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Addressing Social Dilemmas with Mascots, Information and Graphics

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ABSTRACT

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Addressing Social Dilemmas with Mascots, Information, and Graphics

1. Introduction

Nonpoint source (NPS) pollution remains a persistent social dilemma problem across the United States despite considerable financial investment in federal, state, and local pollution mitigation programs. Most of these programs offer financial incentives to individuals who voluntarily change their land management practices to reduce NPS pollution. By focusing on changing individual decisions, the programs have largely ignored the collective nature of NPS pollution, which is generated as a result of decisions of numerous landowners in a community. In addition, information about water quality outcomes is rarely provided to the land managers whose decisions directly affect it. We analyze how the provision of public information about water quality using mascots and different types of data graphics to amplify communication affects individual and group pollution-abatement behavior.

Our research makes three key contributions to the literature on social dilemmas and voluntary NPS pollution abatement. First, we analyze the impact of public information displays on individual and group-level behavior that affects water quality. We test for differential effects between positive and negative feedback to determine whether information framing influences behavior. Second, we use mascots to amplify the feedback provided by public information displays and study how collectively identifying with a mascot influences participants' behavior in an economic experiment. To our knowledge, no previous experimental economics research has analyzed the impact of mascots, despite the frequency in which they are encountered in a variety of contexts, including environmental social dilemmas (such as Smokey Bear and Woodsy

Owl). Third, we test the effect of three graphic data visualization tools on pollution abatement decisions.

The study involves a novel economic laboratory experiment designed to analyze how polluting behavior changes in response to feedback from mascots, public information, and data visualizations. Laboratory experiments have been widely used to test NPS programs and policies when real-world experimentation is not feasible or when preliminary data must be collected prior to testing interventions in the field (Cason and Gangadharan 2004, 2013; Cochard, Willinger and Xepapadeas 2005; Miao et al. 2016; Poe et al. 2004; Spraggon 2002, 2004, 2013; Suter et al. 2008, 2010; Vossler et al. 2006; Vossler, Suter and Poe 2013). The experiment reflects a traditional NPS pollution environment in which participants act as individual firms located along a stream within a watershed. Each firm chooses a level of production that generates firm income and creates pollution of the watershed as a byproduct. Thus, individual production provides private income while aggregate production imposes a public cost due to impaired water quality. The firms are located at different points along the river and a nutrient transport model determines how pollution from each firm expands and moves over time and through space. Previous studies have relied on simple models that, for example, have used a random error term to mimic uncertainty. Our model is spatially explicit—polluters' marginal damage functions are determined not only by the total contaminant load but by each firm's location in the watershed.

The experiment consists of a control group and groups presented with experimental treatments in three categories: (1) *public information* displays in which the outcome of the groups' ambient pollution contributions are announced using negative framing for excessive pollution and positive framing when the announced target is met, (2) *mascots* to amplify the public information about pollution outcomes—one that is connected to the participants' community and one that is not familiar, and (3) *data visualizations* that present the water quality outcomes using a table, a gauge, or a continuous pulse graphic. In the *control treatment*, participants receive information about water quality privately in the form of a simple data table.

The results of this research suggest that public provision of water quality information can limit polluting behavior, particularly when the information is negatively framed and reinforced using a community mascot. Additionally, how the water quality information is presented can influence polluting behavior. We find that a simple, colorful graphic of a water-quality gauge was more effective at reducing water pollution than a more-informative pollution pulse graphic and a basic data table. These results have implications for organizations trying to motivate individuals and firms to improve the quality of their water with nonmonetary incentives that promote collective action by a community.

2. Background

NPS pollution from nutrient and sediment loss is a leading source of water quality impairment in the United States, and it is inherently difficult to identify the origin of NPS pollution because it is produced by numerous sources and enters waterways via surface and subsurface runoff (U.S. Environmental Protection Agency (EPA) 2017). Partly because of those difficulties, the Clean Water Act does not directly regulate NPS pollution from farm land or lawns, and there is a disincentive for individuals to reduce their own emissions voluntarily because they incur a cost without capturing all of the benefit. Therefore, identifying effective approaches to encourage voluntary reduction of NPS pollution is an ongoing challenge (Ribaudo 2015). Economists have shown that taxes and subsidies on ambient pollution can achieve optimal pollution levels (Segerson 1988; Xepapadeas 2011); however, such approaches often are not politically feasible.

Consequently, abatement of agricultural NPS pollution is primarily achieved via agri-environmental programs that offer cost-share payments to producers who voluntarily adopt management practices that reduce nutrient loss from their farms (Claassen, Cattaneo and Johansson 2008; Ribaudo 2015). The programs have improved land management practices on many farms, but they cost billions of dollars each year and have not generated the collective improvement needed to improve water quality on a greater scale.

Collective action can overcome environmental challenges and under-provision of environmental public goods such as clean water (Ayer 1997); however, identifying mechanisms that generate collective action remains a challenge. A number of studies have examined the effectiveness of incentive structures designed to motivate cooperative behavior among land managers to enhance the provision of ecosystem services, including cooperation bonuses and other voluntary, primarily monetary-based incentive programs (Goldman, Thompson and Daily 2007; Stallman 2011; Parkhurst and Shogren 2007). Researchers have also shown that nonpecuniary factors such as environmental attitudes and empathy for other water users influence conservation decisions (Sheeder and Lynne 2011; Ma et al. 2012; Prokopy et al. 2008; Pannell et al. 2006). Other research has investigated the role of social approval and disapproval in public good settings (Dugar 2013; Grieff and Paetzel 2015).

Collective action is most effective when the individuals involved have social ties to each other and some degree of group identity (Gächter and Fehr 1999). Research on public good donations, for example, has shown that donations increase with the strength of the social relationship between the donors and the fundraiser (Scharf and Smith 2016; Meer 2011); when people feel more connected, they are more willing to contribute to the group. Establishing and maintaining social norms can also enhance contributions as people seek to avoid disapproval from their peers (Rege and Telle 2004; Ostrom 2014; Gächter and Fehr 1999).

