiments focused on public goods concerns the voluntary contribution mechanism (VCM). These VCM experiments provide participants an endowment of tokens and then ask participants to provide some amount of the tokens towards the provision of the public good. Benefits received from provision of the public good to the participant are some fraction of the total benefits the good provides, minus the cost the participant voluntarily paid. The Pareto optimal level of the good is the level where everyone contributes their full endowment (Davis and Holt 1993). If the VCM experiment does not include a threshold, it is a dominant strategy[11] for the participant not to cooperate, resulting in a unique, non-cooperative equilibrium that is not Pareto optimal (Ledyard 1995). With a threshold or provision point, the VCM has multiple non-cooperative equilibria, each could be Pareto optimal although none are dominant (Ledyard, 1995). In a two player game, both players earn more if they cooperate (offer their value), but if one player does not cooperate (or defects), that player earns more. The VCM is neither incentive compatible or demand revealing (Davis and Holt 1993), yet a significant finding from these simple experiments is that many individuals contribute to the public good even when pay-offs

[11] A dominant strategy pays at least as much as any other decision in every contingency and more in some.

could be maximized under free-riding (Ledyard 1995). Dawes and Thaler (1988) test the VCM with real money and find mean contributions that range between 40%-60% of the Pareto optimal level.

A common feature in the public good research pertains to thresholds or provision points. Threshold public goods require that a pre-set minimum dollar amount of project cost be met in order for the good to be provided; this minimum establishes a provision point. For the public good, the provision point requires that the sum of the group's offers equal or exceed the cost, if the good is to be provided (Bagnoli and Lipman 1989, Bagnoli and McKee 1991, Schulze 1995). Marwell and Ames (1980) show when a provision point is established free riding is no longer a dominant strategy. Bagnoli and McKee (1991) find increased contributions with a threshold and results that support the possibility of Pareto efficient outcomes. Palfrey and Rosenthal (1991) and Rappoport (1988) examine discrete contribution experiments with heterogeneous endowments. Suleiman and Rapoport (1992) find contributions are greater with a provision point, rather than when the group's funds do not have to meet a pre-specified cost, specifically when there are continuous vs. discrete contributions. In all of the above examples, when aggregate offers are not enough to pay the provision point, no good is provided. Marks and Croson (2001) establish that the provision point establishes an N-person coordination game with multiple efficient Nash equilibria.

In addition to a provision point, a money back guarantee (MBG) will ensure offers are returned if no good is provided and also changes the dominant strategy of participants. A MBG is shown to garner higher offers than without it (Isaac et al. 1989, Rapoport and Eshed-Levy 1989, Dawes et al. 1986, Marks and Croson 1998, Cadsby and Maynes 1999). The MBG works by alleviating the fear that offers will be lost if a provision point is not met, thereby encouraging participants to reveal offers that reflect true value (Isaac et al. 1989). Any set of offers from the group that is less than the provision point is a weak Nash equilibrium since player i does not have to pay to provide the good under this condition

When group offers are in excess of the needed cost or provision point of the project, economists explore rebate policies that examine how to re-disperse excess funds in the hope of identifying how people make decisions and to reduce strategic incentives that may arise from possible free-riding. One example, the proportional rebate (PR) mechanism, returns money in excess of the provision point as a percentage of the individual's offer. Marks and Croson (1998), Rondeau et al. (1999), Poe et al. (2002), and Spencer et al. (2009) show that the PR mechanism does garner higher offers when used with a provision point and MBG. Rondeau et al. (1999) use a single round PR with a provision point and MBG to show this mechanism is empirically demand revealing when tested with large groups of students in the lab. The PR imposes a weaker marginal penalty on participants than other mechanisms on over-contributions because excess money is rebated (Marks and Croson 1998).

More recently, economists have utilized a secondary mechanism in the public good research, the pivotal mechanism (**PM**). The pivotal mechanism, adapted from the Vickrey-Groves-Clarke mechanism, uses a provision point such that the marginal unit is only provided if the sum of the groups' offers equal or exceed the cost of the good. Yet under the **PM** a participant is pivotal on the marginal unit if the good is unable to be provided without their offer and only participants who are pivotal will pay their offer or the fraction of their offer needed to reach the provision point. For example, if the sum of the groups' offers equals \$110, the PP equals \$100 and participant i's offer is \$15; under this scenario participant i is pivotal since without their offer the provision point is not met (\$110 - \$15 < \$100). However, only a fraction of i's offer is needed to reach the provision point, therefore, their payment is \$5 rather than \$15. If a participant is *not* pivotal, they don't pay anything on the marginal unit. The experimenter makes up any deficit needed to cover the provision point when revenues under **PM** fall short in a field setting.

While the **PM** is shown to be incentive compatible in small groups (Tideman and Tullock 1976, Hammond 1979), there is not enough incentive for people to always tell the truth (Tideman and Tullock 1976). Kawagoe and Mori (2001) show that **PM** is only weakly incentive compatible because there are many possible outcomes under which strategies other than revealing full value may leave a participant no worse off than the dominant strategy of revealing full value; this weak incentive compatibility makes it difficult for participants to distinguish the dominant strategy from other best responses. Attieyh et al. (2000) find lower rates of demand revelation under the

PM (< 10%) than some other studies cited here, which may be due to the lack of strict incentive compatibility in their study. However, Kawagoe and Mori (2001) do find that if participants are provided additional information, particularly regarding payoff tables and potential profit, truth telling may become the dominant strategy.

Mechanism design must be clear enough for participants to understand while still eliciting offers that enable efficient public good provision. Rondeau et al. (2005) cite the need to design mechanisms that are not overly complex, enabling participants and decision makers to respond to the designed incentives. While Isaac et al. (1985) explore an approach to supply public goods at the Lindahl equilibrium; their approach elicits one single offer or contribution, and then adds the groups' offers and divides by unit cost to determine the level of provision. In contrast, the IPA designed here solicits marginal offers in order to sketch out individual demand curves and then aggregate to determine the provision level.

The IPA framework, introduced in the next section, aims to provide public goods under a Lindahl equilibrium such that people each pay an individualized price (equal to their marginal benefit on that unit) and the good is supplied at the socially optimal level, where the sum of the individual marginal offers pays for the cost of provision. We evaluate this infra-marginal IPA approach with the **PR** and **PM** mechanisms to evaluate the effectiveness of the mechanisms and the possibility of the IPA as a new approach to supply public goods at a Pareto optimum level.

2.4 Individualized Price Auction

We now explain an auction process that integrates several of the above experimental and incentive rules into an auction designed to solicit offers reflective of Lindahl pricing. The individualized price auction, or IPA, is a system designed to establish an equilibrium quantity of a public good for a given group of people, while simultaneously establishing individualized prices for each participant. As described here, the IPA uses a combination of elements drawn from the experimental economics literature to create a pragmatic approach to private provision of public goods as inspired by Lindahl's framework.

The IPA is a process for soliciting offers on successive units of a public good in order to deliver an equilibrium quantity with individualized prices, reflective of each consumer's marginal benefit. The IPA, by allowing people to name their own schedule of (marginal) offers on successive units, collects information on the individual's marginal benefit curve for each member of the auction, rather than for a single quantity on the curve. An equilibrium quantity is determined based on the last unit for which the sum of the groups' offers equals or exceeds the cost of providing that unit of the public good. The IPA framework consists of the following components: a) an offer schedule, b) the provision rule, c) total payment under a given set of marginal incentive rules, such as the proportional rebate mechanism (**PR**) or pivotal mechanism (**PM**) explained above.

Offer schedule: The auction participant chooses a schedule of marginal offers for the total units (N) available in the auction. The schedule of marginal offers on each unit n, ascending from 1 to N, is submitted to the auctioneer. On this schedule, each individual participant offers to pay a marginal price *per unit* on all units up to and including unit n, thereby voluntarily naming his or her maximum price per unit to obtain one unit, two units, etc., up to a maximum of N units.

Provision rule: The auctioneer determines that a unit, n, will be provided if the sum of the groups' offers for unit n total to equal or exceed the provision cost of unit n, and if the previous unit would be provided by this same criterion. The auctioneer evaluates all offers to identify unit $n^* \leq N$ as the number of units that will be provided through the set of offers obtained.

Thus, if the sum of the groups' offers is not enough to provide the first unit of the good, no units can be provided; $n^* = 0$ in this case. The auctioneer evaluates the sum of all auction participants' marginal offers on each unit relative to the cost of provision for that unit, beginning with the first unit and moving in succession. The auctioneer determines the final level of provision as the highest number of units that can be provided by the groups' offers, conditional on meeting the cost to provide the prior unit. Note also that excess funds offered on earlier units are not considered in determining whether a particular unit is provided.

Total offer: A participants' offer on the final unit ($M\Theta_{n*}$) is multiplied by the number of units provided to obtain that person's total maximum offer in the auction. For example, if participant i's marginal offer on unit two was $15, and unit two is the last unit provided in the auction, participant i's total maximum offer would be $30 ($15 x 2 units).

Total payment under marginal incentive rule: Each participants' payment is based on the final level of units provided (n*) and the marginal incentive rules established *a priori* for the auction.

a) For the marginal incentive rule designated as the Proportional Rebate (**PR**), payment is implemented as follows: i) If the group's marginal offers exceed the cost of providing the last unit (n*), then everyone's <u>price</u> for that unit will be discounted from their actual offer; the discount will equal the proportion of excess money in the total offered by the group. For example, suppose the auctioneer adds up the marginal offers from all participants bidding on unit n* and the auctioneer finds that X% of that money offered is not needed, because the provision point for unit n* is met with [1-X]% of the aggregate, marginal offers. Then the individual's offer will be discounted X% and the result will be their individual price (IP). Each person pays their own IP on each of n* units. ii) In the case where the sum of the groups' marginal offers on unit n* are just equal to the cost of provision, such that the marginal provision cost is exactly equal to the total of marginal offers, each participant just pays their offer. iii) If the group does not offer enough funds to cover the cost of any units of the good then no units of the public good are provided, units greater than zero are not evaluated for provision, all offers are refunded and no payments are made (e.g., a money-back guarantee (MBG)).

b) The marginal incentive rule designated as the Pivotal Mechanism (**PM**) is implemented as follows: i) If the group's marginal offers exceed the cost of providing the last unit (n*), then the auctioneer determines whether or not the marginal unit could still have been provided without a given individual's offer. If an individual offer is needed to fund the equilibrium unit (n*), then the individual pays only that portion of their offer that is needed to provide just exactly enough money to provide the unit (n*). In this case, the auctioneer calculates the discounted price for the equilibrium unit (n*) and the amount offered on the marginal unit is paid on all earlier units. ii) If an individual's offer is <u>*not*</u> needed to fund the equilibrium unit (n*), then the individual will pay nothing for the equilibrium unit (n*) provided and the originally offered amount on all earlier units. iii) Regardless of whether or not an individual gets the last unit (n*) for free, the offer on the equilibrium unit (n*) will be the price paid on all the earlier units. iv) If the group does not offer enough funds to cover the cost of any units of the good then no units of the public good are provided, units greater than zero are not evaluated for provision, all offers are refunded and no payments are made (e.g., a money-back guarantee (MBG)).

2.4.1 Equilibrium Considerations

In this section we use a graphical representation to depict possible equilibrium scenarios under the IPA. If the IPA is performing consistent with Lindahl's marginal benefit theory, it should encourage participants to make offers Mθ at or near their marginal benefit, MB, (such that MB=Mθ for any marginal unit) and the aggregation of these marginal offers across auction participants will reflect the true marginal benefits of all members in society (MSB). As discussed above, with no other structure in place, the usual incentives to free ride prevent Lindahl equilibrium from being a Nash equilibrium; however, our IPA incorporates both a provision point and incentive mechanisms. We note that, in general, the place (number of units n*) where our auction settles will not be a Nash equilibrium, but we find it instructive to discuss the individual's possible incentives for unilateral action at the marginal unit near where the auction settles (e.g., n*, n*-1, n*+1).

Figure 2a illustrates the case where person i, and all other auction participants, offers their marginal benefit (e.g. no cheap or free riding behavior), so the aggregation of offers across participants equals the aggregate marginal social benefit curve, representing all benefits to society (defined as the group of participants) and the provision point is just met (no rebates). We assume marginal cost is increasing. The shaded triangle represents the surplus person i receives when the auction settles at n*.

In considering the possible incentives we focus on three scenario's that illustrate if person i has an incentive to change his offer on n*. First, if person i were to raise their offer on n*, such that their Mθ > MB, they lose a fraction of their surplus since they now pay a higher marginal offer on all n* units. Any rebate that their increased offer would generate is distributed across all participants. Under this scenario, person i could instead increase his offer on unit n*+1 to be equal to his marginal offer on n*; and this offer increase may enable the auction to settle at a higher unit, n*+1. If the auction settles at a higher unit (in this case, n*+1) there is a possibility for additional profit due to the marginal benefit from n*+1. The potential for additional surplus could create a unilateral incentive for person i to increase his offer on unit n*+1, thus changing the incentives.

Second, if person i were to raise their offer on n*+1, in order to move the auction out to a larger number of units for delivery, there are two scenario's. If person i's marginal offer on n*+1 was equal to n* they would gain zero surplus on the additional unit and still pay the same price on all units prior and including to n*. If their marginal offer on n*+1 was less than n* they could gain addition surplus *if* unit n*+1 is provided; however, this is dependent on the slope of MSB and MC curves and potentially not enough to provide an additional unit. Third, if person i were to lower their offer on unit n*, and adopt a cheap riding strategy, the marginal cost is not met for unit n* and unit n*-1 is provided (Figure 2b). Under the assumption that person i's offer on n*-1, is either greater than or equal to their offer on n* (based on the assumption of non-increasing marginal offers and the slope of the MB curve below), their total payment could be smaller, but the amount of the decrease depends on how big a rebate is associated with this decision.

In Figure 2b we explore scenario three, the case where n* may not be the final unit in the auction because person i's offer is not representative of their true marginal value. In figure 2b, person i is cheap-riding, illustrated by the dotted $M\theta_1$ curve underneath the true MB_1 curve; there is some difference between the offered amount and the marginal value ($M\theta < MB$). This cheap riding behavior also impacts the marginal aggregate offers curve ($M\theta_{ALL}$), represented by the dotted line underneath the MSB curve. Cheap riding behavior moves the provided n* to the left relative to Figure 2a. Assuming non-increasing offers on sequential units[12], figure 2b shows that person i is not better off (does not retain additional surplus) under the strategy that reports $M\theta < MB$, since this approach will result in units n*-1 being produced and under the assumption that offers may not be higher than the previous, would mean that the offer on n*-1 would be equal to or higher than the offer on unit n* (the IP for person i on the n* unit is not higher than the IP on the n*-1 unit). Thus, if a participant under-reported their marginal benefit in an effort to cheap ride and gain additional surplus on the last unit, this cheap-riding approach may result in less surplus via a smaller n* and no added surplus from a lower price. Although the rebate associated with n*-1 may make this change negligible.

[12] Non-increasing offers were not imposed in our execution of the IPA but the majority of offers did follow this pattern. Inspection of the data indicates that less than 3% of the lab offers and 2% of the field offers are inconsistent with this format.

This discussion raises the possibility that a participant (with experience in the auction) would increase their offers until their $M\theta = MB$ (at the point where the auction finally settles) or they are unable to increase their offer on n^*+1 (due to the assumption of non-increasing offers on sequential units). Under the rules established here, person i will continue to increase their offer until they are unable to influence the auction's terminal unit and gain additional surplus.

***FIGURE 2a*: Surplus and Efficient Public Good Provision**

IP_1 = individualized price for person 1
MC = Marginal cost curve
MB_1 = Marginal benefit curve for person 1
$M\theta$ = marginal offer curve for person 1
MSB_{ALL} = Marginal benefit curve for society
$M\theta_{ALL}$ = Marginal offer curve for society

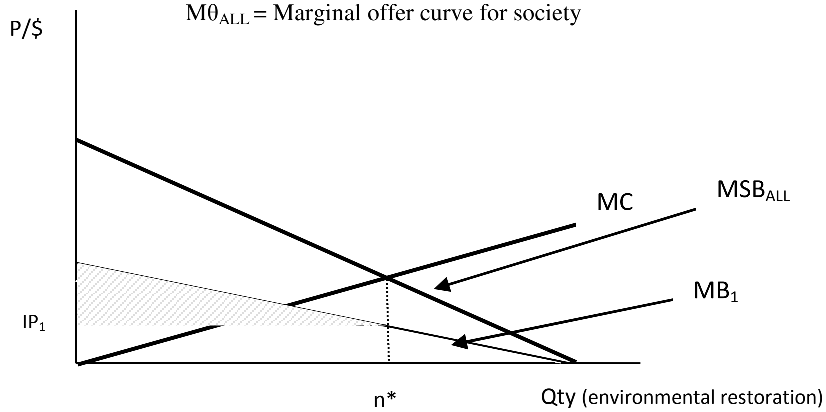
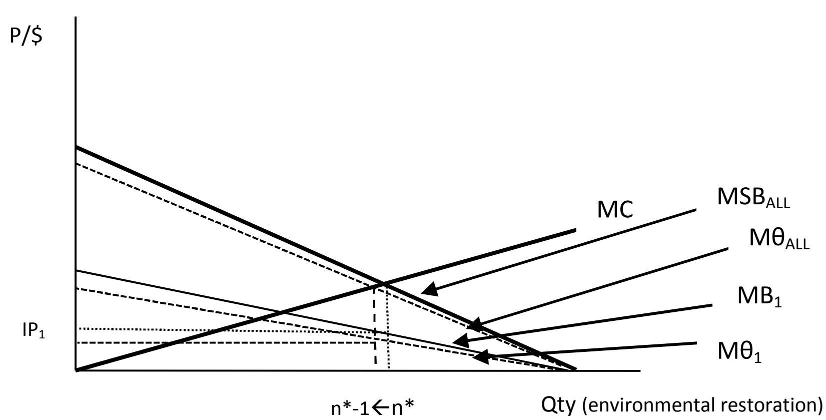


***FIGURE 2b*: Cheap Riding, the IPA and Efficient Public Good Provision**



2.5 Next Steps

The IPA framework has been tested in both a laboratory setting (using induced values) and a field setting to measure the effectiveness of this framework to elicit marginal offers at or near full value, and to assess the possibility of Pareto efficient outcomes – these experiments will be discussed in the next three chapters.

CHAPTER 3: AN EXPERIMENTAL TEST OF THE IPA

3.0 Overview

This chapter focuses on one of the problems of efficient public good provision and laboratory experiments. Building on incentive mechanisms from the experimental economics literature, this research will test the feasibility of an individualized price auction (IPA), motivated by Lindahls' marginal benefit theory for the provision of public goods. Feasibility will be assessed relative to the ability of the IPA to produce marginal offers consistent with an individuals' full marginal value. This chapter does three things: a) it introduces a new framework to enable consumers to express their value for public goods through an auction mechanism that gathers offers at multiple points linked to an individuals' marginal valuation curve, the IPA, b) examines whether certain economic payment rules can elicit individuals' private values for environmental goods, and c) evaluates the potential for the IPA, in conjunction with these economic incentive mechanisms, to provide these public goods. In an induced value experiment, and contrary to expectations based on standing consensus in microeconomics, we find that after initial units, offers are very close to private marginal values.

3.1 Introduction

A fundamental problem faced by economists and others in society is how to value and provide public goods. A standing definition of a public good (Samuelson 1954: 387) is a good which all people enjoy in common, in the sense that each individual's consumption of such a good leads to no subtraction from any other individual's consumption of that good. Since providers are unable to exclude beneficiaries who do not pay for the cost of provision, there exists the opportunity for individuals to "free ride" on those who do pay. The non-excludable nature of public goods generates a need to find better approaches for determining the appropriate level of production while simultaneously setting a price (or set of prices) that will lead to provision of the good. If information is obtained that accurately represents how much a group values a particular public good (or set of public goods), a level of provision can be established that accurately reflects how much members of society value them.

As explained previously, Erik Lindahl first proposed a system to finance public goods in 1919, based on setting an individuals' marginal payment equal to the marginal benefit they receive from provision of the good, thus establishing one level of the good with many individualized prices. Lindahl's approach creates an incentive for individuals to pay their actual marginal benefit for the public good, since the price is reflective of the benefit they will receive if the good is provided. For example, with diminishing marginal willingness to pay, the individual obtains a surplus value on infra-marginal units that would not have been provided under ubiquitous free riding behavior. In this way, no individual can be made better off (e.g. paying less and having more surplus) without making another individual worse off (e.g. paying more than their marginal benefit or not having as much of the good provided) relative to an efficient level of provision.

While Lindahl's approach is theoretically shown to be Pareto efficient, early public good research demonstrated that free riding behavior remains present in empirical tests, likely due to the divergence between private incentives and the public interest. In order to apply the new auction approach we look to past research in the experimental economics literature known to reduce free riding behavior, such as provision points and money back guarantees. Under provision point rules, the public good is only supplied if a certain provision point or cost to supply the project is met. Provision points for public good projects has been shown to increase aggregate demand revelation; and presumably individuals contribute more towards these projects because they do not want to lose the good if the provision point is not met.[13] While provision points increase funds offered to supply the public good, money back guarantees are used when the provision point is not met and the public good is not provided (at a given level). The money back guarantee, in conjunction with the provision point increases contributions since participants receive their money back if the market fails to raise the amount of money needed to supply the good.

One goal of this research is to design a framework, the IPA, which encourages individuals to reveal their true marginal values for public goods while simultaneously providing the goods. Therefore, in addition to the experimental rules above, we also integrate incentive rules into the auction process explained here. These incentive rules, also from the experimental literature, are known to reduce free riding behavior. Our

[13] The results we observe are consistent with individuals contributing towards projects, not adopting a strategy to free ride. We presume these outcomes indicate the participants do not want to lose the good if the provision point is not met, yet this study does not examine if participants decisions are motivated by the loss of the good, peer pressure or something else. We are unable to explicitly determine why the decisions are made yet, we presume the rules of the IPA do influence participant decision making.

experiment specifically applies the Proportional Rebate mechanism (**PR**) and the Pivotal mechanism (**PM**), both well studied in the literature; however, other incentive mechanisms could be integrated into the IPA framework. We look specifically at these two incentive mechanisms to determine if our rules for implementing the mechanisms at the margin of the mechanism impact how participants respond to the IPA process. In order to assess if the IPA, in conjunction with these economic incentive mechanisms, provide the public good at a Pareto efficient level we evaluate several incentive mechanisms for comparison, in conjunction with the IPA process to examine participants' offers against their true value in an attempt to mitigate free riding behavior.

This chapter is organized as follows; we provide a brief overview of the public good issue and the motivation for studying this problem. Since, the focus of this chapter is specifically on a laboratory experiment that illustrates the IPA, we explain induced values and how the incentive mechanisms work as background before outlining the specific experiment parameters, such as choice of values and treatment sequence. We then introduce hypotheses and potential strategies. The experimental results and analysis is presented and finally the conclusion.

3.2 Background

In this section we review some of the past research on public goods to provide background and frame the contributions of this body of research and the IPA process.

As indicated earlier, one goal of this research is to find ways to mitigate free-riding and allow individuals to express true marginal values for public goods. The information generated by this process can facilitate more insightful decisions by non-profits, governments and private firms that may provide public goods.

Previous research in the experimental economics literature (lab experiments) has shown that individuals will increase donations to a public good project if the payment rules reduce the incentives for individuals to free ride on the contributions of others (Isaac et al. 1989; Bagnoli and Lipman 1989; Davis and Holt 1993; Ledyard 1995; Holt 2007). Additionally, individuals have been shown to contribute higher offers towards a project if there is a provision point (PP) and money back guarantee (MBG), presumably because these features initiate a credible threat of non-provision (and less chance to benefit by free-riding). Under these conditions, the public good is supplied only if a pre-specified amount of money, the provision point, is raised, and participants receive their money back if the market fails to raise the threshold level of funding (Bagnoli and McKee 1991; Marks and Croson 1998; Cadsby and Maynes 1999; Chen 1999, Poe et al. 2002; Das 2007; Spencer et al. 2009). While both the provision point and money back guarantee features reduce free-riding behavior in many experiments, free-riding (including cheap riding) is not eliminated. Many of the experimental studies cited here do not include an increasing level of the public good with multiple offer points from individuals yet, the approaches do provide insight on the individual incentives that lead people to make decisions on their marginal offers that mitigates free riding and more frequently leads to efficient provision.

As introduced in chapter two, the two mechanisms we will adopt under the IPA framework are the **PR** and **PM.** Both the **PR** and **PM** are adopted with a provision point (PP) and money back guarantee (MBG). In brief, the **PR** returns money in excess of the provision point as a percentage of the individuals offer and has been shown to garner higher offers when used with the PP and MBG (Marks and Croson 1998, Rondeau et. al. 1999, Poe et. al. 2002, Spencer et. al. 2009). The **PM**, shown to be incentive compatible in small groups (Tideman and Tullock 1976, Hammond 1979), requires that a participant pay their offer only if they are pivotal, such that, a participant's offer is required only if needed for provision of the unit. These mechanisms are explained within the IPA framework in the next section.

While, theoretically, Lindahl's approach can reach a Pareto optimal level of public good provision, if each individual were to reveal their full value (Groves and Ledyard 1977, Walker 1981), it has been thought to be near impossible to garner offers sufficient to provide for the Pareto optimal quantity of public goods in actuality (Nicholson 2005). In laboratory experiments a theoretical analysis can be performed to check and see if Pareto optimal levels of the good are reached and if subjects are playing the Nash equilibria. In equilibrium, each participant will make a decision that is personally optimal, given the decisions of all others (Davis and Holt 1993). The Nash equilibrium is a strategy space where each participant's equilibrium strategy is a best response to the others strategies. The Nash solution is generally not a Pareto efficient solution since if each individual responds only to private incentives; under-provision of the public good is the outcome. It is argued (Marks and Croson 1998, p.364) that "although economic theory suggests subjects will play the Nash equilibria, in practice such equilibria are not as much played as they are arrived at or converged toward". Yet, the literature includes a range of Nash equilibria results within public goods games, with subjects playing the Nash equilibria as high as 54% of the time (Bagnoli and McKee 1991) to as low as 3% (Isaac et al. 1989). We note that, in general, the place (number of units n*) where our IPA auction settles will not be a Nash equilibrium.

If provision is not happening under Nash equilibrium play, are the mechanism rules not optimal? From a theoretical perspective it may make sense to evaluate the internal consistency of mechanisms against a behavior rule such as the Nash equilibrium but how does this extend to actual public good provision? Isaac et al. (1989) and Marks and Croson (1998) evaluate provision under rules that extend benefits with additional funds and find a surprisingly low amount of outcomes at the Nash equilibrium, yet the public good is provided approximately 50% of the time. Is one approach more important than the other? While the usual incentives to free ride prevent the Lindahl equilibrium from being a Nash equilibrium, using experimental and incentive rules we can change the set of Nash equilibria. We evaluate the incentive mechanisms in conjunction with the IPA process to examine how marginal offers are impacted. One goal of this research is to design a framework, the IPA, which encourages individuals to reveal their true marginal values for public goods while simultaneously providing the goods. We now explain a process, the IPA, which integrates several of the above experimental and incentive rules into an auction designed to solicit offers reflective of Lindahl pricing.

3.3 IPA PROCESS

This chapter will explicitly focus on induced value laboratory experiments. In a controlled, economics laboratory setting, the researcher recruits individual participants and provides these participants with a table of financial payoffs that mimic the non-excludable benefits received under certain provision levels of the public good. These benefits, expressed as induced values, allow us to evaluate the IPA framework and mechanism properties by measuring how people's decisions, that is, their offers to pay for the public good, compare to their true, induced, value. Thus we evaluate several incentive mechanisms (**PR, PM**) within the IPA framework to examine participants' offers against their true value in an attempt to understand whether we can eliminate, or at least to mitigate, free riding behavior in this public goods context.

Each participant's offers constitute bids in an auction, albeit an auction that combines the offers of all beneficiaries to determine whether various units of the public good can be delivered. The lab experiment provides an opportunity to evaluate the IPA mechanism's properties where benefits are known and controlled, decisions are rewarded, and we can simulate situations repeatedly. Cash payments ensure participants make deliberate decisions. The design of the induced-value experiment follows the literature testing mechanisms intended to fund public goods (e.g., Cadsby and Maynes 1999; Suleiman and Rapoport 1992; Bagnoli and McKee 1991; Isaac et al. 1989; Smith 1979).

3.2 IPA - Overview[14]

IPA

The IPA describes a process for soliciting offers on ascending units of a public good in order to deliver an equilibrium quantity with individual prices, reflective of each consumer's marginal benefit. The IPA, by allowing people to name their own schedule of marginal offers on ascending units, collects information on the individual's marginal benefit curve for each member of the auction, rather than a single offer point on the curve. An equilibrium quantity is determined based on the last successive unit for which the sum of the groups' offers equals or exceeds the cost of providing that unit of the public good, based on the provision and incentive rules. The IPA framework consists of the following components: a) an offer schedule, b) the provision rule, c) total payment under a given set of incentive rules (either **PR** or **PM**), including rebates.

> ***Offer schedule***: The auction participant chooses a schedule of marginal offers for the total units, N, available in the auction. The schedule of marginal offers on each unit n, ascending from 1 to N, is submitted to the auctioneer. On this schedule, each individual participant offers to pay a marginal price *per unit* on all units up to

[14] The IPA process is explained in Chapter 2 but we reiterate some of it in this chapter for ease of reading about the laboratory experiments.

and including unit n*, thereby voluntarily naming his or her maximum price per unit to obtain one unit, two units, etc., up to a maximum of N units.

Provision rule: The auctioneer determines that a unit, n*, will be provided if the sum of the groups' offers for unit n* total to equal or exceed the provision cost of unit n*, and if the previous unit would be provided by this same criterion. The auctioneer evaluates all offers to identify unit $n^* \leq N$ as the number of units that will be provided through the set of offers obtained.

Thus, if the sum of the groups' offers is not enough to provide the first unit of the good, no units can be provided; $n^* = 0$ in this case. The auctioneer evaluates the sum of all auction participants' marginal offers on each unit relative to the cost of provision for that unit, beginning with the first unit and moving in succession. The auctioneer determines the final level of provision as the highest number of units that can be provided by the groups' offers, conditional on meeting the cost to provide the prior unit. This process assumes the marginal cost is either increasing or constant as more units are provided. Note also that excess funds offered on earlier units are not considered in determining whether a particular unit is provided.

Total offer: A participants' offer on the final unit ($M\Theta_{n^*}$) is multiplied by the number of units provided to obtain that person's total maximum offer in the auction. For example, if participant i's marginal offer on unit two was \$15, and unit two is the last unit provided in the auction, participant i's total maximum offer would be $30 ($15 x 2 units).

Total payment under marginal incentive rule: Each participants' payment is based on the final level of units provided (n*) and the marginal incentive rules established *a priori* for the auction.

Proportional Rebate (PR): Under the PR mechanism, auction participants make offers on each unit, n; when the total of these offers, across all participants, exceeds the provision point, participants receive a rebate from their offers in proportion to the excess of funds raised. This rebate is calculated in the same manner used by Spencer et al. (2009) and Marks and Croson (1998) in their "proportional rebate" treatments. However, in contrast to those studies, within the IPA the calculation determines not only the price of a single unit, but also the price that the individual pays on the preceding n-1 units if the IPA settles on the n*th unit as the last to be delivered. That is, for each individual, the final cost of the last unit provided, after rebates, will be the cost on all earlier units.

The IPA framework, under the **PR** works as follows: i) If the group's marginal offers exceed the cost of providing the last unit (n*), then everyone's price for that unit will be discounted from their actual offer; the discount will equal the proportion of excess money in the total offered by the group. For example, suppose the auctioneer adds up the marginal offers from all participants bidding on unit n* and the auctioneer finds that X% of that money offered is not needed, because the provision point for unit n* is met with [1-X]% of the aggregate, marginal offers. Then the individual's offer will be discounted X% and the result will be their individual price (IP). Each person pays their own IP on each of n* units. ii) In the case where the sum of the groups' marginal offers on unit n* are just equal to the cost of provision, such that the marginal provision cost is exactly equal to the total of marginal offers, each participant just pays their offer. iii) If the group does not offer enough funds to cover the cost of any units of the good then no units of the public good are provided, units greater than zero are not evaluated for provision, all offers are refunded and no payments are made (e.g., a money-back guarantee (MBG)).

<u>Pivotal Mechanism (**PM**):</u> The pivotal mechanism (**PM**), adapted from the Vickrey-Clarke-Groves mechanism (Clarke 1971, Kawagoe and Mori 2001) evaluates aggregate offers of the group, where a person is considered pivotal if their marginal offer can reverse the provision of the good. That is, without the pivotal person's offer, the aggregate offers would fall short of the provision point (provision cost). Within the IPA context, if the IPA settles on delivery of the n*th unit, all individuals, whether or not they are pivotal, pay for n-1 units at a price equal to their own offer on the nth unit.

The IPA framework, under the **PM** works as follows: i) If the group's marginal offers exceed the cost of providing the last unit (n*), then the auctioneer determines whether or not the marginal unit could still have been provided without a given individual's offer. If an individual offer is needed to fund the equilibrium unit (n*), then the individual pays only that portion of their offer that is needed to provide just exactly enough money to provide the unit (n*). In this case, the auctioneer calculates the discounted price for the equilibrium unit (n*) and the amount offered on the marginal unit is paid on all earlier units. ii) If an individual's offer is *not* needed to fund the equilibrium unit (n*), then the individual will pay nothing for the equilibrium unit (n*) provided and the originally offered amount on all earlier units. iii) Regardless of whether or not an individual gets the last unit (n*) for free, the offer on the equilibrium unit (n*) will be the price paid on all the earlier units. iv) If the group does not offer enough funds to cover the cost of any units of the good then no units of the public good are provided, units greater than zero are not evaluated for provision, all offers are refunded and no payments are made (e.g., a money-back guarantee (MBG)).

3.2.1 IPA – Auction Process

The IPA auction is structured as follows: A researcher acted as the auctioneer, who provided participants with written instructions and read the instructions aloud prior to each treatment. A treatment includes a set of rules and some, treatment specific number of decision-making opportunities under a given incentive mechanism. Instructions included an example that explained how profit was calculated and included a quiz to give participants an opportunity to verify their understanding of the payoff functions. A fully copy of the experiment and a sample of each treatment is included in Appendix C.

The experimental moderator provides participants with an endowment, or budget, to fund decisions on some number of units of the public good. The researcher assigns each participant a value for each unit of the good, where these assigned, or induced, values represent the marginal (financial) benefit the participant will receive if the group's decisions provide each unit. A unit is provided only if a group of participants make offers that meet the provision point. In this case, the provision point is the marginal cost of delivering the unit of the public good. For each unit of the public good the participant chooses: a) whether or not they will invest to provide that unit and b) how many experimental dollars to offer. All participants, including non-contributors, benefit from the units of the good provided. We are testing the IPA under the assumptions that individuals all have decreasing marginal values.

The IPA asks auction participants to make offers on all units of the public good that could be delivered through the current auction. Individuals are asked to make offers on each unit n, from 1 to a maximum of N, in succession and submit their offers on all units simultaneously, as privately written offers. Person i's offer on unit n ($1 \leq n \leq N$) is an offer to pay for n units at the marginal price determined by the person's offer on unit n under the provision rules associated with either the **PR** or **PM** mechanisms. That is, participants make offers on all possible units in a given treatment, where each marginal offer determines their payment per unit on that number of units if the auction ends. At the end of each treatment, all decisions were collected from each participant and entered manually into an Excel file by a research assistant. Participants understand that their offer on unit n would only be considered if the sum of offers on unit n-1 equals or exceeds the provision point for unit n-1. One treatment is randomly chosen for provision at the end of the experimental session and profits are calculated for each participant based on their decisions and the decisions of their group for that treatment only. Participants are presented cash payouts as they leave.

