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The Bobolink Project: Selling Public Goods from Ecosystem Services Using Provision Point Mechanisms[#]

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The Bobolink Project: Selling Public Goods

from Ecosystem Services Using Provision Point Mechanisms

Abstract: We report a two-year field experiment that solicited residents of Jamestown, Rhode Island, USA, to contribute funds to support contracts with farmers willing to provide a portfolio of public goods associated with improving the nesting success of grassland birds, particularly the Bobolink. A direct-mail marketing experiment collected funds through four provision point, money-back guarantee mechanisms: a voluntary contribution mechanism with a proportional rebate; a pivotal mechanism based on the Clarke tax; and two novel uniform price auction mechanisms. Valuation estimates recovered from the voluntary contribution mechanism approached that of the pivotal mechanism, with one uniform price auction falling lower.

Keywords: nonmarket valuation; ecosystem services; broker; aggregator; field experiments; cultural ecosystem service; grassland habitat; agriculture; environmental stewardship.

Introduction

The provision of public goods remains a perpetual challenge for any society striving to improve the general welfare, and for economists seeking to understand societal or individual responses to opportunities involving public goods. Economists in various fields work to understand the values of public goods or institutions for their attempted provision. For example, environmental economists address obstacles to measure the benefits of, or willingness to pay for, public goods, while experimental and behavioral economists strive to understand institutions that provide public goods, or mechanisms that might improve their provision (Andreoni 1993; Cropper and Oates 1992; Falkinger et al. 2000; Groves and Ledyard 1977; Kling et al. 2010; Ledyard, 1995; Smith 2000). The complexities of human psychology (Camerer and Fehr 2006) foreshadow that the application of experimental mechanisms likely will leave economists to evaluate performance that, at best, approximates the theoretical, efficient ideal because incentive-compatible mechanisms generally prove impractical (cf., Laffont 1987, p. 567). While research continues regarding efficient mechanisms (e.g., Falkinger et al. 2000), economists increasingly

develop and evaluate mechanisms designed for practical application in the absence of government's coercive authority.

We report on a large scale, natural field experiment (cf. List 2008) which applies a previously-studied mechanism and introduces new mechanisms to elicit actual monetary contributions from private citizens toward provision of a public good. Under the trade name *Nature Services Exchange (NSE) of Jamestown*,[1] we conducted a direct mail campaign among all residents of Jamestown, Rhode Island, USA, eliciting payments in support of grassland nesting bird habitat. This good benefits homeowners who seek a community with a rural character, or an agrarian landscape in harmony with Nature, comprising aesthetic public goods which the MEA (2005) framework would classify as a cultural ecosystem service.[2] Using a split-sample design, our analysis assesses the potential of three provision point mechanisms to serve as real, market-making mechanisms for public goods, with *NSE* acting as broker. While this study contributes to an understanding of ecosystem service values, in particular we address the challenge of developing mechanisms that might capture a large portion of willingness to pay as actual revenues that can enable new, continuously functioning markets for public goods.

Overview of Contributions to the Literature

This study contributes to several threads of inquiry into the values of public goods and institutions for their provision. First, we leverage experimental and applied economics work on better understanding factors influencing contributions to public goods, by extending lab work to the field, and extending fieldwork on donations, to apply incentive-based mechanisms in the field. Our contribution begins from the observation that we do observe individuals voluntarily contributing to public goods provision, such as through non-profit conservation organizations, despite strategic advantages of free-riding. Thus, we expect that it is possible to attract funds for public good ecosystem services, and that variations in the rules of the funding mechanisms may

[1] We operated the *NSE* in collaboration with EcoAsset Markets, Inc., of Providence, Rhode Island,

[2] We will not sort out competing frameworks for ecosystem services here. Our example of managing hayfields for grassland birds tended to provide aesthetic benefits that the MEA defines as cultural services, but one could consider aspects relating to supporting services (habitat supporting aesthetic benefits), regulating services (carbon storage in root mass, nutrient removal from runoff water), or others in the MEA framework. A key here is a focus on public goods being provided; Jamestown residents were asked to pay for the specific action of hayfield management centered on bobolinks.

lead to differences in provision success. Other researchers have focused on mechanisms to provide efficient levels of public goods, developing, for example, complex voluntary mechanisms (e.g., Groves and Ledyard 1977) widely viewed as impractical (cf., Ledyard 1995; Laffont 1987) or coercive methods (e.g., Falkinger et al. 2000) which require government authority for implementation. In contrast, we target the empirical question of whether relatively simple mechanisms might perform well in the field, supporting development of a practical, if theoretically imperfect, market for public goods.

In the field, we implement key features of processes that successfully generate support for induced value and real public goods in laboratory settings. While voluntary contribution mechanism fails to achieve efficient provision (see Ledyard 1995), establishing a threshold—or provision point—for a well-defined group of people can successfully induce higher contributions toward a public good. In a provision point mechanism (PPM), if aggregate contributions meet or exceed the provision point threshold, the public good (or a discrete unit of it) is provided; otherwise, the good is not provided and all contributions are refunded. Bagnoli and Lipman (1989) show provision points induce an interior Nash equilibrium of the contribution game, enhancing social efficiency. Isaac et al. (1989) and Bagnoli and McKee (1991), *inter alia*, observe higher contributions in PPMs than in mechanisms without provision points. In application, the chosen provision point (PP) may be established *a priori* by the fund raiser in an effort to reduce the incentive to free-ride or cheap-ride (Bagnoli and Lipman 1989; Poe et al. 2002; Rondeau et al. 2005; Rose et al. 2002), thereby increasing contributions per person, or it may be established exogenously by costs of supplying a unit.

To generate revenues, we draw further from the experimental literature by modifying the rules for returning contributions in excess of the provision point via alternative rebate rules. Our first mechanism, however, establishes a benchmark for measuring value in order to enable an evaluation of revenues generated by other mechanisms. Mechanism designers have separated agents' offers to support public projects from their actual payments, in an attempt to promote an equilibrium strategy for agents to truthfully reveal their full value. Our version of the pivotal mechanism (PM) collects an agent's contribution only if her contribution is "pivotal" in the sense

that it is required to reach the provision point, given the contributions of all other agents; her full offer is rebated if it is not required (Clarke 1971). While this mechanism provides incentives for truthful value revelation, in general it fails to raise revenues, so we implement the PM using external funds to support actual provision, thereby establishing an incentive compatible baseline estimate of willingness to pay for habitat management, setting a benchmark for comparing contributions received from our revenue-generating mechanisms.

Our first revenue-generating mechanism is based on Marks and Croson (1998), Rondeau et al. (1999, 2005), and Spencer et al. (2009), who assess rules regarding the distribution of contributions in excess of the provision point. Their studies find evidence that a rebate of excess funds in proportion to each contributor's share of aggregate contributions--a proportional rebate (PR)--improves the PPM's performance in terms of the proportion of willingness to pay that an individual offers as a contribution.

In pursuit of revenue-generating mechanisms, we arrive at our second contribution by introducing and applying two new mechanisms for public good provision. We implement two novel uniform price (UP) procurement auctions for public goods, described below. The UP auctions establish rules whereby contributors pay no more than an auction-determined maximum, a characteristic analogous to the single price that consumers find in markets for private goods. While we do not investigate the particular motives of contributors, the PR and UP approaches might be attractive under different notions of fairness, which have been shown to affect outcomes in games of social significance (e.g., Andreoni 1993; Camerer and Fehr 2006; Fehr and Schmidt 1999; Palfrey and Prisbrey 1997; Shang and Croson 2009). In the PR, contributors pay the same proportion of their offer (which could imply the same proportion of their value), while under the UP frameworks no one pays more than a maximum endogenous to the auction, and in one form of the UP all who do pay are asked to pay the same. For experimental or behavioral economists, the study provides an indication of how these factors might manifest in markets outside a tightly controlled lab, and whether the rules of trade might leverage social preferences to improve efficiency.

Our third contribution is that our application elicits values for attributes of nonmarket ecosystem services. While constrained by attributes that actually exist in available farm contracts, offering real ecosystem services in exchange for real payments provides consequential data to contrast with hypothetical approaches.[3] Here, the inclusion of an incentive compatible benchmark mechanism provides an opportunity to understand the extent of free ridership that may suppress revealed values in other consequential contexts. Because the NSE product is a specifically defined service provided by local farmers, rather than a general or open-ended environmental or conservation program, variation in individual price and participation rules is feasible. These features of the study contrast with, for example, Poe et al. (2002) and Rose et al. (2002), whose field component involved a relatively broad green electricity program offered at a single price dictated by the electric utility.

The fourth contribution of this study supports entrepreneurs interested in the role of marketer or broker in markets for the private provision of public goods. Many existing programs to provide ecosystem services from farmland use payments for ecosystem services funded by government tax revenue or philanthropic donations. These programs yield suboptimal outcomes because the levels and goods provided are subject to political influence or formulae that are disconnected from specific local preferences or beneficiaries' desires. A continuously operating private market could improve on these programs, but must overcome the challenges of free ridership. While this might seem an ambitious goal, we operated the *NSE* in collaboration with EcoAsset Markets, Inc., of Providence, Rhode Island, a private firm intent on this mission.

In what follows, we introduce our study site and describe the specific public. We then describe the PPMs and PM included in the study, the data collection process, econometric results, and we draw some conclusions.

[3] Details of such a contrast is beyond the scope of the current paper, but the consequential nature of choice presented to Jamestown residents is in the spirit of Newell and Swallow (2012) who developed a survey-based choice experiment with real monetary payments in a valuation study with consequential choices for land conservation.