Although the effect of varying information in environmental and common pool resource settings has generally been shown to be small (Li et al. 2014; Tisdell, Ward and Capon 2004; Apesteguia 2006) these changes can be highly cost-effective as government agencies. After all, these agencies are already, and can make similar adjustments to the format in which this information is displayed. Thus, important question remain on how various displays of information can influence behavior in a nonpoint source pollution setting.

2.1 Mascots and group identity

Mascots are used by sports teams and advertisers to reinforce a common identity and generate feelings of pride and belonging. They unite fans and players of sports teams, foster school spirit at universities, and attract people to businesses. Mascots are also used to encourage environmental protection and improve management of natural resources. In the United States, Smokey Bear has been trying to prevent forest fires for more than 70 years. He is protected by federal law and has been used in songs, books, and advertisements. Smokey Bear and his message, “Only You Can Prevent Wildfires,” is recognized by 96% of U.S. adults (Ad Council 2014). Despite the popularity of Smokey and other mascots, surprisingly little economic research has addressed use of mascots in environmental protection efforts. They could potentially provide simple, low-cost approaches for changing individual behavior to solve environmental challenges.

The mascot as a tool for changing behavior has been adopted by RARE, a nonprofit organization that is committed to encouraging environmental change in local communities throughout the world. It regularly uses a variety of mascots – often native wildlife characters – to build a sense of collective identity associated with environmental protection in communities

(RARE 2017). The organization began using mascots to promote sustainable resource management in 1977 when it introduced a parrot, Jacquot, as part of a campaign to save an endangered species of parrot in St. Lucia in the Caribbean Islands (Cheney 2017). RARE conducts “Pride Campaigns” that last two or three years and consist of a variety of social events, mascots, and signage to build a sense of collective identity in a community and promote environmental and resource management to protect species habitats (Hayden and Dills 2015). The campaigns are designed to educate communities and motivate change through emotional appeals and creation of social norms, and recent research suggests that RARE’s mascots have been successful (Hayden and Dills 2015; Green et al. 2013). To date, there has been little research on how mascots can be used to improve environmental management and no research using an economic experiment in which the use of mascots in public awareness campaigns can improve behavior (increase abatement efforts) compared to a control treatment.

2.2 Data visualizations and environmental communication

A persistent question for many organizations is whether the nature of graphic displays affects how individuals perceive and respond to the information. In complex situations, could different data visualization improve the public’s understanding of a problem and influence how individuals perceive their own actions and the actions of their peers? Though few economic studies have been conducted, some studies in fields such as journalism, have addressed visualization of data in two- and three-dimensional formats (Chen, Härdle and Unwin 2008; Segel and Heer 2010; Wickens, Merwin and Lin 1994; Orford, Harris and Dorling 1999). With regard to environmental issues, Polson and Selin (2012) described a project in which information on energy use in a “green” building was displayed to the public to encourage people to engage with environmental data in a meaningful way. Holmes (2007) explored whether media art and creative visualizations of real-time energy consumption in a public art project had the ability to trigger greater ecologically-responsible behavior.

Few environmental economics studies have investigated the effects of various methods of displaying data about the environment. This study analyzes three types of graphic displays to determine the extent to which each type of display regarding NPS pollution motivates pollution-abatement behavior. One prior study, Cason and Samek (2015), used an economic experiment to analyze the impacts of using data visualization tools in asset market bubbles. Though not related to NPS pollution, the study used an experimental design similar to ours involving exposing subjects to different types of information displays. They found that a graph-like display was superior to a simple table and that individuals' experience with these types of displays mattered. Their findings suggest that the manner in which environmental data is displayed is important.

3. Methods

This study uses an economic experiment to measure and analyze the effect of using public information displays, mascots, and data graphics on pollution outcomes in a common water resource. In the experiment, each participant operates a firm in a stylized watershed. Six firms are located in each watershed, and a dynamic nutrient-flow model is used to reflect how management decisions made by the individual firms affect the watershed's ambient water quality. Thus, while these six firms are homogenous in terms of their production functions, their impact on water quality is heterogeneous based on their spatial location within the watershed. Figure 1 shows how the unique location of each firm results in heterogeneous impacts on water quality according to the underlying dynamic nutrient-transport model, QUAL2K (Chapra, Pelletier and Tao 2008). This model, which is commonly used by United States Environmental Protection Agency (US EPA), allows for complexities in how pollution mixes and flows downstream. A detailed description of the model is provided by Miao et al. (2016, pp. 3297–98). Participants in the experiment were aware that their actions affected the ambient pollution level in complex ways, but they were not given specific details about the model to maintain their focus on the primary research objectives.

[Insert Figure 1 about here]

The experiment was conducted with 168 undergraduate students from a large university on the East Coast of the United States. Each participant made decisions in 48 rounds, resulting in 8,064 observations. The experiment was conducted in eight sessions, each consisting of three or four groups of six participants and lasting approximately 90 minutes. At the end of each experiment session, the participants' experimental dollars were converted to U.S. dollars at the rate of 65 to 1 and the participants were paid privately in cash. Most students earned between $25 and $35. To ensure that participants did not arrive expecting the presence of a mascot, they were asked to sign a confidentiality agreement barring them from sharing information about the experiment with their peers.