3.2.2 IPA - Expected Benefits

Here we examine the trade-offs that are made in the decision-making process, under the IPA. In any given decision, participants are faced with a choice that may impact the benefits on later units, since failure to reach the provision point on any given unit ends the auction and reduces potential for retained surplus value and ultimately higher profits. The IPA framework is unlike many traditional, single-decision public good scenario's because participants must integrate a strategy to consider potential benefits on successive units as part of the decision on any particular unit.

To demonstrate the trade-offs that an individual may face, we model the payoffs for the **PR** mechanism here, we break the optimization problem into simpler sub-equations, following a dynamic programming process (i.e., establishing the Bellman equation for the individual's payoffs), starting from the terminal unit 'N'. We define, E_{iN}, as the expected incremental net benefit function. Each decision, includes the value (V_{ik}) of the given unit, k, to the individual i; i's total offer on the marginal unit (θ_{iN})

minus any applicable rebate (R_{iN}), multiplied by the number of units to be paid for. Under the rules of the IPA, for any given unit attained (>1), an individual then does not have to pay the previous units' offer since payment is only based on the offer for the last unit provided multiplied by that number of units. Such that, the net cost of a given unit, (N($\theta_{iN} - R_{iN}$)), no longer includes the net cost on the previous unit, ($(N-1)(\theta_{iN-1} - R_{iN-1})$). The entire value-minus-offer term is multiplied by the probability of the unit being provided given the offers of all people in the group, conditioned on reaching the previous unit ($P_{iN,iN-1}$). The probability of a unit being reached is a function of the individual's subjective estimate of how his offer will interact with the collective offer of the other T-1 individuals (for group size T) to raise or lower the probability that the auction reach past any particular unit. We have not induced these probabilities in the experiment, but we expect that such considerations should contribute to the decision calculus of the individual. The probability of not attaining these benefits are expressed through the 1-P term, which under the rules of the IPA, is defined as zero since there are no benefits if the sum of offers does not balance with the cost of provision. The net addition to benefits from decision 'N' are outlined as follows:

$$(1)\ E_{iN} = [V_{iN} - \{N(\theta_{iN} - R_{iN}) - (N-1)(\theta_{iN-1} - R_{iN-1})\}]P_{iN,iN-1} \\ +\ 0 * (1 - P_{iN,iN-1})$$

Equation (1), the expected incremental net benefit function represents the terms an individual will consider for a given decision. For each marginal offer, a participant faces the addition to their benefits if N units are provided (V_{iN}), minus the net addition to cost if they must pay for N units rather than N-1 units, weighted by their estimated probability that N gets delivered rather than N-1. Equation (2), similar to the equation on unit N, represents the expected net benefit function if unit N-1 is provided rather than unit N-2. We see a recursive pattern emerge as we evaluate additional units, where the process continues back to unit 1.

$$(2)\ E_{N-1} = [V_{N-1} - \{(N-1)(\theta_{N-1} - R_{N-1}) - (N-2)(\theta_{N-2} - R_{N-2})\}]P_{N-1,N-2}$$
$$+ 0 * \left(1 - P_{N-1,N-2}\right) + E_N * P_{N-1,N-2}$$

$$(3)\ E_{N-2} = [V_{N-2} - \{(N-2)(\theta_{N-2} - R_{N-2}) - (N-3)(\theta_{N-3} - R_{N-3})\}]P_{N-2,N-3}$$
$$+ 0 * (1 - P_{N-2,N-3}) + E_{N-1} * P_{N-2,N-3}$$

In equation (4), we develop a recursive equation (for the dynamic program) to model the individual's expected net benefit function based on the incremental decision L. This recursive equation can be represented, for any unit L (with $E_{N+1} = 0$ if N is the maximum number of units available in the auction). Since L is defined as the unit on which the individual is considering making offer θ_L, the net addition to benefits from decision L is equal to the value obtained from unit L (V_L), minus the total payment made on L units, specified as the offer on unit L minus any rebate on unit L multiplied by L units ($L(\theta_L - R_L)$); this adjustment to cost, defined E_L, based on the incremental benefits and costs that came through decision L. We subtract from the cost in L units, the cost that would have been paid if L-1 units had been the terminal unit

$((L-1)(\theta_{L-1} - R_{L-1}))$, multiplied by the probability that the L^{th} unit is reached, conditional on the probability of the $L^{th} - 1$ unit being reached. The right hand side of (4) includes the expected net additional benefit from the next unit (E_L+1), multiplied by the probability that the current unit is reached, given the prior unit being reached ($P_{L,L-1}$).

$$(4) E_L = [V_L - \{L(\theta_L - R_L) - (L-1)(\theta_{L-1} - R_{L-1})\}]P_{L,L-1} + E_{L+1} * P_{L,L-1}$$

We can examine the first derivative of the expected incremental net benefit function, with respect to the offer (θ_L), to evaluate the impact of an individual's marginal offer on decision-making.

$$(5)\ \frac{\partial E_L}{\partial \theta_L} =$$

$$-L(P_{L,L-1}) + [V_L - L(\theta_L - R_L) + (L-1)(\theta_{L-1} - R_{L-1})]\frac{\partial P_{L,L-1}}{\partial \theta_L} + E_{L+1}\frac{\partial P_{L,L-1}}{\partial \theta_L} + \frac{\partial E_{L+1}}{\partial \theta_L} P_{L,L-1}$$

Setting the first order condition to zero, equation (5) can be rearranged to express the trade-offs an individual is balancing when they make a decision under this **PR** mechanism. Equation (6) shows the marginal cost of raising an individual offer is balanced against the marginal benefits they may receive from this decision.

$$(6)\; L * P_{L,L-1} = [V_L - L(\theta_L - R_L) + (L-1)(\theta_{L-1} - R_{L-1})]\frac{\partial P_{L,L-1}}{\partial \theta_L}$$

$$+ \frac{\partial E_{L+1}}{\partial \theta_L} P_{L,L-1} + E_{L+1}\frac{\partial P_{L,L-1}}{\partial \theta_L}$$

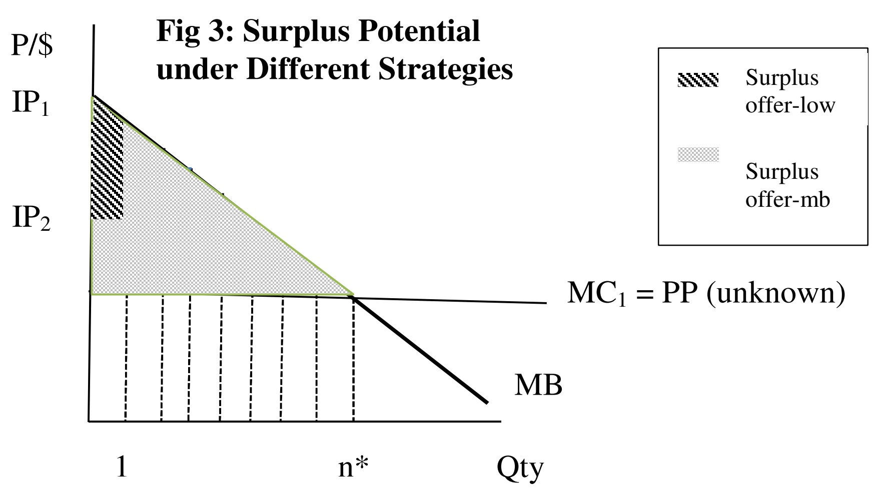
3.2.3 IPA-Strategy

Given the design of the IPA, a participant must balance their marginal offer with the marginal benefit on any given unit, as well as the implications of that offer for possible benefits net of cost for successive units, thus different strategies may be present for initial units than later units in the auction. On early units, there is potential for additional net benefits on successive units as expressed through the expected incremental net benefit equation specified above (equation 4). The participant's individual decision-making strategy would, in principle, consider the impact of a given units' decision on the opportunity for benefits from successive units, since no provision is possible if the group's offers are not large enough to pay for the first units. Thus, free-riding behavior to earn additional surplus, often seen in public goods research, is not necessarily the dominant strategy under the IPA. The last unit (N) in the auction does not include the same strategy since there is no additional surplus opportunity beyond that last decision; our experiment concerns a finite, multi-unit public good.

We outline three general strategies, including when participants' offer is equal to their marginal benefit ($\boldsymbol{\theta_1}^{\mathbf{mb}}$), is less than their marginal benefit ($\boldsymbol{\theta_1}^{\mathbf{low}}$), or is higher than their marginal benefit ($\boldsymbol{\theta_1}^{\mathbf{high}}$).

This figure represents a simple view of the trade-offs a participant might evaluate when making their offers on a given unit, particularly the initial units where there is more surplus available. Figure 3, illustrates the difference in total available surplus between the $\boldsymbol{\theta_1^{mb}}$ and $\boldsymbol{\theta_1^{low}}$ strategies. Our example here assumes a downward sloping marginal benefit curve and a flat marginal cost curve, and we let IP_1 represent the $\boldsymbol{\theta_1^{mb}}$ strategy on unit 1 and let IP_2 represent the $\boldsymbol{\theta_1^{low}}$ strategy on unit 1. If the $\boldsymbol{\theta_1^{low}}$ strategy is adopted on the first unit there is potential for a large amount of surplus *if* the good is provided, seen in the striped trapezoidal shape. However, if the $\boldsymbol{\theta_1^{low}}$ strategy results in the provision point not being met, then the potential foregone surplus is the large grey triangle, when the auction terminates early. One possible incentive on early units is for an individual to offer their marginal benefit in order to earn some marginal surplus on those units while also balancing the opportunity to earn additional surplus via the provision of additional units.

Fig 3: Surplus Potential under Different Strategies



If a participant were to choose an $\boldsymbol{\theta_1}^{\mathbf{high}}$ strategy to ensure that the public good was provided on initial units, we would expect that if the good was provided the incentive is to reduce their offer to equal or below the marginal benefit from the induced value. If the good is not provided, the MBG ensures offers are not lost and the prior unit in the auction is provided. An $\boldsymbol{\theta_1}^{\mathbf{high}}$ strategy may not be adopted on later units since the additional gains from surplus are minimal as balanced against the cost for provision, this is graphically evident through the smaller grey triangle that exists between the marginal cost and marginal benefit curves near n*.

In summary, the individualized pricing auction framework, the IPA, is designed to gather, from auction participants, information on the marginal value of the public good.[15] We examine the changes in marginal offers across units, under different incentive rules, in order to determine if public good provision can be established in a manner analogous to Lindahl's theoretical approach. This framework is intended to incentivize people to reveal their full, marginal value for a public good while simultaneously collecting funds from a given group (or market) for public good provision.

3.3. Experimental Parameters and Procedures

The experimental design was pre-tested in two undergraduate classes at the University of Rhode Island in the spring of 2009 and experimental sessions were conducted in

[15] Ideally, the IPA asks individuals to provide their marginal valuation curve. This study examines whether individuals might report that curve accurately, in part or in whole.

2009 and 2010.[16] Participants were recruited through an email list specifically focused on policy simulation experiments. Overall, data was collected from 118 students in 12 experimental sessions with a mean group size of 11 (see Table 2). The majority of participants were undergraduate students (85%) and male (65%) with some graduate students, ranging across majors. Induced values were homogenous across treatments and participants, although this information was not known to the participants at the time of decision-making. Total payoffs were converted from experimental dollars to real dollars using an exchange ratio of 4:1 conversion to real dollars, which was told to participants at the beginning of their session, and average earnings was $42.

In the experimental sessions discussed here, a participant makes decisions under 3 different treatments or incentive rules on marginal units. Table 1 provides an outline of the experimental sessions performed. Individual decision making treatments include a treatment using rules for the proportional rebate mechanism (**PR**) on each unit; a treatment using rules for the pivotal mechanism (**PM**); and a proportional rebate mechanism with opportunities to revise offers on units not provided after a single, initial set of offers (**PR-Krev** and **PR-UKrev**). Treatments either had 4 or 8 decision making opportunities (units).

The **PR-Krev** and **PR-UKrev** treatments involve collecting offers as described for the IPA, with the auctioneer announcing a potential closure of the auction at the n* unit. After the announced potential settlement at unit n*, the auctioneer allows all

[16] One session was collected at Newbury College, Brookline MA during an undergraduate environmental economics class.

participants a chance to submit a revised set of offers on units $n \geq n^*$. The auctioneer then calculates a final settlement of the auction at unit n^*, based on the final offers. Participants choosing to submit revised offers were allowed only an increase their original offers. The **Krev** and **UKrev** revisions of the treatment indicate respectively whether or not the participants were informed of the opportunities for revision prior to submitting their first offers.

Table 1: Treatment Summary (Laboratory Experiments)
Treatment acronym: description – units – revision (if applicable) **PR – 4**: Proportional Rebate Treatment with 4 decision making units **PM – 4**: Pivotal Mechanism Treatment with 4 decision making units **PR – 8**: Proportional Rebate Treatment with 8 decision making units **PR – 8 UKrev**: Proportional Rebate Treatment that includes an unknown (UK) revision opportunity, with 8 decision making units **PR – 8 Krev**: Proportional Rebate Treatment that includes a known (K) revision opportunity, with 8 decision making units

Our choice of treatments allowed us to examine how individual decision-making was impacted by the following: i) the rules of the incentive mechanisms, ii) the number of decision-making opportunities (units) and iii) the opportunity to revise offers once the group's original offers were totaled. To examine the impact of the marginal incentive mechanisms (i) we included the proportional rebate mechanism (**PR**) and the pivotal mechanism (**PM**) both with a small number of units (4). The number of decision-making opportunities (ii) included a small number of units (4) and a larger number of units (8) under the rules of the **PR** mechanism. Finally, we looked at how a dynamic aspect of decision-making may alter incentives by extending the IPA process to allow participants the opportunity to revise offers (iii), after knowing the outcome of their first set of offers. These revision making opportunities were either known or not known at the time of original offers, executed under the **PR** mechanism, **PR-Krev** and **PR-UKrev** respectively.

Table 2[17] outlines the order of the treatments within each of the 12 sessions, including the number of participants in each group. In all cases but two, a session involved a single group of participants on a given day. Double sessions were run on the same day to allow us to collect additional data given time constraints. Varying the order of the treatments in a given session allowed us to test for an ordering effect. Sessions 1-4 test the same treatments in different order (**PR-4, PM-4, PR-8**), session 5 introduces the revision treatment, and sessions 6-12 contain both **PR-Krev** and **PR-UKrev** treatments, in addition to the **PR-4.**

Table 2: Summary of Individual Sessions (Laboratory Experiments)												
	Session #											
Trtment	1	2	3	4	5	6	7	8	9	10	11	12
1	PM-4	PR-4	PR-8	PM-4	PM - 4	PR-4	PR-4	PR-4	PR-4	PR-4	PR-4	PR-4
2	PR-4	PM-4	PM-4	PR-4	PR-8	PR-8 UKrv	PR-8 UKrv	PR-8 UKrv	PR-8 UKrv	PR-8 UKrv	PR-8 UKrv	PR-8 UKrv
3	PR-8	PR-8	PR-4	PR-8	PR-8 UKrv	PR8 Krev	PR-8 Krev	PR-8 Krev	PR-8 Krev	PR-8 Krev	PR-8 Krev	PR-8 Krev
Grp Size	10	12	9	9	9	9	9	15	15	9	9	12

Participants were provided an endowment at the beginning of each of their treatments and information on their pay off structures (individual benefits) that would be received as monetary rewards (total benefits) in cash at the end of each session. Participants

[17] Not every participant encountered every treatment. Results are displayed in aggregate for those individuals who made decisions under each set of incentive rules.

knew only their own benefits, a condition that mimics conditions in the field, where people are unaware of others' values (Rondeau et al. 2005; Alston and Nowell 1996). Marginal benefits via induced values were homogenous, outlined in table 3 below, and are decreasing with higher units. The Pareto optimal level of provision is set for large unit treatments (8 units) at exactly equal to the marginal benefit for the 8th unit, as displayed in Table 3. For example, in a 10-person group the provision point is 30, or marginal benefit (3) multiplied by group size (10). Participants earn profit based on the decisions they make regarding the public good, their individual benefits, and the decisions made by others in their group.

Table 3: Per Unit Marginal Benefits (MB) for all Laboratory Experiments

Unit	1	2	3	4	5	6	7	8
MB	43	27	12	9	7	5	4	3

Each participant was provided an offer sheet, such as the example in figure 3, as a foundation to demonstrate the IPA for lab participants. The experimental moderator explained the offer sheet, line by line, in order to provide participants, not only an example of what types of decisions they would make but also, to provide additional insight on how the experimental moderator calculates offers. A participant is initially provided information in columns A-D – the unit number, a decision-making budget for each unit, the marginal benefit information on each unit and the total benefit (which is additive). Each participant is asked to fill out columns E (marginal offer) and F (total offer), which are the marginal offer on a given unit and the total offer they may have to pay if the unit is the last one provided (n*) and no rebate is applicable. Each row is a separate decision-making opportunity for each separate unit, where the budget is refreshed and no offers from earlier units apply.

Column G is determined once the research assistant enters all the individual marginal offers into Excel and calculates the sum of marginal offers for a given unit, against the cost of provision. Marginal offers are evaluated for the first unit, if the sum of all marginal offers are greater than or equal to the provision point then only the marginal offers on unit two are evaluated for the second unit. This is done for each and every unit until the sum of all marginal offers does not cover the provision cost, at that unit and the auction terminates. Rebates, total payment and profit are calculated for the last unit in the auction (n*), where the sum of all marginal offers is greater than or equal to the marginal cost. If the sum of all marginal offers is greater than the provision cost, then column H is the rebate for the unit and column I represents the $(\theta_L - R_L)$, seen in equation (4), where $R_L = M\Theta_i \frac{\sum M\Theta - PP}{PP}$. The actual payment, column J, is the number of final units in the auction multiplied by the marginal offer minus rebate, $L(\theta_L - R_L)$. Profit is then determined as $\sum_{i=1}^{N} V_L - \{L(\theta_L - R_L)\}$. This explanation and sample offer sheets are included for each treatment, located in Appendix C.

Fig 4, Example Offer Sheet on PR treatment, 4 units

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Example Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	\$20	\$12	\$12	\$11.00	\$11 (11 x 1)	**Y** / N	(3)	\$8	\$8 (\$8 x 1)	\$24 (20 + 12 – 8)
2	\$20	\$7	\$19 (12 + 7)	\$5.00	\$10 (5 x 2)	**Y** / N	(2)	\$3	\$6 (\$3 x 2)	\$33 (20 + 19 – 6)
3	\$20	\$5	\$24 (12 + 7 +5)	\$3.00	\$9 (3 x 3)	**Y** / N	(0)	\$3	\$9 (\$3 x 3)	\$35 (20 + 24 – 9)
4	\$20	\$3	\$27 (12 + 7 +5 + 3)	\$2.00	\$8 (2 x 4)	Y / **N**	N/A	N/A	N/A	See Unit #3

3.4 Hypotheses

This chapter tests several hypotheses. First, this chapter empirically tests whether the IPA is demand revealing across units. Let $MB_{i,n}$ equal the marginal benefit participant i receives on any unit, n, (where n = 1, 2, …, 8) and let $\theta_{i,n}$ represent the marginal offer of participant i on unit n.

Hypothesis 1A: test the null hypothesis H_o: $MB_{i,n} = \theta_{i,n}$, versus the alternative hypothesis H_A: $MB_{i,n} \neq \theta_{i,n} \;\; \forall\, n=1,2,\ldots,8$

Hypothesis 1B: test the null hypothesis H_o: $MB_{i,n} = \theta_{i,n}, \; \forall \; n \geq 5$ versus the alternative hypothesis H_A: $MB_{i,n} \neq \theta_{i,n} \; \forall \; n \leq 4$

The first set of hypothesis tests examine if the IPA leads individuals to state their marginal values for each unit (1A), such that it is demand revealing, or if the IPA leads individuals to state their marginal values on higher numbered units, but cheap ride on initial units (1B). The high marginal benefits on early units may lead participants to try to maximize surplus on initial units. Since provision on early units is essential to increase the chance of additional profits or benefits on later units, this strategy of offer-high on early units to ensure provision and opportunities for profit on later units may occur as discussed above in the first order conditions on E_L (equations (4) – (6)).

The second hypothesis evaluates the performance of the IPA against the number of finite units available in a given treatment. If offer strategies are invariant to the maximum number of units available, the marginal offer on unit 1 in an eight-unit treatment should be the same as on unit 1 in a four unit treatment under the same marginal incentive mechanisms. Let $\theta^4_{i,n}$ equal participant i's marginal offer for unit n in a 4-unit treatment, and $\theta^8_{i,n}$ participant i's marginal offer for the same unit n, in an 8 unit treatment.

Hypothesis 2: test the null hypothesis H_o: $\theta^4_{i,n} = \theta^8_{i,n}$ versus the alternative hypothesis H_A: $\theta^4_{i,n} \neq \theta^8_{i,n}$ $\forall$ $n \leq 4$

Since participants do not know the provision point or the values of other participants, the potential of gaining surplus on later units may appear to be higher in an 8-unit treatment. The number of units in a treatment may act as an indicator to participants, of where the Pareto optimum point is likely to occur, thus influencing the probability of a unit being reached, seen in the $P_{L,L-1}$ term in equations (4) – (6) above. Yet for the IPA to produce a Pareto optimum outcome does not require that all participants' marginal offer's equal their marginal benefit on the 4^{th} unit (for a small unit treatment) for a Pareto optimal Lindahl equilibrium in small unit treatments, but only that marginal offer's equal marginal benefit near n* units, in order for the efficient outcome to occur.

Third, this chapter investigates the influence of the marginal incentives (PR and PM) on offers within the IPA framework. If the strategies used under the IPA are invariant to marginal incentives, we would expect marginal offers to be identical. However, if participants are responding differently to the marginal incentives and the possibility for additional benefits, they may adopt different strategies under each marginal incentive rule. Let $\theta^{PR}_{i,n}$ equal participant i's marginal offer for unit n under the PR mechanism, and $\theta^{PM}_{i,n}$ participant i's marginal offer for the same unit n under the PM mechanism.

Hypothesis 3: test the null hypothesis H_o: $\theta^{PR}_{i,n} = \theta^{PM}_{i,n}$ versus the alternative hypothesis H_A: $\theta^{PR}_{i,n} \neq \theta^{PM}_{i,n.}$

Finally, the fourth hypothesis examines the differences in revelation when participants have the opportunity to revise initial offers on marginal units not provided by the group based on initial offers. The experiments examined here are predominantly static games, where participants make all their decisions at once and there is no opportunity for feedback, except for the PR-REV treatments (both known and unknown). In **PR-Urev** and **PR-UKrev**, participants may revise offers (upward) on any units not provided based on the initial set of offers. In the **PR-Krev** treatments, participants may adopt a different strategy (vs. the **PR-UKrev**, which sets a baseline) where they have a strategic opportunity to bid low at first in an effort to secure more surplus, but using the revision opportunity to raise their offers if the low-offer strategy does not pay off. In treatments that did *not* announce the revision opportunity in advance (**PR-UKrev**), we expect participants made initial offers in the same manner as those treatments without a revision (**PR**).[18] Let $\theta^{PR}_{i,n}$ equal participant i's marginal offer for unit n under the PR mechanism, and $\theta^{PR\text{-}REVFinal}_{i,n}$ participant i's marginal revised offer for the same unit under the **PR-REV** treatments.

Hypothesis 4: test the null hypothesis H_o: $\theta^{PR}_{i,n} = \theta^{PR\text{-}REVFinal}_{i,n}$ versus the alternative hypothesis H_A: $\theta^{PR}_{i,n} \neq \theta^{PR\text{-}REVFinal}_{i,n}$.

3.5 Results

One of the goals of this research is to evaluate if the IPA has the potential to provide a public good. Table 4 provides a summary, for each incentive mechanism, based on 100% provision of all available units provided under any treatment. Both small unit

[18] PR-UKrev first offers can be combined with the PR offers under treatments with the same number of units.

treatments, **PR-4** and **PM-4**, provide at 100% in all sessions. In such small unit treatments, on average all participants need to offer 33.33% of their marginal benefit on the last unit (one-third of $MB_{i,4}$) for provision to occur. When the **PR** mechanism is extended out to higher units (8), the provision level decreases across all sessions such that only 42% of sessions (5/12) provide all units; yet for the last unit in these higher unit treatments, on average all participants must offer their full marginal benefit (100%) for provision to occur. Comparing this against the total provision in the revision treatments, we see that 50% of sessions provide all units compared to 57% of sessions when participants know they will have the opportunity for revision. Table 4 also includes provision levels in the 8-units treatments at 7 units.

Table 4: Provision Summary by Treatment (Laboratory Experiments)	
Treatment Name -Total Number of Units	**Percent of Treatments Providing Total Available Units**
PR – 4 Units	100% (12/12)
PM – 4 Units	100% (5/5)
PR – 8 Units	42% (5/12) *58% (7/12 provide ≥ 7)*
PR(REV) – 8 Units (includes both **UK**nown and **K**nown Treatments)	53% (8/15) *80% (12/15 provide ≥ 7)*
PR(UK REV) – 8 Units	50% (4/8) *87.5% (7/8 provide ≥ 7)*
PR(K REV) – 8 Units	57.14% (4/7) *71.43% (5/7 provide ≥ 7)*

Demand revelation across treatments is displayed in table 5 as the mean of offers (across individuals) as a percentage of value ($\sum_{i=1}^{N}(\frac{\theta_i}{v_i})$) , to account for the decreasing marginal values across units (hypotheses 2-4). All mechanisms produce offers at 60% or more of marginal value, with the pivotal mechanism (**PM-4**) garnering offers representing a significantly higher percentage of induced value ($p< 0.05$) on units 1 and 2. The **PR-8, KRev** treatments have a noticeably lower proportion of revelation on the early units, where participants knew they would be able to modify their offers if units were not provided. The proportional rebate mechanism on 8 units (**PR-8**) reaches near Pareto optimal levels at the last (8^{th}) unit. We note that earlier unit offers are not exhibiting demand revelation near 100% but offers more closely reveal demand on later units (hypothesis 1a).

Table 5: Mean Offer as a Percentage of Value[a], by Treatment[b] (Laboratory Experiments)								
	Unit Number							
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
PR-4	0.724	0.784	1.060	1.100	--	--	--	--
(SE)	(0.036)	(0.047)	(0.096)	(0.135)				
PR-8	0.705	0.704	0.895	0.873	0.874	0.980	0.993	1.090
(SE)	(0.028)	(0.026)	(0.043)	(0.046)	(0.051)	(0.057)	(0.057)	(0.076)
PR-8 UKRev	0.769	0.759	0.829	0.698	0.756	0.902	1.042	1.136
(SE)	(0.057)	(0.099)	(0.116)	(0.118)	(0.118)	(0.148)	(0.136)	(0.173)
UKRev *FinalOffer*	--	--	--	--	1.050	1.147	1.115	1.248
(SE)					(0.146)	(0.122)	(0.118)	(0.167)
PR-8 KRev	0.647	0.644	0.840	0.858	0.905	1.00	0.977	1.094
(SE)	(0.046)	(0.041)	(0.067)	(0.075)	(0.082)	(0.083)	(0.082)	(0.114)
KRev *FinalOffer*	--	--	--	--	0.924	1.069	1.082	1.197
(SE)					(0.928)	(0.096)	(0.089)	(0.120)
PM-4	0.862	0.863	1.110	0.989	--	--	--	--
(SE)	(0.055)	(0.067)	(0.107)	(0.124)				

[a] Reporting $\sum \frac{(\theta_i/v_i)}{N}$

[b] Table 5 is based on induced values

Data was modeled using least squares regression with robust standard errors[19] to account for multiple responses per individual. With the robust option, the point estimates of the coefficients are exactly the same as in ordinary OLS, but the standard errors take into account heterogeneity and lack of normality. We allow the standard

[19] Introduction to STATA. UCLA: Academic Technology Services, Statistical Consulting Group. from http://128.97.141.26/stat/stata/webbooks/reg/chapter4/statareg4.htm (accessed November 15, 2011)

errors to account for correlation within the group of offers submitted by one person, yet observations are assumed independent across individuals. Using this approach impacts the standard errors and the variance-covariance matrix of the estimates, but not the estimated coefficients.

We estimate three separate models. Models 1 and 2 evaluate the impact of induced value and unit number on *Marginal Offer,* the dependent variable, while model 3 controls for induced value (*MB*), unit number (*nNUnits*), treatment (***PM, PR),*** which offer (first offer or revised final offer) under the revision treatments *(PR-KrevFirstOffer, PR-RevFinalOffer),* total number of units in a treatment (*EightUnits*) and demographics (*Female, Grad*). We use the log of units to allow for curvature, *LNUnits*. Variables are defined in table 6. We compare model fit using an F-test of overall model significance and determine that Model 3 is significantly different from the constant only and we retain the additional variables in the analysis.

Table 6: Variable Definitions (Laboratory Experiments)

Dependent Variable: *Marginal Offer*
Independent Variables:

- *LnUnits*: (marginal) units of public good defined in terms of log units (values: ln(1) –ln (8))
- *MB:* The marginal benefit a participant receives if a specific unit of the public good is provided (values: 3-43)
- *Female:* A dummy variable that identifies if the participant was a female (1) or not (0)
- *Grad*: A dummy variable that identifies if the participant was a graduate student (1) or an undergraduate student (0)
- *PR*: A dummy variable that identifies if the treatment was a proportional rebate (1) mechanism (rather than a pivotal mechanism (0))
- *PM*: A dummy variable that identifies if the treatment was pivotal mechanism (1) (rather than proportional rebate (0))
- *PR-KrevFirstOffer*: A dummy variable that identifies if the offer is an initial offer in a revision treatment when the revision opportunity was announced in advance of submitting initial bids (1) (rather than an unknown (0))[a]
- *PR-RevSecondOffer*: A dummy variable that identifies if the offer is the second offer from a revision treatment (1) or the first offer (0).
- *EightUnits*: A dummy variable that identifies if the treatment had a large number of units, 8 units (1) (rather than 4 units (0))

[a]We note that analyses in this chapter pool first offers under the UKrev with offers from non-revision treatments since participants had no reason to know of the REV opportunity at the time of their initial bid.

Models 1-3 are represented in equations (7) – (9) below:

(7) *Model 1*: $\textit{Marginal Offer} = \beta_0 + \beta_1 \textit{MB}$

(8) *Model 2*: $\textit{Marginal Offer} = \beta_0 + \beta_1 \textit{LnUnits}$

(9) *Model 3*: $\textit{Marginal Offer} = \beta_0 + \beta_1 \textit{MB} + \beta_2 \textit{LnUnits} + \beta_3 \textit{Female} + \beta_4 \textit{Grad} + \beta_5 \textit{PM} + \beta_6 \textit{PR-KrevFirstOffer} + \beta_6 \textit{PR-RevFinalOffer} + \beta_7 \textit{EightUnits}$

Table 7 examines variables that affect the dependent variable, *Marginal Offers,* using a regression, accounting for all different treatment variants and some demographics. The first two columns (model 1) of table 7 report specifically on the relationship between per unit offer and marginal value, where a $1 increase in marginal benefit (*MB*) leads to a $0.69 increase in the *Marginal Offer*. The second two columns (model 2) focus on the relationship between *Marginal Offer* and units (*LnUnits*). The negative significant sign on the *LNunits* coefficient is consistent with the decreasing marginal benefits, induced in the values. The last two columns (model 3) of table 8 include the various marginal incentive treatments and demographics. The variable on induced value (*MB*) is positive and significant so participants are responding to the marginal benefits on individual units within the IPA framework (hypothesis 1a). From column 3, table 7, *Female* students, on average, offer significantly higher amounts than others. The individual mechanism dummy variables indicate that the ***PM*** is producing significantly (P<0.02) higher offers than the ***PR***. Treatments with more units (8 v. 4) produce lower offers under the proportional rebate mechanism (hypothesis 2). Finally, we see that under the **PR-Krev** treatments, initial offers are decreased (*PR*-K*RevFirstOffer)* when participants know they have the opportunity to revise their offers, and the final offers (*PR-RevFinalOffer*) under both **PR-UKrev** and **PR-Krev** are larger, consistent with hypothesis 4.

Table 7: Regression Results (Laboratory Experiments)						
	Model 1		**Model 2**		**Model 3**	
Variables affecting mWTP	**Coefficient (SE)**	**P <**	**Coefficient (SE)**	**P <**	**Coefficient (SE)**	**P <**
LnUnits			-13.746 (0.668)	0.001	-2.932 (1.139)	0.010
MB	0.692 (0.014)	0.001			0.573 (0.055)	0.001
Female					1.962 (0.379)	0.001
Grad					-3.466 (0.509)	0.001
PM					1.982 (0.846)	0.019
PR-RevFinalOffer					1.500 (0.449)	0.001
PR-**K*****RevFirstOffer***					-1.279 (0.414)	0.002
EightUnit					-1.528 (0.414)	0.020
Constant	1.753 (0.532)	0.001	29.433 (1.276)	0.001	8.739 (2.189)	0.001
F (df)	2633.93 (1)	0.001	2495.80 (1)	0.001	360.40 (8)	0.001

Table 8 reports the interaction between *MB* and offers on first, middle and last units to test if participants are trying to build surplus on early units where marginal benefits are large, consistent with the first set of hypothesis tests that examine if the IPA leads individuals to state their marginal values for each unit (1A), such that it is demand revealing, or if the IPA leads individuals to state their marginal values on higher numbered units, but cheap ride on initial units (1B). Table 9 (hypothesis 1b) examines if participants may have different strategies identified through their marginal offers on the first units compared to later units. If participant's offers reflect cheap riding behavior on early units but on later units marginal offers are equal or nearly equal to marginal value, then a Pareto optimal allocation is not out of reach.

Table 8: The Impact of Marginal Units on mWTP

Variables affecting mWTP	**Coefficient (SE)**	**P <**
Value	0.869 (0.094)	0.001
DummyUnits 1-2 * Value	-0.168 (0.074)	0.023
DummyUnits 5-8 * Value	0.097 (0.139)	0.486
Constant	0.653 (0.852)	0.443
LR chi2 (df)	1561.96 (3)	0.001

Table 9 presents results of hypothesis tests 2-4, comparing marginal offers under different treatments and incentive mechanisms.

Table 9: Pairwise Test Results

	Hypothesis 2 (H_o: $\theta^{4}_{i,n} = \theta^{8}_{i,n}$)		**Hypothesis 3:** (H_o: $\theta^{PR}_{i,n} = \theta^{PM}_{i,n}$)		**Hypothesis 4** (H_o: $\theta^{PR}_{i,n} = \theta^{PR\text{-}REV}_{i,n}$)	
	t-stat*	**Conclusion**	**t-stat**	**Conclusion**	**t-stat**	**Conclusion**
1	0.4317	Do not reject Ho	-2.0971	reject Ho	-1.0867	Do not reject Ho
2	1.4901	Do not reject Ho	-0.9174	Do not reject Ho	-1.1304	Do not reject Ho
3	1.5664	Do not reject Ho	-0.3506	Do not reject Ho	-1.056	Do not reject Ho
4	1.5869	Do not reject Ho	0.6142	Do not reject Ho	-0.6285	Do not reject Ho
5					-0.0449	Do not reject Ho
6					-0.8026	Do not reject Ho
7					-0.8538	Do not reject Ho
8	0.0841	Do not reject Ho			-0.7723	Do not reject Ho

* t-statistic is a two sample mean comparison test with unequal variances

3.6 Discussion and Conclusions

The aim of this chapter was to a) introduce a new framework to enable consumers to express their value for public goods through an auction mechanism that gathers offers at multiple points linked to an individuals' marginal valuation curve, b) examine whether certain economic payment rules can elicit individuals' private values for public goods, and c) evaluate the potential for the IPA, in conjunction with economic incentive mechanisms, to provide these public goods.