Study Site and the Public Good

Conanicut Island is an irregularly shaped, 9.7 square mile island in Narragansett Bay, and is incorporated as the Town of Jamestown, Rhode Island. It comprises an exurban community of approximately 2400 homes with about 5600 year-round residents in neighborhoods or village centers, scattered among farm and forest land, averaging 580 residents per square mile. The town is 30 minutes from Providence, Rhode Island, and 80 minutes from Boston, Massachusetts. Jamestown also attracts seasonal residents from New York, three hours away. Farm operations occupy approximately 450 acres, or 7% of the island; importantly, most farmland is in the center of the island and along main roads and bridge access points, and a reminder of the town's rural character during residents' daily or weekly travels. About nine small farms maintain hayfields in support of grass-fed beef, goat, or dairy operations. In Rhode Island, these well-managed hayfields constitute a prime habitat for grassland-nesting bird species.

The focus of our ecosystem service marketing effort, the Bobolink (*Dolichonyx oryzivorus*), is a legally protected, but not endangered, neotropical migratory songbird that is among many bird species experiencing substantial population declines (Perlut et al. 2006; Sauer et al. 2008), and has therefore been designated as a "species of concern" by Partners in Flight, a collaborative of governmental and non-governmental organizations. The Bobolink is a visible, easily identified species: one of only a few species that sings while in flight, the distinctively marked black, yellow, and white males establish territory with flights over open grassland that feature a clear, easily identified song resembling the whistling trill of the *Star Wars*' movie character R2-D2. Unfortunately, the primary nesting season coincides with the peak nutritional value of hay, leading farmers to schedule harvests that destroy nests or expose eggs or chicks to immediate predation. Between late May and early July, hay harvesting leads to nearly complete (99%) loss of Bobolinks' breeding effort (e.g., Bollinger et al. 1990). However, if compensated, farmers may be able to alter their management plans and arrange supplemental sources of feed, so that they may forego or delay an early summer harvest to allow nesting success.

Hayfield management to protect nesting Bobolinks represents an ecosystem service that researchers can control within a typical research budget. Wildlife ecologists note that nesting

bobolinks breed in hayfields of at least 10 acres (4.5 ha), particularly if embedded in a landscape of additional grasslands totaling at least 20 acres (9.1 ha) or more (cf., Vickery et al. 1994). Thus, we worked with members of the Jamestown Farm Viability Committee to establish contracts for fields of at least ten acres, bilaterally negotiating prices of around $5500 per acre for full time farmers which was close to the maximum opportunity cost of hay reported in agricultural statistics. Some cooperators were part-time farmers and agreed to contracts of substantially lower cost.[4] These contract costs are the basis of the provision point under PPMs, although research-grant funds were used to establish *a priori* subsidies so that provision points for some fields could be less than the actual cost paid to farmers.

We established contingent contracts with four farmers managing a total of six fields in 2007, and with three farmers managing a total of four fields in 2008. Bobolinks had been confirmed to be present in and displaying territorial behavior in all fields the year prior to the contract. Each contract specified that the researchers would inform farmers (by early May 2007 and by 1 April, 2008) whether their contracts would be paid to prohibit hay harvesting and grazing from the end of May to beginning of July (about 45 days). Contracts specified a payment of 50% of the cost by late May and the other 50% after 7 July and confirmation of performance. While our marketing campaign described other potential benefits, including habitat for other species, sustaining agrarian views over fields, and farm viability, our direct mail materials focused on a specific farm-wildlife contract for a specific field.

Mechanisms to Provide Public Goods: Raising Revenue and Establishing Value

To establish our experimental market, we implemented four provision-point mechanisms (PPMs) to test for differences among them, seeking to examime: which of the three revenue-raising mechanisms generated the highest offers for the ecosystem service being sold, and whether any of them achieved the same level of offers as our fourth mechanism, an incentive

[4] Given the small number of available farms in Jamestown, and our cooperative relationship with farmers, we did not attempt to minimize contract costs, though that would be an important element of a continuously operating two-sided market. In other northeastern U.S. states, the same contract might cost $2500 or less, but in Rhode Island the historic loss of farmland implies that remaining farmers may need to import supplemental feed from long distances; Jamestown farmers reported years of experience bringing feed from other states (e.g., Delaware and New York) and Ontario, Canada.

compatible pivotal mechanism (PM). In the PM, it is a dominant strategy for respondents to offer their full value or Hicksian willingness to pay (WTP).[5]

All four PPMs establish a threat of non-provision by tying the provision point (PP) to a contract with farmers who agree to manage a hayfield for our public good. Each field, or unit of the public good, is assigned to a group of *N* participants (households) who are responsible for the provision or non-provision of a unit of the public good. For each group, the provision point carries a money-back guarantee, so that the broker refunds all contributions if the group fails to meet their PP.

Each mechanism then consists of two rules: (*i*) a provision rule, which determines whether offers are sufficient to provide the good, and (*ii*) a payment rule, which determines how much each participant pays, and receives as a rebate, based on her own offer, b_i, and the offers of everyone else. In addition, we implement two versions of each mechanism: an open-ended version, where participants are given a menu of possible offers and a blank to fill in, and a dichotomous choice version, where participants are asked to offer, or decline to offer, a specific amount.

Proportional Rebate (PR) Mechanism

Our first mechanism, PR, rebates money collected in excess of the provision point in proportion to each person's offer as a fraction of total contributions. In this mechanism, the good is provided if $\sum_i b_i \geq PP$. The aggregate excess contributions, $(\sum_i b_i - PP)$, are then rebated so that the individual's net payment is in proportion to his or her offer relative to the group's aggregate offers. Thus, *i*'s final payment, c_i, is given by the payment rule

$$c_i = \begin{cases} b_i - R_i & if \ \sum_k b_k - PP \geq 0 \\ 0 & otherwise \end{cases} \quad (1)$$

where $R_i = \frac{b_i}{\sum_k b_k}(\sum_k b_k - PP)$, and the last line of (1) implements the money-back-guarantee.

Under this mechanism, all individuals will pay the same share of their offer as anyone else in their group. As a provision point mechanism that provides the good whenever $\sum_i b_i \geq PP$,

[5] The PM is weakly incentive compatible, meaning individuals choosing to reveal their full WTP may do better but will never be harmed relative to an alternative strategy, but outcomes of group decisions under PM can, but often do not, penalize individuals who fail to reveal their actual WTP (cf., Clarke 1976; Kawagoe and Mori 2001).

any set of bids where every person *i* offers less than or equal to her value for the public good and where $\sum_i b_i = PP$ is a Nash equilibrium (Bagnoli and Lipman 1989). However, there are many bid vectors, $b=\{b_1,\ldots b_N\}$, that meet this condition, and they have much different distributional consequences, with each person preferring a bid vector wherein b_i represents a low share of the *PP*. Especially in large, spatially dispersed groups playing the game one time, this is a very difficult equilibrium selection problem. One way to think about the role of alternative mechanisms is that they return excess contributions in ways that present different marginal incentives for offering a higher b_i than *i*'s most preferred equilibrium vector, in hopes of attracting sufficient contributions to provide the good in disequilibrium. Marks and Croson (1998) showed that PR attracts more contributions than a mechanism without rebates because if an individual contributes more than absolutely necessary given the offers of others, the rebate provision reduces the penalty-rate for over-contribution to below one.

Uniform Price Auction (UPA) Mechanism

For our second mechanism, we introduce a novel uniform price procurement auction (UPA) with a minimum revenue constraint represented by the provision point. In this case, the provision rule depends on both the level and distribution of contributions. The broker evaluates all offers received and searches to identify a maximum uniform price, which is the lowest individual cost, $\bar{c}$, that produces just enough revenue to meet the *PP* such that $n \leq N$ individuals who offer $b_i \geq \bar{c}$, just pay $\bar{c}$, while individuals offering less than the uniform price $\bar{c}$ pay nothing. Thus, the provision rule requires that a provision point $\bar{c} = \min\{p > 0 : np = PP, n = |\{i : b_i \geq p\}|\}$ exists, for which $\sum_{i=1}^{N} b_i \geq PP$ is a necessary, but not sufficient, condition. Individual *i*'s payment rule is given by:

$$c_i = \begin{cases} \bar{c} & if\ b_i \geq \bar{c} \text{ and } \bar{c} \neq \emptyset \\ 0 & otherwise \end{cases} \qquad (2)$$

It is possible that bids received will fail to provide the good, even though that same set of bids might have exceeded the provision point in aggregate, because no payment is collected from

people offering less than $\bar{c}$. If offers are inadequate to find a uniform price $\bar{c}$, then the good is not provided and all offers are refunded under the money back guarantee.

This property alters the Nash equilibrium structure for UPA, as there are only N possible uniform prices, representing the cost being divided among $n \leq N$ individuals each paying *PP/n* (see Li et al. 2012), but the fundamental equilibrium selection problem present in other provision point mechanisms persists. The UPA was motivated both to appeal to participants' views of fairness, as well as to leverage some incentive properties of uniform price auctions. First, the property that all who pay will pay the same may be viewed as more fair, by distributing the actual cost equally among those who pay (cf., Camerer and Fehr 2006), and by focusing the funding burden on people who make higher offers, who may also have higher values. Second, the uniform price may help participants perceive a market that connects payment to a market-like price for a particular good; in this sense, the UPA is more like familiar markets, albeit markets for private goods rather than a donations approach to philanthropic public goods. Third, the calculation of the uniform price begins to separate the participant's payment from her actual offer, as in a Vickrey auction. However, UPA does lack the incentive compatibility of a second-price auction: a bidder would prefer to make a lower offer if doing so would exclude him or her from the group that actually pays, while still enabling provision of the unit of the public good.

Uniform Price Cap Auction (UPC) Mechanism

Initial experience with the UPA, both in the 2007 field experiment reported here and in some preliminary laboratory experiments, suggested that meeting the revenue requirement for a typical *PP* and group size was empirically challenging. We therefore modified the UPA to include low-bidders within the group of payers, creating a uniform price cap auction that we introduced into the field experiment in 2008, replacing the UPA.