In each round, the participant (firm) chose a production level of between 0 and 50 units and generated income as shown in Figure 2. Participants could maximize their firms' incomes by choosing a production level of 40. Production also created pollution that flowed downstream – aggregate pollution was measured by a downstream sensor once during each round. The exogenous target level of aggregate pollution was 5 units, which represented the socially optimal level of pollution in the watershed. Following Segerson (1988), we used an ambient tax policy designed to tax the groups when their collective pollution (the ambient level at the censor) exceeded the target threshold. However, unlike traditional ambient tax policies in which the tax rate equals the marginal social damage of a unit of pollution, our policy imposed a suboptimal tax rate that was less than the marginal social damage from a unit of pollution and thus represented only a portion of the social cost of the pollution that exceeded the threshold. The suboptimal nature of the tax meant that firms did not financially internalize the full value of the externality generated by their production. Since the tax rate was not high enough to incentivize groups to meet the pollution target solely because of the financial lever, the experiment provided space for observing behavioral effects in response to three types of treatments.

[Insert Figure 2 about here]

3.1 Treatments

We test the behavioral effects of three types of treatments using a novel experiment design: (1) public information displays (between-subject), (2) mascots' responses to pollution outcomes (between-subject), and (3) graphics displaying water-quality data (within-subject). We also test for the effects of negative and positive framing of public information displays and mascot feedback using a within-subject treatment in the experiment. Table 1 presents the structure of the public information, mascots, and data visualization treatments in the experiment. As previously noted, in three of the four sessions (42 participants each) participants were presented with a public information treatment (the fourth was a no-information control) in which half of the rounds presented positive framing and the other half presented negative framing. The order of the framings and of the data graphics presented in each session were different to control for potential order effects.

[Insert Table 1 about here]

Upon being presented with a framed information treatment, the participants completed six rounds in which there was no tax on their pollution and the only graphic provided was a data table. These rounds were used to provide participants with an opportunity to learn about how the framing was presented, and we do not analyze those results. The experimental treatments were then tested using the suboptimal ambient tax.

[Insert Figure 3 about here]

In the control treatment, information was private; members of the groups knew only if their own group's pollution contribution exceeded the threshold. In the public information treatments, each group's ambient pollution status was publically described as either "Clean" or "Dirty" on a large screen visible to all groups as shown in Figure 3. When positive framing was used, screens for the groups that met the pollution target displayed "Clean." The screens for groups that failed to meet the target were blank. Likewise, when negative framing was used, the screens for groups that failed to meet the pollution target displayed "Dirty" and the screens for groups that met the target were blank. We tested a null hypothesis that information framing would have no effect on polluting behavior.

Two mascots—a familiar university mascot and an unfamiliar leopard-grouper mascot from RARE (shown in Figure 4)—were used to test the ability of mascots to amplify the effect of public information. The familiar mascot represented a symbol of pride within the university community to which the participants belonged. The RARE mascot was presumably unfamiliar to the participants so they were unlikely to feel any attachment to it. Testing both mascots provided a mechanism by which we could differentiate between the effect of a community symbol and the effect of the mascot itself. The mascots congratulated the "Clean" groups under positive framing and expressed disappointment to the “Dirty” groups under negative framing. (No mascot was used in the control, private-information session.) Ex ante, we hypothesized that there would be no difference in the effects of the familiar and unfamiliar mascots.

[Insert Figure 4 about here]

Motivated by the desire to identify the best way to present information about environmental quality, we tested the effects of three graphics that displayed information about the ambient pollution level in the experimental watershed (Figure 5): (i) a basic data table presenting numerical values that represented the concentration of the group’s pollution, (ii) a simple colorful graphic of a gauge that used green, yellow, and red zones to illustrate “clean,” “approaching dirty,” and “dirty” categories and a pointer that indicated the group’s position on the gauge given the pollution they contributed, and (iii) a continuous pulse graph that depicted the flow of pollution past the sensor over time relative to the target pollution concentration, which was demarcated by a black line. These graphics were displayed on the participants’ individual computer screens. The graphics presented to each group displayed information about the level of that group’s ambient pollution after each round was completed. Figure 5 illustrates how an ambient pollution level of 5.7 units was displayed. Since the pollution target was 5.0 units, a level of 5.7 exceeded the target and group members had to pay a tax on 0.7 units of pollution.

Though these three graphics are by no means an exhaustive set of ways to display data, they represent distinct types of visual features, allowing us to determine how these types of graphic displays affect behavior. We test a null hypothesis that the three graphic data displays would have equivalent effects on participants’ polluting behavior.

[Insert Figure 5 about here]

2.3 Experimental procedure

Upon arriving, participants were given paper instructions for the experiment (See Supplemental Appendix). A prerecorded slideshow narrating the instructions was then presented to maintain consistency across sessions. In the mascot treatments, the mascot was introduced to the participants during the instruction phase to eliminate any surprise that could be associated with introducing it later.

Each experiment session consisted of eight parts—two no-tax and six suboptimal tax exercises—each consisting of six rounds (See Table 1). Participants were randomly assigned to a new group prior to each part of the experiment using random stranger matching. Randomization of the groups allowed the participants to treat each part as a separate scenario. A participant who wound up in a high-producing, high-polluting group in one part would likely be in a lower-producing, less-polluting group in another part of the experiment.

Each participant was provided with a tablet computer and a small bin for their instructions[1] allowing them to move easily from one group to another during the session. At the beginning of each part of the experiment, the participants' tablets displayed their (randomly assigned) group number and the number of their parcel in the group's watershed. They then took their tablet computers and bins with them to their next group's location, allowing for physical proximity of a group's members without their having to log in and out of a computer system. As shown in Figure 3, each group setting consisted of six desks around a large overhead television

[1] In our pilot session, several students attempted to photograph the mascot using their cell phones; we thus instructed participants in the experiment to leave all bags and electronic devices in the bins at the front of the room during the session.

screen. The desks were labeled 1 through 6 to match the parcel numbers and the participants were instructed to sit at the desk labeled with their parcel number for that part of the experiment.

