February 2018 APEC RR18-04

# Behavioral Responses to Science-based Eco-labeling: Gold, Silver, or Bronze

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APPLIED ECONOMICS & STATISTICS

**ABSTRACT**

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**Keywords:** Eco-labeling, Ecosystem Services, Field Experiments, Consumer Preferences



This study uses unique data collected from field experiments to investigate consumer willingness to pay (WTP) for otherwise homogeneous commodities that provide different levels of environmental services. On average, individuals are willing to pay more for products that provide a higher level of ecosystem services. This effect is larger when the label contains symbols that explicitly differentiate the levels and the magnitude is further amplified when it contains brief information on the scientific basis for the levels. However, our results also suggest that the WTP premium for the superior product is smaller than the discount in WTP for the inferior product.



JEL Classifications: D12, Q55, M31, L10

**ACKNOLWEDGEMENTS**

The authors gratefully acknowledge funding from U.S. Oceanic and Atmospheric Administration grant (NA14OAR4170087), State of Delaware Federal Research and Development Matching Grant Program grant (16A00407), U.S. Department of Agriculture (USDA) Economic Research Service CBEAR award (59-6000-4-0064), National Science Foundation EPSCoR Rii3 (1301765), and USDA Hatch. This is one of multiple experimental studies conducted under the aforementioned funding sources. We thank Sunny Jardine, George Parsons, John Ewart, Edward Lewandowski, and Doris Hicks for their helpful comments. We also thank Daniel Awokuse, George Esterling, Linda Grand, James Geisler, Julia Parker, Francesca Piccone, Kaitlynn Ritchie, Maddi Valinski, Shang Wu, and Huidong Xu for research assistance.



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**Suggested Citation for APEC Research Reports**

Kecinski, M., T. Li, K.D. Messer. "Behavioral Responses to Science Based Eco-labeling: Gold, Silver, or Bronze." *Applied Economics and Statistics Research Report,* University of Delaware, RR18-04.

**Behavioral Responses to Science-based Eco-labeling:**
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**Acknowledgements:** The authors gratefully acknowledge funding from U.S. Oceanic and Atmospheric Administration grant (NA14OAR4170087), State of Delaware Federal Research and Development Matching Grant Program grant (16A00407), U.S. Department of Agriculture (USDA) Economic Research Service CBEAR award (59-6000-4-0064), National Science Foundation EPSCoR Rii3 (1301765), and USDA Hatch. This is one of multiple experimental studies conducted under the aforementioned funding sources. We thank Sunny Jardine, George Parsons, John Ewart, Edward Lewandowski, and Doris Hicks for their helpful comments. We also thank Daniel Awokuse, George Esterling, Linda Grand, James Geisler, Julia Parker, Francesca Piccone, Kaitlynn Ritchie, Maddi Valinski, Shang Wu, and Huidong Xu for research assistance.

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**Abstract**

This study uses unique data collected from field experiments to investigate consumer willingness to pay (WTP) for otherwise homogeneous commodities that provide different levels of environmental services. On average, individuals are willing to pay more for products that provide a higher level of ecosystem services. This effect is larger when the label contains symbols that explicitly differentiate the levels and the magnitude is further amplified when it contains brief information on the scientific basis for the levels. However, our results also suggest that the WTP premium for the superior product is smaller than the discount in WTP for the inferior product.



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## Introduction

Some consumer products are considered environmentally-friendly as they produce less environmental damage compared to their conventional counter parts—common examples include sustainable "green" energy and "dolphin-free" tuna. A few other products can be considered impure public goods because they provide environmental benefits through either positive externalities generated in the production process or ecosystem services provided by their nature—examples of these types of products include honey (pollination by honey bees) (Wu et al. 2015), and shellfish, which filter excess nutrients from water (Rose et al., 2015). These "green products" are assumed to increase willingness to pay due the created environmental benefits (Ferraro et al., 2005). As some of these goods, such as oyster aquaculture, have characteristics of both private and public goods; promoting them through private and public markets can increase social welfare.