The UPC modifies UPA to assure the provision if aggregate bids meet the provision point, such that $\sum_{i=1}^{N} b_i \geq PP$ The UPC payment rule collects offers b_i that are below the uniform price $\bar{c}$, establishing the uniform price as a cap on payment. Thus, the payment rule requires the

calculation of a uniform price cap $\bar{c} = \min\{p > 0 : \sum_{k \in \{k:b_k < p\}}^{N} b_k + np = PP, n = |\{i : b_i \geq p\}|\}$ and

determines payment by:

$$c_i = \begin{cases} \bar{c} & if\ b_i \geq \bar{c}\ and\ \bar{c} \neq \emptyset \\ b_i & if\ b_i < \bar{c}\ and\ \bar{c} \neq \emptyset \\ 0 & otherwise \end{cases} \qquad (3)$$

Since the provision rule is the same as PR, UPC has the same set of Nash equilibrium outcomes, and the same equilibrium selection problem. However, the incentives for making offers in each value range around the uniform price are different. UPC preserves the notion of equity among those making high offers, as in UPA, perhaps encouraging them to offer higher amounts with impunity if the money is not needed, but does not absolve those making low offers. If those making low offers have lower values, it allows them to participate in funding, though perhaps at a higher proportion of their value than for those with higher values.

To clarify the differences among these three revenue-generating mechanisms, Figure 1 compares how revenues from PR, UPA, and UPC are calculated from a common set of hypothetical offers from *N* individuals, shown in descending order of b_i. PR lowers all bidders' net payment, c_i, proportionately. UPA and UPC set a uniform price or cap, creating a revenue rectangle of dimension $\bar{c}$ by *n* for UPC that collects revenue as well from the triangle of low-bidders. However, for UPA the revenue rectangle would require a higher uniform price $\bar{c}'$, with a corresponding width *n'*, to attempt to compensate for dropping low-bidders from the group who pay.

Pivotal Mechanism (PM)

We also apply the Pivotal Mechanism (PM) to establish a baseline measure of Hicksian willingness to pay against which we can evaluate whether participants make offers under the revenue-raising mechanisms that approximate their willingness to pay. The PM is a Clarke (1971) tax that establishes a weakly incentive-compatible choice by requiring payment from a bidder only when that person's offer b_i would make or break the ability to provide the unit of

public good for his or her group. The provision rule is that the good is provided if $\sum_{i=1}^{N} b_i \geq PP$. For the open-ended version, *i*'s payment is:

$$c_i = \begin{cases} PP - \sum_{j \neq i} b_j & if \ \sum_k b_k \geq PP \ \ and \ \sum_{j \neq i} b_j \leq PP \\ 0 & otherwise \end{cases} \quad (4a)$$

Bidders pay only if pivotal, and then, in the open-ended version, only the portion of their bid that would actually be needed to enable total contributions to equal the *PP* if all other bids had been collected. Typically few or no participants will be pivotal, so few payments are collected and little money is raised; the PM is intended to elicit accurate WTP values, not to raise revenues.

In the dichotomous choice version of the PM, Das (2007) shows the payment rule needs to be modified to maintain incentive compatibility. In this case, the auctioneer gives *i* a choice of agreeing to offer a_i. If the participant agrees, her bid is $b_i = a_i$; otherwise $b_i = 0$. For the dichotomous choice version of PM, the payment rule is:

$$c_i = \begin{cases} b_i & if \ \sum_k b_k \geq PP \ \ and \ \sum_{j \neq i} b_j \leq PP \\ 0 & otherwise \end{cases} \quad (4b)$$

The Nash equilibrium of the PM is also an equilibrium in dominant strategies, for each participant to offer her true maximum willingness to pay for the public good. Offering just above true value creates a situation where *i* could be expected to pay more than her value, and offering just below could mean that the good is not provided when *i* would have found covering the difference to be privately beneficial. While the PM creates a dominant strategy incentive to reveal, Kawagoe and Mori's (2001) lab experiments show that participants in a pivotal mechanism auction may have difficulty realizing the dominant strategy because they do not often experience being pivotal. They suggest providing participants with an explanation of the dominant strategy when value measurement is the goal.

Open-Ended (OE) and Dichotomous Choice (DC) Response Formats

The literature on stated-preference valuation shows that in a dichotomous choice situation, individuals will agree to a prespecified payment that exceeds the payment they might offer through an open-ended solicitation to name a contribution.[6] In implementing these mechanisms

[6] Champ and Bishop (2006) provide a review and an empirical example with real payments.

above, we created two presentation forms for the solicitation to contribute: One gave a discrete choice (DC) amount to agree to pay or to decline to pay (yes, no), with no opportunity to name another amount. The second approach we designate as "open ended" (OE) for ease of exposition, but the actual implementation presented potential participants with a payment card listing possible offer-values to choose among while also presenting an opportunity to fill in a blank with some other level of payment. Our experimental design enables an examination regarding whether these presentation formats affected responses in both presentations.

Hypotheses

We test these four mechanisms, each in open-ended and dichotomous choice versions, as treatments in a large field experiment in which roughly 2800 households are asked to buy into an ecosystem service which is a public good. Our data will include the treatment to which each household is assigned, and the corresponding response of an agreement to pay alternative amounts, with agreement signified by actual payment using a personal check. Our objective is to identify which mechanism treatment(s) generate the highest offers of payment for changes in hayfield management, so our first hypothesis is:

Null Hypothesis one: Payment offers generated by PR, UPA, UPC, and PM are equal.

Alternative Hypothesis one: Payment offers generated by PR, UPA, and UPC are unequal, but are all less than under PM.

Absent an empirically predictive theory giving expected revenue rankings for the four mechanisms, we state this hypothesis empirically: we have no *a priori* ranking of offers from each mechanism, except that PM is theoretically capable of providing estimates of full Hicksian WTP. Since the revenue-generating mechanisms are not incentive compatible, one expects that payments under these three mechanisms would fall below PM. However, a revenue-generating mechanism that produces a spectrum of offers approaching Hicksian WTP would be an important element in the process of creating a functioning market for public goods.

In addition to the rebate rules of the mechanisms themselves, we evaluate the effects of presentation format. For the revenue-generating mechanisms, we consider:

Null hypothesis two: Payment offers under the OE and DC presentations are equal.

Alternative hypothesis two: (a) Payment offers under OE are less than under DC; (b) payment offers under OE with the low-list (OElow) of suggested payment amounts (lowest of $10) is less than under OE with the high list (OEhigh) of suggested payment amounts (lowest of $35).

We conjecture that the DC presentation may reduce cheap riding, where participants offer less than their value, and that anchoring effects will lead to higher offers when the minimum amount in the proposed offer list is higher.

For the pivotal mechanism, if individual offers are responsive to the incentive-compatibility property, then offers should be invariant to the OE and DC, and this equivalence might arise separately from the outcome for hypothesis one above:

Null hypothesis three: Payment offers under OE and DC for the PM are equal.

Alternative hypothesis three: Payment offers under OE are lower than under DC for the PM.

In addition to these primary hypotheses, we intend to evaluate whether demographic characteristics affect participants' valuation of or payment for the ecosystem service product. Such information could assist in design of marketing and designating groups of consumers for more cost effective sales in future applications.

Experiment Design and Implementation

In order to assess the viability of attracting contributions for ecosystem service public goods, and test hypotheses about differences in contributions among incentive mechanisms, we asked residents of Jamestown, RI, to support a contract with farmers who were willing to manage 10-acre hayfields for grassland nesting birds. With funding from the U.S. Department of Agriculture, Natural Resource Conservation Service, secondary interest concerned identifying how values might be affected by some attributes of the hayfields regarding wildlife potential and visual access by non-farm residents of Jamestown.[7]

[7] The real payment, real consequence nature of our experiment limited the range of offered alternatives to those we could actually contract on Conanicut Island. Uchida et al. (2007) reports on the results of a stated preference study regarding tradeoffs among attributes.

Sampling Frame

We built our sampling frame around the six available farm-field contracts in year one (2007) and the four available contracts in year two (2008), using a commercially available mailing list for households listing Jamestown as their primary residence. We randomly assigned all Jamestown households to groups, with each group responsible for providing one of the available fields. The 2007 fields had some variation in acreage, with fields A, B, and C each 10 acres, field D available with that farmer either as a 6.2 acre portion (with particularly high Bobolink density) or the full 18 acre field, and fields E and F approximately 11 acres (Table 1a).

Fields A, B, and C could be described identically based on attributes, enabling a split-sample comparison of the PM, PR, and UPA mechanisms. For these fields, we assigned 440 Jamestown home addresses. With the variation represented in the two versions of field D along with field E, we created a split sample comparison of PR and PM. This split sample was feasible because the rules of exchange under PR and PM could describe the individual's payment conditional on the sum of offers from all individuals in their group. We assigned 414 addresses to each version of field D, and 440 addresses to field E, and respectively split evenly these between PR and PM treatments. Finally, we assigned the remaining 440 addresses to UPA for field F.

These samples were further split evenly between the DC and OE presentations; within the OE presentation, the sample was split evenly between OEhigh and OElow, except for UPA where one-third of the sample was assigned to each of the OEhigh, OElow, and DC presentation formats. The OE presentation is implemented with a list of suggested payments, OEHigh with a menu of {35,50,80,100,120} and OELow with a menu of {10,20,35,65,80}, each with an option to fill in a different amount. Within the DC presentation, prices $10 and $20 were assigned to 16% of the sample, $35 and $50 to 14% each; and prices $65, $80, $100, and $120 were each assigned to 9.9% of the sample. After accounting for non-deliverable addresses, deceased individuals and those who requested removal from the study, Table 1a reports the net initial mailings for 2007 for 2741 homes receiving mail from the original list of 2898 homes.