Allowing group members to sit together physically facilitated our display of public information about their pollution contribution. When participants looked around the room, they could easily identify which groups were "Clean" (positive framing) or "Dirty" (negative framing), as could the mascots. Equally important for our study was the ability of participants to see the other members of their groups as a way of promoting a sense of collective identity. Their individual production decisions were not disclosed to other members, but the group's ambient pollution level was privately displayed on their tablets at the end of each round and, in the public information treatments, each group's pollution status as clean/dirty was publicly displayed on the television screens at the end of each round.

During each of six rounds, participants chose a level of production given information about the income it would provide and the pollution it would contribute. They were then shown the group's collective level of pollution and how it compared to the concentration target using one of the three data graphics.[2] In the public information treatments, the group's television screen either remained blank or displayed "Clean" under positive framing and "Dirty" under negative framing. And in the mascot treatments, the mascot entered the room in response to the public displays on the television screens, congratulating groups that were clean and expressing disappointment to groups that were dirty. The mascot then left the room until the next round was completed to avoid presenting a distraction during the production-decision phase of the rounds.

[2] Participants were given instructions on how to interpret the graphic at the beginning of each part.

Each round was independent; the pollution concentration from one round did not affect the level of pollution in the next one.

2.4 Empirical model

We analyze participants' production behavior, which directly affects the pollution concentration in the watershed, using two primary dependent variables, group-level production and individual production. We model production rather than pollution concentration to isolate behavioral effects from the nutrient dynamics that govern the pollution model. Individuals' production decisions drive the group's collective production and pollution, but we are also interested in examining the effect of group membership on polluting behavior. Consider, for example, an individual who is strongly influenced by negative feedback but is part of a group that collectively is resistant to negative feedback. In that case, the individual's response could be masked by the actions of the other members. We specify our group-level model as

(1) $$PRODUCTION_{gr} = \alpha_0 + \beta_1 INFO_{gr} + \beta_2 NEG_{gr} + \beta_3 MASCOT1_{gr} + \beta_4 MASCOT2_{gr} + \beta_5 NEGxMASCOT1_{gr} + \beta_6 NEGxMASCOT2_{gr} + \beta_7 GAUGE_{gr} + \beta_8 PULSE_{gr} + \beta_9 NEGxGAUGE_{gr} + \beta_{10} NEGxPULSE_{gr} + \beta_{11} LEARN_{gr} + \varphi_g + \varepsilon_{gr}$$

where $PRODUCTION_{gr}$ is a continuous variable that reflects the aggregate production by group g in round r. Since the membership of the groups changes in each treatment using imperfect stranger matching, $r \in \{1, \dots, 6\}$. $INFO_{gr}$ represents a binary variable that takes a value of one when water quality information is public and zero otherwise. NEG_{gr} is a binary variable that equals one when water quality information is framed negatively and zero when framed positively. $MASCOT1_{gr}$ and $MASCOT2_{gr}$ are binary variables equaling one when the community mascot and the unfamiliar mascot, respectively, reinforce the public information displays. We also test for interaction effects between each mascot and negative information framing using the variables $NEGxMASCOT1_{gr}$ and $NEGxMASCOT2_{gr}$. $GAUGE_{gr}$ and $PULSE_{gr}$ are binary variables for the gauge and pulse graphic treatments respectively. We also include two variables, $NEGxGAUGE_{gr}$ and $NEGxPULSE_{gr}$, to test for interaction effects between negative information and the data graphic and another variable, $LEARN_{gr}$, to test for learning effects. That variable is an integer value between 1 and 48 that reflects the round in which the production decision was made. Note that the baseline for all of the models is no mascot, the data table graphic, and private information.

Our individual-level production model includes all of the covariates in the group-level model plus a control for the location of each participant's parcel in the stream network:

$$(2) \qquad PRODUCTION_{ir} = \alpha_0 + \beta_1 INFO_{ir} + \beta_2 NEG_{ir} + \beta_3 MASCOT1_{ir} + \beta_4 MASCOT2_{ir} + \beta_5 NEGxMASCOT1_{ir} + \beta_6 NEGxMASCOT2_{ir} + \beta_7 GAUGE_{ir} + \beta_8 PULSE_{ir} + \beta_9 NEGxGAUGE_{ir} + \beta_{10} NEGxPULSE_{ir} + \beta_{11} LEARN_{ir} + \sum_{k=1}^{5} \delta_k PARCEL_{k,ir} + \varphi_i + \varepsilon_{ir}$$

where $PRODUCTION_{gr}$ is a continuous variable that reflects the aggregate production by individual i in round r. $PARCEL$ is a set of $k = 5$ binary variables that equal one when individual i is assigned parcel k in round r and zero otherwise. As shown in Table 2, we test several null hypotheses in which our treatments have no effect on production decisions.

[Insert Table 2 about here]

4. Results

The experiment is designed to test how polluting behavior is affected by public information, amplification of information via mascots, and data visualization graphics in a laboratory setting. We econometrically analyze changes in individual and group-level production outcomes – recall that each individual chose a level of production between 0 and 50. Additionally, in Table 3, we report ambient pollution concentrations and 95% confidence intervals (CIs) for each treatment combination – pollution concentrations could range from 0 to 10. Across all of the treatments, the average group pollution concentration is 6.479 units (95% CI [6.423, 6.535]).

Our results show that presenting public information reduced the amount of production and pollution. The highest concentrations of pollution occur when no public information is provided; when the concentrations for the three data-graphic treatments are averaged, the mean pollution concentration is 7.009 (95% CI [6.936, 7.084]). In contrast, the average pollution concentration for all of the public information treatments is 6.303 (95% CI [6.237, 6.369]). The results further show that the effect of public information is strongest when it is negatively framed and is amplified by a community mascot. In that case, the average pollution concentration is 5.863 (95% CI [5.728, 5.998]).