The individualized price auction framework, IPA, is designed to gather information on the marginal decision-making of participants. We examine the changes in marginal willingness to pay across units, under different incentive structures, in order to determine if public good provision can be established in a manner similar to Lindahl's theoretical approach. Model 1 (equation 7) indicates $1 increase in marginal benefit (MB) leads to a $0.69 increase in marginal offer, such that participants are responding to the decreasing marginal benefits in their offers. We note that marginal benefits are decreasing on successive units, yet the simplicity of model 1 (equation 7) does not tell the full story.

Next we look at Table 5 which summarizes the treatment differences under marginal incentive mechanisms across units (via mean offer as a percentage of value). There is demand revelation, although not always at 100% of marginal benefits. In some cases, marginal offers of individual's (and therefore table 5's averages) are greater than marginal benefits. Inspection of the data shows that the majority of offers are below the marginal benefit on units 7 and 8, but a small percentage of offers (< 10%), are greater than the marginal benefit and have a large impact on revelation percentages. Such offers, that are greater than the marginal benefit, may be due to “warm glow” associated with getting the last unit in the auction provided (Palfrey and Prisbee 1997, Rondeau et al. 1999), an inability of participants to fully understand the rules or possibly the effect of the marginal benefits on these higher units being quite small (e.g. MB on unit 8 is 3). Next steps may include testing the IPA with a wider range of values; one possibility includes multiplying our current set of values by 100 in order to provide a wider range between marginal value and zero on later units in particular.

While total benefits increase with more units provided, under the IPA, offers on higher (successive) units are not evaluated for provision or profit, unless earlier units are provided. We see that while offers on the first units are, on average, below induced value by 14-35% (table 5), on average, offers on later units match or nearly match the marginal induced value for those units, unlike much of the literature which indicates that free-riding is the eventual result. While we reject the null hypothesis 1a, that marginal offers are equal to marginal benefits on all units, the IPA does perform consistently, in at least a one-shot setting, and better than many public good experiments seen in the literature. This outcome is not at all anticipated by the consensus in economic literature that Lindahl’s suggestion is impractical.

We look at tables 5, 8 and 9 to examine hypothesis 1B, if participants may have a strategy to maximize surplus on early units. Table 5’s mean offers indicate that marginal offers on units 3-4 and 5-8 in the four and eight unit treatments respectively are at nearly 100% of value. This is a promising empirical result since the IPA is garnering average offers near full value and has implications on Pareto efficient outcomes. We do note that under the execution of the IPA explained here, the marginal cost was flat at $3 per unit for all units, and thus the provision point was set to be equal to the sum of 100% of marginal benefits on the last unit (8) in a large unit treatment and only a fraction (33%) of all marginal benefits for the last unit (4) in a small unit treatment. We expect these differences in marginal benefits, relative to the provision point, account in the differences in provision rates for units across small and large unit treatments, but we leave this topic for future experiments.

In table 8, row 2, the negative coefficient on early units (DummyUnits1-2) suggests that people may be trying to preserve a higher proportion of value as surplus on initial units with larger marginal benefits, consistent with results seen across the public good literature. However, in the IPA, participants are balancing free and cheap-riding behavior with the ability to continue in the auction and gain additional surplus in total (as explained in equations (1) – (6)). The design of the IPA in the experiments discussed here used a provision cost that was equal to the sum of marginal benefits on the last unit in the larger unit treatments. Future tests that alter the provision point will provide additional insight on the strategic decisions concerning manufacturing surplus on early units and balancing the opportunity to continue the auction, as well as possible implications for Nash equilibrium outcomes.

The second hypothesis evaluates the performance of the IPA against the number of finite units available in a given treatment. If offer strategies are invariant to the maximum number of units available, the marginal offer on unit 1 in an eight-unit treatment should be the same as on unit 1 in a four unit treatment under the same marginal incentive mechanisms. We would expect the marginal offers in table 5 to be the same for units 1-4, in both **PR-4** and **PR-8** if hypothesis 2 is true. However, participants do not know the provision point or the values of other participants and the potential of gaining surplus on later units may appear to be higher, in an 8-unit treatment, such that, the number of units in a treatment may act as an indicator to participants of where the Pareto optimum point is likely to occur. The negative coefficient on the *EightUnit* variable (table 8, row 7) supports the conclusion that participant strategies are *not* invariant to the maximum number of units available. Table 9 provides evidence that we are unable to reject null hypothesis 2, that offers under 4-unit treatments are not statistically different than offers made on the same unit under an 8-unit treatment. Further testing that alters the number of units and the Pareto optimal outcome (such that the sum of marginal benefits on the last unit for **PR-4** just equals the provision point) is needed to draw conclusions.

We test the **PM** within the IPA framework in part because the **PM** is shown to be incentive compatible for a single unit public good in small groups (Tideman and Tullock 1976, Hammond 1979). Although under the multi-unit IPA framework incentive compatibility does not hold, we do see high rates of demand revelation. Our results suggest that the pivotal mechanism produces higher offers on the initial units than the proportional rebate mechanisms for four unit treatments (hypothesis 3). Model 3 (equation 9) shows the positive significant coefficient on ***PM*** in table 7, this is further supported in the mean percent of offers in table 5, if we compare row 1 and row 7 and examine the marginal offers under each incentive mechanism. We note that on the first unit only do we reject the null hypothesis that the mean offers are not statistically equivalent to those made under the **PR** treatment. This finding may be explored more in future experiments.

We look at the revision (**PR-REV**) treatments in two ways under hypothesis 4. First, results in table 5 show that initial offers on known revision treatments (**PR-Krev**) start lower, but converge towards **PR-8** on higher units. This finding suggests that participants may adopt a different strategy in the **PR-Krev** treatment when they know they will be provided the opportunity to change their offer. The final offer allows participants the opportunity to potentially gain surplus on initial units (by cheap riding) and also gain information on the group's decision-making. Individuals still do not have knowledge of the provision point and others' values, yet subjective judgments on the provision of units may lead participants to alter their decisions. Model 3 (equation 9) estimates also support the finding that participants may try to gain additional surplus through smaller first offers, seen in the negative significant *PR-KrevFirstOffer* coefficient (table 7). Next, we examine the second offer opportunities in both **PR-Krev** and **PR-UKrev** (hypothesis 4). Regression results in table 7 show that second offers are increased via the positive coefficient on *PR-RevFinalOffer.* The opportunity to increase original offers through larger final offers may enable participants to gain more surplus if additional units are provided due to these increased final offers. This is not a surprising result.

Additionally, participants contribute enough funds to supply, on average, 4/4 units or 7/8 units (table 4). In all cases, the IPA framework supplied multiple units of the public good. As explained above, the provision point was set such that participants only had to offer a fraction (33%) of their marginal benefit, on average, to achieve provision on the last unit in a small unit treatment, rather than 100% of their marginal benefit for the last unit in a large unit treatment. We expect future tests of the IPA to examine small unit treatments with a different provision point to test that the ratio of average marginal benefits to the provision point influences the prospects to achieve a Pareto optimal allocation.

The lab provides an opportunity to evaluate the mechanism properties where benefits are known and controlled, decisions are rewarded and we can simulate repeated situations. In addition we can examine how individuals respond to the incentives without the possible bias associated with preconceived notions about the specific public good's environmental or social impacts. This framework is meant to encourage people to reveal their full value for a public good while simultaneously collecting funds from a given group (or market) for public good provision. Using Lindahl's approach in the designed auction process, the IPA, allows for an estimation of offers at multiple points of an individuals' marginal benefit curve rather than a single point, a new addition to the public goods literature. The information generated by this approach might generate more insightful decisions by non-profits, governments and private firms that may provide public goods. Thus, individualized pricing displayed through our IPA model supports the potential that Lindahl-inspired methods can generate revenues to fund public goods, at least when implemented with rebate mechanisms such as those found in the experimental literature. The experiment at least raises a worthy challenge to the consensus of economics literature. The next two chapters explore a test of the IPA in a field setting.

CHAPTER 4: A FIELD TEST OF A LINDAHL-INSPIRED IPA FOR PROVISION OF PUBLIC GOODS

4.0 Overview

The field execution of the IPA experiment involves residents of Virginia's Eastern Shore and local public goods. This application involves half-acre increments of ecosystem restoration for sea grass habitat in coastal lagoons, plantings for migratory bird habitat, and clam based increments of water quality services, defined as delaying the harvest of clams for six months beyond normal harvest by an existing aquaculture firm. To perform these tasks, participants are provided a budget for decision-making. The auctioneer describes for participants the ecosystem services that may result from additional ecosystem restoration associated with each activity. Data is collected under two scenarios – an incentive compatible choice experiment and our newly developed IPA. Research on public good auctions can initiate development of new approaches to finance public goods, beyond government and philanthropic efforts. This research evaluates the potential to transform economic value into revenues for public goods, using the example of ecosystem restoration that can provide public goods through ecosystem services.

4.1 Introduction

This chapter introduces the field experiments conducted in 2008 and 2009. We build on the previous chapter, which introduced the individualized price auction (IPA) tested via laboratory experiments and allowed for an assessment of the IPA's ability to produce marginal offers consistent with individuals' full marginal value. To further assess the IPA, we will test how it operates in a field setting under different marginal incentive mechanisms and evaluate the IPA against a separate, incentive compatible choice experiment intended to generate data to estimate (Hicksian) willingness-to-pay. We provide an overview of each year, 2008 and 2009, and explain the motivation for the components tested under each design. Preliminary results are presented in this chapter on each year separately, while in chapter 5 we pool data from both years to evaluate the IPA's results against data from the incentive compatible approach. While willingness-to-pay techniques have been used to assess preferences for many environmental goods, this research goes a step further to explore the feasibility of real money auctions that generate revenues sufficient to pay for restoration activities.

The choice experiments (CE^R) constructed here ask individual participants to make commitments, with real money, choosing between bundles of ecosystem restoration that vary in acreage and cost. These choice experiments, unlike studies involving stated preferences, always involve real goods and real dollar payments, *not* hypothetical payments. Under the specified rules of trade, particularly a dichotomous choice vote, an individual is always best off if they make choices consistent with the full value they place on the alternatives. The IPA, in contrast to the CE^R, asks participants to make decisions on incremental units of the public good, such as ecosystem restoration, at the margin. The IPA's approach allows participants to focus on the individual restoration activity and the trade-off between more restoration and more money that the participant can take home. Incentive mechanisms often used in the experimental literature, and adopted in our laboratory experiments, are applied to the IPA framework to potentially mitigate free-riding behavior.

If the offers under an IPA process are close to estimated mWTP based on a CE^R involving real choices in an incentive compatible setting, then the IPA may be viewed as promising as a practical approach to identifying Lindahl's individual, marginal-benefit prices. In chapter 5 we will compare estimates of WTP generated under the CE^R at the margin to the offers from the IPA, to evaluate how the IPA is operating in terms of its effectiveness at generating offers consistent with mWTP. Integrating an individualized pricing framework (IPA) into the public goods research agenda has the potential for generating more accurate estimates of individual and community willingness-to-pay for environmental restoration activities, including the services that well-functioning ecosystems provide.

4.2 Research Components and Approach

This section will explain the two main experimental sections used in 2008 and 2009 field tests, the choice approach (CE^R) and the individualized price auction (IPA), both of which use real money, not hypothetical payments. The CE^R is designed specifically to provide estimates of WTP which we can then compare, at the margin, to the offers from the IPA. This allows us to evaluate how the IPA is operating in terms of its effectiveness at generating offers consistent with mWTP. The approach of each section is discussed, including theoretical models and trade-offs faced by participants.

Section 4 will discuss the field specific parameters, followed by results and analysis for each year.

In order to examine the preferences and willingness to pay of environmental restoration activities under an individualized pricing approach, an incentive compatible approach CE is first constructed and examined. The experiment conducted under this approach asks participants to choose between two bundles (or alternatives) from a choice set. Each bundle is comprised of various half-acre units of restoration activities and an amount of money the individual was asked to pay towards the implementation of those bundles' activities. By causing individuals to choose between pairs of bundles, this task elicits preferences that indicate individuals' preferred trade-offs between the restoration activities or attributes of different bundles and enables the researcher to estimate willingness-to-pay for restoration by estimating how choices relate to the combination of attributes and cost. Participants voted on the bundle of restoration that they most preferred, knowing that majority rule would determine the outcome.

A voting institution with majority rule is incentive compatible because each participant's best strategy is to vote for the alternative that he or she would most prefer to see implemented (Hoehn and Randall 1987, Bagnoli and Lipman 1989). The researcher assumes the person wants to maximize their utility as a result of the bundle chosen; therefore, the participant will balance the personal costs of the restoration with his or her preferences for the specific activities in each alternative, voting for the option which they most prefer. In such a dichotomous choice vote, when a participant evaluates their strategic alternatives, there is no gain from voting contrary to the individual's true values, since there is no other choice that will provide higher utility.

4.2.1. CE^R Theoretical Model

We assume an individual's utility depends on the characteristics of the chosen bundle, where utility of bundle j is:

$$(10) \quad U(X_{ij}, Y_i\text{-}C_{ij}), j\text{=}A, B,$$

where X_{ij} is a vector of the environmental restoration activities of a given bundle j, to person i; Y_i is the individuals' income; and C_{ij} is the cost the individual pays on the chosen bundle (if the aggregate vote leads to implementation of that bundle).The individual will choose bundle A, iff $U_A > U_B$. We adopt the assumption that the individuals' utility function can be split into two parts, one observable, labeled u(.), and one random and unobservable, labeled ε_i, giving (McFadden 1973, Hanemann 1984):

$$(11) \quad U(X_{ij}, Y_i\text{-}C_{ij}) = u(X_{ij}, Y_i\text{-}C_{ij}) + \epsilon_i \text{, } j\text{=}A, B,$$

Thus, the individual i prefers bundle A if

$$(12) \quad \epsilon_B - \epsilon_A < u(X_{iA}, Y_i\text{-}C_{iA}) - u(X_{iB}, Y_i\text{-}C_{iB}).$$

We assume the random, unobservable component is independently distributed (across choices i), with mean zero and a logistic distribution (Haab and McConnell 2002). Such choice experiments provide data for analysis with random utility modeling (Lancaster 1966; Hardie and Strand 1979). A conditional logit model, founded in McFadden's choice theory (1974), is used to examine the trade-offs between ecosystem restoration activities to estimate willingness to pay. The logit model is used to assess the relationship between participants' choices to support restoration and the explanatory variables.

4.2.2 Latent Class Model

Accounting for heterogeneity in a random utility model is problematic since individual characteristics do not vary among a set of choices in a given bundle. Demographics of a given individual are not recognizable in the choice probability, at least not without interacting such individual-specific characteristics with one or more other independent variables (Boxall and Adamowicz 2002). While the discrete choice logit model allows us to estimate individual preferences based on a series of choices made between restoration bundles, it assumes the entire sample is from the same class of preferences, which is often a limiting factor in the analysis (Morey et al. 2006). A latent class model accounts for heterogeneity by assuming the population consists of an identifiable number of different classes of individuals, each with relatively homogenous preferences. Preferences and attitudes differ across classes and an individual's probability of being in a given class depends on demographic characteristics as well as attitudes and perceptions (Swait 1994; Louviere, Hensher and Swait 2000; Boxall and Admowicz 2002; Kikulwe et al. 2009).

We express the utility participant i can gain from choosing bundle $j \in C$, based on their class probability:

$$(13) \quad U_{ij|c} = \beta_c X_{ij} + \varepsilon_{ij|c},$$

where X_{ij} is the vector of attributes associated with bundle j (e.g., acreage of restoration activity, restoration cost) for participant i. β_c is a class-specific vector of parameters where different classes identify groups for which preferences within the group are more homogeneous than preferences between the groups, thereby capturing heterogeneity in preferences across the population sample. Assuming the error terms are identically and independently distributed (IID) and follow a Gumbel distribution, we express the probability of person i, in class c, choosing alternative (bundle) j as:

$$(14) \quad P_{ij|c} = \frac{\exp(\beta_c X_{ij})}{\sum_{h=1}^{C} \exp(\beta_c X_{ih})}.$$

We now specify M* as the latent membership likelihood function that classifies participants' into one of the C classes, with probability $P_{ic.}$ Thus, participant i's, class c membership function is expressed as $M^*_{ic} = \lambda_c Z_{i,}$ where Z_i represents the observed characteristics of the participant, such as demographic characteristics plus attitudes and perceptions. Again, following Swait (1994), we assume error terms entering M* to be IID across participants and classes and follow a Gumbel distribution. Then the probability that i belongs to c is:

(15) $P_{ic} = \frac{\exp(\lambda_c Z_i)}{\sum_{k=1}^{C} \exp(\lambda_k Z_i)}$, where, λ_k (k=1,…,C) are the class-specific parameters.

Thus, in this model, individual specific attributes (rather than choice attributes) drive the choice probabilities. Combining the two probability equations, we estimate the joint model that simultaneously uses bundle choice attributes and class membership to explain individual behavior.

(16) $P_{ijc} = P_{ij|c} * P_{ic} = [\frac{\exp(\beta_c X_{ij})}{\sum_{h=1}^{C} \exp(\beta_c X_{ih})}] * [\frac{\exp(\lambda_c Z_i)}{\sum_{k=1}^{C} \exp(\lambda_k Z_i)}]$

4.2.3 Overview IPA

The second main component of the field experiment is our newly developed IPA model. As discussed in chapter 3, the IPA model asks participants to make incremental decisions on increasing units of restoration, one unit at a time. Participants make offers on all possible units in a given treatment, where each marginal offer is their payment on that number of units if the auction ends. Each participant submits his or her set of offers at once, along with submissions from other participants.

Individual offers are combined with the offers of all other participants in the group to determine the number of units provided. The auctioneer identifies whether the group's collective offer is large enough to pay for the costs to implement a single unit, the first unit, of the good before moving on to evaluate whether the collective offer is large enough to pay for the second unit, and so on. For each unit, only the offers of the group for that unit will determine whether the unit is provided. Offers made on earlier units will not be considered in determining whether a particular unit is provided, except that group offers on the earlier units must have been sufficient to provide those earlier units if the auction had settled or stopped on the earlier unit. Thus, the auctioneer considers the offers made for the second unit only if the first unit can be provided based on the offers for the first unit. Depending on the offers from all members of the group, the auctioneer determines the highest number of units of the good that can be provided, for which the total of offers from the group is enough to pay the cost for the unit. Individual payment is calculated under the rules of the applied incentive mechanism.

In any given marginal decision participants are faced with a choice that may impact the benefits on later units, since failure to reach the provision point on any given unit ends the auction. In entering the IPA process, the individual utility-maximizer will consider the value of the restoration to them (at a given incremental level), their total offer, potential rebates (if applicable), and the likely decisions of other members of their group, which all influence the probability of a given unit's provision (see equations (1) – (6), Chapter 3). The decision-making trade-offs are discussed more in chapter 3.

Alternative incentive mechanisms are evaluated in order to assess whether decision-making is altered when the rules differ on the marginal unit, as explained in Chapter 3.[20] We explain the four general mechanisms here and then review the specifics to the application of the mechanisms below. We look at the following: i) the proportional rebate (**PR**) mechanism, ii) the proportional rebate with additional units provided conditional on the group providing the first unit (**PR-CON**), iii) the proportional rebate mechanism with an opportunity for a revision (**PR-KREV**) and iv) the pivotal mechanism (**PM**).

The **PR** has been shown to generate revenues sufficient for the provision of the public good in single-unit auctions (Spencer et al. 2009; Marks and Croson 1998). For this experiment, **PR** requires that the provision point be met and returns any money in excess of the provision point to the participants in proportion to their offer, on the infra-marginal unit provided. Consistent with the IPA, the offers on the infra-marginal unit are evaluated one at a time and no excess funds from previous units are part of the rebate process. **PR-CON** and **PR-KREV** are both proportional rebate mechanisms, with a twist. Under the **PR-CON**, one group was told that, conditional on their decisions for one restoration activity, a unit of an additional restoration activity would be provided as long as funds to provide a single unit of the first activity were

[20] In chapter 3, mechanisms and their theoretical properties are examined in greater depth through induced value experiments conducted in the policy simulation lab.

collected, and the other usual **PR** rules apply. The **PR-CON** mechanism mimics what is often seen in match donations; thus the experiment matches the offers made by the group if one unit is provided, where the match is an additional unit of restoration. **PR-KREV** gives participants an opportunity to revise their offers on any units not provided by the initial auction round. The final or last unit provided still rebates any excess funds above the provision point in proportion to the participants offer on the infra-marginal unit. A final mechanism, the Pivotal Mechanism (**PM**) also uses a provision point. However, **PM** requires participant payment on the marginal unit only if payment is expressly needed to reach the provision point and provide the good. Payments made on earlier units are equal to the offer made on the last unit. The **PR**, **PM**, and aspects of the **PR-REV** elements were explained in more detail in chapter 3; the **PR-CON** treatment is new to the field experiment and was motivated, in part, by partners providing funding for this experiment.

As explained in chapter three, in any given decision, participants are faced with a choice that may impact the benefits on later units, since failure to reach the provision point on any given unit ends the auction and reduces potential for retained surplus value and ultimately higher profits. To demonstrate the trade-offs that an individual may face, we refer to equations (4) – (6) that models the payoffs for the **PR** mechanism.

In equation (17), we repeat the recursive equation (for the dynamic program) from chapter 3 to model the individual's expected net benefit function based on the incremental decision L. This recursive equation can be represented, for any unit L (with $E_{N+1} = 0$ if N is the maximum number of units available in the auction). Since L is defined as the unit on which the individual is considering making offer θ_L, the net addition to benefits from decision L is equal to the value obtained from unit L (V_L), minus the total payment made on L units, specified as the offer on unit L minus any rebate on unit L multiplied by L units ($L(\theta_L - R_L)$); this adjustment to cost, defined E_L is based on the incremental benefits and costs that came through decision L. We subtract from the cost in L units, the cost that would have been paid if L-1 units had been the terminal unit, ($(L-1)(\theta_{L-1} - R_{L-1})$), multiplied by the probability that the L^{th} unit is reached, conditional on the probability of the $L^{th} - 1$ unit being reached. The right hand side of (17) includes the expected net additional benefit from the next unit (E_L+1), multiplied by the probability that the current unit is reached, given the prior unit being reached ($P_{L,L-1}$).

$$(17) E_L = [V_L - \{L(\theta_L - R_L) - (L-1)(\theta_{L-1} - R_{L-1})\}]P_{L,L-1} + E_{L+1} * P_{L,L-1},$$

We can examine the first derivative of the expected incremental net benefit function, with respect to the offer (θ_L), to evaluate the impact of an individual's marginal offer on decision-making.

$$(18)\ \frac{\partial E_L}{\partial \theta_L} =$$

$$-L(P_{L,L-1}) + [V_L - L(\theta_L - R_L) + (L-1)(\theta_{L-1} - R_{L-1})]\frac{\partial P_{L,L-1}}{\partial \theta_L} + E_{L+1}\frac{\partial P_{L,L-1}}{\partial \theta_L} + \frac{\partial E_{L+1}}{\partial \theta_L}P_{L,L-1}$$

Setting the first order condition to zero, equation (18) can be rearranged to express the trade-offs an individual is balancing when they make a decision under this **PR** mechanism. Equation (19) shows the marginal cost of raising an individual offer is balanced against the marginal benefits they may receive from this decision.

$$(19)\ L * P_{L,L-1} = [V_L - L(\theta_L - R_L) + (L-1)(\theta_{L-1} - R_{L-1})]\frac{\partial P_{L,L-1}}{\partial \theta_L} + \frac{\partial E_{L+1}}{\partial \theta_L}P_{L,L-1} + E_{L+1}\frac{\partial P_{L,L-1}}{\partial \theta_L}$$

4.3 Experimental Design and Procedures

4.3.1 Recruitment and Contracts

The field execution of this experiment involved approximately 90 residents of Virginia's Eastern Shore. Year 1 (2008) took place on a single night in Northampton County and year 2 (2009) took place over two nights in Accomack and Northampton Counties on the Eastern Shore of Virginia. Participants were recruited through various civic organizations on the Eastern Shore, including Citizens for a Better Eastern

Shore, Master Gardeners and Master Naturalists groups. The objectives involve testing an auction process with a group of people who are likely to be “in the market” for the relevant public good(s), so that we were not concerned about obtaining a random sample of the population. Summary demographics on each group are presented in Table 10. An informational flyer sent via email informed potential participants that an experiment to gather information on local residents’ values for the environment would be conducted, was to last approximately 2 hours, and participants would receive $40 as compensation. No other information about potential financial rewards was provided at the time of recruitment.

The researchers established contracts with local service providers, such that decisions involved restoration on local public goods in half-acre increments for sea grass habitat, bird habitat, and clams for water quality.[21] Restoration contracts were established with help from The Nature Conservancy, Virginia Institute of Marine Sciences, and an independently owned and operated R&C Seafood Inc., Oyster, VA. These contracts were designed to provide marginal units of the restoration activities, with the amount (acreage) to be determined by the result of the experiment. The experiment would increase the level of restoration beyond any restoration currently being implemented by environmental managers in the absence of our experiment.

[21] Clam restoration is included only in the 2008 experiment, and was measured in equivalent half-acres or 12,000 clam seedlings per unit.

Table 10: 2008 and 2009 Demographic Comparison					
2008 Variable	**Mean**	**Std. Error**	**2009 Variable**	**Mean**	**Std. Error**
Female	0.510	0.500	Female	0.407	0.492
Age	50.14	14.87	Age	47.73	13.89
Resident Years	13.30	11.34	Resident Years	20.64	15.07
Donates to Env. Causes	0.840	0.367	Donates to Env. Causes	0.627	0.484
Own	0.880	0.325	Own	0.695	0.461
Education – H.S.	0.100	0.300	Education – H.S.	0.237	0.426
Education – Bachelors	0.540	0.499	Education - Bachelors	0.542	0.498
Education - Masters +	0.360	0.480	Education - Masters +	0.220	0.415
Income (< 50k)	0.240	0.427	Income (< 50k)	0.678	0.468
Income (>50k)	0.760	0.427	Income (>50k)	0.322	0.467
Work – Retired	0.380	0.489	Work - Retired	0.136	0.343
Work - Full time	0.440	0.497	Work - Full time	0.475	0.500
Work - Part time	0.160	0.367	Work - Part time	0.245	0.436
Work - Unemplyd	0.020	0.140	Work - Unemplyd	0.186	0.390
Rec. Fisher	0.600	0.490	Rec. Fisher	0.610	0.488
Commercial Fisher	0.060	0.238	Commercial Fisher	0.1186	.3235
Bird Watcher	0.560	0.497	Bird Watcher	0.661	0.474
Recreational Hunter	0.200	0.400	Recreational Hunter	0.2034	0.403
Oyster Gardener	0.100	0.300	Oyster Gardener	0.288	0.453

4.3.2 Background Restoration Activities

Bird Habitat Restoration

Hundreds of thousands of migrating Neotropical birds use Virginia's Eastern Shore as a stopover site on their migration from Canada and northeastern US to Central & South America rainforests, including the Blackpoll Warbler, American Redstart and the Scarlet Tanager (McKay 2008). Increased development has degraded essential habitat while lawn, pavements and rooftops fragment habitat and create high risk spaces for predators to attack (Virginia Department of Conservation and Recreation Bird Habitat Fact Sheet). Additional habitat and restoration provides critical places for migrating birds to rest, food to replenish needed reserves and shelter to protect against prey such as hawks and falcons (Mabey et al. 1991). The presence of these birds creates a unique ecotourism opportunity for local bird watchers and tourists (McKay 2008). In addition, birds consume insects that could otherwise plague people and crops, while money from increased tourism benefits local businesses. Restored habitat can provide access to walking and hiking trails and provides a greater likelihood of survival of endangered species for future generations.

Participants' decisions are used towards the cost of plant materials, labor equipment and site preparation for planting shrubs and canopy trees with high nutritional value. The goal is to establish structure and cover for stopover during fall migration for migratory song birds, which also benefits resident birds and other wildlife year round.

Additional environmental benefits include water quality protection, biodiversity conservation, and carbon sequestration.

Seagrass Habitat Restoration

Seagrass restoration in Virginia's coastal bays is one of the largest efforts in the world (Orth 2001, Orth et al 2009). Seagrass is a flowering vascular plant that grows in shallow water, also referred to as SAV (submerged aquatic vegetation). Sixteen species of underwater grasses are found in coastal Virginia, including eelgrass (*Zostera marina*) (Orth 2001). A slime mold in the 1930's in combination with a powerful hurricane devastated once historic, abundant seagrass meadows in Virginia (Orth et al 2009). Increased coastal development and dredging put tremendous pressure on these meadows. National Academy of Sciences proceedings (June 2009) indicate annual seagrass loss has accelerated from 1% per year prior to 1940 to 7% since 1990, while 58% of seagrass meadows are in decline nationally.

The Virginia Department of Environmental Quality indicates that habitat and restoration activities to preserve and restore seagrass also preserve nurseries for juvenile fish such as menhaden, safe havens for female blue crabs as they shed their exoskeletons and increased food and habitat for waterfowl, fish, shellfish and invertebrates. In addition, seagrass meadows trap sediments that cloud water and impede bottom dwellers (e.g. oysters), an abundant natural resource in coastal Virginia. Restoration removes excess nutrients (phosphorus/nitrogen) from water, limiting unwanted algae growth and absorbs wave energy thus providing protection for shorelines (Orth et al 2009). Seagrass meadows provide protection and restoration of habitat that ensures the survival of endangered species for future generations.

Current efforts on seagrass include ~23 million seeds spread, or 42% of the bay-wide restoration goal (Orth personal communication). Participants' decisions contribute towards restoration that will be used towards the sowing of seagrass seeds and the planting of additional eel grass shoots throughout Chesapeake Bay and the Eastern Shore. Seeds are individually harvested from productive grass beds, then transplanted to areas in the bay that need restoration, including storing the seeds through the summer until planting season in fall.

Clam Restoration

Declining water quality in Virginia's coastal bays from excess nitrogen and phosphorus via point and non-point source pollution drastically alter the habitat and services of an ecosystem (Rothschild et al. 1994, Newell et al 2005). Bivalves, such as oysters and clams have a rich history and culture in Virginia and a large impact on local water quality. In the 1900's bivalves filtered 80% of the water volume in the Chesapeake Bay per day but by 1988, this was reduced to < 1% filtration (Newell 1988, Rice 2008). Oysters, clams, and other shellfish are known to filter nutrients, sediments, and phytoplankton from the water column which can directly enhance water quality (Newell et al 2005, Grabowski and Peterson 2007, Coen et al 2007) and reduce the likelihood of harmful algae blooms that can have enormous economic impacts on coastal communities (Anderson et al 2000). Shellfish have potential to reduce concentrations of greenhouse gases, through the formation of their calcium carbonate cells (acting as a sink for carbon) (Grabowski and Peterson 2007).

Participants' decisions were used to cover the costs associated with extending ecosystem benefits provided by hard shell farm-raised clams by extending their typical grow-out period from two years to two and a half years. Funds are specifically used to cover the costs of the site lease, waterfront & site access, clam seed (~50,000 per 14'x55' plot), labor (planting, maintenance etc), equipment/materials and estimated potential loss in revenues due to project implementation (i.e. mortality). This is a bi-lateral approach intended to incorporate the ecosystem benefits that clams provide, especially to improve water quality along the Chesapeake Bay and Atlantic Ocean and areas that impact the residents of the Eastern Shore.

4.3.3. Procedures

Prior to running experiments in coastal VA the experimental approach was tested. A small pilot study was conducted prior to the 2008 experiment with 8 graduate students who answered a set of hypothetical questions similar to the questions in the actual experiment. We adjusted for timing and word choices as a result. A larger focus group was conducted in 2009, prior to the actual field experiment that year to gain feedback on the information presented on each restoration activity and how this framing impacted decision-making. Based on feedback received from these focus groups, each session began with a presentation that included information about the restoration activities that were part of their decision-set, including how the restoration was to be performed and the ecosystem services that may result from additional ecosystem restoration associated with each activity, as explained above. This presentation was done to familiarize the entire group with the baseline characteristics of the restoration activities on which they were to make decisions. For instance, the information presented included the additional habitat and oxygen resulting from more sea grass restoration, the critical migratory sites and ecotourism opportunities resulting from bird habitat, or the increased water clarity resulting from clam restoration.

4.3.3.1 Year One – 2008 Experimental Parameters and Design

The design of the 2008 experiment aimed to a) introduce baseline science information to participants on each of the restoration activities; b) gather information on participants' willingness to pay via a real money choice experiment (CE^R) which could then be used for comparison with our newly developed IPA approach; c) gather information in a secondary choice experiment that included restoration activities and money provided to local government;[22] d) gather information on participants' marginal willingness to make payments for individual restoration activities via a real money auction, the IPA; and e) obtain demographic information on participants.

Participants were randomly assigned to one of two groups as they arrived, which assigned them to one of four different versions of the CE^R as well as incentive mechanisms under the IPA framework. In the introduction, participants were informed that they would each be provided with a budget constraint between $90 and $120,

[22] The choice experiment using government instead of take home cash was used only in the 2008 experiment and is not discussed in this document.

which each person could allocate between ecosystem restoration and money retained for use for household expenses (including donations to causes chosen at home after the experiment) and that they would each answer questions from different sections of the experiment, including separate instructions for various parts of the experiment. Although multiple questions were answered by each participant, only one question from each group would be randomly chosen for implementation at the end of the evening session. For each section, the moderator read instructions to participants including example questions for each treatment (see Appendix D for full instructions and sample questions).

Section I implemented a choice experiment where participants faced a choice between two bundles of restoration activities (A or B) including a cost to support restoration. Each participant was presented with 8 choice sets, following an orthogonal fractional factorial design (Addelman and Kempthorne 1961, SAS 2009).[23,24] All 8 of the paired choice sets could be implemented through contracts with firms that restore ecosystems, so all choices could be real. However, due to budget limitations of the research, the experiment moderator did inform participants that after they answered all 8 questions only one question would be chosen for each group, at random, for implementation.[25] Under this procedure, data from all 8 questions can be treated as a

[23] While our design uses the fractional factorial design, recent developments in the CE literature do point out that orthogonality properties would only hold for OLS.
[24] The code for the choice set designs was generated using SAS software, Version 8 of the SAS System for Windows. Copyright © 2009, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.
[25] The question implemented was chosen via random draw from a bag that contained numbered balls associated with each question number. Each question had an equal probability of being chosen.

real choice since participants knew the outcome of any one question could affect real restoration and allocation of their budget between restoration and other (personal) use.

The survey design for the CE^R questions created a Bundle A and a Bundle B, each with different attributes in terms of the acreage of seagrass, bird habitat, or clam restoration, and a cost to the person if that bundle was chosen by majority vote. Figure 4 is an example of a CE^R question. Restoration activities included, bird habitat restoration, seagrass habitat restoration and clam habitat restoration (for water quality improvement). A budget was provided for each participant on every question, where any money not applied to the cost of restoration would be available as cash for the participant to take home. The budget was either \$90 or \$120 and alternated for each participant between section I and section II (e.g., if i received \$90 in section I, then i received \$120 in section II).

Figure 5: Example CE^R Question		
Bird Habitat Restoration	2 increments	1increments
Clam Restoration	0 increments	1 increments
Sea Grass Restoration	2 increments	1 increments
Allocation of money, if this question is chosen for implementation:	From your \$90.00, Bundle A will use \$54.00 to help pay for the restoration above and you will receive \$36.00 to take home.	From your \$90.00, Bundle B will use \$85.50 to help pay for the restoration above and you will receive \$4.50 to take home.

I vote to support (check one box below)

☐ Bundle A ☐ Bundle B

The orthogonal design used four restoration-acreage levels (ranging between 0 and 4 half acres), and four levels for the percentage of the person's total budget allocated to restoration costs (ranging between $0 and $120). Table 11 provides additional information on the attribute levels. Regarding this monetary attribute, for example, for a 0.20-level, an individual with a provided-budget of $90 would pay $18, retaining $72 for other uses, while an individual with a provided-budget of $120 would pay $24 and retain $96. The two groups faced the same questions but in reverse order to enable a test for an ordering effect. More information on the specific variables and attribute levels used in this section is available in Table 11 and Appendix B: The Design Process.