Table 1b also shows the attributes of the four available fields that were described in the presentation to households for 2008 fields G, H, I, and J. All fields were configured to be described as 10-acres, with or without a view from a primary road in Jamestown. Based on qualitative feedback from participants in 2007, we replaced the attribute listing the number of bird territories with a range of supported fledglings based on ecological experts' expectations of the number of females a territorial male could defend and the number of territories identified in prior years. Table 1b also reveals that the PM and PR mechanisms were assigned to individuals in the groups for fields G, H, and I.

While we updated the mailing list in 2008, we tried to identify people who had received 2007 mailings and strove to maintain about half the households in the mechanism-presentation combination that they received in 2007. We also replaced UPA with UPC, and replaced OELow with OEHigh. The other addresses were assigned systematically across treatment-presentation combinations they previously had not received. This assignment yielded an initial mailing for 2008 of 459 and 461 for PM in the DC and OE treatments, respectively; 464 and 463 for PR in DC and OE, and 376 and 568 for UPC in DC and OE treatments. Table 1b summarizes this assignment by mechanism for the 2684 deliverable addresses in 2008.

The design in Tables 1a-b involves split samples of treatments spread across two or more fields. Marketing materials did not provide treatment information to individuals, but rather focused their decision on the field described and the rules of exchange applying to their payment. In both years, we described the individual's payment in both PR and PM as conditional on the sum of offers in the person's group as compared to the provision point, without revealing that the group might consist of a mix of individuals making decisions under PR and PM; the research grant budget included an allowance to cover budget shortfalls arising through the PM. With regard to the option of two acreage sizes for field D, provision of the small (6-acre) field, D1, depended only upon the response of only those individuals receiving the small-field solicitation. If D1 were to be provided, then the sum of all payments from individuals in both the D1 group and the D2 group would be used to determine whether the offers received would cover the provision point for the 18-acre configuration of field D. In this manner, individuals in the group

for D1 could receive a larger field than they anticipated, while the cost for the larger field still depended upon its established provision point and group. These approaches enabled us to establish split samples that balanced for mechanism and field descriptions, while maintaining truthful information in marketing to each household.[8]

Marketing

Our experiment mimics a direct-mail marketing business under the unique trademark, *Nature Services Exchange of Jamestown (NSE).* Prior to mailing offers, we conducted a month-long advertising campaign in *The Jamestown Press*, a weekly local paper distributed to all residents' households free of charge. Despite free delivery, this newspaper provides substantial news, information, and independent reporting, and town residents are known as consistent readers, using the *Press* as a key vector for community cohesion. In 2007, each full-page ad featured a single photograph of a pastoral scene, the *NSE* logo, a set of key words around the ad's theme, and a couple of sentences explaining the theme (e.g., Figure 3). Themes included an initial announcement that we had contacts with farmers and would be contacting residents about executing the contracts; an explanation of the declining status of bobolinks; providing information on declining farming activity in Jamestown over 40 years; highlighting the other species affected by our contracts; how our bobolink-friendly haying practices enhance the financial viability of farms; and announcements that the solicitations were being mailed and of the deadline for payment. In 2008, we hired an environmental marketing firm, *Marketing for Change*, and developed a more community-centered lifestyle branding associated with the *NSE*. This effort focused on the birds living within a human community, establishing a branding theme around "Their home, your home town." The sampling process involved two mailings of a brochure and offer-letter to all households during March and April in both years.[9] Feedback through phone calls or email from recipients indicated that our advertising was noticed, and

[8] It was not impossible that the group D could have met the provision point for the 18-acre field without group D1 first meeting the provision point for the 6-acre configuration, but this was judged as extremely unlikely as the provision point for the 18-acre field was nearly three times the cost of the 6-acre configuration. Previously, Newell and Swallow (2012) used this type of overlapping configuration of alternative land parcels in valuation using real conservation choices.

[9] In 2007, first mailing was on March 16 and the second on April 16. In 2008, the first mailing was on March 1, the second on April 10, and a reminder post card was sent April 14.

information relayed by farmers of the Jamestown Farm Viability Committee indicated that the attention reached throughout Jamestown.

Our 2007 marketing effort encountered some resistance from the local land trust, which raised concern that we might confuse residents during the land trust's own private campaign to raise $5 million to purchase conservation easements on three farms. These easements would not assure provision of grassland habitat services for nesting birds. The land trust published an open letter in the *Press*, expressing the land trust's support for conservation efforts generally, but also concern that the "bobolink project" might distract from their goals. The land trust also mailed this letter to all residents during our 2007 market, potentially enhancing the visibility of our market. However, during the winter of 2007-2008, the land trust's partnership with the town government generated some controversy which resulted in taxpayer funding of a larger than anticipated share of the easement costs, potentially generating a downward pressure on participation in our market for spring 2008. The land trust engaged in no similar activity during our 2008 market period. As our experiment involves a direct-mail marketing implementation, rather than a survey project, we were unable to obtain data to gauge the consequences, positive, negative, or inconsequential, on individuals' decisions in our market.

The Solicitation

The solicitations was mailed to one randomly selected adult in each household and included a cover letter explaining the project, a full-color brochure with *NSE* branding, and a payment card (e.g., Figure 2) that provided the specific opportunity to offer payment. This individualized payment card described the field to which the subject was assigned, the mechanism through which the subject could make an offer through submitting payment by check or credit card authorization for the maximum payment offered. Instructions noted that refunds or rebates would occur according to the rules of exchange described on the payment card. The marketing materials omitted the provision points and exact locations of hayfields to protect the farmers' confidentiality and to avoid generating idiosyncratic information effects regarding individual farms or farmers.

Figure 2 shows a sample payment card used for the pivotal mechanism with a binary (DC) payment choice. The top left column outlines the features of the product being offered. The top right section explains how the subject's payment is calculated based on their offer and the offers of others in their group.[10] All payment cards included the text at the top of this payment card, through the first two numbered paragraphs, providing information that residents were placed in groups and assigned specific fields, the purpose of raising funds across the group, the deadline for payment offers, and wording to implement the money back guarantee and provision point. The third numbered paragraph, subsequent bullet points, and the paragraph beginning "Because…" was adapted for each payment mechanism and for the DC and OE presentations. Figure 2 shows this material for PM. Text for additional mechanisms is in the Appendix.

The marketing package included a return envelope addressed to the project at the University of Rhode Island. We established an April 30 deadline for receipt of contributions, in order to notify farmers prior to the May 7 beginning of the contracts. The first packet was mailed to all subjects in March, followed by a second packet to non-respondents in mid April. In 2008 we also sent a reminder postcard after the second mailing. The package encouraged response by requesting that recipients return the card, even if their decision is "No, thanks" (Figure 2).

Results and Analysis

Tables 1a and 1b summarize the response rates and amounts of money offered for each field under each mechanism. In total, we received offers for all fields of $9,763 in checks and credit card authorizations in 2007, and $6,555 in 2008. Three fields, A, B and E were provided in 2007, and two, G and J, in 2008. Others failed to receive enough offers to meet their respective provision points.

The overall response rate was 13.3% in 2007 (12.7%, 13.4%, and 13.7%, respectively for PM, PR, and UPA) and 7.86% in 2008 (7.46%, 8.60%, and 7.52%, respectively for PM, PR, and

[10] The notion of being pivotal is termed "critical" in this exposition. Since the mechanism descriptions are unfamiliar to many people, somewhat complicated, and our main treatment of interest, we worked through many versions of the descriptions. We pretested the descriptions with students and staff, but process timing prohibited formal focus groups emphasizing mechanisms.

UPC). This decline in response could reflect qualitative feedback from residents who received rebates or refunds under the rules of exchange, but expressed a preference not to receive money back. Alternatively, the decline could reflect the controversy surrounding the local land trust's actions between our market seasons or it could reflect a strategic move toward free-rider behavior. Available data do not permit us to distinguish among these explanations. Nonetheless, this participation rate is considerably higher than common direct-mail marketing experience.

Tables 1a and 1b show that the majority of respondents actually made an offer (54.7%, 203 of 371 respondents in 2007; 66.8%, 141 of 211 in 2008). Average responses varied by mechanism, and ranged from $14.58 (under UPA in 2007) to $36.78 (under UPC in 2008); average contributions (zeros removed) ranged from $32.73 (UPA 2007) to $53.09 (PR 2008). Contrary to expectations, the average offer under PM is below PR and also below UPC, reflecting that the incentive compatible mechanism may not have been successful in eliciting true values.

Econometric Model

Given the dimensional complexity of our treatment design, we test our hypotheses with an econometric model, which has two stages, separating the binary choice to respond from the choice of amount to contribute toward changes in hayfield management. The participation choice equation is of interest in helping to identify who are likely participants, what aspects of offers are more likely to lead people to read and respond, and as a control for endogenous selection in the econometric model of conditional offer.

We model both participating and conditional offers using field attributes, mechanism treatment attributes, and information about the individual household. Specifically, (*i*) the attributes of the fields available to the respondent's group, with size (*Acres*), the number of bobolink territories observed in the preceding summer (2006 or 2007) (*NTerritory*), number of fledglings stated in the payment card (*NFledglings*, set to zero for 2007 data), and whether the field provided a view from main roads (*View*, where 1 indicates "yes," 0 indicates "no," and 0.5

indicates "partial" view);[11] (*ii*) features of the presentation, with *DC* as a dummy variable taking a value of one for the DC presentation and zero otherwise, and dummy variable *OEhigh* taking a value of one for the OEhigh presentation and zero otherwise; (*iii*) identifiers for the mechanism, using effects-coded dummy variables with PR as the base mechanism, so that in the three effects-coded variables *PMe*, *UPAe,* and *UPCe* all take a value of negative one (-1) to represent the PR treatment, while these take a value of one for respondents under the treatment corresponding to the variable name, and a value of zero otherwise;[12] (*iv*) variables capturing interactions between the mechanisms and the DC presentation, created as the product of *DC* with each effects-coded variable, respectively generating *PMe*×*DC*, *UPAe*×*DC*, and *UPCe*×*DC*; (*v*) variables capturing respondent-specific characteristics, as obtained from the marketing company that provided the mailing list; (*vi*) a dummy variable, *Y08*, taking a value of one for 2008 data, zero otherwise; and (*vii*) a variable indicating the natural log of the minimum amount of money the respondent viewed in his or her payment card, *lnMinAmt*. This last variable equals the log of the minimum amount presented to the respondent, which is the amount presented in a DC treatment or the lowest amount presented in an OEhigh or OElow treatment. In addition, variables interacted with *Y08* are identified with suffix "*08*."