[Insert Table 3 about here]

The regression models presented in Table 4 analyze the separate impacts of public information, mascots, and data displays on group and individual production using estimators that are robust to panel-level heteroskedasticity. In the linear model estimated with panel-corrected standard errors, the errors are assumed to be heteroskedastic and contemporaneously correlated across panels. In the second model, we assume that the disturbances are heteroskedastic but are not correlated across panels. Since the experiment is a repeated game with feedback between rounds, we also test for autocorrelation within panels using Wooldridge's test for panel-data models (Drukker 2003; Wooldridge 2002) and a panel-corrected AR(1) model and find evidence of autocorrelation using the Wooldridge test ($F(1,167) = 23.02$).

[Insert Table 4 about here]

Result 1: Provision of public information about the group-level water quality outcomes significantly reduces mean production and the reductions are greatest when the public information is negatively framed.

Relative to the control treatment of no public information, providing public information has a negative effect on the intensity of group-level ($p < 0.01$) and individual-level production ($p < 0.01$), reducing it by 15.3 (total possible group production of 300 units) and 2.6 (total possible individual production of 50 units) units, respectively. Since information about water quality is provided at the group level, the actions of all of the individuals in a group influence the outcome, and the group's members must collectively reduce production to improve the quality of the water. Therefore, a sense of collective group identity could develop, leading to less production and pollution when the group-level water quality outcomes are announced.

Negative framing (with and without amplification by a mascot) also decreases production relative to positive framing, generating an average individual production of 30.12 versus 32.21 across all mascot and data visualization treatments. This effect is highly significant in regression 1 but is not significant in the other regression models. Average group-level production with positive and negative framing is 184.2 and 173.2 units, respectively, a statistically significant difference ($t = 5.58$, $p < 0.1$).

Result 2. A familiar community mascot can motivate a further decline in group-level production beyond what can be achieved by displaying public information and the result is strongest when the mascot demonstrates negative emotions in response to excess pollution.

Our results indicate that mascots can amplify the effect of providing public information. Both the familiar and the unfamiliar mascot are (weakly) significant drivers of the group production level, but the direction of the effect depends on the type of mascot used. Feedback from the familiar community mascot reinforced the effect of public information by further reducing production—by 6.5 units on average, which is a 3.5% reduction relative to the overall mean. Feedback from the unfamiliar mascot *increased* group production by 6.2 units. Thus, community attachment to a mascot could encourage "green" behavior while an unfamiliar mascot could be ineffective or even counterproductive. When the community mascot (YoUDee) was used in conjunction with negative framing, group production decreased an additional 7.6 units, and this effect was significant in two of the three group-level production models. Thus, it appears that expressions of sadness from a community mascot were particularly effective in altering participants' behavior.

Result 3. Presenting data about water quality using a gauge graphic significantly decreases production compared to the table and pulse presentations.

Comparing the results for the three data visualizations, we find that mean production is the lowest for the gauge, and that result is robust across all of the between-subject treatments and the positive and negative framing at the group and individual levels. The gauge graphic reduced group-level production by about 4.7 units, *ceteris paribus* ($p < 0.1$) and was a significant driver of individual production decisions ($p < 0.10$). Under the information treatments, the average pollution concentration is 61.3 with the gauge and 63.9 without ($t = 3.57$, $p < 0.1$). Compared to the other graphics, the gauge is the easiest to interpret and is the only one that is colorful.

5. Discussion and Conclusion

The social dilemma of NPS pollution is difficult to manage because of its diffuse and anonymous nature. The classic economics literature has offered regulatory policies aimed at achieving desired pollution targets but, to be effective, the policies must require the firms to coordinate their pollution reductions as a group and resist the temptation to free-ride on the efforts of others. Taxes and subsidies can be helpful under certain conditions but often are not politically feasible. Furthermore, the dynamic natural and spatial processes associated with water pollution make understanding the potential incentives even more complicated for firms and regulators in compromised watersheds. This research uses experimental economics to explore use of displays of mascots, public information, and various types of graphics depicting water quality to reduce pollution. The results suggest that provision of public information can promote cooperative pollution abatement by fostering a sense of group responsibility for water quality. Mascots can amplify this effect by making feedback to individuals more emotional and reinforcing social norms in group settings. The potential for these types of non-traditional, nonmonetary incentives to change individual decisions highlights the value of behavioral economics to environmental conservation efforts.

Two organizations motived our research. The first was RARE, a nonprofit committed to bringing positive environmental changes to local communities throughout the world. RARE has used mascots in a variety of settings; however, to our knowledge, no prior economic research has formally investigated the effectiveness of mascots in promoting changes in behavior. The second organization is the Delaware Environmental Monitoring and Analysis Center, which is striving to identify cost-effective ways to display environmental data about resources such as water. Our results shed light on some of the issues confronting these organizations.

We find that displays of public information and mascots can have significant impacts on participants' production and pollution decisions under certain conditions, which is important for organizations such as RARE. These results also expand the range of possibilities for incorporating behavioral triggers in environmental policies. Publicly displaying information about the effect of production decisions on the ambient level of pollution could significantly reduce pollution of a watershed. Furthermore, including a familiar mascot as a form of feedback could strengthen the effect of the public information, particularly when the mascot reinforces negative feedback about pollution exceeding the desired threshold. Of the three types of data graphics tested, the easy-to-understand, colorful gauge was most effective at limiting polluting behavior.

Some earlier studies have identified the value of nonmonetary incentives in other contexts, such as social comparisons and depicting smiley faces on utility bills (Allcott 2011; Ferraro, Miranda and Price 2011). Similarly, we find that mascots, public information, and graphic presentations of data and progress toward a goal can potentially be combined to reinforce a sense of collective identity and attention to social norms among contributors of pollution, thus reducing NPS pollution.