Numerous studies have examined how best to promote green products using regulatory instruments such as taxes or subsidies on the production side (e.g., Kolstad, 2010). Fewer studies have investigated how to promote them on the consumption side. Since market demand is an essential driver for production, a better understanding of consumer preferences for green products will help build and improve such welfare-enhancing programs.

Golan et al. (2001) found that providing consumers with positive information on green products significantly increases their willingness to pay (WTP) for such products. Often, that information is conveyed via product labeling, so how to use eco-labels effectively have gained considerable attention from researchers and policymakers in recent years (Vermeer et al., 2010). Research has proposed that policymakers should develop next-generation food labels that use scores or levels measuring the products' environmental impacts as determined by scientific assessments to more clearly inform consumers of their benefits (Council for Agricultural Science and Technology (CAST), 2015).

Green products can be horizontally differentiated—some consumers prefer the environmental externalities of a green product while others do not. For example, Li and McCluskey (2017) found that consumers who identified themselves as environmentally-friendly were willing to pay significantly more for a second-generation biofuel, a product that helps mitigate greenhouse gas emissions in the transportation sector. Theory and policy implications mainly rely on the assumption that there are two products in the economy: a green product and brown product that are otherwise homogeneous with different environmental externalities (Amacher et al., 2004; Rodriguez-Ibeas, 2007; Espinola and Zhao, 2012). In reality, green products also can be further differentiated based on the objective level of positive externalities provided by various products within a category. All else equal, promoting products that provide a greater level of environmental benefit will yield higher returns in terms of social welfare. This raises an important question: Within green markets, does consumers' WTP for a product increase with the level of environmental benefit?

This study examines how level-based eco-labeling affects consumer preferences for oysters. Is there a difference in consumers' WTP for oysters that are distinguishable only by their eco-labels? What distinguishes effective labels from ineffective labels? Under what circumstances do level-based eco-labels increase economic returns?

Our results suggest that consumers are responsive to differentiation by the level of ecosystem service provision among otherwise homogeneous products. In general, our respondents are willing to pay more for a relatively high level of ecosystem service provision. This effect is larger when the eco-label contains symbols that explicitly differentiate the ecosystem service levels and the magnitude is further amplified when it contains brief information explaining the basis of the levels. Our findings also suggest that level-based eco-labels can increase economic returns but the effects are highly sensitive to the market structure for the specific product.

**Literature Review**

Consumer goods labeling can have a significant impact on price and the market structure (Golan et al., 2001). In particular, it can influence a consumer's WTP for a product (McCluskey and Loureiro, 2003). Studies of product labeling have generally focused on labels that address quality (Caswell and Mojduszka, 1996; Bialkova et al., 2013), health attributes (Hu et al., 2006; Liaukonyte et al., 2013), health risks (Fox et al., 2002; Hayes et al., 2002; Dillaway et al. 2011; Payne et al., 2009; Kanter et al., 2009; Messer et al. 2011), food processes (Lusk et al., 2005; Costanigro and Lusk, 2014; Liaukonyte et al., 2015; Messer et al., 2017), and environmental attributes, which are the focus of this study. The market for environmentally-friendly goods has experienced strong growth in the United States and throughout the world (Vermeer et al., 2010). Currently, there are more than 465 eco-labels used in more than 25 industry sectors operating in nearly 200 countries, and more than 200 eco-labels are in use in the United States (Ecolabel Index, 2016).

Numerous studies have examined the effects of eco-labels on consumer preferences for food products. In general, they have found that consumers are willing to pay a premium for production processes labeled as environmentally sound or "ecofriendly" relative to conventional practices; examples include organic food labeling (McCluskey and Loureiro, 2003; Liu et al. 2013), ecolabels on sustainable forest products (Thompson et al., 2010), and sustainable seafood (Bronnmann and Asche, 2017). Blend and van Ravenswaay (1999) surveyed 972 U.S. consumers and estimated that more than 40% of them were willing to pay a premium of at least \$0.40 per pound for apples carrying an eco-label compared with unlabeled apples. Govindasamy and Italia (1999) found that a majority of U.S. households were willing to pay a premium for organic produce. Similarly, Loureiro et al. (2002) found that consumers in the Pacific Northwest were willing to pay a premium of approximately 5% for apples produced using certified sustainable practices. In addition, previous research analyzed the interaction among different product labels. For example, Onozaka and

Mcfadden (2011) analyze the interactive effects of sustainable production labels and conclude that multiple sustainability labels can be either competing or reinforcing.