Respondent-specific characteristics for the addressee include the natural log of purchasing power (*lnPPower* in $\$10^3$);[13] *Age* in years; a dummy variable *DonateAny* equal to one for individuals with past donations to any cause, zero otherwise; *MOkids* equaling one for those who mail ordered products for children, zero otherwise; *DonateEnv* equaling one for those who previously donated to environmental causes, zero otherwise; and *HeadHouse* equaling one if the randomly selected adult in the household to whom our mailings were addressed was identified as head of household, zero otherwise. The marketing database contained missing values for some of these characteristics. Purchasing power data was missing for about 4% of our subjects, while

[11] In analysis reported here, we treat *View* as a continuous variable. In extensive pre-tests, we found no evidence that this assumption affects the main results. As will be seen, *View* is not a statistically significant factor in the models.

[12] In one model below, variables identifying the mechanisms other than UPA are removed; in that case we use a 0-1 dummy, *UPA*, taking a value of one for the UPA treatment and zero otherwise.

[13] Fifty-four observations with a purchasing power of less than $20k were coded as a purchasing power of 10k.

other attributes were missing somewhat more frequently but commonly as a set. To minimize the loss of observations due to missing values, we created variables IncomeMis (3% of observations), *MOkidsMis* (4%), and *DonateEnvMis* (5%) equaling one when data were missing for, respectively, purchasing power, mail-order behavior for kids, or donation behavior for environmental causes; these "*Mis*" variables equaled zero otherwise.[14]

Participation Equation

We considered subjects to have participated if they responded by returning their payment card, even if that card reflected an offer of $0 ("No, thanks"). While we did not receive precise information regarding non-respondents, participants confirmed their consideration of the solicitation and revealed their offer of zero or more. Thus participants provided information related to their utility from the farm field presented. Still, some non-respondents may have considered the solicitation before discarding the payment card. While non-response provides no information regarding the recipient's utility, it does provide information on the potential to obtain revenue. If non-response reflects a decision to express willingness to pay of $0, then we would expect dimensions of the contract to affect the participation decision.

Table 2 provides the baseline participation equation using the 2007 and 2008 data pooled as a panel data set and estimated with a random effects probit model to predict the probability that a subject chose to respond by sending a reply to the marketing package.[15] This model is statistically significant (χ^2 = 108.92, 26 df, p<0.001), yet most of its components are not individually significant at a 10% level. In particular, results show that the interactions included for the DC presentation, mechanisms tested, and *Y08* are not jointly significant (χ^2 = 7.374, 6 df, p=0.28); the four attributes of the farm field are not jointly significant (χ^2 = 0.692, 4 df, p=0.95); and the DC presentation and main effects of the mechanisms also are not jointly significant (χ^2 =

[14] If a "*Mis*" variable equals one, the corresponding primary variable equals zero and is not missing. Missing values for *HeadHouse* and *DonateAny* were almost universally captured by these three "*Mis*" variables. Extensive sensitivity analysis was conducted to assure results were robust to this approach.
[15] We used STATA10's *xtprobit*, to allow for panel data structure.

2.238, 4 df, p=0.69).[16] The main effect for *Y08* captures the between-year decline in participation.

These results show that older individuals, with higher income, and a past record of donating to any cause or environmental causes were more likely to respond to the direct marketing, while households with a record of mail-ordering children's goods (or missing data for such mail-ordering) were less likely to respond, while individuals with missing data for income or donations were more likely to respond. We conjecture that the *IncMis* is an indicator of higher income levels and supports our interpretation of results for *lnPPower,* which is borderline significant (P<0.06). Likewise, *MOkids* may identify households with higher pressure on their budgets or higher demands on their time.

The results in Table 2 also support the interpretation that most of the aspects of the treatments did not affect subjects' participation decision, suggesting minimal selection bias related to the treatment variables of interest. In particular, the attributes of the farm fields (e.g., *Acres* and *NFledglings*) and the rules of exchange (PR, PM, UPC, and UPA) and forms of presentation (DC and OEhigh) had no statistically significant effect on the participation decision. While the insignificance of the field attributes suggest variation in the value of the ecosystem services offered does not influence participation, the significance of *lnMinAmt* (p<0.01) suggests people were more likely to respond if requested or suggested to give a smaller contribution, reflecting that at least some of the non-respondents opened the marketing package and actually considered the offer.

Offer Equation

We estimate an offer equation to examine hypotheses one through three above. Although the participation equation suggests that the treatments of primary interest did not influence the participation decision, we use Wooldridge's (1995) panel version of a Heckman-type selection model to control for any selection bias due to the participation decision. In the selection stage,

[16] The likelihood ratio tests reported here assume coefficients are restricted to zero. The test for all these restrictions jointly also fails to reject the null hypothesis of zero coefficients (χ^2=10.305, 14 df, p=0.73). In addition, *OEhigh* is not statistically significant in all models (p=0.50).

we estimate a participation equation for each year of data separately, and calculate inverse-Mills ratios (*IMR*) from these equations. In the second-stage random effects regression of payment-offers on treatment variables and individual-specific characteristics, we include the *IMR* for each observation and an interaction between that ratio and *Y08* (*IMR08*).

We model offers with a random effects interval regression (e.g., Cameron and Huppert (1989) for an environmental valuation example) to account for the fact that our payment data comes in two forms: binary agreement or decline to pay a DC amount, and a payment selected from the OE list or filled into the blank.[17] Interval regression captures the dependent variable through upper and lower bounds that convey what is known about the respondent's willingness to make an offer. We conservatively interpret the actual offer, b_i, as a limited indicator of the participant's maximum willingness to make an offer (WTO), except we treat offers that the respondent wrote into the blank under an OE presentation as equal to their WTO.[18] For an offer b_i selected from the OE list, the interval regression treats the amount chosen as the lower bound on WTP and uses the next higher amount on the list as the upper bound. For a DC response of agreement to pay the DC amount, the regression treats that amount as the lower bound on WTO, while the upper bound is infinity. If a respondent declines to pay the DC amount, the regression treats zero as the lower bound on WTO and uses the amount presented as the upper bound. If a respondent wrote an offer in the blank under an OE presentation, the lower and upper bounds on WTO are both set to that value.[19] Coefficients are interpreted as for a standard regression model.

For purposes of estimating Wooldridge's correction for selection bias, we estimate simplified participation models using 2007 and 2008 data separately, as shown in Table 3. These probit models are used to calculate the inverse Mill's ratio variables *IMR* and *IMR08* in the offer equation. Although they do not leverage the panel nature of the data, results are largely consistent with Table 2: in the 2007 model only *Age* and *IncMis* are significant at conventional

[17] We used STATA's xtintreg command to implement the random effects regression, as described below.
[18] We use WTP to distinguish our offers from Hicksian WTP as the PR, UPA, and UPC mechanisms are not incentive compatible. In principle, WTP would equal WTP under PM.
[19] Our approach is similar to Champ and Bishop (2006) except they set the lower bound for the DC amount to negative infinity if the respondent declined to pay the amount presented.

levels, while the 2008 model also has the dummy variables for donations and mail-order purchases by individuals as significant along with *lnMinAmt*.

Table 4 contains the estimated offer equation. A primary unrestricted model, Model A, and several restricted versions of that model enable a discussion of the primary hypotheses.[20] Model B assesses the effects of mechanism-DC presentation interactions; Models C assesses effects of demographic variables; Model D omits all mechanism effects; and Model E omits all mechanisms except UPA. By likelihood ratio test, Model E cannot be significantly improved upon by adding additional mechanism variables, or significantly simplified by dropping demographic or UPA indicator variables.[21] Initially, we note that in all models IMR is borderline significant, with a significantly smaller selection effect for 2008.

First we consider hypothesis one, that all mechanisms produce similar offers. Given the omitted variable categories, the coefficients on the effects-coded mechanism variables measure the effect of the mechanism above or below the mean offer from all mechanisms under OElow.[22] From these results, we see that the PM treatment nominally increases the mean offer under OE, while both the UPA and UPC treatments reduce the mean offer in our base Model A (by about \$8.09 and \$3.58, respectively) and only UPA reduces the mean in models B, C and E (e.g., by \$9.76 and \$11.64 in models B and C). Given the effects coding, in unrestricted Model A, PR tends to add about \$11 to the mean, but this amount is almost exactly offset by a decline under the DC presentation with PR (see n. 22). These tendencies are largely consistent with observations in the last column of Tables 1a and 1b, which rank mechanisms by per-respondent contributions as UPC > PR > PM > UPA. However, the z-test of the coefficients for mechanism variables in the payment regressions are generally not statistically significant (Table 4).

[20] Expanding the unrestricted model, we examined the addition of *lnMinAmt* and *Y08* which influenced the participation equation, but these were not significant individually (Z equals 0.96 and 0.50, respectively with $p>0.50$) or jointly ($\chi^2 = 1.1869$, 2 df, $p=0.55$) in the offer regression. We therefore proceed from Model A.
[21] A comparison of Models E and A shows the restrictions in E are insignificant ($\chi^2= 4.651$, 5 df, $p=0.45$).
[22] By definition of effects coded variables each mechanism variable takes value -1 for PR. Therefore, the main effect and interaction effects for PR are calculated as the negative of the sum of the main effects coefficients and of the mechanism interactions. This gives the impact of PR relative to the mean across all mechanisms for OE and, with the interactions, for DC presentations.