In particular, we find that the mascot is not effective unless the community has a degree of attachment to it and that an unfamiliar mascot is likely to be ineffective and could be counterproductive. A familiar mascot can induce a greater sense of community that increases individuals' desire to protect their environment. Our results suggest that it is critical to invest in efforts to unify the community and instill a sense of pride and collective identity early in an environmental restoration campaign. The more familiar or connected the mascot is to the community, the more successful it is likely to be.

A limitation of our analysis is that we test only three types of data graphics when there are numerous other ways to present data about individuals' contributions to water quality. Furthermore, we cannot determine why one type of graphic was more effective than the others. Future studies could employ focus groups to gain a better understanding of how various types of colors and formats are interpreted and identify the behavioral responses they evoke. For organizations, such as the Delaware Environmental Monitoring and Analysis Center, graphic displays that can be easily understood by the general public with a quick glance are likely to be important for website presentations while the greater complexity provided by a graphic such as our pulse chart is likely to be more appropriate for professional audiences. The preliminary results provided by this study suggest that the visual design of environmental graphics can have a profound effect on polluters' behavior.

This study is the first to our knowledge to analyze the effects of mascots on improving social dilemma outcomes such as reducing NPS pollution. The results are promising but additional work in this area is needed. RARE's Pride Campaigns have typically used mascots that represent animals, plants, and other objects that are commonly found in the region, such as a native animal, and combined the mascots with signage, information, and community events. While it can be difficult to isolate the effect of the mascot in such settings, the laboratory provides space to explore those impacts through experiments. It is important to keep in mind that the scope of a laboratory experiment can be limited because of hypothetical bias and/or an inability to conduct long-term analyses. Addressing complex environmental issues might also require dissemination of more-specific information than can be provided in a laboratory experiment, particularly when the desired behaviors depend on the state of the resource (e.g., reducing emissions when the level of ambient pollution is excessive). Ultimately, a field experiment using community-based and non-community-based mascots that allows them to display negative emotions might best provide a true measure of the mascots' capacity to spur environmental improvement. Despite these caveats, this study demonstrates how nonmonetary incentives can be used to nudge groups toward achieving a collective environmental goal.

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Tables

Table 1. Experimental design showing both within- and between-subject treatments (168 total subjects)

			Within-subject Treatments				
				Data Visualizations			
			Information	No Tax	Suboptimal tax		
				Table	Table	Gauge	Pulse
Between-subject Treatments	No Public Info	42 subjects	n/a	12 rounds	12 rounds	12 rounds	12 rounds
	Public Info Only	42 subjects	Positive	6 rounds	6 rounds	6 rounds	6 rounds
			Negative	6 rounds	6 rounds	6 rounds	6 rounds
	Public Info + University Mascot	42 subjects	Positive	6 rounds	6 rounds	6 rounds	6 rounds
			Negative	6 rounds	6 rounds	6 rounds	6 rounds
	Public Info + RARE Mascot	42 subjects	Positive	6 rounds	6 rounds	6 rounds	6 rounds
			Negative	6 rounds	6 rounds	6 rounds	6 rounds

Table 2. Hypothesis table

Treatment variable	Hypothesis	Result	
		Group-level production	Individual production
Public information	H_0: β_1=0	Reject	Reject
Negative framing	H_0: β_2=0	Inconclusive[a]	Fail to reject[b]
Mascot feedback			
YoUDee	H_0: β_3=0	Reject	Reject
Meloy	H_0: β_4=0	Reject	Fail to reject
Data visualization			
Gauge	H_0: β_5=0	Reject	Reject
Continuous pulse	H_0: β_6=0	Fail to reject	Fail to reject

[a] We reject at the 1% level in 1 of 3 of our models.

[b] There is a significant negative interaction effect between YoUDee and negative information framing.

Table 3. Mean group-level pollution concentration by treatment cell

			Within-subject Treatments		
			Data Visualizations		
		(observations)	Table	Gauge	Pulse
Between-subject Treatments	No Public Info	n/a (n=84)	7.008 [6.867, 7.150]	6.947 [6.819, 7.076]	7.074 [6.919, 7.191]
	Public Info Only	Positive (n=42)	6.540 [6.176, 6.903]	6.413 [6.087, 6.739]	6.442 [6.177, 6.707]
		Negative (n=42)	6.448 [6.163, 6.733]	6.064 [5.805, 6.323]	6.091 [5.814, 6.367]
	Public Info + University Mascot	Positive (n=42)	6.489 [6.253, 6.724]	6.001 [5.815, 6.189]	6.200 [6.004, 6.397]
		Negative (n=42)	5.988 [5.710, 6.266]	5.677 [5.481, 5.873]	5.925 [5.696, 6.154]
	Public Info + RARE Mascot	Positive (n=42)	6.753 [6.423, 7.083]	6.568 [6.305, 6.831]	6.575 [6.278, 6.872]
		Negative (n=42)	6.707 [6.467, 6.947]	6.081 [5.778, 6.384]	6.485 [6.132, 6.837]

Note: The 95% confidence intervals are shown in brackets.