An additional question was added in 2008 which presented participants with a specially designed choice question where bundle A always consisted of zero restoration (Section Ib). This question then always asked participants to choose between a bundle of restoration at some cost and another bundle with no restoration and no cost, such that the entire budget would be available for them to take home.

Section III introduces the IPA. Participants in each group made choices for budget allocation in half-acre increments on each individual restoration activity, where any money not used to support restoration could be taken home as cash. Figure 6 is a sample question and payment card for a 4-unit question about seagrass under the IPA. As opposed to the CE^R design, in which the design identifies how much of the budget is allocated towards restoration, the IPA allows participants' to choose their own designation of the budget to use towards each individual restoration activity. The groups face different treatments under the two decision rules, the proportional rebate

(**PR**) and the proportional rebate with an additional unit conditional on initial provision (**PR-CON**). For this experiment, **PR** requires that the provision point be met and returns any money in excess of the provision point to the participants in proportion to their offer on the infra-marginal unit. The second group also faced similar choices on each restoration activity under the proportional rebate rule but for each question, a half-acre of a second restoration activity would be provided as long as the groups' funds provided the first unit (**PR-CON**).

Section IV collected the demographic information on all participants.

Figure 6: Sample Question and Payment Card for IPA, 4-units

For this section, you have a budget of $100 to make each decision with

Questions 9) a-d are specifically about sea grass restoration activities only.

Please *circle* your decisions for the allocation of your personal budget for each unit of *sea grass* restoration activities. You should circle one dollar value in each column, a-d, or fill in your own number at the bottom of each column in the space for "name your own price" (but not in excess of your budget).

Per Unit Prices ($)	(a) price x 1 Half-Acre = Payment	(b) price x 2 Half-Acres = Payment	(c) price x 3 Half-Acres = Payment	(d) price x 4 Half-Acres = Payment
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

Table 11: **2008 Field Experiment Overview including Relevant Variables and Attributes:** Outline of a survey booklet designed to collect CE^R data and IPA offers from auction participants.

- **<u>Section 0: Introduction</u>** – Basic instructions, research motivation, and presentation of basic scientific information on the restoration activities.

- **<u>Section I: Choice experiment</u> (CE^R)-** Participants face a choice between two bundles of restoration activities, including a cost to support the activities
  - **Groups** – 2 on the same night, participant id's 1-25 (group A) and 26-50 (group B)
  - **Questions** 1 through 8. Groups A and B received the same 8 questions in reverse order
  - **Restoration activities** – Seagrass, Clams, Birds
  - **Cost of Restoration** -budget minus cash added to take home pay **Provided budget** - \$120 or \$90
  - **Design** – Based on an orthogonal fractional factorial design, 4 levels
    - Restoration acreage
      - 0 – 4 half acres
    - cost levels
      - Group A: .20, .45, .60, .95
      - Group B: .25, .50, .80, 1.00

- **<u>2008 - Section Ib: Choice experiment Q9</u> -** Participants face a choice between two bundles of restoration activities, including a cost to support the activities. Question 9 was a special design, not part of the orthogonal design, where bundle A was always zero acres restored of all types and the entire budget could be taken home as cash.
  - **Groups** – 2 on the same night, participant id's 1-25 (group A) and 26-50 (group B)
  - **Questions** – 1. (Q9)
  - **Restoration activities** – Seagrass, Clams, Birds
  - **Cost of restoration -**budget minus cash added to take home pay
  - **Provided budget** - \$120 or \$90 (note: budget alternated for a given participant between section I and section II).
  - **Design** – Bundle A is always \$0 cost with no restoration. Bundle B varied, as in Section Ia above.

- **<u>2008 - Section II: Choice experiment (CE^G) -</u>** Participants face a choice between two bundles of restoration activities, including a cost to support the activities. Money not supporting the specific implementation of the restoration was given to the county government for discretionary use.
  - **Groups** – 2 on the same night, participant id's 1-25 (group A) and 26-50 (group B)

- **Questions** – 8. Groups A and B received the same questions in reverse order
- **Restoration activities** – Seagrass, Clams, Birds
- **Cost of restoration** -budget minus cash given to local governments (Accomack or Northampton given the participants county of residence)
- **Provided budget** - $120 or $90
- **Design** – using an orthogonal fractional factorial design, identical to Section I

2008 - Section III: IPA

- **Groups** – 2 on the same night, participant id's 1-25 (group A) and 26-50 (group B)
- **Questions** – 3, one for each restoration activity
- **Restoration Activities** – Birds, Clams, Seagrass
- **Cost of restoration -**budget minus total paymet, based on rules of the incentive mechanism
- **Budget** - $100
- **Design**
  - Group A: choices for budget allocation on individual restoration activities in half acre increments and a budget that can be taken home as cash. Budget = $100
    - Bundles are in half acreage increments, 1-4.
    - Decision Rule - proportional rebate (PR)
    - Seagrass
    - Clam
    - Bird
  - Group B: choices for budget allocation on individual restoration activities in half acre increments and a budget that can be taken home as cash. Budget = $100
    - Bundles are in half acreage increments, 1-4.
    - Decision Rule - proportional rebate with conditionality (PR-CON)
    - Seagrass with birds provided on first unit
    - Clam with sea grass provided on first unit
    - Bird with sea grass provided on first unit

2008 – Section IV: Demographics – 20 questions collecting information on age, income range, education and other identifying characteristics of the participants.

4.3.3.2 Design Influence

Preliminary results of the logistic regressions performed on the CE^R data in year one (2008) show an unexpected result, producing a positive sign on the coefficient representing cost of restoration to the participant. The sign of the cost coefficient is notable because the positive sign indicates that the probability an individual chose a bundle was positively correlated with the cost of the restoration bundle, such that, the more a bundle cost the more a participant was likely to choose it. In other words, this preliminary result appeared to produce a *negative* marginal utility of income. Results of a basic linear logistic regression are displayed in table 23, Appendix B: The Design Process, indicating a significant, positive, albeit similar, impact across the restoration activities and a significant but weak cost coefficient. A more detailed analysis is discussed later, but preliminary results in Appendix B, are noted to explain the research process, including how and why changes were made between the field experiments in 2009 vs. 2008. However, preliminary regression results from year 1 also indicated that participants were making decisions consistent with decreasing marginal benefits in the IPA sections, such that participants were neither taking the entire budget home with them nor giving the entire budget to restoration.[26]

Upon further inspection of the data, it became apparent that not all of the participants made decisions consistent with 'giving the most money away' in the CE^R section, identified through the positive coefficient on *Rmoney*, in table 23 in Appendix B.

[26] These findings will be explored more fully in the Results section of this chapter, however, we introduce these preliminary results here to inform the reader of the sequence of events and how the design of the experiments was impacted by such results.

Using a latent class model approach, we were able to identify sub-sections of the participants comprised of individuals across Groups A and B in the experimental plan outlined in Table 11, one sub-section with a statistically significant positive cost coefficient on *RMoney* and one with a statistically significant negative *RMoney* coefficient. The Latent Class Estimation Results are in Table 27, Appendix B. We believe that the sub-section of the group who appeared to make decisions not consistent with the intended design of the experiment may have done so because of social pressure from the sub-population of environmentally related groups that participated in the experiment, such as the master gardeners.[27]

In reviewing the data from all the IPA sections, we did not find evidence of the trend to give away all money. While those participants, who appeared to give money away in the CE^R, may, on average, offer higher dollar amounts towards restoration in the IPA, they did not appear to give their entire budget away universally, leading us to believe these participants may not have completely thought about the trade-offs between restoration and money they could take home in the CE^R section.

4.3.3.2 Year Two – 2009 Experimental Parameters and Design

The results and feedback gained in the 2008 experiment influenced the design of the experiment in year 2 (2009). The experiment in 2009 still aimed to a) introduce baseline science information to participants on each of the restoration activities; b) gather information on participants' willingness to pay via a real money choice

[27] This conclusion is based on discussions held with a group of participants at the end of experiment

experiment which could then be used for comparison with our newly developed IPA approach; c) gather information on participants marginal willingness to pay for individual restoration activities via a real money IPA; and d) obtain demographic information on participants. Changes to the original design include i) a more in depth presentation and description of the restoration activities, ii) a series of questions to identify participant attitudes and preferences on restoration and conservation, iii) a removal of the government choice experiment section, iv) additional data based on incentive mechanisms under the IPA approach. Additionally, in 2009 the experimental moderator inserted several reminders to participants that any money received from the experiment could be used for a variety of purposes, including personal or other (post-experiment) philanthropic causes. This reminder was to reinforce to participants that decisions on offers to support specific restoration are balanced against any other uses the individual could determine for his or her money at home.

Section I collected information on participants attitudes and beliefs on environmental and general restoration activities. Participants were asked how much they identify with 11 statements; responses ranged from strongly disagree to strongly agree. The full set of questions is in Appendix E, but example statements include, "I have opportunities to take part in environmental preservation activities" or "we should preserve the local environment for future generations". This information was collected to allow for further development of latent class models based on results and insights from 2008.

Section II implemented a choice experiment (CE^R) where participants faced a choice between two bundles of restoration activities including a cost to support restoration. Each participant was presented with 8 choice sets, following an orthogonal fractional factorial design (as explained above). Similar to 2008, all 8 of the paired choice sets could be implemented through contracts with firms that restore ecosystems, so all choices could be real. However, due to budget limitations of the research, the experiment moderator did inform participants that after they answered all 8 questions only one question would be chosen, at random, for implementation.[28] Under this procedure, data from all 8 questions can be treated as a real choice since participants knew the outcome of any one question could affect real restoration.

Restoration activities included, bird habitat restoration and seagrass habitat restoration. A budget was provided for each participant on every question, where any money not applied to the cost of restoration would be available as cash for the participant to take home (CE^R). The budget was $100. The orthogonal design used four restoration-acreage levels (ranging between 0 and 4 half acres), and four levels for the percentage of the person's total budget allocated to restoration costs (ranging between $0 and $96). Table 12 provides additional information on the attribute levels. Both groups faced the same questions but in reverse order to test for an ordering effect. More information on the specific values and levels of variables used in this section of CE^R questions is available in Table 12 and Appendix B: The Design Process.

[28] The question implemented was chosen via random draw from a bag that contained numbered balls associated with each question number.

Section III-V introduces the IPA, under different decision rules. The design divided the participants into Groups A and B, with respective budgets of $100 and $150, for IPA questions. Participants made choices for IPA sections via budget allocation in half acre increments on each individual restoration activity, where any money not used to support restoration could be taken home as cash. As opposed to the CE^R design, which identifies how much of the budget is allocated towards restoration, the IPA allows participant to choose their own marginal price to use towards each individual restoration activity. Both groups faced the following decision rules: proportional rebate (**PR**), proportional rebate with the opportunity for revision (**PR-KREV**) and pivotal mechanism (**PM**), but Group A made decisions on four half acres of restoration under a $100 budget and Group B made decisions on eight half acres of restoration under a $150 budget.

The proportional rebate (**PR**) requires that the provision point be met and returns any money in excess of the provision point to the participants in proportion to their offer on the marginal unit. Such that, the individualized price is established as person i's offer minus any rebate on the last unit provided. The PR does not include any opportunity for participants to revise their offers if all available acreage units are not provided. The proportional rebate with a known revision (**PR-KREV**) operates identical to the PR, but once all offers are made and a provision level is calculated, it allows participants to revise their offers on any units that are not provided initially. Participants know they will have a second chance to make offers after initial offers are made and balance against the cost of provision. The pivotal mechanism (**PM**) also uses a provision point; however, **PM** requires participant payment on the marginal unit only if the participant is pivotal to provision of the last unit, so his or her payment is expressly needed to reach the provision point and provide the good. Payments made on earlier units are equal to the offer made on the last unit.

Section VI collected the demographic information on all participants.

Table 12: 2009 Field Experiment Overview including Relevant Variables and Attributes: Outline of a survey booklet designed to collect CE^R data and IPA bids offered by auction participants.

Section 0: Introduction – Basic instructions, research motivation. Presentation of scientific information on the restoration activities.

2009 - Section I: Attitude Questions: Participants are asked to how much they identify with each statement (11 in total) regarding environmental restoration. Responses ranged between strongly agree to strong disagree.

2009 - Section II: Choice experiment : Participants face a choice between two bundles of restoration activities, including a cost to support the activities

- **Groups** – 1 on each night, in different locations (23, 18 people respectively), participant id's 1-23 (group A) and 31-49 (group B)
- **Questions** – 8. Groups A and B received the same questions
- **Restoration activities** – Seagrass, Birds
- **Cost of Restoration -**budget minus cash added to take home pay
- **Provided budget** - $100.
- **Design** – using an orthogonal fractional factorial design, similar to the approach used in 2008.

2009 - Section III-V: IPA

- **Group A**: choices for budget allocation on individual restoration activities in half acre increments and a budget that can be taken home as cash. Budget = $100
  - Bundles are in half acreage increments, 1-4.
  - Decision Rule is proportional rebate
    - Seagrass
    - Bird
  - Decision rule is proportional rebate with a known chance to revise their offers
    - Seagrass
  - Decision rule is pivotal mechanism
    - Birds
- **Group B**: choices for budget allocation on individual restoration activities in half acre increments and a budget that can be taken home as cash. Budget = $150
  - Bundles are in half acreage increments, 1-8.
  - Decision Rule is proportional rebate
    - Seagrass
    - Bird
  - Decision rule is proportional rebate with a known chance to revise their offers
    - Seagrass
  - Decision rule is pivotal mechanism
    - Birds

2009 – Section VI: Demographics – 20 questions collecting information on age, income range, education and other identifying characteristics of the participants.

4.4 Hypotheses

We examine the following hypotheses with regards to the IPA.[29] The field test allows us to evaluate the IPA and marginal incentive mechanisms (as discussed in chapter 3) in a field setting to determine if the IPA is operating similarly in the field as it did in the experimental lab, in terms of provision. If the IPA is not affected by the marginal incentives we would expect marginal offers to be equal across treatments with different incentive mechanisms. However, if participants are responding differently to the marginal incentives and the possibility for additional benefits, they may adopt different strategies under each marginal incentive rule. Let $\theta^{PR}_{i,n}$ equal participant i's marginal offer for unit n under the **PR** mechanism treatment, and $\theta^{PM}_{i,n}$ participant i's marginal offer for the same unit n under the **PM** mechanism. Also, let $\theta^{PR\text{-}CON}_{i,n.}$ represent participant i's marginal offer for unit n under the conditional treatment, **PR-CON**, and $\theta^{PR\text{-}KREVFinal}_{i,n}$ represent participant i's marginal final (revised) offer for unit n under the treatment with revision opportunities, **PR-KREV**.

Hypothesis 1: test the null hypothesis H_o: $\theta^{PR}_{i,n} = \theta^{PM}_{i,n}$ versus the alternative hypothesis H_A: $\theta^{PR}_{i,n} \neq \theta^{PM}_{i,n.}$

Hypothesis 2: test the null hypothesis H_o: $\theta^{PR}_{i,n} = \theta^{PR\text{-}KREVFinal}_{i,n}$ versus the alternative hypothesis H_A: $\theta^{PR}_{i,n} \neq \theta^{PR\text{-}KREVFinal}_{i,n.}$

Hypothesis 3: test the null hypothesis H_o: $\theta^{PR}_{i,n} = \theta^{PR\text{-}CON}_{i,n}$ versus the alternative hypothesis H_A: $\theta^{PR}_{i,n} \neq \theta^{PR\text{-}CON}_{i,n.}$

[29] Hypotheses evaluating the IPA and CE together are in Chapter 5.

4.5 Models

This section will explain the models we tested and the process used to determine the final model used for CE^R analysis and comparison with IPA data. First we explain the primary variables used in the models discussed here (table 13), while a full variable list appears in Appendix B (Table 28). Three unrestricted models (equations 23-25) are shown and we present the pre-tests used to test of the robustness and best fit of the model (table 14). Preliminary results of the three restricted models are in table 15, these results are based on the pooled data that uses a sub-section of the 2008 data (based on the latent class analysis) and all of the 2009 data.

The empirical econometrics model is comprised of various explanatory variables: restoration activities (*Clams, Birds, Seagrass*), personal cost (*Rmoney*) and various socio-economic characteristics (*Female, Age, ResYrs,* Income and Education*).* Income is a vector of two dummy variables, *IncLow* and *IncHigh*, while education is also a two vector variable of high school (*HS*) and masters (*MS*). Table 13 defines the variables for the restricted models (equations (23) - (25)).[30] We examine three separate models, a simple linear model (model 1) and two models that allow flexibility to estimate the curvature that is expected in willingness to pay estimates, where model 2 uses natural log units and model 3 estimates squared and cubic units of restoration. We

[30] The full list of variables and expanded unrestricted models are available in APPENDIX B – The Design Process.

use a vector approach below to denote coefficients on interactions for each restoration activity and the demographic variables.

Table 13: Variable Definitions, CE models
Dependent Variable: *Choice* Independent Variables: - *RMoney*: Cost to participant of a specific bundle of restoration (values: 0-120) - *Birds:* Half acres of bird habitat restoration (values: 0-4) - *Birds*^{2}*:* Squared half acres of bird habitat restoration (values: 0-16) - *LnBirds:* Natural log of half acres of bird habitat restoration (values: 0-1.3863) - ***D****BirdsZero:* Dummy variable that identifies if there are zero half acres of bird habitat restoration, used in conjunction with LN model (values: 0/1) - *Seagrass:* Half acres of seagrass habitat restoration (values: 0-4) - *Seagrass*^{2} :Squared half acres of seagrass habitat restoration (values: 0-16) - *Lnseagrass:* Natural log of half acres of seagrass habitat restoration (values: 0-1.3863) - D*SeagrassZero:* Dummy variable that identifies if there are zero half acres of seagrass habitat restoration, used in conjunction with LN model (values: 0/1) - *Clams*: Half acres of clam habitat restoration (values: 0-4) - *Clams*^{2} :Squared half acres of clam habitat restoration (values: 0-16) - *LnClams:* Natural log of half acres of clam habitat restoration (values: 0-1.3863) - *DClamZero:* Dummy variable that identifies if there are zero half acres of clam habitat restoration, used in conjunction with LN model (values: 0/1) - *BSGC*^{3}*:* Cubed half acres of all restoration, birds+seagrass+clam (values: 0-343) *total additive bundle max = 7 ***Demographic*** - *Female:* Dummy variable for sex of participant, where female equals one (value: 0/1) - *Age:* Participants age (value: 18-81) - *ResYrs:* Numbers of years the participant has resided on the eastern shore (value: 0-81) - *IncLow:* Income less than $40,000 (value: 0/1) - *IncHigh:* Income greater than $50,000 (value: 0/1) - *HS:* Education level, high school or less (value: 0/1) - *MS:* Education level, masters degree or higher (value: 0/1)

4.5.1 The Unrestricted Models

Equations 20-22 are the unrestricted forms of the three models (linear, log and cubic) for CE^R data. *Demographics* is a vector of variables describing respondent characteristics listed in Table 13. Equation (20) presents the model that includes the linear form of the restoration activities and the interaction of linear restoration variables with the vector of demographics. Equation (21) presents the natural log of the restoration activities and the interaction of natural log of restoration variables with the vector of demographics, allowing for curvature in model estimation. Finally, equation (22) includes the restoration activities squared, the sum of all restoration activities in a bundle cubed and the interaction of linear restoration variables with the vector of demographics. These unrestricted models were pre-tested using likelihood ratio (LR) test statistics for a test of the robustness and best fit of the model. A likelihood ratio test compares model fit of the restricted models with unrestricted models that contain more explanatory variables. For each model the unrestricted model is compared to five restricted models (table 14), which restrict variables or groups of variables to zero, to allow us to perform hypothesis tests on the impact of specific parameter estimates. Thus, to test the null hypotheses, we focus on whether restrictions implied by null hypotheses are statistically insignificant when imposed to generate a restricted model, such as model 5 (table 14). Based on results of the likelihood ratio tests displayed in table 14, the demographics are dropped from the restricted models, generating estimates representing models in equations (23)-(25) below.

(20) **Unrestricted form of Model 1:** Marginal Offer **=** $\beta_0 + \beta_1 Rmoney + \beta_2 Seagrass + \beta_3 Birds + \beta_4 Clams + \gamma_i\,(Bird\ x\ Demographics) + \delta_i\,(Seagrass\ x\ Demographics) + \psi_i\,(Clam\ x\ Demographicss)$

(21) **Unrestricted form of Model 2***:* Marginal Offer = $\beta_0 + \beta_1 Rmoney + \beta_2 LnSeagrass + \beta_3 LnBirds + \beta_4 LnClams + \gamma_i\,(LnBird\ x\ Demographics) + \delta_i\,(LnSeagrass\ x\ Demographics) + \psi_i\,(LnClam\ x\ Demographics)$

(22) **Unrestricted form of Model 3***:* Marginal Offer = $\beta_0 + \beta_1 Rmoney + \beta_2 Seagrass + \beta_3 Birds + \beta_4 Clams + \beta_5 Seagrass^2 + \beta_6 Birds^2 + \beta_7 Clams^2 + \beta_8 BSGC3 + \gamma_i\,(Bird\ x\ Demographics) + \delta_i\,(Seagrass\ x\ Demographics) + \psi_i\,(Clam\ x\ Demographics)$

Table 14: Logit Model Statistics and Hypothesis Tests				
Model	**Econometric Restrictions**	**Log-likelihood (No. of parameters)**	**X^2 (d.f.)**	**P <**
Log Model (unrestricted model 2, equation 21)				
Unrestricted	None	-202.0 (41)	n/a	n/a
Restricted 1	βResYrs = 0, βInc=0	-210.2 (26)	16.4 (15)	0.3560
Restricted 2	βEduc=0, βInc=0	-212.3 (22)	20.6 (19)	0.3593
Restricted 3	βAge=0, βInc=0	-211.8 (26)	19.6 (15)	0.1878
Restricted 4	All β=0 except bundle + fem	-218.1 (13)	32.3 (28)	0.2664
Restricted 5	All β=0 except bundle	-222.8 (7)	41.6 (34)	0.1735
Cubic Model (Unrestricted model 3, equation 22)				
Unrestricted	None	-201.8 (29)	n/a	n/a
Restricted 1	βEduc = 0,	-203.3 (24)	3.00 (5)	0.7000
Restricted 2	βEduc=0, βInc=0	-208.2 (18)	12.8 (11)	0.3066
Restricted 3	βAge=0, βEduc=0,βResYrs=0	-206.3 (18)	9.00 (11)	0.6219
Restricted 4	All β=0 except bundle + fem	-237.6 (11)	71.6 (18)	0.000
Restricted 5	All β=0 except bundle	-220.6 (8)	37.6 (21)	0.0144

4.5.2 Restricted CE^R Model

Based on the LR tests presented in table 14, we present the restricted form of the three models (equations (23) – (25)), which includes the restoration activities affecting birds, clams, and seagrass, and the cost of the bundle (*RMoney*). A set of dummy variables is defined to indicate when the a particular restoration activity has zero units, so that, for example, *DSGzero* = 1 if a bundle has zero half-acres of restoration of seagrass, and a 0 if a positive amount of seagrass restoration is included. With this convention, we define the variable *LnSeagrass* as the natural log of half-acres of seagrass when this restoration activity occurs at a positive quantity, and *LnSeagrass* is zero otherwise; paired with this, *DSeagrassZero* = 1 if *LnSeagrass* =0 and *DSeagrassZero* = 0 otherwise. The convention allows us to avoid taking the log of zero units while using a dummy variable to represent all situations in the data. We used the same convention with the log of half-acres of birds and clams, including corresponding dummy variables (*DBirdZero**,* *DSeagrassZero* and *DClamzero*).

(23) **Model 1´**: $Marginal\ Offer = \beta_o + \beta_1 RMoney + \beta_2 Birds + \beta_3 Seagrass + \beta_4 Clams$

(24) **Model 2´**: $Marginal\ Offer = \beta_o + \beta_1 RMoney + \beta_2 LNBirds + \beta_3 LNSeagrass + \beta_4 LNClams + \beta_5 DBirdsZero + \beta_6 DSeagrassZero + \beta_6 DClamsZero$

(25) **Model 3´**: $Marginal\ Offer = \beta_o + \beta_1 RMoney + \beta_2 Birds + \beta_3 Seagrass + \beta_4 Clams + \beta_5 Birds^2 + \beta_6 Seagrass^2 + \beta_7 Clams^2 + \beta_1\ BSGC^3$

We compare the three restricted models in equations (23)-(25) based on the Bayesian Information Criteria (BIC), which compares the model fit for models 1´, 2´ and 3´ as a preliminary result in Table 15. The BIC identifies the best fitting model as that which minimizes the information criteria (Swait 1994, Greene and Hensher 2003), which is equation (24) or model 2, in table 15.[31] The natural log model (equation 24), will be used as the model of estimation for the CE^R for the remainder of this document.

[31] The choice of model uses a combined 2008 and 2009 participant dataset through the latent class model approach used to split the 2008 participants into two groups. Thus model estimates are based on part of the 2008 subject population and the entire 2009 subject population. This is discussed more in Appendix B.

Table 15 – Preliminary Model Estimates for Restricted Models, CE[R]									
	Model 1: Linear			**Model 2:LN**			**Model 3: AltCubic**		
Variable	Par Est	SE	Pr >|Z|	Par Est	SE	Pr > |Z|	Par Est	SE	Pr > |Z|
RMoney	-0.015	(0.004)	0.001	-0.017	(0.004)	0.001	-0.018	(0.004)	0.001
Birds	0.869	(0.106)	0.001				1.511	(0.320)	0.01
Seagrass	0.884	(0.099)	0.001				1.422	(0.240)	0.01
Clams	0.957	(0.185)	0.001				2.894	(0.446)	0.01
$Seagrass^2$							-0.166	(0.052)	0.01
$Birds^2$							-0.281	(0.075)	0.01
$Clams^2$							-0.829	(0.123)	0.01
BSGC3							0.005	(0.004)	0.29
LnSeagrass				1.911	(0.361)	0.01			
LnBirds				1.29	(0.212)	0.01			
LnClams				0.72	(0.345)	0.07			
DSeagrassZero				-1.202	(0.304)	0.01			
DBirdsZero				-1.285	(0.223)	0.01			
DClamsZero				-2.615	(0.414)	0.01			
n=	1068			1068			1068		
BIC[b]	517.22			494.50			497.08		
Log likelihood	-244.7			-222.8			-220.6		
χ^2 statistic	91.45	< 0.001[a]		122.8	< 0.001[a]		137.4	< 0.001[a]	
	(d.f. =4)			(d.f. =7)			(d.f. =8)		

[a] The level of significance (i.e. P value) for the $\chi2$ statistic

[b] BIC (Bayesian Information Criterion) is calculated as {-LL+[(P/2)*ln(N)]}

4.5.3 Restricted IPA

Data was modeled using an interval regression with robust standard errors to account for multiple responses per individual. Participants receive a payment card (Figure 5) with offers presented in \$5.00 increments; this creates gives a range of willingness-to-pay by presenting data in intervals (where the marginal offer is the lower bound of the interval range) as opposed to a precise value. When a participant indicates a number on the payment card it means the person's offer (if they had been allowed to name any number less than the budget) would have been at least as much as the number circled and less than the next higher number available. We estimate robust standard errors to allow for correlation among offers from a single individual, while assuming offer schedules are independent between individuals. Using this approach impacts the standard errors and the variance-covariance matrix of the estimates, but not the estimated coefficients which remain asymptotically unbiased.

The IPA model presented in equation (26) accounts for impacts from individual treatments under different incentive mechanisms, the maximum number of units or total acreage available and some demographics (variables are defined in Table 13).

$$\textbf{(26)} \qquad \text{Marginal Offer}^{\text{IPA}} = \beta_o + \beta_1 Units + \beta_2 Birds + \beta_3 Clams + \beta_4 PR\text{-}CON + \beta_5 PR\text{-}REV + \beta_6 PM + \beta_7 EightUnits + \beta_8 Female + \beta_9 Age + \beta_{10} Own + \beta_{11} EnvDonor + \beta_{12} HS + \beta_{13} MS + \beta_{14} IncLow + \beta_{15} IncHigh$$

4.6 Results

The CE^R is estimated using a conditional logit model to determine willingness-to-pay for ecosystem restoration, where we investigate how individual offers are impacted by independent variables (attributes of the choice bundles and possibly demographic variables) using the following log model specification, based on equation (27):

$$(27)\quad u(B_{ij}, Y_i\text{-}C_{ij}) \cong B_o + B_R RMoney + B_B LnBirds + B_S LnSeagrass + B_C\, LnClams + B_{DB} DBirdsZero + B_{DS} DSeagrassZero + B_{DC} DClamsZero$$

Results of the CE^R model are in table 16, including estimates for each year, 2008 and 2009. The 2008 estimates are based on the modified participant group, identified through the latent class analysis (see Tables 23 and 27, Appendix B). The 2009 estimates are based on the full participant group. Additionally, clams are not included in the 2009 model because restoration involving clams was not included in the 2009 experiment, although the coefficient on the pooled data is positive and significant.

Table 16: Estimated Choice Model – 2008 and 2009 Field Experiments				
	2008		**2009**	
Variable Name	**2008 Coefficient (SE)**	**Sig. (P<)**	**2009 Coefficient (SE)**	**Sig. (P<)**
RMoney	-0.004 (0.006)	0.465	-0.032 (0.005)	0.001
LnSeagrass	1.594 (0.490)	0.001	2.114 (0.627)	0.001
LnBirds	1.013 (0.321)	0.002	1.740 (0.347)	0.001
LnClams	0.770 (0.354)	0.03	n/a	n/a
DSeagrassZero	-0.958 (0.396)	0.015	-1.592 (0.575)	0.006
DBirdZero	-1.253 (0.266)	0.001	-1.244 (0.004)	0.004
DClamsZero	-2.038 (0.423)	0.001	n/a	n/a
LR chi2 (df)	54.47 7	n=414	99.43 5	n=654
Model significance (p <)	0.0001		0.0001	

The functional form chosen for the IPA model is derived from the final utility model used for the CE^R data involving each restoration activity (equations X-Y). Marginal willingness to pay is calculated for each separate restoration activity via equations (28) – (30).

$$(28) \qquad mWTP^{Seagrass} \cong \frac{\frac{\partial U}{\partial Seagrass}}{-\frac{\partial U}{\partial I}} \cong \frac{[\frac{\beta_{Seagrass}}{Searass}+\frac{\beta_{DSeagrassZero}}{DSearassZero}]}{\beta_R}$$

$$(29) \qquad mWTP^{Birds} \cong \frac{\frac{\partial U}{\partial Birds}}{\frac{\partial U}{-\partial I}} \cong \frac{[\frac{\beta_{Birds}}{Birds}+\frac{\beta_{DBirdsZero}}{DBirdsZero}]}{\beta_R}$$

$$(30) \qquad mWTP^{Clams} \cong \frac{\frac{\partial U}{\partial Clams}}{\frac{\partial U}{-\partial I}} \cong \frac{[\frac{\beta_{Clams}}{Clams}+\frac{\beta_{DClamsZero}}{DClamsZero}]}{\beta_R}$$

Participant responses are provided via payment card (figure 6), and an interval regression is used to estimate. Table 17 contains the IPA model estimates for year one and year two, 2008 and 2009, accounting for the different treatments that we conducted in each year and demographics. The 2008 model estimates do not include *PR-Rev*, *PM* or *EightUnits* while the 2009 model estimates do not include *PR-CON* or *Clams.* We note that other differences in the two samples are on education and income coefficients, identified earlier in Table 10.

Table 17: IPA Estimates: 2008, 2009

Variable Name	**2008 Coefficient (SE)**	**Sig. (P<)**	**2009 Coefficient (SE)**	**Sig. (P<)**
LNUnits	-10.971 (1.04)	0.001	-8.157 (0.31)	0.000
Birds	2.305 (2.84)	0.417	0.062 (1.76)	0.972
Clams	1.47 (2.81)	0.601	--	
PR-CON	9.947 (2.40)	0.001	--	
PR-FinalOffer	--		2.232 (1.62)	0.168
PM	--		0.591 (1.76)	0.737
EightUnits	--		28.031 (1.84)	0.001
Female	-2.071 (2.60)	0.426	4.551 (1.32)	0.001
Age	0.643 (0.11)	0.001	0.484 (0.06)	0.001
Own	6.775 (3.76)	0.071	-9.056 (1.70)	0.001
EnvDonor	6.504 (3.32)	0.050	10.24 (2.07)	0.001
HS	-14.808 (4.66)	0.001	9.304 (2.07)	0.001
MS	-3.113 (2.97)	0.295	9.077 (1.66)	0.001
IncLow	15.293 (3.19)	0.001	-2.863 (1.78)	0.107
IncHigh	16.135 (2.88)	0.001	6.627 (2.23)	0.003
Constant	18.091 (6.26)	0.004	15.084 (4.07)	0.001
Observations	584		1,061	
Log likelihood	-1189.747		-4651.445	
DF	12		13	
chi2	212.150		643.190	

Tables 18 and 19 provide information on the individual treatments for each year, 2008 and 2009. Table 18 indicates provision level under each treatment and table 19 shows mean offers under each treatment to allow for comparison.

Table 18: Provision Summary by Treatment, IPA

Year	Treatment Name (includes total number of units, restoration activity)	Percent of Units Provided
2008	PR-4, Birds	50% (2/4)
	PR-4, Seagrass	50% (2/4)
n=25	PR-4, Clams	75% (3/4)
2008	PR-CON – 4 Units, Birds	75% (3/4)
	PR-CON – 4 Units, Seagrass	75% (3/4)
n=25	PR-CON – 4 Units, Clams	75% (3/4)
2009	PR-4, Birds	50% (2/4)
	PR-4, Seagrass	50% (2/4)
	PM-4, Birds	50% (2/4)
n=18	PR-REV-4, Seagrass	75% (3/4)
2009	PR-8, Birds	37.5% (3/8)
	PR-8, Seagrass	37.5% (3/8)
	PM-8, Birds	37.5% (3/8)
n=23	PR-REV-8, Seagrass	37.5% (3/8)

Table 19: Mean Offer by Treatment (Field Experiments)								
	Unit Number							
Treatments	1	2	3	4	5	6	7	8
2008, n=150 **PR-4** (SE)	63.64 (32.86)	35.45 (14.25)	25.55 (9.37)	20.34 (6.51)	--	--	--	--
2008,n=75 **PR-CON -4** (SE)	67.96 (32.48)	37.87 (13.33)	27.35 (8.64)	21.20 (6.20)	--	--	--	--
2009, n=46 **PR-4** (SE)	52.50 (31.21)	32.25 (15.15)	22.74 (10.03)	19.13 (6.44)	--	--	--	--
2009, n=23 **PM-4** (SE)	49.78 (34.03)	30.22 (15.99)	21.66 (10.11)	17.09 (7.46)	--	--	--	--
2009, n=23 **PR-Krev-4** (SE)	55.43 (32.47) n=23	32.17 (14.99)	21.27 (8.91)	17.89 (5.03)	--	--	--	--
2009, **PR-Krev-4, *FinalOffer*** (SE)	--	--	24.18 (9.51)	18.84 (5.95)	--	--	--	--
2009, n=46 **PR-8** (SE)	74.31 (48.70)	42.78 (24.86)	29.03 (15.74)	22.78 (11.33)	19.03 (9.09)	16.39 (7.52)	13.56 (6.40)	10.83 (5.66)
2009, n=23 **PR-Krev-8** (SE)	85.28 (49.46)	43.08 (25.95)	31.48 (16.06)	24.33 (10.66)	21.53 (7.54)	18.19 (6.67)	15.11 (5.19)	11.94 (4.75)
2009, **PR-Krev-8, *FinalOffer*** (SE)	--	--	--	--	23.06 (6.47)	19.17 (6.00)	16.22 (4.51)	12.78 (4.53)
2009, n=23 **PM-8** (SE)	81.67 (50.93)	46.11 (24.04)	31.94 (14.32)	23.78 (9.74)	20.00 (7.07)	16.39 (5.89)	14.28 (4.78)	12.00 (3.88)

4.7 Discussion and Conclusions

This chapter explains the process and initial results for each main component of the field test. Overall, results indicate that participants did reveal support for higher quantities (e.g., more acres) of ecosystem restoration as estimated using a conditional logit model (see table 16) and as shown in the provision summary in table 18. Examination of the individual incentive mechanisms (hypotheses 1-3) did show that the marginal incentive rules had an impact on individual decision-making.