A comparison of Model A to Model D tests hypothesis one, that the mechanisms all elicit the same offers. This likelihood ratio test fails to reject the null hypothesis that the main effects of the mechanisms, along with interactions with the DC presentation, generate statistically equivalent offers (χ^2=8.568, 6 df, p=0.19). This failure to reject the null also occurs with a comparison between Model B, which omits only the DC interactions, and Model D (χ^2=5.273, 3 df, p=0.15). However, Model E uses only a dummy variable for UPA, which is individually significant and reflects that UPA attracts a significantly lower average offer than the other mechanisms, by an average of $14.72 ($p$=0.05). This is important evidence that participants did evaluate, at least to some extent, the strategic aspects of the mechanisms, although the other mechanisms did not generate significantly different offers when considered in the multivariate context.[23]

To evaluate hypothesis two, we consider separately the open-ended, discrete choice comparison and the two versions of OE. Results across the models show that the main effect for *OEhigh*, which captures the difference in the mean offer under the higher OE series, is nominally $7-10, but not statistically significant (generally p>0.14); moreover, in preliminary models we found no reason to include interactions between the *OEhigh* and the mechanism variables. In contrast, the main effect of the DC presentation increases the mean contribution by about $30 and that result is highly significant (p <0.001 in all models). This suggests that cheap riding was both prevalent and economically meaningful in the OE treatments, as presenting a take-it-or-leave-it participation opportunity significantly increased the estimated average maximum WTO.

While there is no theoretical reason to expect that offers would be invariant to the presentation under the non incentive-compatible, revenue raising mechanisms, hypothesis three tests that PM offers are invariant to presentation, which they should be if respondents are revealing their true values in OE and DC treatments of the PM. From testing hypothesis two, we found the DC treatment significantly increases offers by roughly $30. To not reject hypothesis three, Model A's coefficient on *PME×DC* would need to offset that difference for the PM.

[23] The lower offers received under UPA in 2007 actually drove its replacement for the 2008 market.

However, *PME×DC* is nominally \$0.69, and not significantly different from zero (p=0.94), so the effect of DC persists under PM. This means it is unlikely that PM is eliciting respondents' true maximum willingness to pay for the ecosystem services, despite being incentive compatible.

In addition to the three hypotheses around which we built treatments, we are also interested in how individual-specific characteristics affect offers. Model C omits all demographic variables, and comparing it with Model B, indicates they are jointly significant (χ^2=14.730, 7 df, p=0.04).[24] Across the models, this joint significance is driven by purchasing power, which increases offers by roughly \$14 per *lnPPower*, and a history of mail-ordering childrens' goods, which decreases offers (p=0.01) by roughly \$24. Other factors were not individually significant (p>0.14), although results above showed that these factors did influence the participation decision.

Finally, we examine how the attributes of our farm fields affected offers, which could give insight into the nonmarket values for these ecosystem services in a real money experiment. Most of the field attributes were not significant (p>0.10), except that the number of fledglings emerged as borderline significant in parsimonious models D and E at (p=0.07 and p=0.05, respectively). This result is weak evidence that these attributes mattered to participants in an experiment that could not be designed to achieve strong results, due to limited variation in attributes of available farms in Jamestown. Furthermore, the market solicitation gave individuals a choice of only one field, so that the presentation did not explicitly encourage a consideration of these attributes in a manner similar to, for example, choice experiments or paired-comparisons used in stated preference valuation. Our own choice experiments with the Jamestown population did identify preferred tradeoffs among these attributes (Uchida et al. 2007).

Discussion

This two-year field experiment demonstrates that it is possible to attract payments for ecosystem services comprising public goods affecting a community's quality of life. By leveraging provision-point mechanisms from experimental economics, and introducing two new

[24] It might be noted that the rejection of the null is weaker if the test is included with a test of the mechanism-*DC* interactions in comparing Models C and A (χ^2=18.026, 10 df, p=0.055).

mechanisms, this study provides a proof-of-concept and also provides insight to the challenges of market-making approaches and of transferring mechanisms from economics laboratories to field implementation. Residents of Jamestown were not only responsive to the specific ecosystem service product, but also to market-making methods of soliciting revenues.

With provision-point mechanisms, it may be price, rather than process (or rebate rules), that most strongly determines payment offers. However, individuals do respond strategically. Results for the UPA mechanism at least weakly support the concept of differential impacts of marginal incentive rules. And results for the dichotomous choice (DC) and open-ended (OE, payment list) presentations indicate that in actual payment decisions, participants may avail themselves of opportunities to respond strategically. For example, in a focus group discussion in pretesting marketing materials, some individuals wondered aloud about our rationale for using the DC presentation, noting that we might lose contributors who would not pay, say, $80, but might have offered their own number, such as $52. Other focus group participants quickly noted that they may have been willing to pay a high price, but, if given the opportunity, an individual might provide a "low ball" offer. Indeed, our results show that on average the DC presentation increased offers per participant by $30, and without a significant effect on the participation rate.

An entrepreneur desiring to develop a revenue stream might balance the considerations of limiting strategic options through a DC-type presentation and loss of potential buyer-contributors when the amount suggested drives some individuals out of the market. In our ongoing field efforts, we have modified the DC presentation to set a minimum offer, allowing individuals to name a higher amount at their discretion, but disqualifying non-zero offers lower than the price in a modified-DC format. In principle, however, one could learn the relationship between individual-specific characteristics like income or previous support of environmental causes. An entrepreneur might then develop targeted marketing material that matches a DC amount differentially across, say, the local income distribution. Our groups were randomly composed, but in practice, a market broker might consider establishing groups around neighborhoods or some social connection among potential participants. Indeed, our field experiment anticipates the potential of an entrepreneur to use group size, relative to the distribution of values, as a

control variable in application of provision point mechanisms, a potential not explicitly recognized in many lab experiments. However, the effects of social connection on revenue performance remain an open question for research. Clearly there are transaction costs in such effort to optimize revenues per capita for a given community, and these transactions costs are contributors to the economists' consensus that private provision of public goods faces substantial obstacles to beating the incentives to free ride. Yet this represents a challenge for researchers, and taking on these challenges outside the laboratory may prove critical to, for example, the U.S. Department of Agriculture's efforts to move environmental markets forward.

Our study is subject to these challenges. Importantly, we intended that the PM approach would allow us to estimate the upper bound on willingness to pay for the aesthetic ecosystem services represented by farm-managed habitat for nesting birds. Available data suggests that the revenue-raising mechanisms, particularly PR and UPC, raised revenues that reflected statistically equivalent values relative to PM. Such a result could be taken as evidence that, in a second-best world, the non incentive-compatible mechanisms may produce a good approximation to revenue-raising methods under the as-yet elusive first-best ideal.

However, our qualitative results that offers per participant were higher in UPC and PR than in the incentive compatible PM are not consistent with theory. Our experience, in the field experiment and focus groups, suggests that incentive compatible mechanisms, including a broad class of pivotal mechanisms, may not be sufficiently transparent to participants in a one-time, mail-based auction, and may therefore not yield results consistent with the dominant strategy that individuals agree to offer at or just below their full value. Work such as that of Kawagoe and Mori (2001) implies a need to test marketing presentations that improve the transparency, for participants, not only of incentive-compatible mechanisms but also of the advantages of, or incentives for, cooperation under revenue-raising mechanisms. Our field experience endorses this concern.

Our field study appears to show that the UPA approach, introduced here, is inferior, while the UPC may be a reasonable modification to consider along with the PR approach familiar from existing literature. However, in lab experiments (Li et al., 2012; Liu et al., 2012),

we have evidence that a factor driving revenue generation (or value revelation) may be the balance between the provision point and the distribution of values for the group charged with provision of a unit. The UPA may prove inferior for revenue generation, but it may have practical value for understanding human behavior toward threshold public goods or measuring revealed value.

This first effort to conduct a field market involved substantial support from public funds to develop a demonstration project. While the revenues raised were substantial and paid a notable share of the actual costs of provision by farms on Conanicut Island, our experimental implementation did not balance revenues to include coverage of the substantial costs of marketing. In practice, prospective market makers might need to expand the scope of ecosystem services marketed in order to raise the value of the product offered and gain some scale economies in marketing. Alternatively, entrepreneurs might apply methods where ecosystem services may be offered at lower opportunity costs (such as in regions where larger expanses of farmland give farm producers more options).[25] Yet an alternative use of revenue-generating mechanisms might be to establish a public process that leads communities to reveal their values for ecosystem services, with results used to guide the allocation of government program dollars to those services or locations revealed as highest value. In our own study, we established provision points for groups after first designating a portion of our research budget to offset a part of the total negotiated cost of the farm-contracts. In a similar manner, subsidy payment programs could follow matching funds generated by ecosystem service markets or auctions as demonstrated here.