Table 4. Regression analysis

	Production			
	(Group-level)			(Individual-level)
	(1) Panel-corrected standard errors	(2) Heteroskedastic-corrected panels	(3) Panel-corrected standard errors AR(1)	(4) Panel-corrected standard errors
Public Information	–15.344***	–15.344***	–13.980***	–2.557***
	(1.285)	(2.476)	(1.976)	(0.497)
Negative Feedback	–5.939***	–5.939	–2.662	–0.990
	(1.136)	(4.022)	(3.411)	(1.003)
YoUDee	–6.457***	–6.457**	–6.492***	–1.076***
	(0.620)	(2.990)	(0.430)	(0.322)
Meloy	6.207***	6.207*	9.671***	1.035
	(1.087)	(3.185)	(2.722)	(0.708)
Negative Feedback				
X YoUDee	–7.631***	–7.631*	–7.546	–1.272***
	(1.809)	(4.631)	(4.808)	(0.488)
X Meloy	0.096	0.096	–8.046**	0.016
	(1.731)	(4.566)	(3.777)	(1.335)
Gauge Visualization	–4.720***	–4.720**	–6.244***	–0.787*
	(0.871)	(2.106)	(1.570)	(0.459)
Pulse Visualization	–0.373	–0.373	0.445	–0.062
	(0.855)	(2.131)	(1.351)	(0.455)
Negative Feedback				
X Gauge	–3.359**	–3.359	–1.368	–0.560
	(1.489)	(3.921)	(3.014)	(0.736)
X Pulse	–3.267	–3.267	1.490	–0.544
	(2.422)	(4.101)	(3.231)	(0.736)
Round	0.313***	0.313***	0.272***	0.052***
	(0.039)	(0.060)	(0.056)	(0.012)
Parcel Number == 1	–	–	–	0.170
				(0.393)
Parcel Number == 2	–	–	–	–0.904**
				(0.449)
Parcel Number == 3	–	–	–	–2.414***
				(0.602)
Parcel Number == 4	–	–	–	–2.803***
				(0.545)
Parcel Number == 5	–	–	–	–1.704***
				(0.642)
Parcel Number == 6	–	–	–	
C	192.584***	192.584***	194.464***	33.373***
	(1.731)	(2.310)	(2.060)	(0.620)

N	1,008	1,008	1,008	6,048
Number of Groups/Individuals	168	168	168	168

Figure 1. Location of firms in the watershed

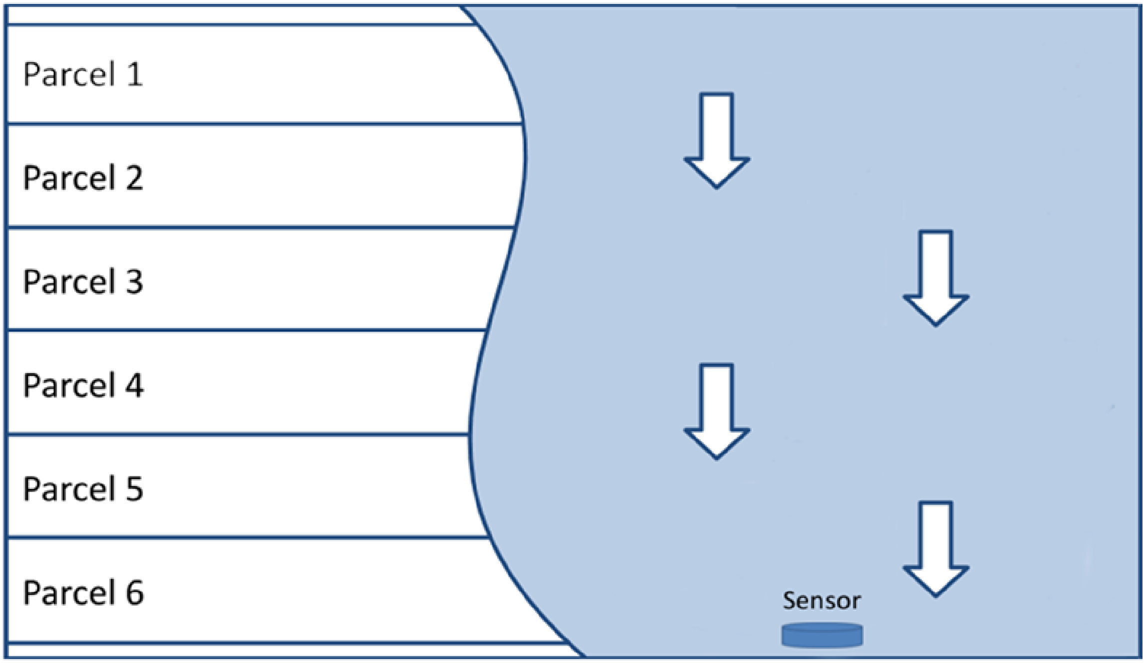


Figure 2. The relationship between production and income for all firms in the experiment.

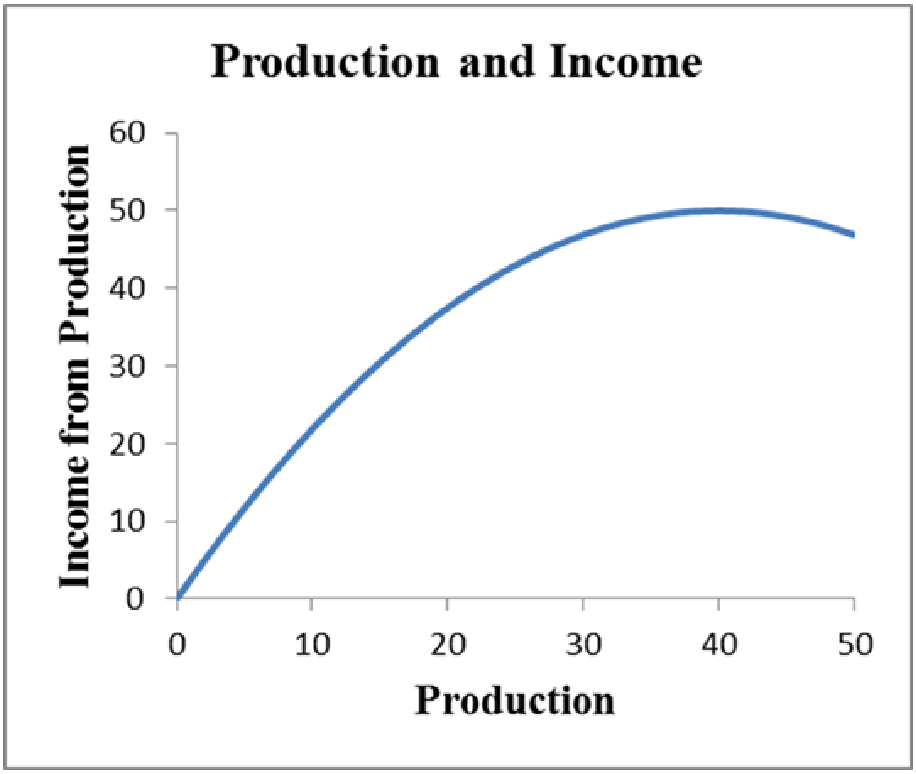


Figure 3. Physical group configuration in laboratory and public information displays