Moreover, eco-labeling has gained attention from the seafood industry, and studies have been conducted recently to understand how these labels influence consumer preferences for seafood products around the world (Alfnes et al., 2017; Rickertsen et al.; 2017; Wakamatsu et al., 2017; Kecinski et al., 2017; 2018; Li et al. 2017). Rickertsen et al. (2017), for example, point to the importance of sustainability labels, such as the Marine Stewardship Council (MSC) label to demonstrate that wild fisheries are managed sustainable. Additionally, some researchers have compared the effectiveness of ecolabels to other product differentiation, specifically, to generate WTP premium and found that ecolabels can be more effective than quality differentiation – see Carlucci et al. (2017) for oysters and Bronnmann and Asche (2017) for salmon.

These studies have typically relied on dichotomous choice (yes/no) formats in which the product was, for example, either organic or not organic, processed or not processed. In reality, the level of the environmental service provided can vary depending on a number of factors, such as where the food was grown. In an effort to improve labeling, Messer et al. (2015) in a CAST Issue Paper suggested moving beyond dichotomous labels and instead focusing on indicators that vary by level as a way to better reflect the scientific understanding of the environmental impact of various foods. This would be similar to the levels of Leadership in Energy and Environmental Design (LEED) certification that is available for buildings.

Recent research has begun to theoretically analyze the potential effects of multi-tiered eco-labels (Fischer and Lyon, 2014). These studies mainly focused on market competition under a variety of assumptions (Li and van't Veld, 2015). However, few empirical studies have been conducted to investigate how consumer preferences respond to products accompanied with multi-tiered labels.

Introducing indicators on labels that show the level of environmental benefit generated by a product passes additional information to consumers, which plays a role in their purchasing decisions. After decades of research on the role of information in markets, there is a general consensus that labeling bridges the information gap between producers and consumers, creating effective communication and establishing trust (Nelson 1970). On the other hand, some studies have found that there is downside to providing excessive information (Jacoby et al., 1977). For example, Verbeke (2005) noted that information is likely to be effective only when it addresses specific information needs and can be processed and used by its target audience. Lusk and Marette (2012) showed that additional information could distract consumers and complicate their search processes, leading to a decrease in consumer welfare. Salaün and Flores (2001) also argued that an excess of information carries a cost for consumers in terms of time spent looking for the necessary information, causing boredom and impatience. McCluskey and Swinnen (2004) pointed out that consumers tend to ignore label information when it is excessive or difficult to interpret.

This study analyzes labeling that distinguishes products by the level of environmental benefit provided using multiple information treatments and compares the effectiveness of the labels in terms of increasing WTP. The treatments test both scientifically based language that is relatively complex and pictures that reduce the cognitive load on participants, thus communicating different pieces of information regarding environmental services in a simple and concise manner.

**Conceptual Model**

The economic literature has documented deadweight losses (DWL) of economic efficiency in social welfare in markets for products that provide positive externalities. The DWL is measured by considering the consumer surplus, the producer surplus, and the benefits and costs to the regulator (Tirole, 1988; Mas-Colell et al., 1995). Consider a perfectly competitive market in which supply is perfectly elastic and the marginal cost curve is horizontal. Introduction of an eco-label for a green product generates a premium in consumer WTP and shifts the marginal benefit curve outward, shrinking the DWL relative to a market with no eco-label. Sexton (1981), for example, developed a model to identify welfare losses to consumers arising from imperfect information and how improved consumer information can result in reduction in DWL. Teisl et al. (2002) report on a theoretical framework of welfare related to dolphin-safe tuna labeling and used a welfare analysis to measure the behavioral implications of society's demand for eco-labels.