The results of the CE^R model show support for each restoration activity (*Birds, Seagrass, Clams*). The sign on the *Rmoney* coefficients are negative[32], such that a higher cost on the bundle of restoration makes individuals less likely to choose the bundle, however we note the lack of significance in year one (2008) on *Rmoney*. From the results of the interval regression used to estimate the IPA model, offers on infra-marginal units are consistent with decreasing marginal benefits and it appears there are minimal differences on the estimates across the restoration activities. In addition, there are some noteworthy differences between years in our sample. As mentioned earlier there are differences in education and income across the two years (table 10). In year 1, those with lower incomes (< 50k) have a positive significant coefficient (*IncLow*) but in year 2, we see a negative coefficient on *IncLow*. This may be due to the higher number of retirees in year 1 or the higher percentage of unemployed participants in year 2.

[32] We note that the 2008 reported data is for a modified subject pool based on our latent class analysis, tables 23 and 27, Appendix B.

In Table 17, we note the coefficients on individual incentive mechanisms are not significant. *PM* is positive but not significant (hypothesis 1) and PR-REV is also positive and not significant (hypothesis 3). In our field exercise it appears that the incentive mechanisms on infra-marginal units may not be driving the per-unit-offers. However, we do note the positive significant increase on offers under the PR-CON (hypothesis 2), where an additional unit of restoration was provided if the groups' aggregate offers are large enough to meet the provision cost on the first unit.

Table 19's summary of mean offers provides additional information on the impact of the marginal incentive mechanisms. The mean offers under **PM** in the field treatment are lower than under the **PR** in 4 unit treatments, which is unlike what we saw in the laboratory experiments. In 8-unit laboratory treatments, **PM** offers are significantly higher on the first unit only, and then offers between the two treatments converge. Without further testing we are unable to determine if the incentive structure of the **PM** is driving the offers, or if the number of units or some other aspect of the experiment is motivating participants (hypothesis 1). Hypothesis 2 examines the **PR-CON** treatments. Table 19 indicates higher offers in the **PR-CON** than the **PR** treatments, consistent with results seen in table 17. Finally, we examine revision offers. Initial offers under the **PR-REV** treatment are lower than the **PR** offers under 4 unit treatments. Also seen in chapter 3, this behavior may suggest that participants offer lower than their marginal benefit on early units to maximize surplus since they know that there is still a second chance to get units provided. The revision treatment also provides participants an opportunity to gain information on the behavior of other group members without losing the opportunity of units being provided since revision offers act as a second chance to get units provided.

Our discussion of the field experiments continues in chapter 5. We compare the marginal willingness to pay data from the field test of the IPA to the marginal willingness to pay derived from the CE^R, which should produce offers consistent with full Hicksian value. If the offers under the IPA process are close to the estimated mWTP based on a CE^R involving real choices, in an incentive compatible setting, then the IPA may be viewed as a promising and practical approach to identifying Lindahl's individual marginal benefit prices.

CHAPTER 5: A COMPARISON OF TWO FIELD TESTS OF WTP FOR PROVISION OF PUBLIC GOODS

5.0 Introduction

This research examines a practical method to attempt to implement an individualized pricing approach to public good provision, grounded in Lindahl's marginal benefit theory. Willingness-to-pay techniques have been used to assess preferences for many environmental goods, yet this research goes a step further to explore real money auctions that generate revenues sufficient to pay for public goods, specifically those focused on ecosystem restoration. The first phase of this research (presented in chapter three) explored induced value experiments conducted on our newly developed individualized pricing auction (IPA) that examined how individuals responded to incentives without the possible bias associated with preconceived notions about the specific public good's environmental or social impacts. The second phase of this research included a field experiment (presented in chapter 4) that explored field tests of the IPA, as well as incentive compatible choice experiments. Now we compare the marginal willingness to pay data from the field test of the IPA to the marginal willingness to pay derived from the CE^R, which should produce offers consistent with full Hicksian value. If the offers under the IPA framework are close to the estimated mWTP based on a CE^R involving real choices, in an incentive compatible setting, then the IPA may be viewed as a promising and practical approach to identifying Lindahl's individual marginal benefit prices. Integrating an individualized pricing framework (IPA) into the public goods research agenda has the potential for generating more accurate estimates of individual and community willingness-to-pay for environmental restoration activities, including the services that well-functioning ecosystems provide.

5.1 Process

As presented in chapter 4, data was collected using field experiments employing an IPA approach with mechanisms to reduce free riding often seen in the experimental economics literature. These incentive mechanisms are applied to individual restoration activities and marginal willingness to pay estimates are compared to a baseline choice experiment (CE^R) that employs an incentive compatible, majority vote mechanism and actual (not hypothetical) money payments. We evaluate the offers from the incentive compatible CE^R approach and the IPA to assess estimates of mWTP against true value. The CE^R provides estimates of WTP, which we can then compare, at the margin, to the offers from the IPA.

The next section briefly reviews the CE^R and IPA the process, and then we present the hypothesis for this chapter before re-presenting the models[33] and regression results from 2008, 2009 and the combined data.[34] Finally we explain the methods used to construct marginal willingness-to-pay and marginal offer estimates under each approach (the CE^R and IPA respectively) and the results from these tests.

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[33] Models used in this chapter are from chapter 4, however, we repeat them here to ensure the reader is aware of the process used to construct both the CE^R and IPA used in the comparison.

[34] The combined data includes a subset of the 2008 participants based on the latent class analysis presented in Table 27, Appendix B, plus all of the 2009 participants for the CE^R and all participants for the IPA in both 2008 and 2009.

5.2 Background

CE^R

As explained earlier, economists have created a rich literature on valuing environmental goods and services through choice experiments (Hanley et. al. 1998, Adamowicz et. al. 1994, Adamowicz et. al. 1998, Johnston et. al. 2002, List et. al. 2006, Carlsson and Martinsson 2001). Under the choice experiment explained here, offers established under the CE^R are consistent with truthfully revealing the full value (full willingness to pay (WTP)) for the alternative that an individual prefers most. For example, in a choice among two alternative sets of restoration activities and required payments from the individual, a voting institution with majority rule is incentive compatible because each participant's best strategy is to vote for the alternative that he or she would most prefer to see implemented (Hoehn and Randall 1987, Bagnoli and Lipman 1989). We use the WTP estimates produced CE^R to construct estimates of mWTP, that we can then compare to the marginal offers (Mθ) estimated under the IPA.

IPA

Our IPA model asks participants to make incremental decisions on increasing units of restoration, one unit at a time. All treatments of the IPA include a provision point (PP) and money back guarantee (MBG) if the marginal offers do not equal or exceed the cost of providing the good. Alternative incentive mechanisms are evaluated in order to assess whether decision-making is altered when the rules differ on the marginal unit –

as explained in Chapter 3.[35] We provide a brief synopsis of the incentive mechanisms here. For this experiment, **PR** requires that the provision point be met and returns any money in excess of the provision point to the participants in proportion to their offer, on the marginal unit. The **PR** mechanism is examined for both 4 and 8 unit treatments and with and without an opportunity for participants to revise their offers on any units not provided by the initial auction round. In addition, one group was told conditional on their decisions for one restoration activity, a unit of an additional restoration activity would be provided as long as funds to provide a single unit of the first activity were collected under the PR mechanism (**PR-CON**). The **PR-CON** mechanisms mimics what is often seen in match donations, thus the experiment is matching the offers made by the group if one unit is provided, with an additional unit of restoration. A secondary mechanism, the Pivotal Mechanism (**PM**) also uses a provision point. However, **PM** requires participant payment on the marginal unit only if the person is pivotal and his or her payment would be needed to reach the provision point and provide the good.

5.3 Hypothesis

This chapter focuses on whether estimates produced under the IPA adequately reflect mWTP, or those estimates from an incentive compatible approach. Let $mWTP^{CE}$ represent the estimates derived from the CE model and let $M\theta^{IPA}$ represent the estimates from the IPA.

[35] In chapter 3, mechanisms and their theoretical properties are examined in greater depth through induced value experiments conducted in the policy simulation lab.

Hypothesis 1: test the null hypothesis H_o: $mWTP^{CE} = M\theta^{IPA}$, versus the alternative hypothesis H_A: $mWTP^{CE} \neq M\theta^{IPA}$

5.4 Basic Models and Preliminary Results

CE^R

The CE^R is estimated using a conditional logit model to determine willingness to pay for ecosystem restoration, where we investigate how individual offers are impacted by independent variables (attributes of the choice bundles and possibly demographic variables) using the following log model specification:

$$(31)\quad u(B_{ij}, Y_i\text{-}C_{ij}) \cong B_o + B_R RMoney + B_B LnBirds + B_S LnSeagrass + B_C LnClams + B_{DB} DBirdsZero + B_{DS} DSeagrassZero + B_{DC} DClamsZero$$

These variables were defined in Table 13 and results of the model are in table 20, including estimates for 2008, 2009 including the pooled data. We use the pooled data to test our hypothesis on marginal offers produced under the CE^R and the IPA. The coefficient on the pooled restoration cost coefficient (*RMoney*) is negative after using the latent class model to split the 2008 subject pool; however, the coefficient on the 2008 restoration cost is not significant (tables 16 and 20). Additionally, clams are not included in the 2009 model, although the coefficient on the pooled data is positive and significant. Figure 7 provides a graphical representation the WTP estimates constructed for each restoration activity.

Table 20: Estimated Choice Model – 2008 and 2009 Field Experiments

Variable Name	2008 Coefficient (SE)	Sig. (P<)	2009 Coefficient (SE)	Sig. (P<)	ALL Coefficient (SE)	Sig. (P<)
RMoney	-0.004 (0.006)	0.465	-0.032 (0.005)	0.000	-0.017 (0.004)	0.000
LnSeagrass	1.594 (0.490)	0.001	2.114 (0.627)	0.001	1.911 (0.361)	0.000
LnBirds	1.013 (0.321)	0.002	1.740 (0.347)	0.000	0.983 (0.409)	0.000
LnClams	0.770 (0.354)	0.03	n/a	n/a	0.72 (0.345)	0.037
DSeagrassZero	-0.958 (0.396)	0.015	-1.592 (0.575)	0.006	-1.202 (0.304)	0.000
DBirdsZero	-1.253 (0.266)	0.001	-1.244 (0.004)	0.004	-1.285 (0.223)	0.000
DClamsZero	-2.038 (0.423)	0.001	n/a	n/a	-2.615 (0.414)	0.000
LR chi2 (df)	54.47 7	n=414	99.43 5	n=654	122.81 7	n=1068
	0.0001		0.0001		0.0001	

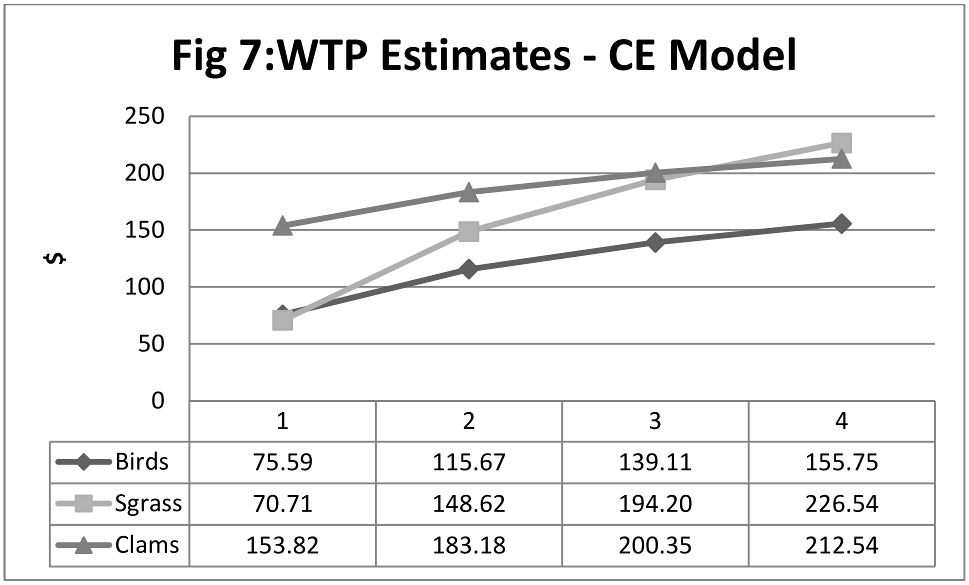


Fig 7:WTP Estimates - CE Model

	1	2	3	4
Birds	75.59	115.67	139.11	155.75
Sgrass	70.71	148.62	194.20	226.54
Clams	153.82	183.18	200.35	212.54

IPA

The chosen functional form of the IPA model is based on the derived utility function for each restoration activity. Consistent with the CE^R model, this estimation uses the log model (*LnUnits*), where *DBirds* indicates if the auction was for birds and takes a value of 1 if the auction involved restoration of bird habitat and zero otherwise. *DClams* indicates if the auction was for a clam auction and takes a value of 1 if the auction involved restoration of clam habitat and zero otherwise. Participant responses are provided (as explained in chapter 3), via payment card, and an interval regression is used to estimate. Table 21 contains the IPA model estimates for year one and year two, 2008 and 2009, accounting for the different treatments that we conducted in each year and demographics. The 2008 model estimates do not include *PR-Rev*, *PM* or *EightUnits* while the 2009 model estimates do not include *PR-CON* or *Clams.* We note that other notable differences in the two samples are on education and income coefficients, identified earlier in Table 10.

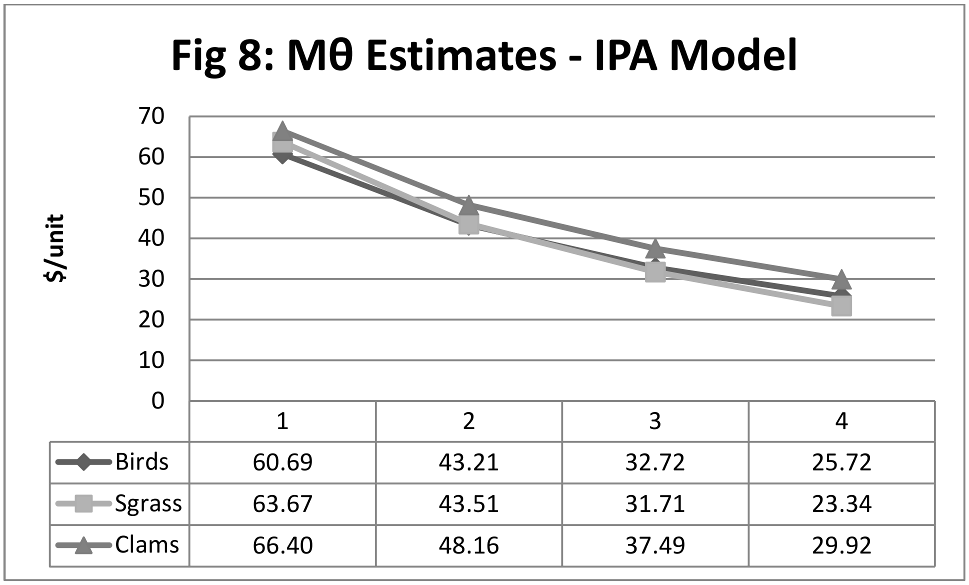
We use the pooled data used in the comparison of marginal offers between the CE^{R} and IPA. Figure 8 presents a graphical representation of the Mθ's under each restoration activity.

$$(32) \qquad mWTP^{\text{Seagrass}} \cong \frac{\frac{\partial U}{\partial Seagrass}}{-\frac{\partial U}{\partial I}} \cong \frac{[\frac{\beta_{Seagrass}}{Searass}+\frac{\beta_{DSeagrassZero}}{DSearassZero}]}{\beta_R}$$

$$(33) \qquad mWTP^{\text{Birds}} \cong \frac{\frac{\partial U}{\partial Birds}}{\frac{\partial U}{-\partial I}} \cong \frac{[\frac{\beta_{Birds}}{Birds}+\frac{\beta_{DBirdsZero}}{DBirdsZero}]}{\beta_R}$$

$$(34) \qquad mWTP^{\text{Clams}} \cong \frac{\frac{\partial U}{\partial Clams}}{\frac{\partial U}{-\partial I}} \cong \frac{[\frac{\beta_{Clams}}{Clams}+\frac{\beta_{DClamsZero}}{DClamsZero}]}{\beta_R}$$

Table 20: IPA Estimates: 2008, 2009, ALL (2008 & 2009)						
Variable Name	**2008 Coefficient (SE)**	**Sig. (P<)**	**2009 Coefficient (SE)**	**Sig. (P<)**	**ALL Coefficient (SE)**	**Sig. (P<)**
LnUnits	-10.971 (1.04)	0.001	-8.157 (0.31)	0.000	-8.622 (0.32)	0.001
Birds	2.305 (2.84)	0.417	0.062 (1.76)	0.972	0.934 (1.52)	0.539
Clams	1.47 (2.81)	0.601	--		5.403 (2.09)	0.010
PR-CON	9.947 (2.40)	0.001	--		16.853 (1.77)	0.001
PR-REV	--		2.232 (1.62)	0.168	-0.168 (1.63)	0.918
PM	--		0.591 (1.76)	0.737	-2.924 (1.81)	0.106
EightUnits	--		28.031 (1.84)	0.001	23.394 (1.64)	0.001
Female	-2.071 (2.60)	0.426	4.551 (1.32)	0.001	3.883 (1.14)	0.001
Age	0.643 (0.11)	0.001	0.484 (0.06)	0.001	0.44 (0.05)	0.001
Own	6.775 (3.76)	0.071	-9.056 (1.70)	0.001	-3.385 (1.51)	0.025
Env Donor	6.504 (3.32)	0.050	10.24 (2.07)	0.001	6.104 (1.61)	0.001
HS	-14.808 (4.66)	0.001	9.304 (2.07)	0.001	3.566 (1.76)	0.042
MS	-3.113 (2.97)	0.295	9.077 (1.66)	0.001	4.667 (1.44)	0.001
IncLow	15.293 (3.19)	0.001	-2.863 (1.78)	0.107	2.605 (1.52)	0.086
IncHigh	16.135 (2.88)	0.001	6.627 (2.23)	0.003	8.785 (1.67)	0.001
Constant	18.091 (6.26)	0.004	15.084 (4.07)	0.001	21.618 (3.10)	0.001
Observations	584		1,061		1,645	
LL	-1190.747		-4651.445		-5928.720	
DF	12		13		15	
chi2	212.150		643.190		871.38	



	1	2	3	4
Birds	60.69	43.21	32.72	25.72
Sgrass	63.67	43.51	31.71	23.34
Clams	66.40	48.16	37.49	29.92

5.5 Model Comparison

We used the WTP estimates produced under the CE^R model (equation (31)) to derive mWTP estimates on infra-marginal units of each restoration activity. These mWTP estimates could be compared to the estimated offers, Mθ, produced by the IPA (equations (32) – (34)) to test whether the IPA can produce offers consistent with full Hicksian value. Since mWTP estimates provide only a single set of point estimates we use the Krinsky-Robb bootstrapping approach (Haab and McConnell, 2002) to construct confidence intervals and evaluate the Mθ estimates from the IPA with those mWTP estimated under the CE^R.

The bootstrap method is used when we have a random sample from an unknown distribution (Falkinger et al 2000). The drawnorm command in STATA runs a simulation of the model by taking random draws from a normal distribution with a given correlational structure (STATA 2009). By taking draws from the normal distribution and constructing 500 estimates of mWTP and Mθ's we have more accurate estimates and reduce the uncertainty from individual estimates (Haab and McConnell, 2002). We calculate the confidence intervals for each restoration activity by using a 95% range of the bootstrap sample mean willingness-to-pay estimates.[36] Estimates for WTP, mWTP and Mθ are displayed in Table 22 (a-c) below, based on equations (27) – (30). In addition, the lower bound (LB) and upper bound (UB) confidence intervals on the estimates are shown. Figures 9 (a) – (c) are a graphical depiction of table 22 for each individual restoration activity.

Table 22a: Birds -WTP, mWTP and Mθ Estimates and Confidence Intervals

		Units			
Birds - Estimates (by Treatment)		**1**	**2**	**3**	**4**
WTP (CE^R)		75.59	115.67	139.11	155.75
mWTP (CE^R)		75.59	40.08	23.45	16.63
Mθ (IPA)		60.69	43.21	32.72	25.72
Birds – 95% Confidence Intervals					
mWTP (CE^R)	(LB)	48.09	32.73	19.45	13.76
	(UB)	120.39	86.14	51.18	36.20
Mθ (IPA)	(LB)	56.76	40.71	30.25	22.39
	(UB)	64.49	45.72	35.62	28.68

[36] The regression models provide a single point estimate. We calculate error bounds around the point estimate using a Krinsky Robb approach. This approach uses the estimated beta's from the WTP model as the mean-vector for a multivariate normal distribution, and uses the regression's estimated variance-covariance matrix as the multivariate sigma. Drawing 500 sets of estimated beta's, the Krinsky Robb approach then uses these beta'sto produce point estimates of mWTP and we use these 500 estimates of mWTP to find the 97.5th percentile and 2.5th percentile to produce the 95% confidence interval for mWTP displayed in tables 22 (a) – (c).

Table 22b: Seagrass -WTP, mWTP and Mθ Estimates and Confidence Intervals

		Units			
Seagrass - Estimates (by Treatment)		**1**	**2**	**3**	**4**
WTP (CE^R)		70.71	148.62	194.20	226.54
mWTP (CE^R)		70.71	77.92	45.58	32.34
Mθ (IPA)		63.67	43.51	31.71	23.34
Seagrass – 95% Confidence Intervals					
mWTP (CE^R)	(LB)	42.04	47.23	28.06	19.85
	(UB)	110.33	121.08	71.94	50.89
Mθ (IPA)	(LB)	59.63	41.04	29.12	19.98
	(UB)	68.6	45.97	34.51	26.83

Table 22c: Clams -WTP, mWTP and Mθ Estimates and Confidence Intervals

		Units			
Clams - Estimates (by Treatment)		**1**	**2**	**3**	**4**
WTP (CE^R)		153.82	183.18	200.35	212.54
mWTP (CE^R)		153.82	29.36	17.17	12.18
Mθ (IPA)		66.40	48.16	37.49	29.92
Clams – 95% Confidence Intervals					
mWTP (CE^R)	(LB)	102.52	6.05	3.6	2.54
	(UB)	234.42	54.29	32.26	22.82
Mθ (IPA)	(LB)	61.83	44.83	34.05	25.8
	(UB)	71.08	51.17	40.72	34.12

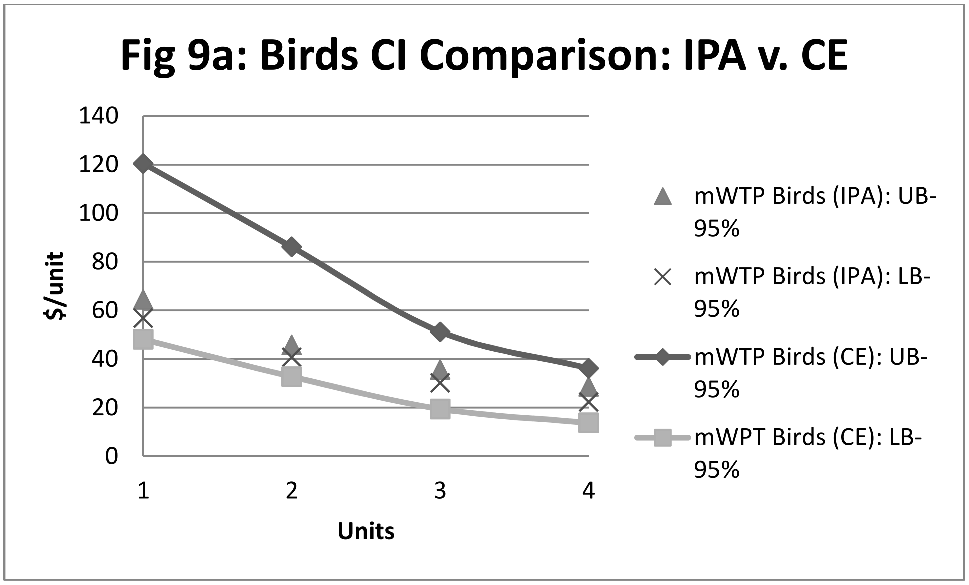


Fig 9a: Birds CI Comparison: IPA v. CE
140
120
100
80
60
40
20
0
$/unit
1
2
3
4
Units
mWTP Birds (IPA): UB-95%
mWTP Birds (IPA): LB-95%
mWTP Birds (CE): UB-95%
mWPT Birds (CE): LB-95%

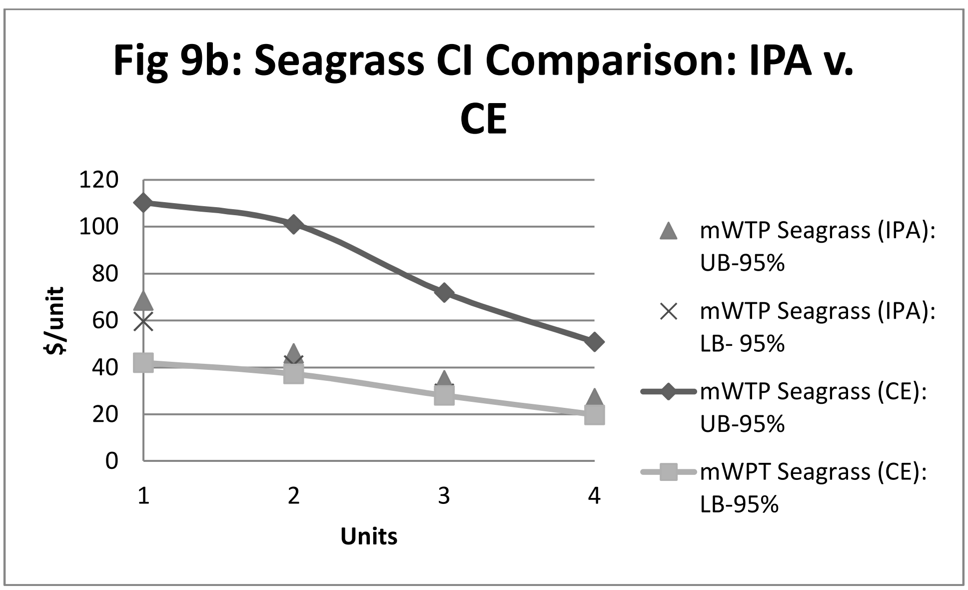


Fig 9b: Seagrass CI Comparison: IPA v. CE
120
100
80
60
40
20
0
$/unit
1
2
3
4
Units
mWTP Seagrass (IPA): UB-95%
mWTP Seagrass (IPA): LB- 95%
mWTP Seagrass (CE): UB-95%
mWPT Seagrass (CE): LB-95%

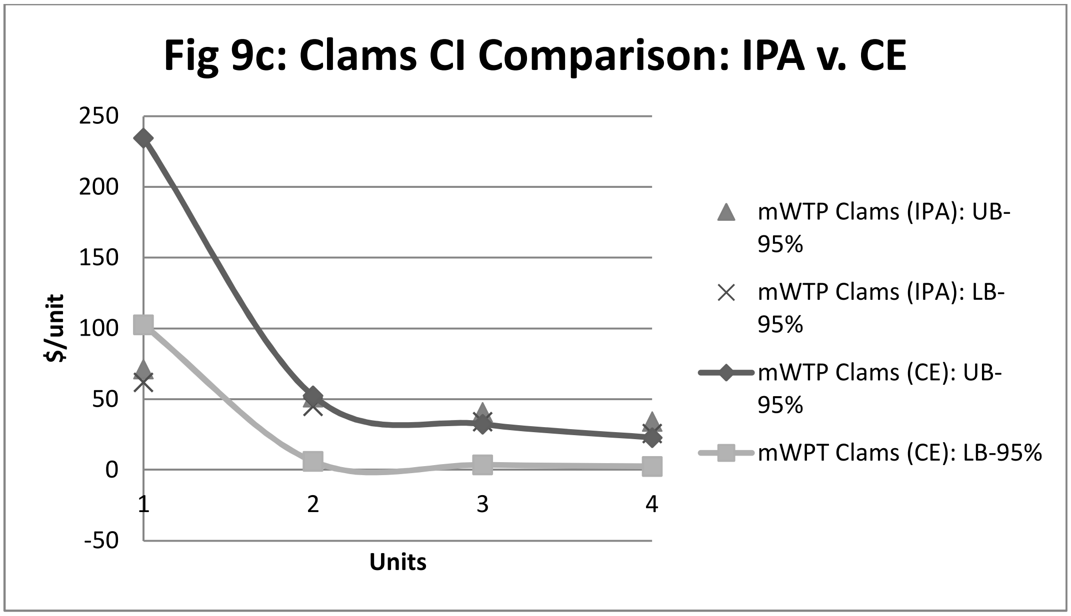


Fig 9c: Clams CI Comparison: IPA v. CE
250
200
150
100
50
0
-50
$/unit
1
2
3
4
Units
mWTP Clams (IPA): UB-95%
mWTP Clams (IPA): LB-95%
mWTP Clams (CE): UB-95%
mWPT Clams (CE): LB-95%

5.6 Discussion

This chapter is an extension of chapter 4. We pool the data across both years (2008 and 2009) to construct estimates of WTP then derived to mWTP from the CE^R and marginal offers under the IPA. The question we examine is if the marginal offers, Mθ, from the IPA are equal to the (full Hicksian value) mWTP from the incentive compatible CE^R.

WTP, mWTP and mθ

Estimates under the CE^R approach use all the data from 2009 and the subset of data from 2008.[37] Table 19 presents the regression results that indicate participants did reveal support for higher quantities (e.g., more acres) of ecosystem restoration as estimated using a conditional logit model. In addition WTP estimates constructed from the CE^R data indicate some differences across the restoration activities (Figure 7), specifically the first units of clam restoration. Without further testing we are unable to say precisely why WTP for clam restoration is so much larger than other initial restoration, although our presentation of clam habitat restoration is tied to water quality improvements, which is an ongoing issue on the Eastern Shore.[38]

From the results of the interval regression on IPA data (table 21), offers on marginal units are consistent with decreasing marginal benefits and it appears there are minimal

[37] The latent class model allowed us to split the 2008 CE^R data into two groups. The group that did not give money away was retained and combined with the 2009 data.
[38] We note that water quality on the Atlantic side, where restoration was performed, is such that additional filtration isn't at the same critical level as on the Chesapeake side, yet water quality remains an important issue for citizens on the entire Eastern Shore.

differences on the estimates across the restoration activities in the pooled data. Figure 8 is a graphical representation, including point estimates, on infra-marginal units of corresponding Mθ estimates from the IPA, which also depicts little difference in marginal offers across restoration activities.

Comparison of IPA to CE

If the IPA is producing offers that are a good approximation to Hicksian value at the margin, and if the choice framework is generating estimates of value under conditions of incentive-compatibility, then our null hypothesis 1 is that the Mθ estimates from the individualized price model should equal mWTP estimates from the choice model. We examine the confidence intervals constructed (table 22 a-c) for both the CE^R and the IPA to determine if our results suggest IPA offers are estimating within the 95% of CE^R. Figures 9a - 9c depict this comparison graphically between the IPA and CE^R estimates for each restoration activity.

Table 22 (a-c) summarizes the estimates from both utility models, including confidence intervals constructed under the Krinsky-Robb approach (Haab and McConnell 2002). IPA estimates in table 21 are specific to the **PR** mechanism with 4 unit treatments from both 2008 and 2009. Given the range of units participants made decisions on under the CE^R (no more than 4 units of any given restoration activity), we decided to use only this subset of the IPA data. Table 22 in conjunction with figures 9 (a) – (c), allow us to compare estimates from IPA and CE^R in order to answer hypothesis 1.

We note the wide confidence intervals estimated under the CE^R. Figures 9a and 9b are the comparisons for bird and seagrass habitat restoration respectively. Both bird and seagrass estimates under the IPA fall within the CE^R estimates, close to the lower bound. As noted earlier, the IPA estimates are constructed from **PR-4** unit treatments in 2008 and 2009, yet positive significant coefficient estimates in Table 21 on the **PR-CON** and PR-8 unit treatments will drive the IPA estimates up. The clam restoration estimates under the IPA depicted in figure 9c are somewhat different – first unit IPA estimates do not fall within the CE^R confidence intervals and IPA estimates for units 2-4 are at the top of the CE^R range. Since clam restoration was not used in 2009, there are fewer observations for the clam restoration estimates. We also note that 2009 **PR-4** mean offers were lower than 2008 on the initial unit (table 18). Neither the decreased number of observations nor the decreased mean offers in table 18 provide further clarification as to why the estimates do not fall within range.

Nevertheless, the results presented here suggest that we are unable to reject null hypothesis 1, that the marginal estimates from the IPA are producing offers that are equivalent to the mWTP estimates from the choice model

Overall, the CE^R approach may encourage participants to think more clearly about tradeoffs between the available restoration activities. This conjecture has been advanced by practitioners of stated-preference valuation based on choice experiments because the simultaneous presentation of a choice among bundles of several attributes naturally emphasizes the possible tradeoffs (see Adamowicz et al. 1998). In contrast, the IPA approach focuses attention solely on a single habitat type, one unit at a time. This focus may limit, or make less likely, the consideration of alternative conservation options available for participants. In the design of our experiment, we assumed that the choice exercise might sharpen the participants' attention to the possibility of alternative conservation options, and our introductory presentation and instructions to participants did include reminders that money not spent through the experimental exercises could be used for other purposes at home, including possible donations to conservation organizations. However, the experimental design and presentation did not establish an obvious, facilitated opportunity to make donations to conservation free of transaction costs (participants would have needed to make that decision and take action at home). These factors could be related to the unexpected result that the IPA estimates for clams tended to generate mWTP values at the very top of the confidence interval range generated from the choice approach, that were anticipated to establish the theoretical (estimated) upper limit of value.

As the results presented here suggest that we are unable to reject null hypothesis 1, that the marginal estimates from the IPA are producing offers that are equivalent to the mWTP estimates from the choice model. This research is a first step to show that Lindahl’s theory of marginal benefit pricing should not be dismissed as a practical approach to provide public goods.

CHAPTER 6 – CONCLUDING REMARKS

These first results with a Lindahl-inspired auction suggest it may be feasible, as a practical if not theoretically ideal approach, to use an auction process to enable revenue-generation for public goods. Here we identify just a few areas for future research or caveats.

This body of research sets out to develop a new process to measure consumers' value and provide public goods, motivated by an ongoing challenge faced by economists and policy-makers and others, regarding how to link the value of public goods (such as ecosystem services) to people and integrate these values into the economy. Since providers are unable to exclude beneficiaries who do not pay for the cost of provision, there exists the opportunity for individuals to "free ride" on those who do pay. The non-excludable nature of public goods generates a need to find better approaches for determining the appropriate level of production while simultaneously setting a price (or set of prices) that will lead to provision of the good. If information is obtained that accurately represents how much a group values a particular public good (or set of public goods), a level of provision can be established that accurately reflects how much members of society value them.