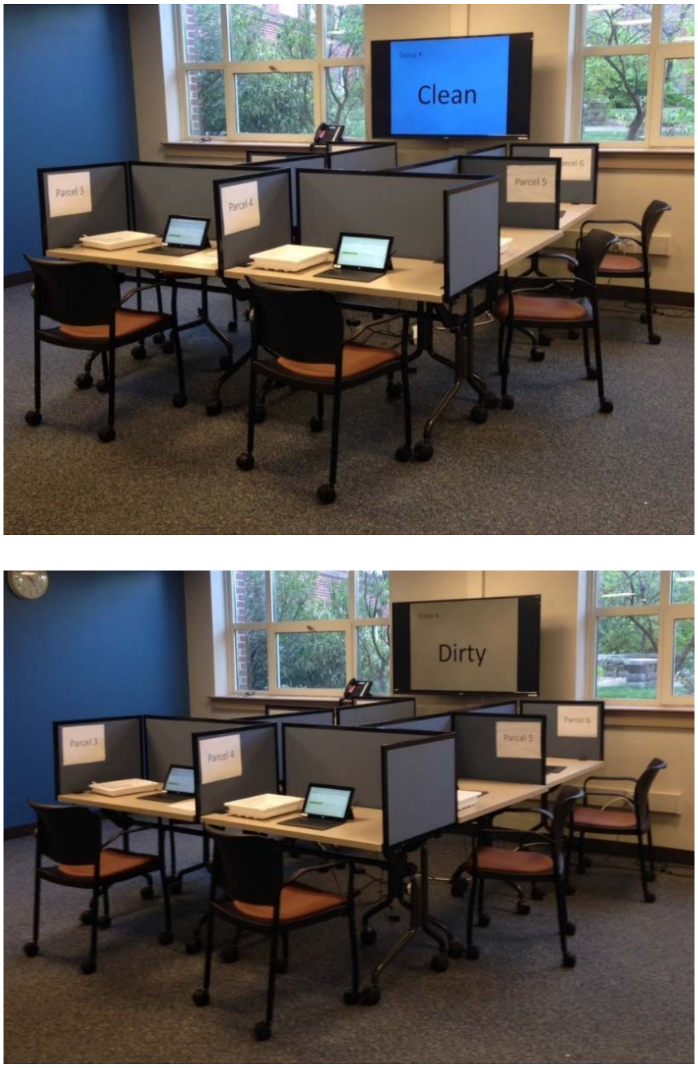


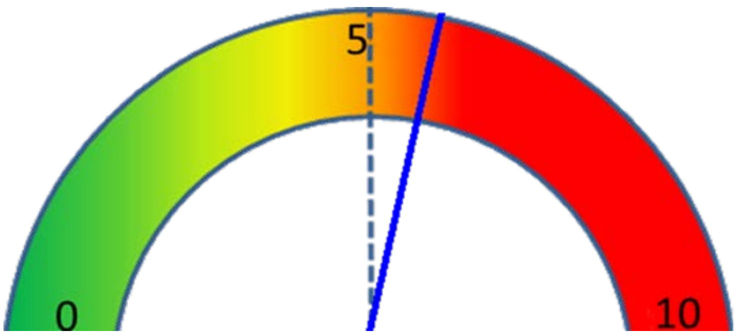
Figure 4. The two mascots used in the experiment include the unfamiliar mascot, Meloy Junior (left) and the community mascot, YoUDee, (right).

Figure 5. Data graphics tested in the experiment

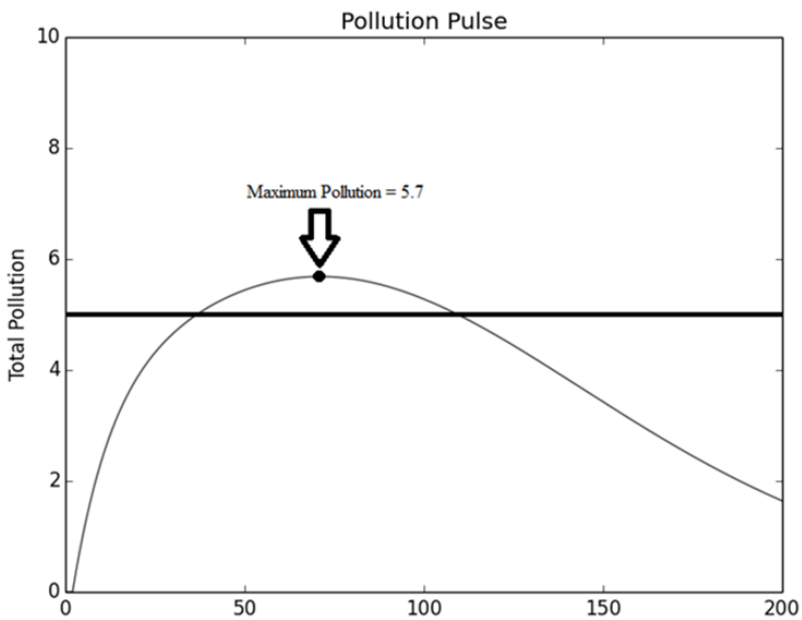
i. Table Graphic

Your Group's Concentration Number	Target Number
5.7	5

ii. Gauge Graphic



iii. Pulse Graphics



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