Following this concept, a green market is usually studied in a horizontally differentiated framework in which the green products differ from conventional products according to features that cannot be objectively ordered, such as quality and taste. Consumers' WTP for the environmentally-friendly products usually depends on their individual environmental beliefs. The following model is widely used in empirical studies to identify "green" consumers who are willing to pay a price premium for commodity goods that provide ecosystem services.

$$V_{ij} = \beta_0 + \beta_1' p_j + \beta_2' X_i + \beta_3' f(X_i) \cdot G_j + \varepsilon_{ij} \tag{1}$$

where $V_{ij}$ is the indirect utility function; $X_i$ is a vector of observable characteristics of consumer $i$, $p_j$ is the price for project $j$, $f(\bullet)$ is an indicator function that represents whether a consumer values the environmental aspect of the product, and is a function of observable characteristics of consumer $i$, and $G_j$ is a dummy variable which takes value 1 if good $j$ has environmental benefits and 0 otherwise.

Upon introducing scientifically based eco-labels that assign a level to ecosystem services provided by the product, we may create a differentiable market for green products that are otherwise homogeneous but provide different levels of ecosystem services. That is, the products can be ranked from highest to lowest in terms of the amount of ecosystem. In this case,

$$V_{ij} = \beta_4 + \beta_5' p_j + \beta_6' X_i + \beta_7' Q_j + \varepsilon_{ij} \quad (2)$$

where $Q_j$ is an ordinal variable that measures the level of ecosystem service a product provides.

Consider a representative case in which two levels are introduced: a product that provides high levels of ecosystem services (*ecohigh*) and another that provides low level of services (*ecolow*). The externality provided by *ecohigh* is larger than the average products while the externality provided by *ecolow* is smaller: $MB_{soclow} - MB_{indlow} < MB_{soc} - MB_{ind} < MB_{sochigh} - MB_{indhigh}$. Upon introducing an eco-label that differentiates the two products, we hypothesize that the change in the marginal benefit curve for *ecohigh* will be greater than the change in the marginal benefit curve for *ecolow*. That is, $MB_{ecolow} - MB_{indlow} < MB_{ecohigh} - MB_{indhigh}$. Therefore, the change in overall social welfare will depend on the relative externalities of the *ecohigh* and *ecolow* products, their market shares, and the changes in the marginal benefit curves. The level of externality and the market shares are determined by specific products while the relative changes in the marginal benefit curves are estimated by studying how consumer behavior changes after the eco-label is introduced into the marketplace.

**Experimental Design and Data**

We conducted a field experiment to estimate consumer WTP for goods that offer different levels of an ecosystem service. Our green good is oysters, which filter excess nutrients from agricultural runoff from the water in which they live. The oysters used in the experiment were harvested from different estuaries and thus provided different levels of the ecosystem service since some of the estuaries were polluted and some were not. The National Oceanic and Atmospheric Administration (NOAA) promotes oyster aquaculture as a best management practice for waters containing a high level of such nutrients (NOAA, 2016).

The steps of the research are shown in Appendix A. The experiment was conducted at an office of the Division of Motor Vehicles (DMV) on the east coast of the United States in 2016.

Since DMV offices serve diverse groups of people, they provide a representative sample of the local population. In addition, there is usually a relatively long wait at the DMV so visitors had spare time that could be used to participate in the experiment.

At the beginning of the experiment, all participants were given some information on how oysters provide ecosystem services by consuming excess nutrients and improving water quality (Appendix B). To avoid potential confusion about the term "nutrients", participants were given information that clearly stated that oysters provide ecosystem services by consuming nutrients in the surrounding water and not that these oysters were more nutritious from dietary perspective (see Appendix A). During the experiment, participants were offered four types of oysters with labels that provided additional information on the level of ecosystem service provided by each sample based on the amount of excess nutrients in the water in which the oysters were produced: low, medium, high, and not specified.