Lindahl's dissertation work presented an approach to price public goods, based on an individuals' marginal payment being equal to the marginal benefit they receive from provision of the last unit of the good. These individualized prices are summed and then balanced against the cost of delivery, such that the level of the public good is at a

Pareto optimal level if each individual reveals their full marginal benefit. Balancing the sum of these payments against the cost of delivery, at the margin, establishes one level of the good with many individualized prices. Economists in recent decades, noting the useful characteristics of Lindahl's theoretical approach, regarded the potential of gathering such individualized prices and translating them into revenues as near impossible. We use Lindahl's approach, integrated with recent advancements in the experimental literature, to explore ways to gather individual willingness to pay and provide public goods.

We review the goals we set out at the beginning of this research project. 1) To establish an individualized-price experimental auction scenario, grounded in Lindahl's theory of marginal benefit pricing for public goods; specifically to evaluate if the individualized pricing experimental auction can, in practice, mitigate free-riding or cheap-riding. 2) To establish an incentive compatible scenario that evaluates the Hicksian willingness-to-pay for alternative ecosystem restoration activities to compare to the individualized pricing experimental auction.

Consistent with our first goal, chapter 3 introduces a new framework to enable consumers to express their value for public goods through an experimental auction mechanism that gathers offers at multiple points linked to an individuals' marginal valuation curve, the IPA. Building on incentive mechanisms from the experimental economics literature, we test the feasibility of the IPA, where feasibility is assessed relative to the ability of the IPA to produce marginal offers consistent with an individuals' full marginal value. While we are unable to formally prove a Nash equilibria generally occurs where the IPA settles (where the auction settles on provision of n* units), this auction successfully provided multiple units. Results indicate that participants are making offers consistent with decreasing marginal benefits from each additional unit of the public good. While marginal offers are not equal to marginal benefits on all units, the IPA does perform consistently and better than many public good experiments seen in the literature, based on, for example, a comparison of the average proportion of induced value offered on (the first) unit of a public good in the IPA as compared to that proportion in a one-shot, single-unit induced-value experiment. This outcome is not at all anticipated by the consensus in economic literature that Lindahl's suggestion is impractical.

In chapter three we also explore the trade-offs an individual is balancing within the IPA framework. Equation (6) shows the marginal cost of raising an individual offer is balanced against the marginal benefits they may receive from this decision. The participant's individual decision-making strategy would, in principle, consider the impact of a given units' decision on the opportunity for benefits from successive units, since no provision is possible if the group's offers are not large enough to pay for the first units. The trade-offs imposed by the design of the IPA impede the usual incentives to free-ride and to earn additional surplus. Thus, free riding behavior is not necessarily the dominant strategy under the IPA.

In order to accomplish our second goal, we do a field test of our IPA, introduced in chapters 4 and 5. Our IPA approach generates offers on incremental units of the public good, at the margin. We evaluate the marginal offers under the IPA framework for incremental levels of the public good, using econometrics to estimate our specified function relative to marginal changes in provision. We evaluate the offers from an incentive compatible CE^R approach and the IPA to assess estimates of Mθ against true mWTP. The CE^R provides estimates of WTP, which we can then compare, at the margin, to the offers (Mθ) from the IPA. This allows us to measure how the IPA is operating in terms of its effectiveness at generating offers consistent with mWTP. Figures 9a – c are a graphical representation of the comparison between Mθ and mWTP; the results suggest that the marginal offers under the IPA are close to estimated mWTP from CE^R involving real choices in an incentive compatible setting. We conclude that the IPA may be viewed as promising as a practical approach to identifying Lindahl's individual, marginal-benefit prices.

Shortcomings

There are short-comings to this research. One limitation to the application of the IPA framework is with public goods that have high fixed upfront costs that may prevent provision of initial units. In such a case, an initial subsidy may be applied, assuming decreasing marginal costs, to provide first or early units.[39] Secondly, the application of this research is specific to local public goods and while we see this extension as an

[39] Indeed, our field experiment likely would have been impossible if The Nature Conservancy and scientists of the Virginia Coastal Reserve NSF/LTER site had not already invested in seawater tanks and holding facilities to manage seagrass seeds between harvest in spring and distribution for restoration in fall. That fixed investment enabled our provision point to be only $600 per half-acre, to defray marginal costs.

obvious first step there could be a next step that includes a test of the IPA that extends the application to incremental units of a non-local public good.

Next steps

There are several interesting questions that resulted from the research to date. First, under the current laboratory design, marginal benefits are identical in small (4) and large (8) unit treatments, in order to test the impact that the maximum number of units had on marginal offers, and marginal cost is constant. This design led to a Pareto optimal outcome under the large unit treatments, if all participants were to offer exactly their marginal benefit on the 8^{th} unit. The side effect of this design was that participants only had to offer a percentage (33%) of their marginal benefit in order to have all (4) units provided in the small unit treatments, thus resulting in provision of all units in every 4-unit treatment in our laboratory experiments. We expect future designs of the IPA to test the role of the magnitude of MB's (and MSB's) relative to the marginal cost in terms of driving participants to make offers that more fully reflect their MB.

Second, due to budget constraints all laboratory treatments had the same marginal benefits or induced values. The constant marginal benefits allowed us to compare the marginal offers under different incentive treatments to determine if the rules impact decision-making, but we were unable to test if the range of the marginal benefits ($3 to $47) in the laboratory treatments had an effect on marginal offers. While the marginal offers as a percentage of marginal benefit suggest very high demand revelation, data inspection reveals the range around the mean may need further testing. Increasing the induced values, such as by 100%, would allow a larger range of responses and a more accurate test of whether marginal offers are reflective of marginal benefit.

The tests of the IPA done here we retain homogenous values for the MB's in all laboratory treatments. Further tests may include an expanded test of differences in the MB's. One test may include, a case where average MB's may stay the same, ranging from $43 - $3, but the group is split so that a percentage of people have values 20% higher than the current values and a second sub-group has values 20% lower than the current values. Heterogeneous values are frequently used in laboratory experiments and are more likely to represent the range of values in a field setting (e.g. we do not expect that values are homogenous in our field tests), but to date we have not attempted to identify these with the available sample.[40]

Overall this body of research contributes to the public good literature in a manner that could have a meaningful effect on non-profits, government entities and entrepreneurs that may see an opportunity to make profits from, or have a greater impact on, the actual provision of (local) public goods. Results and insights into such preferences, valuations, and revenue-generating mechanisms are potentially useful for private enterprises looking to establish new markets, philanthropic organizations who regularly solicit voluntary contributions from the public, and policy makers looking to establish a better balance between the public value of environmental quality, the

[40] Except with our use of the latent class model

alternative uses of environmental resources, and opportunities for private, entrepreneurial success.

APPENDIX A: PROOF OF PARETO OPTIMALITY

Lindahl's equilibrium establishes a Pareto optimal level of the public good with individualized prices. The Pareto optimal level of provision occurs when the sum of the marginal rates of substitution (MRS) equals the marginal rate of transformation (MRT) (Greene and Henscher 2003). We show the Lindahl equilibrium is Pareto optimal in the proof below.

We assume a 2 person world with a single public good and all other goods. The public good's full price (full marginal cost) is P_{public} and the price of all other goods is $P_{AOG.}$ Person 1 does not know the cost of the public good, only her percentage of cost in equilibrium, identified as θ. Person 2 then pays the remaining percentage, 1- θ. Assuming Person 1 maximizes her utility, she chooses a bundle where

(1) $\frac{\theta * P_{public}}{P_{AOG}} = MRS_1.$

Person 2 chooses

(2) $\frac{(1-\theta) * P_{public}}{P_{AOG}} = MRS_2.$

In a competitive equilibrium the marginal cost ratio is equal to the marginal rate of transformation, such that

(3) $\frac{MC_{public}}{MC_{AOG}} = \frac{P_{public}}{P_{AOG}} = MRT$

In order to show the Lindahl equilibrium is Pareto optimal, $MRS_1 + MRS_2 = MRT$, we use equations 1, 2 and 3,

(4) $MRS_1 + MRS_2 = \frac{\theta * P_{public}}{P_{AOG}} + \frac{(1-\theta) * P_{public}}{P_{AOG}}$

$$= \frac{\theta * P_{public} - \theta * P_{public} + 1 * P_{public}}{P_{AOG}}$$

$$= \frac{P_{public}}{P_{AOG}}$$

= MRT

APPENDIX B: FIELD EXPERIMENT – THE DESIGN PROCESS

This appendix provides design information and further background on econometrics and modeling of the 2008 and 2009 field experiments.

1. *Preliminary 2008 CE^R Results used to influence 2009 design*

We note the positive significant coefficient on *Rmoney* which led us to estimate a latent class model to determine if there were sub-sections within our population.

Table 23. Preliminary Results for Year 1 (2008) - CE^R

basic linear results, n=794

Restoration activity	Coefficient	Standard Error	Significance Level
Birds	0.653	(0.108)	***
Clams	0.658	(0.135)	***
Seagrass	0.669	(0.145)	***
Rmoney	0.007	(0.003)	**

** indicates significance at the 90% level, *** indicates significance at the 95% level

2. ***Orthogonal Design:***

The following two tables more fully explain how we used the orthogonal design process to execute the set of choice questions that were used for both groups (A & B) in the 2008 field experiment. Each restoration activity and the participants' cost had four possible levels. Group's A and B each had their own set of cost percentages, allowing us to collect a wider range of data. Additionally, there were two different possible budgets that were provided to participants, $90 or $120. If a participant received a $90 budget for section I questions, then they would receive a $120 budget for section II, or vice versa.

Table 24a: 2008, SAS Design Levels, Section's I and II–Group A

SAS Level Design	Acreage total cost – BIRDS	Acreage total cost CLAMS	Acreage total cost – SEAGRASS	Percent of Budget to Pay	Percent of Budget = $90	Percent of Budget = $120
1	1200	0	1800	0.95	85.50	114.00
2	600	600	1200	0.6	54.00	72.00
3	0	1200	600	0.45	40.50	54.00
4	1800	1800	0	0.2	18.00	24.00

Table 24b: 2008, SAS Design Levels, Section's I and II –Group B

SAS Level Design	Acreage total cost – BIRDS	Acreage total cost - CLAMS	Acreage total cost – SEAGRASS	Percent of Budget to Pay	Percent of Budget = $90	Percent of Budget = $120
1	1200	0	1800	0.8	72	96
2	600	600	1200	1	90	120
3	0	1200	600	0.25	22.5	30
4	1800	1800	0	0.55	49.5	66

<u>*Design Process Continued*</u>

An example of the data is displayed below (Table 24) to help illustrate orthogonal design. Table 24 contains data for 8 participants, 4 from group A and 4 from group B. Data for a single question a participant faces is displayed in two rows, where the first row displays the acreage and costs for bundle A and the second line displays the acreage and costs for bundle B. For any given question, participants faced the same combination of restoration activities (columns F-H), with a different cost for restoration (column I). The orthogonal design provided four different levels, thus four different versions of a question, differing through the cost to restoration. Table 24 also displays that question 1 for group A was identical to question 8 for group B. This was to test for an ordering effect.[41]

Table 24: Example of 2008 CE^R data for participants in Groups A and B

Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J
Group	**Question**	**ID**	**Budget**	**Bndl**	**Birds**	**Clams**	**Seagrass**	**Restoration Cost**	**Cash**
A	1	1	120	A	3	2	1	72	48
A	1	1	120	B	1	0	3	54	66
A	1	2	90	A	3	2	1	54	36
A	1	2	90	B	1	0	3	40.5	49.5
A	1	3	120	A	3	2	1	120	0
A	1	3	120	B	1	0	3	30	90
A	1	4	90	A	3	2	1	90	0
A	1	4	90	B	1	0	3	22.5	67.5
B	8	25	90	A	3	2	1	54	36
B	8	25	90	B	1	0	3	40.5	49.5
B	8	26	120	A	3	2	1	72	48
B	8	26	120	B	1	0	3	54	66
B	8	27	90	A	3	2	1	90	0
B	8	27	90	B	1	0	3	22.5	67.5
B	8	28	120	A	3	2	1	120	0
B	8	28	120	B	1	0	3	30	90

[41] Results indicate there was no ordering effect due to the sequence of the choice questions

3. *Details of Factory Analysis on Discrete Attitudinal Statements about Restoration Issues.*

The 2009 field experiment included a section to gather individual's opinions and attitudes towards various local ecosystem restoration issues for use in the joint choice/latent class model (Boxall and Adamowicz 2002). Participants stated their agreement on a scale of 1 through 5, from Strongly Agree to Strongly Disagree on eleven questions. In addition, six questions from the demographic section were used to construct three indices of restoration attitudes using a principal components factor analysis, varimax rotation. Following Kline and Wichelns (1998), Boxall and Adamowicz (2002) three factors were retained with Eigen values greater than one, providing the following variables to use in our latent class analysis – ProPsrv, ProLoc, ProUse.

Factor one, Pro- Preservation (ProPsrv) has significant factor loadings on statements concerning restoration of both, sea-grass and bird habitat restoration, the activities included in the choice bundles. It also loads high on those who identified with preserving the environment for future generations. Bird watchers and those that want access to fishing in the area are identified in factor two, Pro-Local (ProLoc). In factor three, Pro-Use (ProUse), there are high factor loadings on several activities that rely on restrictions to enable usage, such as commercial fishing and recreational hunting, as well as on a need for environmentally sensitive areas to be restricted.

Table 26: Variables used in Factor Analysis and LCM, 2008 CE^R (Field)			
Variables[42]	**ProPreservation**	**ProLoc**	**ProUse**
FishHab	**0.7205**	0.1959	0.0011
SgRestr	**0.8270**	-0.0948	0.0584
SgH20Qty	**0.8223**	0.1181	-0.1683
Prsrve	0.5393	0.3894	-0.2271
BdWatch	0.5479	-0.5521	0.2590
HabRestr	0.5173	-0.3433	-0.4091
HabH20Qty	**0.8169**	0.0150	-0.0065
FutGen	**0.6417**	0.0849	0.2651
Fish	0.2787	**0.6648**	-0.1285
Restrict	0.4357	-0.0873	**0.5255**
LocBenefit	0.2648	-0.1126	-0.5583
RecFish	-0.1065	-0.8371	0.1178
ComFish	-0.0999	-0.2660	**0.7845**
Bdwatr	-0.1004	**0.7051**	0.0611
RecHunt	-0.1716	-0.1799	**0.6163**
OysGdn	0.3719	0.0555	**0.5629**
EnvDon	-0.0477	0.4371	0.4563
Scale variables for questions 1-11: 1=Strongly Agree, 5=Strongly Disagree. Scale variables for questions 12-17: 1=Identify with this statement, 0 otherwise. Total variance explained by these factors 55.80%			

[42] Full statements can be found in appendix D

4. Latent Class Model (LCM) Analysis

Results from the latent class analysis used on the 2008 CE^R data indicated we could split the 2008 participant group into two subsets, as indicated in table X below. We focus our attention on the *RMoney* coefficients across the two classes, where the sign of *RMoney* is negative in class one and positive in class two. This LCM is used to pool the 2008 participants associated with class one with the 2009 participants for our analysis.

Table 27: Latent Class Estimation Results, 3 Class Model: 2008 CE^R Data

		Class One			**Class Two**	
Variables	**Coefficient**	**(SE)**	**P <**	**Coefficient**	**(SE)**	**P <**
RMoney	-0.0106	(0.0049)	0.0301	0.0360	(0.0046)	0.0001
Birds	1.0796	(0.1715)	0.0001	0.3032	(0.1600)	0.0580
Clams	1.0865	(0.2051)	0.0001	0.4566	(0.2282)	0.0450
Seagrass	0.9431	(0.2041)	0.0001	0.6066	(0.2239)	0.0067
	Class Probability Model One			**Class Probability Model Two**		
Constant	0.9452	(1.7350)	0.0827	0		
ProPreserv	1.6320	(0.9485)	0.0854	0		
ProLoc	0.8081	(0.6161)	0.1897	0		
ProUse	0.9431	(0.4173)	0.4052	0		
Average Class Probabilities:						
0.625				0.375		

Log likelihood: -207.8054
Number of Parameters: 12
Number of Observations: 397*
* 50 people x 8 questions each, equals 400 observations. Participant 1 did not answer questions 4-6

5. Variables

Table 28: All Variable Definitions, CE and IPA models
Dependent Variable: *Choice* Independent Variables: - *RMoney*: Cost to participant of a specific bundle of restoration (values: 0-120) - *Birds:* Half acres of bird habitat restoration (values: 0-4) - *Birds^2:* Squared half acres of bird habitat restoration (values: 0-16) - *LnBirds:* Natural log of half acres of bird habitat restoration (values: 0-1.3863) - ***D****BirdsZero:* Dummy variable that identifies if there are zero half acres of bird habitat restoration, used in conjunction with LN model (values: 0/1) - *Seagrass:* Half acres of seagrass habitat restoration (values: 0-4) - *Seagrass^2* :Squared half acres of seagrass habitat restoration (values: 0-16) - *Lnseagrass:* Natural log of half acres of seagrass habitat restoration (values: 0-1.3863) - D*SeagrassZero:* Dummy variable that identifies if there are zero half acres of seagrass habitat restoration, used in conjunction with LN model (values: 0/1) - *Clams*: Half acres of clam habitat restoration (values: 0-4) - *Clams^2* :Squared half acres of clam habitat restoration (values: 0-16) - *LnClams:* Natural log of half acres of clam habitat restoration (values: 0-1.3863) - *DClamZero:* Dummy variable that identifies if there are zero half acres of clam habitat restoration, used in conjunction with LN model (values: 0/1) - *BSGC^3:* Cubed half acres of all restoration, birds+seagrass+clam (values: 0-343) *total additive bundle max = 7
- *Fem:* Dummy variable for sex of participant, where female equals one (value: 0/1) - *Age:* Participants age (value: 18-81) - *Resyrs:* Numbers of years the participant has resided on the eastern shore (value: 0-81) - *Inclow:* Income less than $40,000 (value: 0/1) - *Inchigh:* Income greater than $50,000 (value: 0/1) - *HS:* Education level, high school or less (value: 0/1) - *MS:* Education level, master's degree or higher (value: 0/1)
- *LnBirdFem:* Interaction variable between natural log of bird units and sex - *LnBirdAge:* Interaction variable between natural log of bird units and age - *LnBirdResyrs:* Interaction variable between natural log of bird units and resident years - *LnBirdInclow:* Interaction variable between natural log of bird units and low income participants

- *LnBirdInchigh:* Interaction variable between natural log of bird units and high income participants
- *LnBirdHS:* Interaction variable between natural log of bird units and participants with a high school diploma or less education
- *LnBirdMS:* Interaction variable between natural log of bird units and participants with a masters degree or more education
- *LnSGFem:* Interaction variable between natural log of seagrass units and sex
- *LnSGAge:* Interaction variable between natural log of seagrass units and age
- *LnSGResyrs:* Interaction variable between natural log of seagrass units and resident years
- *LnSGInclow:* Interaction variable between natural log of seagrass units and low income participants
- *LnSGInchigh:* Interaction variable between natural log of seagrass units and high income participants
- *LnSGHS:* Interaction variable between natural log of seagrass units and participants with a high school diploma or less education
- *LnSGMS:* Interaction variable between natural log of seagrass units and participants with a masters degree or more education
- *LnClamFem:* Interaction variable between natural log of clam units and sex
- *LnClamAge:* Interaction variable between natural log of clam units and age
- *LnClamResyrs:* Interaction variable between natural log of clam units and resident years
- *LnClamInclow:* Interaction variable between natural log of clam units and low income participants
- *LnClamInchigh:* Interaction variable between natural log of clam units and high income participants
- *LnClamHS:* Interaction variable between natural log of clam units and participants with a high school diploma or less education
- *LnClamMS:* Interaction variable between natural log of clam units and participants with a masters degree or more education
- -----------------
- *DLnBirdFem:* Interaction variable between dummy variable indicating zero natural log of bird units and sex
- *DLnBirdAge:* Interaction variable between dummy variable indicating zero natural log of bird units and age
- *DLnBirdResyrs:* Interaction variable between dummy variable indicating zero natural log of bird units and resident years
- *DLnBirdInclow:* Interaction variable between dummy variable indicating zero natural log of bird units and low income participants
- *DLnBirdInchigh:* Interaction variable between dummy variable indicating zero

natural log of bird units and high income participants

- *DLnBirdHS:* Interaction variable between dummy variable indicating zero natural log of bird units and participants with a high school diploma or less education
- *DLnBirdMS:* Interaction variable between dummy variable indicating zero natural log of bird units and participants with a masters degree or more education
- *DLnSGFem:* Interaction variable between dummy variable indicating zero natural log of seagrass units and sex
- *DLnSGAge:* Interaction variable between dummy variable indicating zero natural log of seagrass units and age
- *DLnSGResyrs:* Interaction variable between dummy variable indicating zero natural log of seagrass units and resident years
- *DLnSGInclow:* Interaction variable between dummy variable indicating zero natural log of seagrass units and low income participants
- *DLnSGInchigh:* Interaction variable between dummy variable indicating zero natural log of seagrass units and high income participants
- *DLnSGHS:* Interaction variable between dummy variable indicating zero natural log of seagrass units and participants with a high school diploma or less education
- *DLnSGMS:* Interaction variable between dummy variable indicating zero natural log of seagrass units and participants with a masters degree or more education
- *DLnClamFem:* Interaction variable between dummy variable indicating zero natural log of clam units and sex
- *DLnClamAge:* Interaction variable between dummy variable indicating zero natural log of clam units and age
- *DLnClamResyrs:* Interaction variable between dummy variable indicating zero natural log of clam units and resident years
- *DLnClamInclow:* Interaction variable between dummy variable indicating zero natural log of clam units and low income participants
- *DLnClamInchigh:* Interaction variable between dummy variable indicating zero natural log of clam units and high income participants
- *DLnClamHS:* Interaction variable between dummy variable indicating zero natural log of clam units and participants with a high school diploma or less education
- *DLnClamMS:* Interaction variable between dummy variable indicating zero natural log of clam units and participants with a masters degree or more education

6. Models

Equations (X) – (Y) present the unrestricted forms of the CE^{R} models (equations 15-17) written out long form without any vector notation.

(15)* Unrestricted form of Model 1:* $Choice = \beta_{0} + \beta_{1}Rmoney + \beta_{2}Seagrass + \beta_{3}Birds + \beta_{4}Clams + \beta_{9}BirdFem + \beta_{10}BirdAge + \beta_{11}BirdResyrs + \beta_{12}BirdInclow + \beta_{13}BirdInchigh + \beta_{14}BirdHS + \beta_{15}BirdMS + \beta_{16}SGFem + \beta_{17}SGAge + \beta_{18}SGResyrs + \beta_{19}SGInclow + \beta_{20}SGInchigh + \beta_{21}SGHS + \beta_{22}SGMS + \beta_{23}ClamFem + \beta_{24}ClamAge + \beta_{25}ClamResyrs + \beta_{26}ClamOwn + \beta_{27}ClamInclow + \beta_{28}ClamInchigh + \beta_{29}ClamHS + \beta_{30}ClmMS$

(16) **Unrestricted form of Model 2***:* $Choice = \beta_{0} + \beta_{1}Rmoney + \beta_{2}LnSeagrass + \beta_{3}LnBirds + \beta_{4}LnClams + \beta_{5}LnBirdFem + \beta_{6}LnBirdAge + \beta_{7}LnBirdResyrs + \beta_{8}LnBirdInclow + \beta_{9}LnBirdInchigh + \beta_{10}LnBirdHS + \beta_{11}LnBirdMS + \beta_{12}LnSGFem + \beta_{13}LnSGAge + \beta_{14}LnSGResyrs + \beta_{15}LnSGInclow + \beta_{16}LnSGInchigh + \beta_{17}LnSGHS + \beta_{18}LnSGMS + \beta_{19}LnClamsFem \quad \beta_{20}LnClamsAge \quad \beta_{21}LnClamsResyrs \quad \beta_{22}LnClamsInclow \quad \beta_{23}LnClamsInchigh \quad \beta_{24}LnClamsHS \quad \beta_{25}LnClamsMS + \beta_{26}DSGZero + \beta_{27}DBirdsZero + \beta_{28}DClamsZero + \beta_{29}DLnBirdFem + \beta_{30}DLnBirdAge + \beta_{31}DLnBirdResyrs + \beta_{32}DLnBirdInclow + \beta_{33}DLnBirdInchigh + \beta_{34}DLnBirdHS + \beta_{35}DLnBirdMS + \beta_{36}DLnSGFem + \beta_{37}DLnSGAge + \beta_{38}DLnSGResyrs + \beta_{39}DLnSGInclow + \beta_{40}DLnSGInchigh + \beta_{41}DLnSGHS + \beta_{42}DLnSGMS + \beta_{43}DLnClamFem + \beta_{44}DLnClamAge + \beta_{45}DLnClamResyrs + \beta_{46}DLnClamInclow + \beta_{47}DLnClamInchigh + \beta_{48}DLnClamHS + \beta_{49}DLnClamMS$

(17)* Unrestricted form of Model 3:* $Choice = \beta_{0} + \beta_{1}Rmoney + \beta_{2}Seagrass + \beta_{3}Birds + \beta_{4}Clams + \beta_{5}Seagrass^{2} + \beta_{6}Birds^{2} + \beta_{7}Clams^{2} + \beta_{8}BSGC3 + \beta_{9}BirdFem + \beta_{10}BirdAge + \beta_{11}BirdResyrs + \beta_{12}BirdInclow + \beta_{13}BirdInchigh + \beta_{14}BirdHS + \beta_{15}BirdMS + \beta_{16}SGFem + \beta_{17}SGAge + \beta_{18}SGResyrs + \beta_{19}SGInclow + \beta_{20}SGInchigh + \beta_{21}SGHS + \beta_{22}SGMS + \beta_{23}ClamFem + \beta_{24}ClamAge + \beta_{25}ClamResyrs + \beta_{26}Clamown + \beta_{27}ClamInclow + \beta_{28}ClamInchigh + \beta_{29}ClamHS + \beta_{30}ClmMS$

APPENDIX C: LABORATORY EXPERIMENTS

C.0 Lab Experiment – General Instructions

This is an experiment in the economics of decision-making. You have already earned $5.00 for showing up at the appointed time. If you follow the instructions closely and make decisions carefully, you can substantially add to this total.

Overview

Today's experiment is composed of three Treatments, each consisting of multiple decision-making rounds with different rules. In each Treatment we will provide you with a budget of experimental dollars that you can keep or invest towards a public fund that provides a public good, which benefits many people at the same time. People benefit as follows: each of you is told how many experimental dollars you may earn based on the number of units of the public good that the public fund can provide –the more units of the good provided, the more you could potentially earn. The number of units provided depends on your decision to invest in this fund AND those decisions of the other people in your group. Thus, earnings in each Treatment are based on how much you are willing to invest to provide each unit, how much you earn (your benefits) if the good is provided and the investment decisions of the others in your group.

Earnings

During the experiment you will be earning money (your benefits) in experimental dollars. The money you earn will be your "profit" from the decisions made today. These experimental dollars will be converted into real dollars at the end of the experiment, using an exchange rate of $1:4 experimental dollars. Your budget and benefits are listed on your Experimental Worksheet (described below).

While you will answer questions in three different Treatments only one Treatment will be drawn randomly for implementation. At the end of the experiment we will randomly choose – in front of everyone – the Treatment, I, II or III, that will be the one from which your profit will be determined. This means that only one set of decisions will be evaluated by the project coordinator to determine your profit, but you will not know which Treatment until the experiment is complete. To earn the best profit in real dollars, you want to earn the highest amount of experimental dollars in all Treatments, so that you will have the best profit possible whichever Treatment is randomly chosen to be implemented.

Groups
Your group is important because the project coordinator will look at the combined decisions (i.e. offers) of each member of your group to determine the outcome in each Treatment. In this way, the decisions of every person in your group may impact your profit. While you know how much you stand to earn based on the value (benefits) given to you, you do not know how much other people in your group might earn based on the value (benefit) of each unit to them.

Timing & Communication
We will wait for every person to complete Treatment I before we move on to Treatment II, and so on. Please do not move ahead on your own. It is important that we go through the instructions together. Once Treatment I begins, you can complete each decision-making round on your own. When you are finished please turn your Experimental Worksheet for that Treatment over so it can be collected by the project coordinator.

There is no communication allowed between participants once we begin today. Since you are each provided with different information, it is important that you keep your information private. If you have any questions during the treatments, please raise your hand.

C.1 Lab Experiment – Proportional Rebate, PR(4)

Treatment I - PR

In this Treatment you will choose whether or not to invest money in the public fund and how much money to offer for 1, 2, 3 & 4 units of the good. You will make all your decisions upfront, before knowing how many units of the good can be provided by the group fund. You will consider the value (benefit) you will receive if various units are provided, which in turn affects the profit you stand to earn.

<u>Determining the outcome:</u>
For each number of units of the good, you will choose: a) whether or not you want to invest in the public fund to provide that unit and b) how many experimental dollars to offer. Since your offer combined with the offers of the other individuals in your group determine the level of the fund, and therefore the number of units provided, the project coordinator will begin by identifying if the fund is large enough to pay for the costs needed to implement a single unit of the good before moving on to evaluate whether the fund is large enough to pay for the second unit and so on. For each unit, only the offers of you and your group <u>*for that unit*</u> will determine whether the unit is provided. Offers you and others made on earlier units will not be considered in determining whether a particular unit is provided. The project coordinator considers the offers made for the second unit only if the first unit can be provided based on the offers for the first unit. Depending on the offers from all members of your group, the project coordinator will determine the highest number of units of the good that can be provided, for which the total of offers from the group is enough to pay the cost for the unit.

<u>How you make money:</u>
Your profit is calculated based on your offer for the last unit that is provided by your group, as follows: if the group offered more than enough to pay the cost of providing that last unit, then everyone's price for that unit will be less than (discounted from) their actual offer; the discount will equal the proportion of excess money in the total offered by the group. For example, if, for the last unit to be provided, X% of the money offered by your group is not needed, then your offer will be discounted X% and the result will be your 'personal price'. This personal price applies to all other units.

Profit = Your Budget + Total of your value (benefit) for the units provided – Your payment (which is your personal price x the number of units)

EXAMPLE
*You will not have to calculate these columns, they are only for discussion / explanation.

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Example Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	$20	$12	$12	$11.00	$11 (11 x 1)	**Y** / N	(3)	$8	$8 ($8 x 1)	$24 (20 + 12 – 8)
2	$20	$7	$19 (12 + 7)	$5.00	$10 (5 x 2)	**Y** / N	(2)	$3	$6 ($3 x 2)	$33 (20 + 19 – 6)
3	$20	$5	$24 (12 + 7 +5)	$3.00	$9 (3 x 3)	**Y** / N	(0)	$3	$9 ($3 x 3)	$35 (20 + 24 – 9)
4	$20	$3	$27 (12 + 7 +5 + 3)	$2.00	$8 (2 x 4)	Y / **N**	N/A	N/A	N/A	See Unit #3

QUIZ:

If you offered the total amount of your budget for unit 1 and it was the last unit provided with zero discount, how much profit would you earn?

____

If the group fund for the 3rd unit is less than the cost of providing unit #3 – how much money do you pay for the units provided (based on the table above)?

____

Treatment I (PR) EXPERIMENTAL WORKSHEET

Unit
 	
(A)
	Budget
	
	(B)
		Your Value (Benefit)
		
		(C)
			Total Benefit (based on # of units provided)
			
			(D)
				Your Offer (per unit) **(Today's Decision)**
				
				(E)
					Potential Total to Pay (based on # of units provided)
					
					(F)
					
					A x E
						Can the fund provide for the unit *
						
						(G)
							Actual Discount*
							
							(H)
								Your Personal Price*
								
								(I)
								
								E - H
									Your Actual Payment*
									
									(J)
									
									I x A
										Profit *
										If (G) is Yes, (B + D - J).
										
										If (G) is No, (B)

1	$100	$43	$43			Y / N				
2	$100	$27	$70 (43 + 27)			Y / N				
3	$100	$12	$82 (43 + 27 + 12)			Y / N				
4	$100	$9	$91 (43 + 27 + 12 + 9)			Y / N				

C.2 Lab Experiment – Proportional Rebate, PR(8)

Treatment II - PR

In this Treatment you will choose whether or not to invest money in the public fund and how much money to offer for 1, 2, 3…up to 8 units of the good. You will make all your decisions upfront, before knowing how many units of the good can be provided by the group fund. You will consider the value/benefit you will receive if various units are provided, which in turn affects the profit you stand to earn.

Determining the outcome:

For each number of units of the good, you will choose: a) whether or not you want to invest in the public fund to provide that unit and b) how many experimental dollars to offer. Since your offer combined with the offers of the other individuals in your group determine the level of the fund, and therefore the number of units provided, the project coordinator will begin by identifying if the fund is large enough to pay for the costs needed to implement a single unit of the good before moving on to evaluate whether the fund is large enough to pay for the second unit and so on. For each unit, only the offers of you and your group *for that unit* will determine whether the unit is provided. Offers you and others made on earlier units will not be considered in determining whether a particular unit is provided. For example, the project coordinator considers the offers made for the second unit only if the first unit can be provided based on the offers for the first unit. Depending on the offers from all members of your group, the project coordinator will determine the highest number of units of the good that can be provided, for which the total of offers from the group is enough to pay the cost for the unit.

How you make money:

Your profit is calculated based on your offer for the last unit that is provided by your group, as follows: if the group offered more than enough to pay the cost of providing that last unit, then everyone's price for that unit will be less than (discounted from) their actual offer; the discount will equal the proportion of excess money in the total offered by the group. For example, if, for the last unit to be provided, X% of the money offered by your group is not needed, then your offer will be discounted X% and the result will be your 'personal price'. This personal price applies to all other units.

Profit = Your Budget + Total of your value (benefit) for the units provided – Your payment (which is your personal price x the number of units)

EXAMPLE
* You will not have to calculate these columns, they are only for discussion / explanation

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Example Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	$20	$12	$12	$11.00	$11 (11 x 1)	**Y** / N	(3)	$8	$8 ($8 x 1)	$24 (20 + 12 – 8)
2	$20	$7	$19 (12 + 7)	$5.00	$10 (5 x 2)	**Y** / N	(2)	$3	$6 ($3 x 2)	$33 (20 + 19 – 6)
3	$20	$5	$24 (19 +5)	$3.00	$9 (3 x 3)	**Y** / N	(0)	$3	$9 ($3 x 3)	$35 (20 + 24 – 9)
4	$20	$3	$27 (24 + 3)	$2.00	$8 (2 x 4)	**Y** / N	(1)	$1	$4 ($1 x 4)	$43 (20 + 27 – 4)
5	$20	$3	$30 (27 + 3)	$4.00	$20 (4 x 5)	**Y** / N	(1.50)	$2.50	$12.50 ($2.50 x 5)	$37.50 (20 + 30 – 12.50)
6	$20	$2	$32 (30 + 2)	$2.00	$12 (2 x 6)	Y / **N**	N/A	N/A	N/A	See Unit #5
7	$20	$1	$33 (32 + 1)	$.50	$3.50 (.50 x 7)	Y / **N**	N/A	N/A	N/A	See Unit #5
8	$20	$1	$34 (33 + 1)	$0	$0 (0 x 8)	Y / **N**	N/A	N/A	N/A	See Unit #5

QUIZ:

Based on the information in the example above, what is the last unit provided? __________. How much was your offer? __________

How much do you actually pay per unit? ____________

Treatment II (PR.2) EXPERIMENTAL WORKSHEET

Unit
 	
(A)
	Budget
	
	(B)
		Your Value (Benefit)
		
		(C)
			Total Benefit (based on # of units provided)
			
			(D)
				Your Offer (per unit) **(Today's Decision)**
				
				(E)
					Potential Total to Pay (based on # of units provided)
					(F)
					
					A x E
						Can the fund provide for the unit *
						
						(G)
							Actual Discount*
							
							(H)
								Your Personal Price*
								
								(I)
								
								E - H
									Your Actual Payment*
									
									(J)
									
									I x A
										Profit *
										If (G) is Yes, (B + D - J).
										