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Table 1a. Attributes, mechanisms, samples, and response for the hayfields in 2007

	Field							
Attribute	**A**	**B**	**C**	**D1**	**D2**	**E**	**F**	
Size (acres)	10	10	10	6.2	18	11.4	10.6	
2006 Territories	1+	1+	1+	3	4	1+	2+	
View	Yes	Yes	Yes	Partial	Partial	No	No	
Mechanism	*N of subjects net of non-deliverables*							**Total**
PM	427			195	187	205		1014
PR		429		200	204	212		1045
UPA			432				300	732
	N of Subjects who Made an Offer/Total Respondents [proportion who made an offer]							
PM	35/52 [0.673]			16/28 [0.571]	9/22 [0.409]	17/27 [0.630]		77/129 [0.597]
PR		34/60 [0.567]		14/26 [0.538]	19/29 [0.655]	14/26 [0.538]		81/141 [0.574]
UPA			31/64 [0.484]				14/37 [0.378]	45/101 [0.446]
	Amounts offered (total)							
PM	$1475			$645	$430	$660		$3210 ($24.88) [$41.69]
PR		$1790		$625	$965	$920		$4300 ($30.50) [$53.09]
UPA			$1390				$863	$1473 ($14.58) [$32.73]
Provided?	Yes	Yes	No	No	No	Yes	No	

Table 1b. Attributes, mechanisms, samples, and response for the hayfields in 2008

	Field				
Attribute	**G**	**H**	**I**	**J**	
Size (acres)	10 acres	10	10	10	
NFledglings[a]	6-10	6-10	14-18	10-14	
View	Yes	No	No	Yes	
Mechanism	*N of subjects net of non-deliverables*				**Total**
PM	260	255	356		871
PR	265	273	357		895
UPC				918	918
	N of Subjects who Made an Offer/Total Respondents [proportion who made an offer]				
PM	11/22 [0.500]	9/18 [0.500]	18/25 [0.720]		38/65 [0.585]
PR	19/25 [0.760]	10/19 [0.526]	25/33 [0.758]		54/77 [0.701]
UPC				49/69 [0.710]	49/69 [0.710]
	Amounts offered (total)				
PM	$625	$235	$660		$1520 ($23.38) [$40.00]
PR	$962.5	$360	$1175		$2497.5 ($32.44) [$46.25]
UPC				$2537.5	$2537.5 ($36.78) [$51.79]
Provided?	Yes	No	No	Yes	

[a]NFledglings corresponded to values of 1, 1, 3, and 2 for NTerritories, as presented in marketing materials for 2008.

Table 2. Random effects probit model of decision to return reply card

Variable	Coef	S.E.	P>|z|
Constant	-3.29	0.554	0.001
Acres	0.00569	0.0168	0.734
View	0.0971	0.107	0.366
NTerritory	0.00418	0.0506	0.934
NFledglings	0.00351	0.0258	0.892
OEhigh	0.0497	0.154	0.746
lnMinAmt	-0.148	0.0666	0.026
UPAe	0.0681	0.118	0.563
PMe	-0.0566	0.0983	0.565
UPCe	0.0355	0.143	0.804
DC	0.0307	0.160	0.848
UPAe×DC	0.0172	0.192	0.928
PMe×DC	0.145	0.144	0.316
UPCe×DC	-0.385	0.199	0.053
Y08	-0.516	0.307	0.093
PMe08	0.0281	0.126	0.824
DC08	0.0129	0.193	0.947
PMe×DC×Y08	-0.0908	0.182	0.617
lnPPower	0.146	0.0777	0.060
Age	0.0177	0.00412	0.001
HeadHouse	0.0134	0.110	0.903
DonateAny	0.284	0.107	0.008
DonateEnv	0.253	0.145	0.081
MOkids	-0.219	0.111	0.047
IncomeMis	3.24	0.887	0.001
DonateEnvMis	0.660	0.394	0.094
MOkidsMis	-2.26	0.815	0.006
σ_u	1.36	0.107	
□	0.649	0.036	

N=5425 observations on 3169 households
lnL=-1680.682 $\square^2(26)=108.92$

Table 3. Probit models estimating probability that a subject chose to respond to direct mail marketing, separating 2007 and 2008 data for use in Wooldridge correction for selection bias.

	2007 Data			2008 Data		
Variable	**Coef**	**S.E.**	**P>|z|**	**Coef**	**S.E.**	**P>|z|**
lnMinAmt	-0.05	0.038	0.191	-0.17***	0.064	0.007
lnPPower	0.08	0.053	0.115	0.06	0.065	0.333
Age	0.01***	0.003	0.001	0.01***	0.003	0.001
DonateAny	0.10	0.075	0.165	0.20**	0.090	0.024
DonateEnv	0.10	0.118	0.403	0.21*	0.113	0.065
MOkids	0.10	0.084	0.244	-0.36***	0.094	0.001
IncMis	1.12***	0.382	0.003	1.15*	0.689	0.094
DonateEnvMis	-0.13	0.192	0.506	-0.05	0.530	0.920
Constant	-1.99***	0.323	0.001	-1.73***	0.422	0.001
	N=2741			N=2684		
	lnL=-1069.13 $\chi^2(8)$=31.28			lnL=-709.25 $\chi^2(8)$=59.69		

Table 4. Results of interval regression of payment offers, corrected for selection bias (N=581 observations on 477 households)

	Model A			Model B			Model C			Model D			Model E		
Variable	**Coef**	**S.E.**	**P>|z|**	**Coef**	**S.E.**	**P>|z|**	**Coef**	**S.E.**	**P>|z|**	**Coef**	**S.E.**	**P>|z|**	**Coef**	**S.E.**	**P>|z|**
Acres	0.32	1.10	0.769	0.43	1.08	0.689	0.40	1.11	0.718	0.57	1.07	0.598	0.56	1.07	0.604
View	9.20	7.17	0.200	8.72	6.89	0.205	8.87	7.01	0.206	6.79	5.62	0.226	6.98	5.67	0.219
NTerritory	-3.46	3.12	0.268	-3.73	3.10	0.229	-4.79	3.11	0.124	-3.21	2.94	0.275	-4.21	3.00	0.162
NFledglings	3.11	1.67	0.063	3.18	1.63	0.051	3.61	1.64	0.028	2.93	1.61	0.068	3.25	1.63	0.045
DC	33.95	8.75	0.000	29.05	7.62	0.000	31.94	7.60	0.000	31.18	7.56	0.000	29.75	7.61	0.000
OEhigh	10.80	7.69	0.160	8.85	7.41	0.233	11.03	7.44	0.139	9.31	7.29	0.202	9.00	7.36	0.222
PMe	0.26	5.54	0.963	1.32	4.59	0.774	0.95	4.63	0.837						
UPA													-14.72	7.36	0.046
UPAe	-8.09	7.21	0.262	-9.76	6.07	0.108	-11.64	6.12	0.057						
UPCe	-3.58	8.65	0.679	0.38	7.80	0.961	1.65	7.88	0.834						
PMe×DC	0.69	9.02	0.939												
UPAe×DC	-7.70	11.85	0.516												
UPCe×DC	18.44	13.29	0.165												
lnPPower	13.80	5.66	0.015	13.97	5.64	0.013				14.11	5.67	0.013	14.33	5.65	0.011
Age	0.09	0.40	0.813	0.12	0.39	0.771				0.12	0.39	0.757	0.15	0.39	0.702
DonateAny	2.33	8.13	0.774	2.44	8.10	0.764				3.03	8.09	0.708	2.29	8.06	0.777
MOkids	-24.79	8.01	0.002	-24.23	8.00	0.002				-26.51	7.97	0.001	-24.81	7.99	0.002
IncMis	60.26	49.73	0.216	63.23	49.28	0.216				59.22	49.25	0.137	65.85	49.25	0.201
DonateEnv	12.18	9.84	0.226	12.14	9.80	0.199				14.61	9.82	0.229	12.56	9.83	0.181
DonateEnvMis	12.93	21.84	0.554	12.81	21.80	0.557				14.46	22.11	0.513	12.00	21.98	0.585
IMR	52.73	34.63	0.128	55.50	33.70	0.100	31.16	18.09	0.085	57.37	33.00	0.082	57.92	33.30	0.082
IMR08	-26.79	12.44	0.031	-27.12	12.08	0.025	-27.39	11.03	0.013	-25.36	11.69	0.030	-28.81	11.88	0.015
Constant	-124.70	86.89	0.151	-130.10	84.58	0.124	-25.67	31.96	0.422	-135.20	83.62	0.106	-132.10	84.29	0.117
σ_u	49.20	3.97		49.45	3.71		50.45	3.75		50.83	3.70		49.79	3.70	
σ_e	24.05	3.95		23.78	1.27		24.77	1.21		22.62	1.15		23.68	1.32	
ρ	0.81	0.07		0.81	0.03		0.81	0.03		0.84	0.03		0.82	0.03	
Wald χ^2(df)	53.05	21		52.26	18		39.25	11		47.56	15		50.70	16	
-LnL		768.93			770.58			777.95			773.22		771.26		

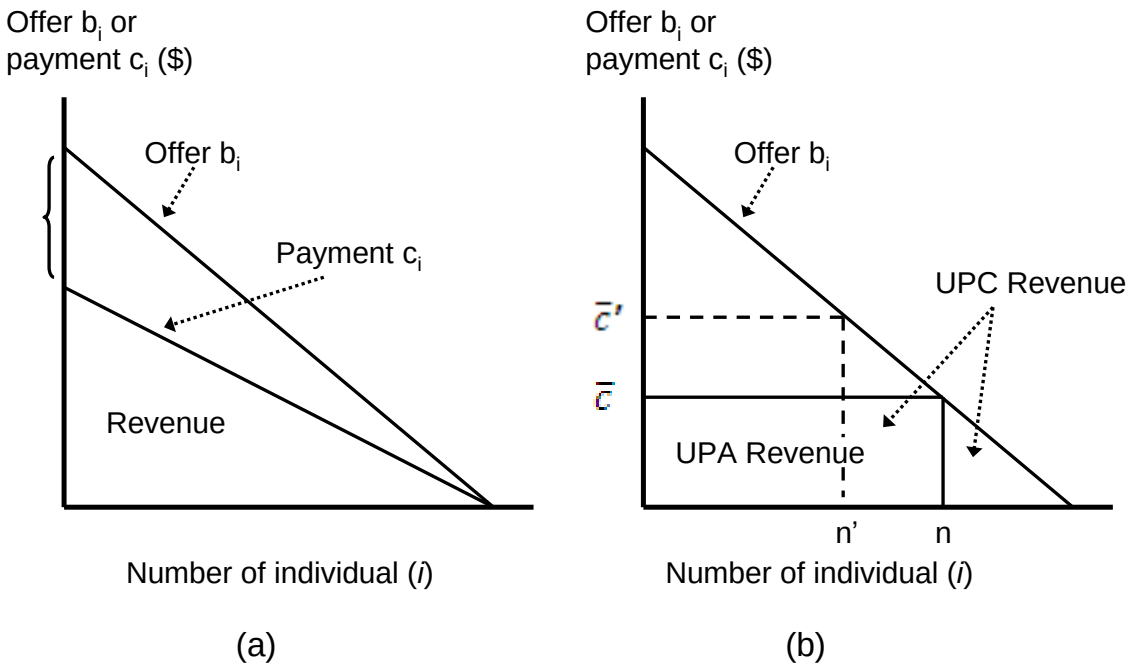

Figure 1. Comparison of revenues from (a) the Proportional Rebate (PR) mechanism and (b) the Uniform Price Auction (UPA) and Uniform Price Cap (UPC) for a given distribution of offers by a group of individuals.