										If (G) is No, (B)

1	$100	$43	$43			Y / N				
2	$100	$27	$70 (43 + 27)			Y / N				
3	$100	$12	$82 (70 + 12)			Y / N				
4	$100	$9	$91 (82 + 9)			Y / N				
5	$100	$7	$98 (91 + 7)			Y / N				
6	$100	$5	$103 (98 + 5)			Y / N				
7	$100	$4	$107 (103 + 4)			Y / N				
8	$100	$3	$110 (107 + 3)			Y / N				

* For project coordinator to fill in only

Treatment II (Cont)

Your Offers and Potential Total to Pay (Columns E and F) – Initial Offers

(column E) (column F)

Unit 1 Offer: ___________ / Potential Total to Pay: ___________

Unit 2 Offer: ___________ / Potential Total to Pay: ___________

Unit 3 Offer: ___________ / Potential Total to Pay: ___________

Unit 4 Offer: ___________ / Potential Total to Pay: ___________

Unit 5 Offer: ___________ / Potential Total to Pay: ___________

Unit 6 Offer: ___________ / Potential Total to Pay: ___________

Unit 7 Offer: ___________ / Potential Total to Pay: ___________

Unit 8 Offer: ___________ / Potential Total to Pay: ___________

C.3 Lab Experiment – Proportional Rebate with Known Revision, PR-KREV(8)

Treatment III.B - PR

In this Treatment you will choose whether or not to invest money in the public fund and how much money to offer for 1, 2..up to 8 units of the good. You will make all your decisions upfront, before knowing how many units of the good can be provided by the group fund. You will consider the value (benefit) you will receive if various units are provided, which in turn affects the profit you stand to earn. In this treatment there will be a *single opportunity to revise* your offers.

Determining the outcome:
For each number of units of the good, you will choose: a) whether or not you want to invest in the public fund to provide that unit and b) how many experimental dollars to offer. Since your offer combined with the offers of the other individuals in your group determine the level of the fund, and therefore the number of units provided, the project coordinator will begin by identifying if the fund is large enough to pay for the costs needed to implement a single unit of the good before moving on to evaluate whether the fund is large enough to pay for the second unit and so on. For each unit, only the offers of you and your group *for that unit* will determine whether the unit is provided. Offers you and others made on earlier units will not be considered in determining whether a particular unit is provided. The project coordinator considers the offers made for the second unit only if the first unit can be provided based on the offers for the first unit. Depending on the offers from all members of your group, the project coordinator will determine the highest number of units of the good that can be provided, for which the total of offers from the group is enough to pay the cost for the unit.

After everyone makes offers one time on each unit, the potential outcome will be announced, each person will then have an opportunity to revise their offers. This revision opportunity is a second chance for the group to earn money on the same units if the group fund is not large enough to provide the units initially. Any revised offers will be submitted to the project coordinator and can only be an increase from the previous offer on the same unit. The actual outcome will be determined by the set of final offers (including revised offers, if any) from you and your group.

How you make money:
Profit is based on your (final) offer for the last unit (including revisions) that is provided by your group, as follows: if the group offered more than enough to pay the cost of providing that last unit, then everyone's price for that unit will be less than (discounted

from) their actual offer; the discount will equal the proportion of excess money in the total offered by the group. For example, if, for the last unit to be provided, X% of the money offered by your group is not needed, then your offer will be discounted X% and the result will be your 'personal price.' This personal price applies to all other units.

Profit = Your Budget + Total of your value/benefit for the units provided – Your payment (which is your personal price x the number of units)

Treatment III EXPERIMENTAL WORKSHEET

EXAMPLE

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Example Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	$20	$12	$12	$11.00	$11 ($11 x 1)	**Y** / N	(3)	$8	$8 ($8 x 1)	$24 (20 + 12 – 8)
2	$20	$7	$19 (12 + 7)	$5.00	$10 ($5 x 2)	**Y** / N	(2)	$3	$6 ($3 x 2)	$33 (20 + 19 – 6)
3	$20	$5	$24 (12 + 7 +5)	$3.00	$9 ($3 x 3)	**Y** / N	(0)	$3	$9 ($3 x 3)	$35 (20 + 24 – 9)
4	$20	$3	$27 (12 + 7 +5 + 3)	$2.00	$8 ($2 x 4)	**Y** / N	(1)	$2	$8	$39 (20 + 27 -8)

* You will not have to calculate these columns, they are only for discussion / explanation.

Quiz

If the group fund had not been not large enough to provide the 3rd unit, will the project coordinator evaluate if the group fund is large enough to provide the 4th unit? Explain why

____

If the group fund does not provide unit 2 (your offer was $5) and an opportunity to revise your offer for unit 2 is provided, could you offer $4?

____

PLEASE MAKE SURE TO COPY YOUR DECISIONS FROM COLUMN'S E and F, ONTO THE NEXT PAGE.

EXAMPLE (cont.)

Your Offers and Potential Total to Pay (Columns E and F) – Initial Offers (FOR PARTICIPANT RECORD KEEPING)

(column E) (column F)
Unit 1 Offer: ______11____ / Potential Total to Pay: ____11______

Unit 2 Offer: _______5___ / Potential Total to Pay: _____10_____

Unit 3 Offer: _____3_____ / Potential Total to Pay: ______9___

Unit 4 Offer: _____2_____ / Potential Total to Pay: ______8____

REVISED OFFERS

Unit
(A)
	Budget
	(B)
		Your Value (Benefit)
		(C)
			Total Benefit (based on # of units provided)
			(D)
				Your Offer (per unit) **(Today's Decision)**
				(E)
					Potential Total to Pay (based on # of units provided)
					(F)
					A x E
						Can the fund provide for the unit *
						(G)
							Example Discount*
							(H)
								Your Personal Price*
								(I)
								E - H
									Your Actual Payment*
									(J)
									I x A
										Profit *
										If (G) is Yes, (B + D - J).
										If (G) is No, (B)

1	$20	$12	$12	N/A (same as above)	N/A (same as above)	**Y** / N	($3)	$8.00	$8 ($8 x 1)	$24 (20 + 12 – 8)
2	$20	$7	$19 (12 + 7)	$7.00	$14 ($7 x 2)	**Y** / N	($2)	$5.00	$10 ($5 x 2)	$29 (20 + 19 – 10)
3	$20	$5	$24 (12 + 7 +5)	$6.00	$18 ($6 x 3)	**Y** / N	($0)	$6.00	$18 ($6 x 3)	$26 (20 + 24 – 18)
4	$20	$3	$27 (12 + 7 +5 + 3)	$3.00	$12 ($3 x 4)	Y / **N**	N/A	N/A	N/A	See Unit #3

* You will not have to calculate these columns, they are only for discussion / explanation.

Treatment III

EXPERIMENTAL WORKSHEET

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Actual Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	$100	$43	$43			Y / N				
2	$100	$27	$70 (43 + 27)			Y / N				
3	$100	$12	$82 (70 + 12)			Y / N				
4	$100	$9	$91 (82 + 9)			Y / N				
5	$100	$7	$98 (91 + 7)			Y / N				
6	$100	$5	$102 (98 + 4)			Y / N				
7	$100	$4	$105 (102 + 3)			Y / N				
8	$100	$3	$106 (105 + 1)			Y / N				

* For project coordinator to fill in

PLEASE MAKE SURE TO COPY YOUR DECISIONS FROM COLUMN'S E and F, ONTO THE NEXT PAGE.

Your Offers and Potential Total to Pay (Columns E and F) – Initial Offers (FOR PARTICIPANT RECORD KEEPING)

(column E) (column F)

Unit 1 Offer: __________ / Potential Total to Pay: __________

Unit 2 Offer: __________ / Potential Total to Pay: __________

Unit 3 Offer: __________ / Potential Total to Pay: __________

Unit 4 Offer: __________ / Potential Total to Pay: __________

Unit 5 Offer: __________ / Potential Total to Pay: __________

Unit 6 Offer: __________ / Potential Total to Pay: __________

Unit 7 Offer: __________ / Potential Total to Pay: __________

Unit 8 Offer: __________ / Potential Total to Pay: __________

REVISED OFFERS

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Actual Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	$100	$43	$43			Y / N				
2	$100	$27	$70 (43 + 27)			Y / N				
3	$100	$12	$82 (70 + 12)			Y / N				
4	$100	$9	$91 (82 + 9)			Y / N				
5	$100	$7	$98 (91 + 7)			Y / N				
6	$100	$5	$102 (98 + 4)			Y / N				
7	$100	$4	$105 (102 + 3)			Y / N				
8	$100	$3	$106 (105 + 1)			Y / N				

C.4 Lab Experiment – Pivotal Mechanism, PM(4)

In this Treatment you will choose whether or not to invest money in the public fund and how much money to offer for 1, 2, 3 & 4 units of the good. You will make all your decisions upfront, before knowing how many units of the good can be provided by the group fund. You will consider the value/benefit you will receive if various units are provided, which in turn affects the profit you stand to earn.

Determining the outcome:
For each number of units of the good you will choose a) whether or not you want to invest in the public fund to provide that unit and b) how many experimental dollars to offer. Since your offer and the offers of the other individuals in your group determine the level of the fund, and therefore the number of units provided, the project coordinator will begin by identifying if the fund is large enough to pay for the costs needed to implement a single unit of the good before moving on to evaluate whether the fund is large enough to pay for the second unit and so on. For each unit, only the offers of you and your group *for that unit* will determine whether the unit is provided. Offers you and others made on earlier units will not be considered in determining whether a particular unit is provided. The project coordinator considers the offers made for the second unit only if the first unit can be provided based on the offers for the first unit. Depending on the offers from all members of your group, the project coordinator will determine the highest number of units of the good that can be provided for which the total of offers from the group is enough to pay the cost for the unit.

How you make money:
Your profit is calculated based on your offer for the last unit that is provided by your group, as follows: if the group offered more than enough to pay the cost of providing that unit, then the coordinator will determine whether or not the good could still have been provided without your offer. If your offer is needed for that last unit, then you will need to pay only that portion of your offer that is needed to provide just exactly enough money to provide the unit. In this case, the coordinator calculates the discounted price for the last unit. If your offer is *not* needed for that unit, then you will pay nothing for the last unit provided, and the last-unit discount-price will be zero. Regardless of whether or not you get the last unit for free, your offer on the last unit *provided* will be your personal price for all the earlier units.

Profit = Your Budget + Total of your value/benefit for the units provided – Your payment [your personal price x (the number of units - 1)] + (your payment (if any) on the last unit)]

EXAMPLE:

Treatment II (PM)

EXPERIMENTAL WORKSHEET

Unit **(A)**	Budget **(B)**	Your Value/ Benefit **(C)**	Total Benefit (based on # of units provided) **(D)**	Your Offer **(Today's Decision)** **(E)**	Potential Total Payment (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit **(G)**	Discounted Price (on last unit) **(H)**	Personal price (on all other units) **(I)**	Actual payment **(J)** **I*(n-1) + H**	Profit **A + D - J**
1	20	12	12	11.00	$11	**Y** / N	Not needed – 0.00	11.00	0	32 (20 + 12 – 0)
2	20	7	19 (12 + 7)	5.00	$10 ($5 x 2)	**Y** / N	Needed – 5.00	5.00	$10 ($5 x 1) + 5	29 (20+19 - 10)
3	20	5	24 (12 + 7 +5)	3.00	$9 ($3 x 3)	**Y** / N	Not needed – 0.00	3.00	$6 ($3 x 2) + 0	38 (20 + 24 – 6)
4	20	3	27 (12 + 7 +5 + 3)	2.50	$10 ($2.50 x 4)	**Y** / N	Needed – 1.00	2.50	$8.50 ($2.50 x 3) + 1	38.50 (20 + 27 – 8.50)

Unit (A)	Budget (B)	Your Value/ Benefit (C)	Total Benefit (based on # of units provided) (D)	Your Offer **(Today's Decision)** (E)	Potential Total Payment (based on # of units provided) (F) A x E	Can the fund provide for the unit (G)	Discounted Price * (on last unit) (H)	Personal price* (on all other units) (I)	Actual payment* (J) I*(n-1) + H	Profit * A + D - J
1	100	43	43			Y / N				
2	100	27	70 (43 + 27)			Y / N				
3	100	12	82 (43 + 27 + 12)			Y / N				
4	100	9	91 (43 + 27 + 12 + 9)			Y / N				

* for the project coordinator to fill in only

C.5 Lab Experiment – Proportional Rebate Unknown Revision, PR-UKRev(8)

In this Treatment you will choose whether or not to invest money in the public fund and how much money to offer for 1, 2, 3…up to 8 units of the good. You will make all your decisions upfront, before knowing how many units of the good can be provided by the group fund. You will consider the value/benefit you will receive if various units are provided, which in turn affects the profit you stand to earn.

Determining the outcome:
For each number of units of the good, you will choose: a) whether or not you want to invest in the public fund to provide that unit and b) how many experimental dollars to offer. Since your offer combined with the offers of the other individuals in your group determine the level of the fund, and therefore the number of units provided, the project coordinator will begin by identifying if the fund is large enough to pay for the costs needed to implement a single unit of the good before moving on to evaluate whether the fund is large enough to pay for the second unit and so on. For each unit, only the offers of you and your group *for that unit* will determine whether the unit is provided. Offers you and others made on earlier units will not be considered in determining whether a particular unit is provided. For example, the project coordinator considers the offers made for the second unit only if the first unit can be provided based on the offers for the first unit. Depending on the offers from all members of your group, the project coordinator will determine the highest number of units of the good that can be provided, for which the total of offers from the group is enough to pay the cost for the unit.

How you make money:
Your profit is calculated based on your offer for the last unit that is provided by your group, as follows: if the group offered more than enough to pay the cost of providing that last unit, then everyone's price for that unit will be less than (discounted from) their actual offer; the discount will equal the proportion of excess money in the total offered by the group. For example, if, for the last unit to be provided, X% of the money offered by your group is not needed, then your offer will be discounted X% and the result will be your 'personal price'. This personal price applies to all other units.

Profit = Your Budget +Total of your value (benefit) for the units provided –Your payment (which is your personal price x the number of units)

EXAMPLE

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Example Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	$20	$12	$12	$11.00	$11 (11 x 1)	**Y** / N	(3)	$8	$8 ($8 x 1)	$24 (20 + 12 – 8)
2	$20	$7	$19 (12 + 7)	$5.00	$10 (5 x 2)	**Y** / N	(2)	$3	$6 ($3 x 2)	$33 (20 + 19 – 6)
3	$20	$5	$24 (19 +5)	$3.00	$9 (3 x 3)	**Y** / N	(0)	$3	$9 ($3 x 3)	$35 (20 + 24 – 9)
4	$20	$3	$27 (24 + 3)	$2.00	$8 (2 x 4)	**Y** / N	(1)	$1	$4 ($1 x 4)	$43 (20 + 27 – 4)
5	$20	$3	$30 (27 + 3)	$4.00	$20 (4 x 5)	**Y** / N	(1.50)	$2.50	$12.50 ($2.50 x 5)	$37.50 (20 + 30 – 12.50)
6	$20	$2	$32 (30 + 2)	$2.00	$12 (2 x 6)	Y / **N**	N/A	N/A	N/A	See Unit #5
7	$20	$1	$33 (32 + 1)	$.50	$3.50 (.50 x 7)	Y / **N**	N/A	N/A	N/A	See Unit #5
8	$20	$1	$34 (33 + 1)	$0	$0 (0 x 8)	Y / **N**	N/A	N/A	N/A	See Unit #5

* You will not have to calculate these columns, they are only for discussion / explanation.

QUIZ:

1. Based on the information in the example above, what is the last unit provided? __________. How much was your offer? __________

2. How much do you actually pay per unit? ____________

Treatment II (PR.2) EXPERIMENTAL WORKSHEET

Unit (A)	Budget (B)	Your Value (Benefit) (C)	Total Benefit (based on # of units provided) (D)	Your Offer (per unit) **(Today's Decision)** **(E)**	Potential Total to Pay (based on # of units provided) **(F)** **A x E**	Can the fund provide for the unit * (G)	Actual Discount* (H)	Your Personal Price* (I) **E - H**	Your Actual Payment* (J) **I x A**	Profit * If (G) is Yes, (B + D - J). If (G) is No, (B)
1	$100	$43	$43			Y / N				
2	$100	$27	$70 (43 + 27)			Y / N				
3	$100	$12	$82 (70 + 12)			Y / N				
4	$100	$9	$91 (82 + 9)			Y / N				
5	$100	$7	$98 (91 + 7)			Y / N				
6	$100	$5	$103 (98 + 5)			Y / N				
7	$100	$4	$107 (103 + 4)			Y / N				
8	$100	$3	$110 (107 + 3)			Y / N				

Treatment II (Cont)

Your Offers and Potential Total to Pay (Columns E and F) – FINAL Offers

(column E) (column F)

Unit 1 Offer: __________ / Potential Total to Pay: __________

Unit 2 Offer: __________ / Potential Total to Pay: __________

Unit 3 Offer: __________ / Potential Total to Pay: __________

Unit 4 Offer: __________ / Potential Total to Pay: __________

Unit 5 Offer: __________ / Potential Total to Pay: __________

Unit 6 Offer: __________ / Potential Total to Pay: __________

Unit 7 Offer: __________ / Potential Total to Pay: __________

Unit 8 Offer: __________ / Potential Total to Pay: __________

C.6 Lab Experiment – Exit Survey

Exit Survey

Are you male / female? (please circle one)

Are you an undergrad or graduate student? (please circle one)

Have you ever participated in an experiment (SIMLAB or paper) before?

What is your major? _________

Did you offer more than your 'benefit' on any units? If so, what did you think were the advantages of this decision?

Did you ever offer $0? If so, why?

Did you ever offer your entire budget? If so, why?

Any other comments?

APPENDIX D: FIELD EXPERIMENT SECTIONS, 2008

APPENDIX D.0 General Instructions

Introduction

This project involves the value, in economic terms, that area residents have for environmental or ecosystem restoration. You will be asked to make decisions involving the allocation of money to different sets of activities involving ecosystem restoration as well as other non-environmental benefits.

The decisions you make tonight, through answering our questionnaire, will impact local restoration. All of the questions are potentially real – all could lead to real actions for spending money for environmental restoration or other purposes, as explained in each choice-question.

You might find the questions here involve difficult or easy choices, based on your personal preferences and priorities. Your answers will be confidential and will *not* be shared in any way that identifies you. Also, we recognize that your time is valuable and we hope you view any payments you take home from this session to be well-earned. We hope that you will take enough time to think carefully about each question, relative to your personal preferences and priorities. All questions could be implemented. Your participation is important to management and policy for coastal areas.

For this session, we are able to pay a $40 participation fee, no matter which choice question below is implemented. Thus, money referred to below is *in addition* to the $40 participation fee that we will give you at the end of tonight's session.

General Instructions

1) The participants in this session are divided into two separate groups, at random. This means that not every single person in the room is in your group, but you will not be informed as to who is in your group and who is not. Your group is important because in some questions the project coordinator will look at the combined decisions of the group to determine the final outcome for a question. This will be explained more fully in the following instructions.

2) There are 3 separate sections, each with their own set of instructions and choice-questions. Please read each set of instructions carefully, and do not hesitate to raise your hand if you have questions. The instructions will give you important information about the a) allocation of funds to restoration or to other activities and b) the specific restoration activities that could be provided and c) information on how your groups' decisions impact restoration.

3) You will be asked to answer approximately 20 choice-questions today. Each of these questions has the possibility for provision, but only one question in each of the two groups of people will be implemented. Once every participant has completed the set of questions, the project coordinator will randomly choose one question for each group. Based on the choices made by you and the people in your group, the results for that question will be implemented for your group.
4) 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 project coordinator can come to you and address your question.

STOP and Wait Here:

If you have questions for the project coordinator, please raise your hand now.

Appendix D.1 Field Experiment 2008, Section I (CE^R)

For the questions in Section I, you will make decisions between bundles of differing levels of restoration activities that contribute to additional ecosystem services, as well as an individual *rebate of cash* to you. In this section, each individual will be given a **personal budget** to allocate (or spend) in each choice-question. Please select the bundle that best represents your preferences –by voting for the option, Bundle A or Bundle B, which you would want implemented if that question is the one randomly chosen at the end of the today's session.

Determining the Outcome: The bundle that will be provided will be decided by **majority vote** of your group. For example, if your group has 10 people in it and 6 choose Bundle B and 4 choose Bundle A, then Bundle B will be the set of restoration activities provided and Bundle A will not be provided. All funds will be used for the restoration activity and take-home payment (either Bundle A **or** Bundle B) chosen by your group's majority.

EXAMPLE

For this question you have been given **$80** to make a decision with

	Bundle A	Bundle B
Bird Habitat Restoration	2 increments	1 increments
Clam Restoration	1 increments	3 increments
Sea Grass Restoration	3 increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $80, Bundle A will use $60 to help pay for the restoration above and you will receive $20 to take home.	From your $80, Bundle B will use $50 to help pay for the restoration above and you will receive $30 to take home.

I vote to support (check one box below)

Bundle A X Bundle B

In the example question above, if your group has 10 people and the majority of people in your group chose Bundle B, and if everyone had the same allocations of money, then $500 ($50 x10) will be used towards the provision (or cost) of Bundle B and the project leaders will implement that bundle while paying $30 to you. Bundle A will not be provided at all. If you voted for A (and the majority voted for B) then your personal budget will be paid according to B because that is what the majority chose.

Please note: The dollar amounts above are only for example. Please make your decisions based only on the information provided in the choice questions (each of which could be randomly chosen for implementation tonight).

For section I, you have a budget of $90 to make each decision with.

Question 1: Bundle A Bundle B

Bird Habitat Restoration	3 increments	1 increments
Clam Restoration	2 increments	0 increments
Sea Grass Restoration	1 increments	3 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home	From your $90.00, Bundle B will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home

I vote to support (check one box below)
Bundle A Bundle B

Question 2: Bundle A Bundle B

Bird Habitat Restoration	2 increments	1increments
Clam Restoration	0 increments	1 increments
Sea Grass Restoration	2 increments	1 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.	From your $90.00, Bundle B will use $85.50 to help pay for the restoration above and you will receive $4.50 to take home.

I vote to implement (check one box below)
Bundle A Bundle B

Question 3: Bundle A Bundle B

Bird Habitat Restoration	3 increments	3 increments
Clam Restoration	1increments	2 increments
Sea Grass Restoration	2 increments	3 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home.	From your $90.00, Bundle B will use $85.50 to help pay for the restoration above and you will receive $4.50 to take home.

I vote to support (check one box below)

Bundle A Bundle B

Question 4:

	Bundle A	Bundle B
Bird Habitat Restoration	0 increments	1 increments
Clam Restoration	3 increments	3 increments
Sea Grass Restoration	2 increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $85.50 to help pay for the restoration above and you will receive a $4.50 to take home.	From your $90.00, Bundle B will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.

I vote to support (check one box below)
Bundle A Bundle B

Question 5:

	Bundle A	Bundle B
Bird Habitat Restoration	2 increments	0 increments
Clam Restoration	3 increments	1 increments
Sea Grass Restoration	1 increments	3 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home.	From your $90.00, Bundle B will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.

I vote to support (check one box below)
Bundle A Bundle B

Question 6:

	Bundle A	Bundle B
Bird Habitat Restoration	1 increments	0 increments
Clam Restoration	1 increments	2 increments
Sea Grass Restoration	1 increments	2 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $85.50 to help pay for the restoration above and you will receive $4.50 to take home	From your $90.00, Bundle B will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home.

I vote to support (check one box below)
Bundle A Bundle B

Question 7: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	0 increments	2 increments
Clam Restoration	0 increments	1 increments
Sea Grass Restoration	1increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $18.00 to help pay for the restoration above and you will receive $72.00 to take home.	From your $90.00, Bundle B will use $18.00 to help pay for the restoration above and you will receive $72.00 to take home.

I vote to support (check one box below)
Bundle A Bundle B

Question 8: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	0 increments	1 increments
Clam Restoration	1 increments	2 increments
Sea Grass Restoration	3 increments	2 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.	From your $90.00, Bundle B will use $18.00 to help pay for the restoration above and you will receive $72.00 to take home.

I vote to support (check one box below)
Bundle A Bundle B

Question 9: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	0 increments	0 increments
Clam Restoration	0 increments	2 increments
Sea Grass Restoration	0 increments	1 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $0 to help pay for the restoration above and you will receive $120.00 to take home.	From your $120.00, Bundle B will use $114.00 to help pay for the restoration above and you will receive $6.00 to take home.

I vote to support (check one box below)
Bundle A Bundle B

Appendix D.2 – 2008 Field Experiment Section II (CE^G)

Section II

For the questions in section II, you will again make decisions between bundles of goods comprised of differing levels of restoration activities. However, in this Section, you are allocating money between supporting restoration and contributing funds to the *local government* for the benefit of the county. In this section, each individual will again be given **a personal budget** to allocate (or spend) in each choice-question. Please vote to select the bundle that best represents your preferences and thus which option you want your personal budget to be used towards, Bundle A or Bundle B.

Please read the remainder of this page silently to yourself. If you have questions, please raise your hand for the project coordinator to answer your question quietly.

Determining the Outcome: The bundle that will be provided is decided by the **majority vote** of your group. For example, if your group has 10 people in it and 6 choose Bundle B and 4 choose Bundle A, then Bundle B will be the set of restoration activities provided and Bundle A will not be provided. All funds will be used for the restoration activities and payment to local government (either Bundle A **or** Bundle B) chosen by your group's majority.

Please note: Please make your decisions based only on the information provided in the choice questions (each of which could be randomly chosen for implementation tonight).

Stop!! Please wait to turn the page until instructed to do so.

For this section, you have a budget of <u>$120</u> to make each decision with

Question 10:

	Bundle A	Bundle B
Bird Habitat Restoration	2 increments	1increments
Clam Restoration	3 increments	1 increments
Sea grass Restoration	2 increments	1increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $72.00 to help pay for the restoration above and will give $48.00 to the local county government for general use.	From your $120.00, Bundle B will use $114.00 to help pay for the restoration above and will give $6.00 to the local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Question 11:

	Bundle A	Bundle B
Bird Habitat Restoration	1 increments	3 increments
Clam Restoration	3 increments	1 increments
Sea grass Restoration	2increments	1 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $114.00 to help pay for the restoration above and will give $6.00 to the local county government for general use.	From your $120.00, Bundle B will use $54.00 to help pay for the restoration above and will give $66.00 to the local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Question 12:

	Bundle A	Bundle B
Bird Habitat Restoration	0 increments	3increments
Clam Restoration	1 increments	0 increments
Sea grass Restoration	2increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $54.00 to help pay for the restoration above and will give $66.00 to the local county government for general use.	From your $120.00, Bundle B will use $72.00 to help pay for the restoration above and will give $48.00 to the local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Question 13: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	1 increments	2 increments
Clam Restoration	3 increments	0 increments
Sea grass Restoration	1 increments	2 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $72.00 to help pay for the restoration above and will give $48.00 to local county government for general use.	From your $120.00, Bundle B will use $54.00 to help pay for the restoration above and will give $66.00 to the local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Question 14: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	2 increments	0 increments
Clam Restoration	3 increments	3 increments
Sea grass Restoration	1 increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $114.00 to help pay for the restoration above and will give $6.00 to the local county government for general use.	From your $120.00, Bundle B will use $24.00 to help pay for the restoration above and will give $96.00 to the local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Question 15: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	1 increments	1 increments
Clam Restoration	1 increments	0 increments
Sea grass Restoration	0 increments	1 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $114.00 to help pay for the restoration above and will give $6.00 to the local county government for general use.	From your $120.00, Bundle B will use $54.00 to help pay for the restoration above and will give $66.00 to local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Question 16: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	3 increments	0 increments
Clam Restoration	3 increments	0increments
Sea grass Restoration	0 increments	3 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $54.00 to help pay for the restoration above and will give $66.00 to the local county government for general use.	From your $120.00, Bundle B will use $72.00 to help pay for the restoration above and will give $48.00 to the local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Question 17: Bundle A Bundle B

	Bundle A	Bundle B
Bird Habitat Restoration	0 increments	1 increments
Clam Restoration	2 increments	1 increments
Sea grass Restoration	1 increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $120.00, Bundle A will use $114.00 to help pay for the restoration above and will give $6.00 to the local county government for general use.	From your $120.00, Bundle B will use $72.00 to help pay for the restoration above and will give $48.00 to local county government for general use.

I vote to support (check one box below)
Bundle A Bundle B

Appendix D.3 Field Experiment 2008, Group A Section III (IPA / PR)

For the questions in section III, you will choose between allocating your funds between an environmental restoration activity (or set of restoration activities) and an amount that you can keep for your household's use. In this section, however, each question will ask about your willingness to contribute part of your budget towards different increments of additional restoration of a particular type. Each individual will again be given **a personal budget** to allocate (or spend) in each choice-question.

Determining the Outcome:
Your choice and the choices of the other individuals in your group will determine the level of each action influencing restoration activities and ecosystem services. This means that the project coordinator will look at the decisions of the entire group to determine the how much restoration will be provided, if any. If one of these questions is randomly drawn for implementation, then the project coordinator will begin by identifying whether your group's decisions allocated enough funds to pay the costs needed to implement one increment of the restoration activity, before moving on to evaluating whether your group allocated enough funds to pay for the second increment, and so on. Depending on the decisions of all members of your group, the project coordinator will determine the highest level of restoration activities that can be achieved as the largest number of increments that can be provided from the funds your group allocated in that question.

After determining how many increments of the restoration activity can be provided, any money allocated by you and the members of your group that is *in excess of the pre-determined* cost to implement the restoration *will be rebated* to you and your group members. Your rebate will be in proportion to the excess of funds allocated by the group. For example, if the project coordinator determines that your group provided enough funds for 4 increments and your group allocated X% more money than was actually needed to implement 4 increments of restoration, then we will rebate X% of your money back to you as additional funds you can take home.

Instructions:
In this section, each question will provide you with a table, like the one below. Each question provides you with a personal budget ($100 for the example below) with which to make decisions for each part (a-d) of the question. Each part (a-d) will give you a *new opportunity* to allocate some amount of funds towards a certain increment of restoration activities and the remainder for you to take home.

You will make a decision for how much money to allocate (per increment) for varying levels of the restoration activity (1, 2, 3 & 4). The table will give you the breakdown of your funds, for each increment. For example, in column (a) you will decide how much to allocate on a single increment. If you choose to pay $40 towards restoration, and enough funds are allocated from your group to provide 1 increment of restoration, you will keep (take home) $60, plus any available rebate.

In column (b) you will decide how much to allocate for two increments of restoration activities. If you again choose to pay $40 per increment, you will allocate $80 ($40 x2) for restoration activities, and if enough funds are allocated from your group to provide 2 increments of restoration, you will keep (take home) $20 plus any available rebate.

In column (c) you will decide how much to allocated for three increments of restoration activities. In this example, your budget is $100 which prevents you from allocating $40 per unit ($40 x 3 = $120), but does allow you to allocate up to $33.33 per unit (3 x $33.33 = $100) for restoration activities, and if enough funds are allocated from your group to provide 3 increments of restoration, you will take home $0.

You can make any allocation you like in each column. The above numbers are ONLY examples.

After the project coordinator determines the largest number of increments that can be provided, in the event one of these questions is chosen for implementation, then any excess money allocated above the amount needed to implement the restoration will be rebated to you in proportion to the excess and added to your money to take home.

EXAMPLE

	(a)				(b)				(c)				(d)			
Per Unit Prices ($)	price x 1 Half-Acre = Payment				price x 2 Half-Acres = Payment				price x 3 Half-Acres = Payment				price x 4 Half-Acres = Payment			
0	0	x 1	=	0	0	x 2	=	0	0	x 3	=	0	0	x 4	=	0
5	5	x 1	=	5	5	x 2	=	10	5	x 3	=	15	5	x 4	=	20
10	10	x 1	=	10	10	x 2	=	20	10	x 3	=	30	10	x 4	=	40
15	15	x 1	=	15	15	x 2	=	30	15	x 3	=	45	15	x 4	=	60
20	20	x 1	=	20	20	x 2	=	40	20	x 3	=	60	20	x 4	=	80
25	25	x 1	=	25	25	x 2	=	50	25	x 3	=	75	25	x 4	=	100
30	30	x 1	=	30	30	x 2	=	60	30	x 3	=	90	**NAME YOUR OWN PRICE**			
33.3	33	x 1	=	33.3	33	x 2	=	66.6	33.3	x 3	=	99.9		x 4	=	
35	35	x 1	=	35	35	x 2	=	70	**NAME YOUR OWN PRICE**							
40	40	x 1	=	40	40	x 2	=	80		x 3	=					
45	45	x 1	=	45	45	x 2	=	90								
50	50	x 1	=	50	50	x 2	=	100								
55	55	x 1	=	55	**NAME YOUR OWN PRICE**											
60	60	x 1	=	60		x 2	=									
65	65	x 1	=	65												
70	70	x 1	=	70												
75	75	x 1	=	75												
80	80	x 1	=	80												
85	85	x 1	=	85												
90	90	x 1	=	90												
95	95	x 1	=	95												
100	100	x 1	=	100												
	NAME YOUR OWN PRICE															
OWN		x 1	=													

For this section, you have a budget of <u>$100</u> to make each decision with

Questions 18 a-d are specifically about sea grass restoration activities only.

Please *<u>circle</u>* your decisions for the allocation of your personal budget for each incremental unit of *<u>sea grass</u>* restoration activities. You should circle one dollar value in each column, a-d.

Q.18

Per Unit Prices ($)	**(a)** price x 1 Half-Acre = Payment	**(b)** price x 2 Half-Acres = Payment	**(c)** price x 3 Half-Acres = Payment	**(d)** price x 4 Half-Acres = Payment
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

Questions 19 a-d are specifically about clam restoration activities only.

Please *circle* your decisions for the allocation of your personal budget for each incremental unit of *clam* restoration activities. You should circle one dollar value in each column, a-d.

Q.19

	(a)	(b)	(c)	(d)
Per Unit Prices ($)	**price x 1 Half-Acre = Payment**	**price x 2 Half-Acres = Payment**	**price x 3 Half-Acres = Payment**	**price x 4 Half-Acres = Payment**
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

Questions 20 a-d are specifically about bird habitat restoration activities.

Please *circle* your decisions for the allocation of your personal budget for each incremental unit of *bird habitat* restoration activities. You should circle 1 dollar value in each column, a-d.

Q.20

	(a)				(b)				(c)				(d)			
Per Unit Prices ($)	**price x 1 Half-Acre = Payment**				**price x 2 Half-Acres = Payment**				**price x 3 Half-Acres = Payment**				**price x 4 Half-Acres = Payment**			
0	0	x 1	=	0	0	x 2	=	0	0	x 3	=	0	0	x 4	=	0
5	5	x 1	=	5	5	x 2	=	10	5	x 3	=	15	5	x 4	=	20
10	10	x 1	=	10	10	x 2	=	20	10	x 3	=	30	10	x 4	=	40
15	15	x 1	=	15	15	x 2	=	30	15	x 3	=	45	15	x 4	=	60
20	20	x 1	=	20	20	x 2	=	40	20	x 3	=	60	20	x 4	=	80
25	25	x 1	=	25	25	x 2	=	50	25	x 3	=	75	25	x 4	=	100
30	30	x 1	=	30	30	x 2	=	60	30	x 3	=	90	**NAME YOUR OWN PRICE**			
33.3	33	x 1	=	33.3	33	x 2	=	66.6	33.3	x 3	=	99.9		x 4	=	
35	35	x 1	=	35	35	x 2	=	70	**NAME YOUR OWN PRICE**							
40	40	x 1	=	40	40	x 2	=	80		x 3	=					
45	45	x 1	=	45	45	x 2	=	90								
50	50	x 1	=	50	50	x 2	=	100								
55	55	x 1	=	55	**NAME YOUR OWN PRICE**											
60	60	x 1	=	60		x 2	=									
65	65	x 1	=	65												
70	70	x 1	=	70												
75	75	x 1	=	75												
80	80	x 1	=	80												
85	85	x 1	=	85												
90	90	x 1	=	90												
95	95	x 1	=	95												
100	100	x 1	=	100												
	NAME YOUR OWN PRICE															
OWN		x 1	=													

Appendix D.4 Field Experiment 2008, Group B Section III (IPA / PR-CON)

Section III

For the questions in section III, you will choose between allocating your funds between an environmental restoration activity (or set of restoration activities) and an amount that you can keep for your household's use. In this section, however, each question will ask about your willingness to contribute part of your budget towards different increments of additional restoration of a particular type. Each individual will again be given **a personal budget** to allocate (or spend) in each choice-question.