Your Contract with the Farmer

Your group's farm-wildlife contract includes:

10 acres of active farmland in Jamestown

Viewable from public road

At least 1 bobolink territory found in 2006

No hay harvesting during nesting and breeding season (May 7th -July 6th)

No grazing during this period

Invitation to a bird walk in June

Here is how the process works:

We have randomly organized all Jamestown residents into "groups" for this market. Each group is assigned to a specific Jamestown farm field on which we could implement a farm-wildlife contract. Your group's contract is described on the left.

Each person in your group is being asked to make an offer to pay a share of the cost that the farmer will incur to implement this contract. Your participation is very important, and gives your group the best chance of implementing its farm-wildlife contract.

1. On April 30, we will total up the offers your group has made on its farm-wildlife contract.
2. We give a 100% money-back guarantee: If the total is too low to cover the contract cost, your group's farm-wildlife contract will not be implemented and no one will pay anything. Any money submitted will be refunded, and credit cards will not be charged.
3. If the total of your group's offers is more than enough to cover the costs of the contract, we will implement the contract and determine your payment as follows:
   - If the total of everyone else's offers—not including yours—is higher than the amount needed to implement your group's contract, then we really don't need your money. Because everyone else's offers are enough, we will implement the contract and you will pay nothing.
   - If the total of everyone else's offers is not enough to implement the contract, then your decision could be **critical**. If your offer raises the total offers high enough so we can implement the contract, then we need your money and we will collect the portion of your offered amount to meet the contract cost. (If the total offers including yours still falls short, then we cannot implement the contract and we will refund your money.)

Because you pay only when your decision is critical, it is in your interest to offer the highest amount you feel the farm-wildlife contract is worth to you. If you value the contract more than your offer, and if your decision is critical, a lower offer may prevent us from implementing the contract, when your highest value would have implemented the contract.

All offers must be received at URI no later than **April 30** to ensure that farmers can implement contracts in time for breeding of bobolinks and other wildlife. Once you have decided, please return the card below, with your payment if applicable. Even if you do not want to make an offer, please check the box marked "No, thanks" and return the form in the enclosed envelope. Your decision is confidential.

Thank you.

John Smith
123 Main Street
Jamestown, RI 02835
(If you prefer a different address, please indicate below.)

☐ I would like to make an offer for this farm-wildlife contract. ☐ No, thanks.

Please select a payment method:

☐ I authorize a **maximum payment** of (*circle one*) $80 $65 $35 $20 $10 other $_____.
The University of Rhode Island (URI) is authorized to charge my credit card for an amount up to this **maximum payment and will reduce my charge by a refund of any excess money, as described above.** I understand that URI will not charge my credit card until early May.

☐ Visa ☐ Mastercard ☐ American Express

Name on Card _____Card #: _____Exp. Date. _____

Signature _____

Billing address (if different from above): _____

☐ I have enclosed a check for my **maximum payment** of (*circle one*) $80 $65 $35 $20 $10 other $_____.
The check is made payable to the University of Rhode Island (URI). I understand that URI will deposit my check in early May and **will refund any excess money, as described above.**

URI will notify you of the outcome of your group's farm-wildlife contract, and return any money refunded, at the address above (please correct if you prefer an alternative address.)

Contract id# xxxxxxxxxxxxx

Figure 2: Sample payment card for discrete choice pivotal mechanism treatment, 2007.

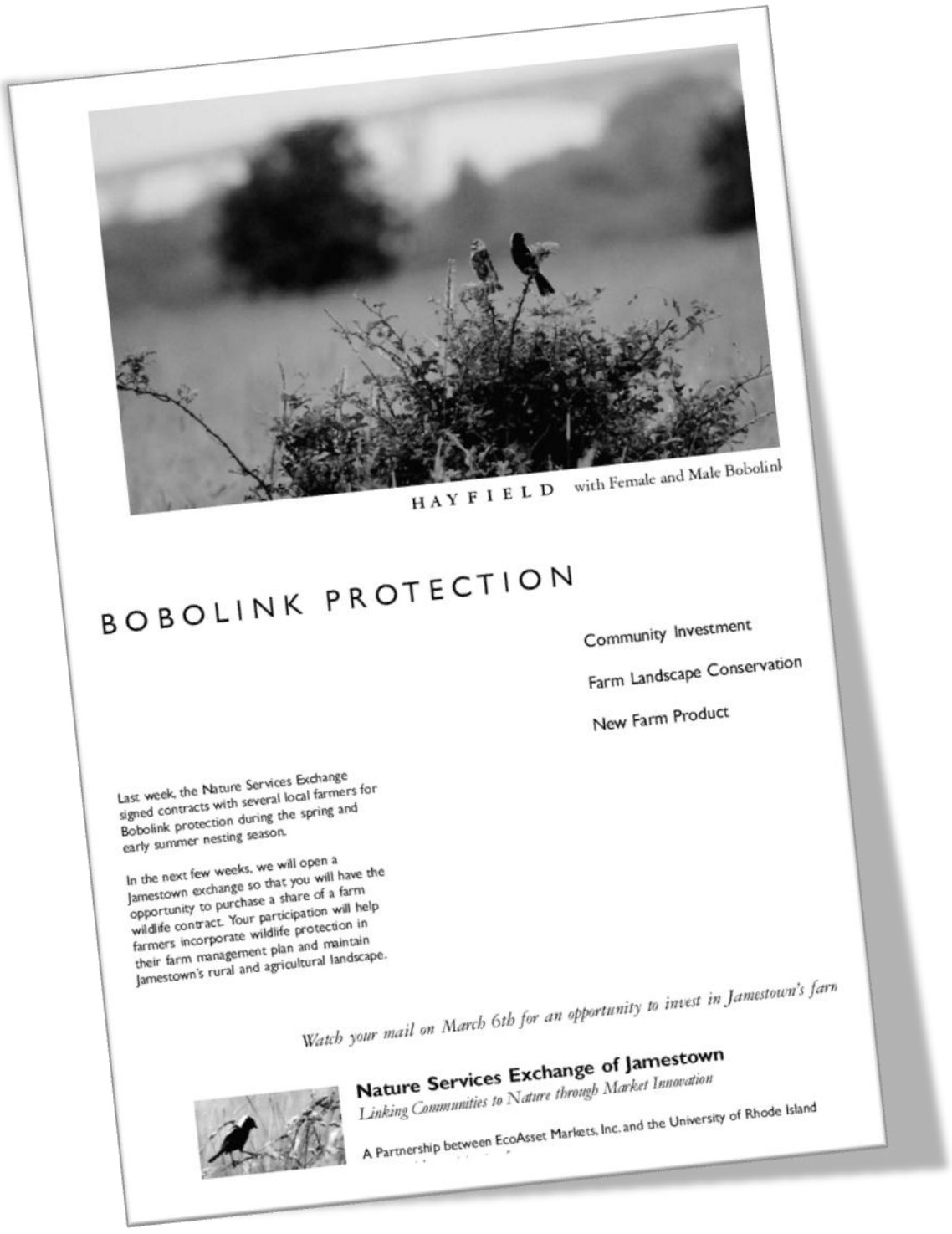

Figure 3: Example of a full-page advertisement in the local newspaper, 2007.

Appendix: Mechanism Descriptions from Payment Cards

The following text, for each mechanism, replaced the material in Figure 2 from the paragraph numbered "3" through the paragraph beginning "Because . . .," inclusive.

Proportional Rebate (PR)

3. If the total of your group's offers is more than enough to cover the costs of the contract, we will pay the costs to implement the contract and refund any extra money offered.

- All extra funds received will be refunded to everyone in proportion to their share of the total offers we received.

Making your highest possible offer increases your group's chance to succeed in implementing this contract. Remember that you will pay no more than the amount you offer, and it is possible that you would pay less.

Uniform Price Auction (UPA, 2007 only)

3. If the total of your group's offers is more than enough to cover the costs of the contract, then we will calculate a **"group price"** so that everyone who pays ends up paying the same price.

- We will try to find a group price that divides the contract cost evenly across the maximum number of people, while still collecting enough money.
- If the group price is higher than your offer, you pay nothing and receive a 100% refund.
- If the group price is lower than your offer, you pay only the group price and we will refund any excess money offered above that price.
- If too few people offered enough money, so that it is impossible to determine such a group price, the contract will not be implemented and you will pay nothing.

Making your highest possible offer increases your group's chance to succeed in implementing this contract. Remember that you will pay no more than the amount you offer, and it is possible that you would pay less.

Uniform Price Cap (UPC, 2008 only)

We are asking for your money now, but we will use it only if necessary. That is:

- We are asking everyone in your community group to contribute to a dedicated fund to buy a farm wildlife contract for the 2008 Bobolink nesting season.
- On April 30, if the fund contains sufficient money, we will buy the farm-wildlife contract.
- We will return any leftover money as follows. We will look for the lowest contribution that we can set as a "contribution cap" and still buy the contract. If your contribution was above this cap, we will return to you the amount you contributed above the cap. If the fund does not

contain enough to pay for the contract, then we will return all money collected and the hayfield will not be managed for Bobolinks this year.

This approach is designed to bring many people to participate at the same time, which means costs to you and each Jamestown resident in your group will be kept low.