Determining the Outcome:
Your choice and the choices of the other individuals in your group will determine the level of each action influencing restoration activities and ecosystem services. This means that the project coordinator will look at the decisions of the entire group to determine the how much restoration will be provided, if any. If one of these questions is randomly drawn for implementation, then the project coordinator will begin by identifying whether your group's decisions allocated enough funds to pay the costs needed to implement one increment of the restoration activity, before moving on to evaluating whether your group allocated enough funds to pay for the second increment, and so on. Depending on the decisions of all members of your group, the project coordinator will determine the highest level of restoration activities that can be achieved as the largest number of increments that can be provided from the funds your group allocated in that question.

After determining how many increments of the restoration activity can be provided, any money allocated by you and the members of your group that is *in excess of the pre-determined* cost to implement the restoration *will be rebated* to you and your group members. Your rebate will be in proportion to the excess of funds allocated by the group. For example, if the project coordinator determines that your group provided enough funds for 4 increments and your group allocated X% more money than was actually needed to implement 4 increments of restoration, then we will rebate X% of your money back to you as additional funds you can take home.

Instructions:
In this section, each question will provide you with a table, like the one below. Each question provides you with a personal budget ($100 for the example below) with which to make decisions for each part (a-d) of the question. Each part (a-d) will give you a *new opportunity* to allocate some amount of funds towards a certain increment of restoration activities and the remainder for you to take home.

You will make a decision for how much money to allocate (per increment) for varying levels of the restoration activity (1, 2, 3 & 4). The table will give you the breakdown of your funds, for each increment. For example, in column (a) you will decide how much to allocate on a single increment. If you choose to pay $40 towards restoration, and enough funds are allocated from your group to provide 1 increment of restoration, you will keep (take home) $60, plus any available rebate.

In column (b) you will decide how much to allocate for two increments of restoration activities. If you again choose to pay $40 per increment, you will allocate $80 ($40 x2) for restoration activities, and if enough funds are allocated from your group to provide 2 increments of restoration, you will keep (take home) $20 plus any available rebate.

In column (c) you will decide how much to allocated for three increments of restoration activities. In this example, your budget is $100 which prevents you from allocating $40 per unit ($40 x 3 = $120), but does allow you to allocate up to $33.33 per unit (3 x $33.33 = $100) for restoration activities, and if enough funds are allocated from your group to provide 3 increments of restoration, you will take home $0.

You can make any allocation you like in each column. The above numbers are ONLY examples.

After the research coordinator determines the largest number of increments that can be provided, in the event one of these questions is chosen for implementation, then any excess money allocated above the amount needed to implement the restoration will be rebated to you in proportion to the excess and added to your money to take home.

EXAMPLE

	(a)	(b)	(c)	(d)
Per Unit Prices ($)	price x 1 Half-Acre = Payment	price x 2 Half-Acres = Payment	price x 3 Half-Acres = Payment	price x 4 Half-Acres = Payment
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

For this section, you have a budget of $100 to make each decision with

Questions 18 a-d are specifically about sea grass restoration and bird habitat restoration activities. If your group provides any increments of sea grass restoration then an increment of bird habitat restoration will also be provided. If no sea grass restoration is provided, then the increment of bird habitat will not be provided.

Please *circle* your decisions for the allocation of your personal budget for each incremental unit of *sea grass* restoration activities, and 1 increment of bird habitat restoration activities will also be provided if enough funds are allocated to provide at least some sea grass. You should circle one dollar value in each column, a-d.

Q.18

	(a)	(b)	(c)	(d)
Per Unit Prices ($)	price x 1 Half-Acre = Payment	price x 2 Half-Acres = Payment	price x 3 Half-Acres = Payment	price x 4 Half-Acres = Payment
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

Questions 19 a-d are specifically about clam restoration and sea grass restoration activities. If your group provides any increments of clam restoration then an increment of sea grass restoration will also be provided. If no clam restoration is provided, then the increment of sea grass will not be provided.

Please *circle* your decisions for the allocation of your personal budget for each incremental unit of *clam* restoration activities, and 1 increment of sea grass restoration activities will also be provided if enough funds are allocated to provide at least some clams. You should circle one dollar value in each column, a-d.

Q.19

	(a)	(b)	(c)	(d)
Per Unit Prices ($)	**price x 1 Half-Acre = Payment**	**price x 2 Half-Acres = Payment**	**price x 3 Half-Acres = Payment**	**price x 4 Half-Acres = Payment**
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

Questions 20 a-d are specifically about bird habitat restoration and sea grass restoration activities. If your group provides any increments of bird habitat restoration then an increment of sea grass restoration will also be provided. If no bird habitat is provided, then the increment of sea grass restoration will not be provided.

Please *circle* your decisions for the allocation of your personal budget for each incremental unit of *bird habitat* restoration activities, and 1 increment of sea grass restoration activities also being provided if enough funds are allocated to provide bird habitat. You should circle 1 dollar value in each column, a-d.

Q.20

Per Unit Prices ($)	**(a)** price x 1 Half-Acre = Payment	**(b)** price x 2 Half-Acres = Payment	**(c)** price x 3 Half-Acres = Payment	**(d)** price x 4 Half-Acres = Payment
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

Appendix D.5 Field Experiment 2008, Section IV (Demographics)

1. How clear and certain are you about how the implementation of each activity would be (1=not very certain at all; 10=completely certain). Please circle a number in each case:
   Sea grass 1 2 3 4 5 6 7 8 9 10
   Bird habitat 1 2 3 4 5 6 7 8 9 10
   Clams for water quality 1 2 3 4 5 6 7 8 9 10

2. How much had you heard about (each restoration activity) in the VCR/ Eastern Shore area prior to tonight (1=nothing at all,, 10= quite a bit).
   Sea grass 1 2 3 4 5 6 7 8 9 10
   Bird habitat 1 2 3 4 5 6 7 8 9 10
   Clams for water quality 1 2 3 4 5 6 7 8 9 10

3. How do you think each of the following restoration activities would benefit YOU
   a. Sea Grass
      ____
   b. Bird Habitat
      ____
   c. Clams
      ____

4. Please design your 'ideal bundle' of restoration activities, based on your preferences. You have a total of 6 increments that can be used. (Please fill in the numbers below)

Bird Habitat Restoration	_______ increments
Clam Restoration	_______ increments
Sea grass Restoration	_______ increments
TOTAL	***6 increments***

5. What is your gender? Male / Female (please circle one)
6. What is your age? _____

7. How long have you lived in the Eastern Shore area? _____ (please enter in years)
8. In what county is your primary residence? (please circle one)
    a. Accomack
    b. Northampton
    c. other __________________
9. Do you own or rent your home? (please circle one)
10. If you own the house, is this your primary residence? Yes / No (please circle one)

11. Circle the highest level of education you have completed (please circle one)
    a. high school or less,
    b. bachelor's degree or some college,
    c. graduate degree (Master's, Ph.D. etc.) or some graduate school
12. Are you currently working for income? (please circle all that apply)
    a. Full-time
    b. Part-time
    c. Unemployed
    d. Retired
13. If you are currently working for income, how many hours per month do you typically work? _______And approximately how much are you paid per hour? ______
14. Which category most closely describes your household's income before taxes? (please circle one)
    a. Under A$25,000
    b. $25,000 to under $40,000
    c. $40,000 to under $50,000
    d. $50,000 to under $75,000
    e. $75,000 to under $100,000
    f. Over $100,000

15. Do you consider yourself a: (please circle all that apply)

a. A recreational fisherman
b. A commercial fisherman
c. A bird watcher
d. A recreational hunter

16. Have you ever participated in oyster gardening activities (yes or no)? (please circle one)
17. Do you or any member of your family work for a clam grower (yes or no)? (please circle one)
18. Have you ever donated money to environmental group(s) (yes or no)? (please circle one)
19. If you answered yes to the above, how often have you donated (please circle one)

a. Once
b. A few times
c. Regularly (monthly, yearly, etc

APPENDIX E: FIELD EXPERIMENT SECTIONS, 2009

Appendix E.0 General Instructions

Introduction

This project involves the value, in economic terms, that area residents have for environmental or ecosystem restoration. You will be asked to make decisions involving the allocation or spending of money to different sets of activities involving ecosystem restoration as well as other non-environmental benefits, including your household's uses.

The decisions you make tonight, through answering our questionnaire, will impact local restoration in the Eastern Shore area. All of the questions are potentially real – all could lead to real actions for spending money for environmental restoration or other purposes, as explained in each choice-question.

You might find the questions here involve difficult or easy choices, based on your personal preferences, values and priorities. Your answers will be confidential and will *not* be shared in any way that identifies you. Also, we recognize that your time is valuable and we hope you view any payments you take home from this session to be well-earned. Your participation is important to management and policy for coastal areas.

For this session, we are able to pay a $40 participation fee, no matter which choice question below is implemented. Thus, money referred to below is *in addition* to the $40 participation fee that we will give you at the end of tonight's session. Any money that you receive from this experiment (as a participation fee or from an implementation decision) may be used by you for a variety of purposes, such as

To pay your electric bill
To use toward holiday purchases
To add to your vacation fund
Or to add to your savings fund
To donate to the charity or "good causes" of your choice

These are all excellent choices and we are asking that you remember these needs and possibilities as you make decisions today. We also ask that you wait until you leave this building before making any decisions. Your responses are meant to be private.

General Instructions

1) The participants in today's session are a single group. Your group is important because in some questions the project coordinator will look at the combined decisions

of the group to determine the final outcome for a question. This will be explained more fully in the following instructions.

2) There are 5 separate sections, each with their own set of instructions and choice-questions. Please read each set of instructions carefully as I read them aloud, and do not hesitate to raise your hand if you have questions. The instructions will give you important information about the a) allocation of funds to restoration or to other activities and b) the specific restoration activities that could be provided and c) information on how your groups' decisions impact restoration.

3) You will be asked to answer approximately 12 choice-questions today. Each of these questions has the possibility for provision, but only one question will be implemented. Once every participant has completed the set of questions, the project coordinator will randomly choose one question. Based on the choices made by you and the people in your group, the results for that question will be implemented.

STOP and Wait Here

Appendix E.1 Attitude and Preference Questions

Section I

Please place an X in the under the column that you identify with most closely for each statement

It is important to me personally:	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
…that we preserve habitat for many fish species					
…that sea grass restoration brings a positive environmental benefit to my local area					
…that sea grass restoration aids water quality efforts					
…that I have opportunities to take part in environmental preservation activities					
…that we create opportunities for local bird watching					
…that habitat restoration brings a positive environmental benefit to my local area					
…that habitat restoration aids water quality efforts					
…that we preserve the local environment for future generations					
…that I have access to go fishing in my local area					
…that access to environmentally sensitive coastal areas is restricted					
…that local economies benefit from the sale of equipment, supplies or services related to coastal recreation and tourism					

Appendix E.2 Field 2009, Section II (CE^R)

For the questions in this section, you will make decisions between bundles of differing levels of restoration activities that contribute to additional ecosystem services, as well as an individual *rebate of cash* to you. In this section, each individual will be given a **personal budget** to allocate (or spend) in each choice-question. Please select the bundle that best represents your preferences –by voting for the option, Bundle A or Bundle B.

Determining the Outcome: The bundle that will be provided will be decided by **majority vote** of your group. For example, if your group has 10 people in it and 6 choose Bundle B and 4 choose Bundle A, then Bundle B will be the set of restoration activities provided and Bundle A will not be provided. All funds will be used for the restoration activity and take-home payment (either Bundle A **or** Bundle B) chosen by your group's majority.

EXAMPLE

For this question you have been given **$80** to make a decision with

	Bundle A	Bundle B
Bird Habitat Restoration	2 half-acres	1 half-acres
Sea Grass Restoration	3 half-acres	0 half-acres
Personal Cost	Bundle A will cost you $60 to help pay for the restoration above	Bundle B will cost you $50 to help pay for the restoration above

I vote to support (check one box below)

☐ Bundle A ☒ Bundle B

In the example question above, if your group has 10 people and the majority of people in your group chose Bundle B, and if everyone had the same allocations of money, then $500 ($50 x10) will be used towards the provision (or cost) of Bundle B and the project leaders will implement that bundle while paying $30 to you. Bundle A will not be provided at all. If you voted for A (and the majority voted for B) then your personal budget will be paid according to B because that is what the majority chose.

Please note: The dollar amounts above are only for example. Please make your decisions based only on the information provided in each choice question below.

For section II, you have a budget of $90 to make each decision with.

Question 1:

	Bundle A	Bundle B
Bird Habitat Restoration	3 increments	1 increments
Clam Restoration	2 increments	0 increments
Sea Grass Restoration	1 increments	3 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home	From your $90.00, Bundle B will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home

I vote to support (check one box below)

☐ Bundle A ☐ Bundle B

Question 2:

	Bundle A	Bundle B
Bird Habitat Restoration	2 increments	1increments
Clam Restoration	0 increments	1 increments
Sea Grass Restoration	2 increments	1 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.	From your $90.00, Bundle B will use $85.50 to help pay for the restoration above and you will receive $4.50 to take home.

I vote to implement (check one box below)

☐ Bundle A ☐ Bundle B

Question 3:

	Bundle A	Bundle B
Bird Habitat Restoration	3 increments	3 increments
Clam Restoration	1increments	2 increments
Sea Grass Restoration	2 increments	3 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home.	From your $90.00, Bundle B will use $85.50 to help pay for the restoration above and you will receive $4.50 to take home.

I vote to support (check one box below)

☐ Bundle A ☐ Bundle

Question 4:

	Bundle A	Bundle B
Bird Habitat Restoration	0 increments	1 increments
Clam Restoration	3 increments	3 increments
Sea Grass Restoration	2 increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $85.50 to help pay for the restoration above and you will receive a $4.50 to take home.	From your $90.00, Bundle B will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.

I vote to support (check one box below)

☐ Bundle A ☐ Bundle B

Question 5:

	Bundle A	Bundle B
Bird Habitat Restoration	2 increments	0 increments
Clam Restoration	3 increments	1 increments
Sea Grass Restoration	1 increments	3 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home.	From your $90.00, Bundle B will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.

I vote to support (check one box below)

☐ Bundle A ☐ Bundle B

Question 6:

	Bundle A	Bundle B
Bird Habitat Restoration	1 increments	0 increments
Clam Restoration	1 increments	2 increments
Sea Grass Restoration	1 increments	2 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $85.50 to help pay for the restoration above and you will receive $4.50 to take home	From your $90.00, Bundle B will use $40.50 to help pay for the restoration above and you will receive $49.50 to take home.

I vote to support (check one box below)

☐ Bundle A ☐ Bundle B

Question 7: Bundle A Bundle B

Bird Habitat Restoration	0 increments	2 increments
Clam Restoration	0 increments	1 increments
Sea Grass Restoration	1increments	0 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $18.00 to help pay for the restoration above and you will receive $72.00 to take home.	From your $90.00, Bundle B will use $18.00 to help pay for the restoration above and you will receive $72.00 to take home.

I vote to support (check one box below)

☐ Bundle A ☐ Bundle B

Question 8: Bundle A Bundle B

Bird Habitat Restoration	0 increments	1 increments
Clam Restoration	1 increments	2 increments
Sea Grass Restoration	3 increments	2 increments
Allocation of money, if this question is chosen for implementation:	From your $90.00, Bundle A will use $54.00 to help pay for the restoration above and you will receive $36.00 to take home.	From your $90.00, Bundle B will use $18.00 to help pay for the restoration above and you will receive $72.00 to take home.

I vote to support (check one box below)

☐ Bundle A ☐ Bundle B

STOP and Wait Here

Appendix E.3 Field 2009, Section III (IPA / PR / 4 units)

Section III
For the questions in this section, you will choose, based on your own preferences and needs, between allocating your funds between an environmental restoration activity (or set of restoration activities) and an amount that you can keep for your household's use. In this section, however, each question will ask about your willingness to contribute part of your budget towards different levels of additional restoration of a particular type. Each individual will again be given **a personal budget** to allocate (or spend) in each choice-question.

Determining the Outcome:
Your choice and the choices of the other individuals in your group will determine the level (in half-acre units) of each action influencing restoration activities and ecosystem services. This means that the project coordinator will look at the decisions of the entire group to determine how much restoration will be provided, if any. The project coordinator will begin by identifying whether your group's decisions allocated enough funds to pay the costs needed to implement one half-acre of the restoration activity, before moving on to evaluating whether your group allocated enough funds to pay for an additional half-acre, and so on. Depending on the decisions of all members of your group, the project coordinator will determine the highest level of restoration activities that can be achieved as the largest number of half-acres that can be provided from the funds your group allocated to each half-acre in that question.

After determining how many half-acres of the restoration activity can be provided, any money allocated by you and the members of your group that is *in excess of the pre-determined* cost to implement the restoration *will be rebated* to you and your group members. Your rebate will be in proportion to the excess of funds allocated by the group. For example, if the project coordinator determines that your group provided enough funds for the 4^{th} half-acre and your group allocated X% more money than was actually needed to implement the 4^{th} half-acre of restoration, then we will rebate X% of your money back to you as additional funds you can take home.

Instructions:
In this section, each question will provide you with a table, like the one below. Each question provides you with a personal budget ($100 for the example below) with which to make decisions for each part (a-d) of the question. Each part (a-d) will give you a *new opportunity* to allocate some amount of funds towards a certain level of restoration activities and the remainder for you to take home (or use in any way you choose).

You will make a decision for how much money to allocate (per half-acre) for varying levels of the restoration activity (1, 2, 3 & 4). The table will give you the breakdown of your funds, for each half-acre. You may choose to allocate a dollar amount pre-specified in the provided table or choose your own dollar amount, as long as it does not exceed your allocated budget.

For example, in column (a) you will decide how much to allocate on 1 half-acre. If you choose to pay $40 towards restoration, and enough funds are allocated from your group to provide the 1st half-acre of restoration, you will keep (take home) $60, plus any available rebate.

In column (b) you will decide how much to allocate for 2 half-acres of restoration activities. If you again choose to pay $40 per half-acre, you will allocate $80 ($40 x2) for restoration activities, and if enough funds are allocated from your group to pay for the 2nd half-acre of restoration, you will keep (take home) $20 plus any available rebate.

In column (c) you will decide how much to allocate for 3 half-acres of restoration activities. In this example, your budget is $100 which prevents you from allocating $40 per unit ($40 x 3 = $120), but does allow you to allocate up to $33.33 per unit (3 x $33.33 = $100) for restoration activities, and if enough funds are allocated from your group to provide the 3rd half-acre of restoration, you will take home $0.

In column (d) you will decide how much to allocate for four half-acres of restoration activities. In this example, your budget is $100, which prevents you from allocating $33.33 per unit, but allows you to allocate a maximum of $25 per unit ($25 x 4 = $100). In the example below, ‘choose your own’ price was selected, using $12 per half-acre or a total allocation for four units of $48 ($12 x 4).

You can make any allocation you like in each column. The above numbers are ONLY examples.

After the research coordinator determines the largest number of half-acres that can be provided, then any excess money allocated above the amount needed to implement the restoration will be rebated to you in proportion to the excess and added to your money to take home and use in whatever way you decide.

	(a)				(b)				(c)				(d)			
Per Unit Prices ($)	**price x 1 Half-Acre = Payment**				**price x 2 Half-Acres = Payment**				**price x 3 Half-Acres = Payment**				**price x 4 Half-Acres = Payment**			
0	0	x 1	=	0	0	x 2	=	0	0	x 3	=	0	0	x 4	=	0
5	5	x 1	=	5	5	x 2	=	10	5	x 3	=	15	5	x 4	=	20
10	10	x 1	=	10	10	x 2	=	20	10	x 3	=	30	10	x 4	=	40
15	15	x 1	=	15	15	x 2	=	30	15	x 3	=	45	15	x 4	=	60
20	20	x 1	=	20	20	x 2	=	40	20	x 3	=	60	20	x 4	=	80
25	25	x 1	=	25	25	x 2	=	50	25	x 3	=	75	25	x 4	=	100
30	30	x 1	=	30	30	x 2	=	60	30	x 3	=	90	**NAME YOUR OWN PRICE**			
33.3	33	x 1	=	33.3	33	x 2	=	66.6	33.3	x 3	=	99.9		x 4	=	
35	35	x 1	=	35	35	x 2	=	70	**NAME YOUR OWN PRICE**							
40	40	x 1	=	40	40	x 2	=	80		x 3	=					
45	45	x 1	=	45	45	x 2	=	90								
50	50	x 1	=	50	50	x 2	=	100								
55	55	x 1	=	55	**NAME YOUR OWN PRICE**											
60	60	x 1	=	60		x 2	=									
65	65	x 1	=	65												
70	70	x 1	=	70												
75	75	x 1	=	75												
80	80	x 1	=	80												
85	85	x 1	=	85												
90	90	x 1	=	90												
95	95	x 1	=	95												
100	100	x 1	=	100												
	NAME YOUR OWN PRICE															
OWN		x 1	=													

For this section, you have a budget of <u>$100</u> to make each decision with

Questions 9) a-d are specifically about sea grass restoration activities only.

Please *circle* your decisions for the allocation of your personal budget for each unit of *sea grass* restoration activities. You should circle one dollar value in each column, a-d, or fill in your own number at the bottom of each column in the space for "name your own price" (but not in excess of your budget).

Q.9

	(a)	(b)	(c)	(d)
Per Unit Prices ($)	**price x 1 Half-Acre = Payment**	**price x 2 Half-Acres = Payment**	**price x 3 Half-Acres = Payment**	**price x 4 Half-Acres = Payment**
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

Questions 10) a-d are specifically about bird habitat restoration activities only.

Please *circle* your decisions for the allocation of your personal budget for each unit of *bird habitat* restoration activities. You should circle one dollar value in each column, a-d, or fill in your own number at the bottom of each column in the space for “name your own price” (but not in excess of your budget).

Q.10

Per Unit Prices ($)	(a) price x 1 Half-Acre = Payment				(b) price x 2 Half-Acres = Payment				(c) price x 3 Half-Acres = Payment				(d) price x 4 Half-Acres = Payment			
0	0	x 1	=	0	0	x 2	=	0	0	x 3	=	0	0	x 4	=	0
5	5	x 1	=	5	5	x 2	=	10	5	x 3	=	15	5	x 4	=	20
10	10	x 1	=	10	10	x 2	=	20	10	x 3	=	30	10	x 4	=	40
15	15	x 1	=	15	15	x 2	=	30	15	x 3	=	45	15	x 4	=	60
20	20	x 1	=	20	20	x 2	=	40	20	x 3	=	60	20	x 4	=	80
25	25	x 1	=	25	25	x 2	=	50	25	x 3	=	75	25	x 4	=	100
30	30	x 1	=	30	30	x 2	=	60	30	x 3	=	90	**NAME YOUR OWN PRICE**			
33.3	33	x 1	=	33.3	33	x 2	=	66.6	33.3	x 3	=	99.9		x 4	=	
35	35	x 1	=	35	35	x 2	=	70	**NAME YOUR OWN PRICE**							
40	40	x 1	=	40	40	x 2	=	80		x 3	=					
45	45	x 1	=	45	45	x 2	=	90								
50	50	x 1	=	50	50	x 2	=	100								
55	55	x 1	=	55	**NAME YOUR OWN PRICE**											
60	60	x 1	=	60		x 2	=									
65	65	x 1	=	65												
70	70	x 1	=	70												
75	75	x 1	=	75												
80	80	x 1	=	80												
85	85	x 1	=	85												
90	90	x 1	=	90												
95	95	x 1	=	95												
100	100	x 1	=	100												
	NAME YOUR OWN PRICE															
OWN		x 1	=													

STOP and Wait Here:

Appendix E.4 Field 2009, Section IV (IPA / PR-KREV)

Section IV

For the questions in this section, you will face the same choices as you did in the previous section, except now you will have an opportunity to revise your offers if the highest possible level of restoration is not reached.

You will again choose between allocating your funds between an environmental restoration activity (or set of restoration activities) and an amount that you can keep for your household's use. Once all the first round (initial) offers have been made, the coordinator will determine, sequentially, how many half-acres of restoration can be provided and the result will be announced to the group. Then there will be an opportunity to revise your offers for any level of restoration for which the group's *initial offer* did not provide enough funds. For instance, if the decisions of your group's initial offers allocated enough funds to pay for only 2 half-acres, each member of your group will be asked if they would like to revise their offers for the 3rd or 4th half-acres. Revision offers must be higher than first round offers.

Determining the Outcome:
After determining the final level of the restoration activity that can be provided, any money allocated by you and the members of your group that is *in excess of the pre-determined* cost to implement the restoration *will be rebated* to you and your group members. Your rebate will be in proportion to the excess of funds allocated by the group. For example, if the project coordinator determines that your group provided enough funds for the 4th half-acre and your group allocated X% more money than was actually needed to implement the 4th half-acre of restoration, then we will rebate X% of your money back to you as additional funds you can take home.

The question in this section has 2 pages, one for your initial decision and one for the revision of your offers, if needed. The project coordinator will collect the initial decisions for both questions in this section and determine the highest level of restoration that can be provided by each group. On the second page of each question is a place for you to make a note of your initial offer choices in the event that a revision offer is relevant and you wish to revise your offers.

Note: Although group decisions will be calculated on the questions in this section before the end of tonight's session, these questions are no more likely to be the question randomly chosen for implementation than any other. If one of the questions in this section is drawn for implementation, the final offers (including any revisions) will be used to determine the outcome.

For this section, you have a budget of <u>$100</u> to make each decision with

Questions 11) a-d are specifically about sea grass restoration activities only.

Please *circle* your decisions for the allocation of your personal budget for each unit of *sea grass* restoration activities. You should circle one dollar value in each column, a-d or fill in your own number at the bottom of each column in the space for "name your own price" (but not in excess of your budget).

Q.11 (A)

Per Unit Prices ($)	(a)				(b)				(c)				(d)			
	price x 1 Half-Acre = Payment				price x 2 Half-Acres = Payment				price x 3 Half-Acres = Payment				price x 4 Half-Acres = Payment			
0	0	x 1	=	0	0	x 2	=	0	0	x 3	=	0	0	x 4	=	0
5	5	x 1	=	5	5	x 2	=	10	5	x 3	=	15	5	x 4	=	20
10	10	x 1	=	10	10	x 2	=	20	10	x 3	=	30	10	x 4	=	40
15	15	x 1	=	15	15	x 2	=	30	15	x 3	=	45	15	x 4	=	60
20	20	x 1	=	20	20	x 2	=	40	20	x 3	=	60	20	x 4	=	80
25	25	x 1	=	25	25	x 2	=	50	25	x 3	=	75	25	x 4	=	100
30	30	x 1	=	30	30	x 2	=	60	30	x 3	=	90	**NAME YOUR OWN PRICE**			
33.3	33	x 1	=	33.3	33	x 2	=	66.6	33.3	x 3	=	99.9		x 4	=	
35	35	x 1	=	35	35	x 2	=	70	**NAME YOUR OWN PRICE**							
40	40	x 1	=	40	40	x 2	=	80		x 3	=					
45	45	x 1	=	45	45	x 2	=	90								
50	50	x 1	=	50	50	x 2	=	100								
55	55	x 1	=	55	**NAME YOUR OWN PRICE**											
60	60	x 1	=	60		x 2	=									
65	65	x 1	=	65												
70	70	x 1	=	70												
75	75	x 1	=	75												
80	80	x 1	=	80												
85	85	x 1	=	85												
90	90	x 1	=	90												
95	95	x 1	=	95												
100	100	x 1	=	100												
	NAME YOUR OWN PRICE															
OWN		x 1	=													

Please make note of the decisions you made above on the next page

YOUR DECISIONS:
1 Unit __________
2 Units __________
3 Units __________
4 Units __________

Q.11 (B)
REVISION

Per Unit Prices ($)	(a) price x 1 Half-Acre = Payment	(b) price x 2 Half-Acres = Payment	(c) price x 3 Half-Acres = Payment	(d) price x 4 Half-Acres = Payment
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

STOP and Wait Here:

Appendix E.5 Field 2009, Section V (PM)

Section V

For the questions in this section, you will choose between allocating your funds between an environmental restoration activity (or set of restoration activities) and an amount that you can keep for your household's use. Each individual will again be given **a personal budget** to allocate (or spend) in each choice-question.

Determining the Outcome:
Your choice and the choices of the other individuals in your group will determine the level of each action influencing restoration activities and ecosystem services. This means that the project coordinator will again look at the decisions of the entire group to determine the how much restoration will be provided, if any. If one of these questions is randomly drawn for implementation, then the project coordinator will begin by identifying whether your group's decisions allocated enough funds to pay the costs needed to implement 1 half-acre of the restoration activity, before moving on to evaluating whether your group allocated enough funds to pay for an additional half-acre, and so on. Depending on the decisions of all members of your group, the project coordinator will determine the highest level of restoration activities that can be achieved as the largest number of half-acres that can be provided from the funds your group allocated in that question.

After determining how many half-acres of the restoration activity can be provided, the project coordinator determines your cost as follows: if the group offered more than enough to pay the cost of providing a given half-acre, the coordinator determines whether or not the restoration could still have been provided without your offer. If your offer is needed for that last unit, then you will need to pay only that portion of your offer that is needed to provide just exactly enough money to provide the unit. In this case, the coordinator calculates the discounted price for the last unit. If your offer is not needed for that unit, then you will pay nothing for the last unit provided (and you can use these funds at your discretion), and the last-unit discount price will be zero. Regardless of whether or not you get the last unit for free, your offer on the last unit provided will be your personal price for all the earlier units.

For example, if your offer for the 4th half-acre was \$20, and if all 4 half-acres are able to be provided by your group, then the most you would contribute is \$80 (4 x \$20). The project coordinator will determine if your \$20 is needed for the 4th half-acre unit: if only \$10 of your offer is needed for the last half-acre, then you will pay \$70, \$60 on the first 3 half-acres (\$20 x 3) plus \$10 on the last half-acre; if your offer is not needed for the last half-acre, then you will only need to pay \$60 towards the first 3 half-acres and the 4th half-acre is provided but at no cost to you.

Questions 12) a-d are specifically about bird habitat restoration activities only.

Please *circle* your decisions for the allocation of your personal budget for each unit of *bird habitat* restoration activities. You should circle one dollar value in each column, a-d, or fill in your own number at the bottom of each column in the space for “name your own price” (but not in excess of your budget).

Q.12

Per Unit Prices ($)	(a) price x 1 Half-Acre = Payment	(b) price x 2 Half-Acres = Payment	(c) price x 3 Half-Acres = Payment	(d) price x 4 Half-Acres = Payment
0	0 x 1 = 0	0 x 2 = 0	0 x 3 = 0	0 x 4 = 0
5	5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20
10	10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40
15	15 x 1 = 15	15 x 2 = 30	15 x 3 = 45	15 x 4 = 60
20	20 x 1 = 20	20 x 2 = 40	20 x 3 = 60	20 x 4 = 80
25	25 x 1 = 25	25 x 2 = 50	25 x 3 = 75	25 x 4 = 100
30	30 x 1 = 30	30 x 2 = 60	30 x 3 = 90	**NAME YOUR OWN PRICE**
33.3	33 x 1 = 33.3	33 x 2 = 66.6	33.3 x 3 = 99.9	x 4 =
35	35 x 1 = 35	35 x 2 = 70	**NAME YOUR OWN PRICE**	
40	40 x 1 = 40	40 x 2 = 80	x 3 =	
45	45 x 1 = 45	45 x 2 = 90		
50	50 x 1 = 50	50 x 2 = 100		
55	55 x 1 = 55	**NAME YOUR OWN PRICE**		
60	60 x 1 = 60	x 2 =		
65	65 x 1 = 65			
70	70 x 1 = 70			
75	75 x 1 = 75			
80	80 x 1 = 80			
85	85 x 1 = 85			
90	90 x 1 = 90			
95	95 x 1 = 95			
100	100 x 1 = 100			
	NAME YOUR OWN PRICE			
OWN	x 1 =			

You have now completed the main questions for our environmental study on coastal values.

Appendix E.6 Field 2009, Section VI (Demographic)

The next section is to help us understand audience characteristics, these questions are also very important to the study. Your name will not be linked to any of your answers and again, ALL information will be kept strictly confidential.

Statistical/Demographic

At the start of the session we spoke about the many good uses for any money you receive from this evening's activities. We would like to know how you think you may use this money, although you are under no obligation to spend your money in any of these ways and whatever you choose to do will be kept private. Please mark your decisions with an X next to any of the following:

______To pay your electric bill
______To use toward holiday purchases
______To add to your vacation fund
______To add to your savings fund
______To donate to the charity or "good cause" of your choice

1. How clear and certain are you about how the implementation of each activity would be (1=not very certain at all; 10=completely certain). Please circle a number in each case:

   Sea grass 1 2 3 4 5 6 7 8 9 10

   Bird habitat 1 2 3 4 5 6 7 8 9 10
2. How much had you heard about (each restoration activity) in the VCR/ Eastern Shore area prior to tonight (1=nothing at all, 10= quite a bit).

   Sea grass 1 2 3 4 5 6 7 8 9 10

   Bird habitat 1 2 3 4 5 6 7 8 9 10
3. How do you think each of the following restoration activities would benefit YOU
   a. Sea Grass ____
   b. Bird Habitat

      ____
4. Please design your 'ideal bundle' of restoration activities, based on your preferences. You have a total of 7 half-acres that can be used. (Please fill in the numbers below)

Bird Habitat Restoration	_______	half-acres
Sea grass Restoration	_______	half-acres
TOTAL	***7***	half-acres

5. What is your gender? Male / Female (please circle one)
6. What is your age? _____
7. How long have you lived in the Eastern Shore area? _____ (please enter in years)
8. In what county is your primary residence? (please circle one)
   a. Accomack
   b. Northampton
   c. other __________________
9. Do you own or rent your home? (please circle one)
10. If you own the house, is this your primary residence? Yes / No (please circle one)

11. Please circle the highest level of education you have completed (please circle one)
    a. high school or less,
    b. bachelor's degree or some college,
    c. graduate degree (Master's, Ph.D. etc.) or some graduate school
12. Are you currently working for income? (please circle all that apply)
    a. Full-time
    b. Part-time
    c. Unemployed
    d. Retired
13. Which category most closely describes your household's income before taxes? (please circle one)
    a. Under $25,000
    b. $25,000 to under $40,000
    c. $40,000 to under $50,000
    d. $50,000 to under $75,000
    e. $75,000 to under $100,000
    f. Over $100,000
14. Do you consider yourself: (please circle all that apply)

a. A recreational fisherman
b. A commercial fisherman
c. A bird watcher
d. A recreational hunter

15. Have you ever participated in oyster gardening activities (<u>yes</u> or <u>no</u>)? (please circle one)
16. Have you ever donated money to environmental group(s) (<u>yes</u> or <u>no</u>)? (please circle one)
17. If you answered yes to the question 16, which category below best describes your total annual contributions (please circle one)
    a. \$1 - \$100
    b. \$101 - \$500
    c. \$501 - \$1000
    d. Over \$1000

Thank you very much for participating in our experiment. Please add any additional comments in the space below/ on the back.

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