To establish a more realistic market environment for oysters, we also included product variations in other dimensions. For example, food miles—the distance between production and consumption of fresh foods—are another important aspect of consumer WTP for seafood (Fonner and Sylvia, 2015). Because the oysters offered in the experiment traveled dramatically different distances, we also were able to test consumer preferences for local versus non-local and west coast versus east coast oysters. Together, eight different oyster options were offered to each participant.

Since the concentration of excess nutrients in a water body is directly linked to the degree of oxygen deprivation (eutrophication) of the water, oysters in highly polluted water provide a higher level of ecosystem service than oysters in relatively clean water—the greater the pollution, the greater the benefit from oyster aquaculture. The nutrient levels of the estuary systems from which the oysters were harvested (in Washington state, New Jersey, and New York) were based on data from NOAA's National Estuarine Eutrophication Assessment Update Project (Bricker et al. 2007).

The experiment involved six treatments consisting of a symbol and/or information about the level of ecosystem service provided on labels of oysters presented for purchase (summarized in Table 1). The labels in the first two treatments were marked with symbols only and provided no information about the nutrient level of the water in which the oysters were produced. In the first treatment (T1), the label presented a blue water drop representing "clean" water; in the second (T2), the water drop symbol was encircled with a ring meant to symbolize an Olympic medal, and the color of the ring indicated the degree of nutrients in the water and the level of ecosystem service provided by the oysters with gold as the highest level, followed by silver and bronze. The third and fourth treatments presented NOAA information on the level of nutrients in the water in which the oysters were produced; the third treatment (T3) presented text describing the nutrient level of the water as high, moderate, or low while the fourth (T4) added a color-coded NOAA symbol for eutrophication (red for high, yellow for moderate, and blue for low (see Figure 1). The final two treatments combined the textual information about the nutrient level with the symbols introduced in the first two treatments—the blue water drop in the fifth treatment (T5) and the blue water drop and color-coded Olympic ring in the sixth treatment (T6). The seventh treatment was the control group in which the labels provided no symbols or information about the water in which the oysters were produced. This design allowed us to analyze the effects of each of the label elements (textual nutrient information, NOAA color-coded bars, the water drop, and the Olympic ringed water drops) separately.

We used a price-based revealed-preference model to estimate consumer WTP for the oysters. In the experiment, participants chose whether to purchase the oysters in a single-bounded dichotomous-choice format (Venkatachalam, 2004) involving the following choice tasks. First, they chose the number of oysters they wanted to purchase (three, six, nine, or twelve) and the preparation method for the oysters (raw on the half shell, deep fried, or take-home in a bag on ice).

We worked closely with industry experts such as fishers and local restaurant owners in developing these options. Then, participants made eight purchasing decisions (hereafter referred to as options) at randomly generated prices that were obtained from random draws from a normal distribution based on a set of typical market prices for oysters, $p \sim N(1.5, 0.5^2)$, determined by consulting with local oyster experts such as restaurant owners, fishers, and other stakeholders.

In the experiment, employees of a professional oyster-shucking service prepared and presented the oysters onsite to ensure both a high-quality presentation and adherence to food safety requirements. The shucking table was physically separated from the area where the participants made their decisions so they were not encouraged (but not forbidden) to see or smell the oysters they were considering purchasing. Tasting of the oysters before making purchase decisions was not allowed. This design sought to control for individual preferences for specific oyster characteristics that were not part of our analysis.

All of the experiment and survey activities were performed on Microsoft Surface Pros using the Willow software program, a Python-based software library for experimental economics. Presentation of the dichotomous-choice questions was randomized to avoid potential order effects. Participants responded to each of the eight oyster options and associated prices by selecting either "yes" (to purchase) or "no" (not purchase). At the end of the eight decisions, the participants completed a survey that collected information on their demographic characteristics and shopping behaviors.

Once the survey was done, the software randomly selected one of each participant's decisions for implementation. Participants who chose to purchase oysters in the implemented round used their account balances of $10 to purchase the oysters at the posted price and were given the professionally prepared oysters; those who chose not to purchase oysters retained the balance in their account. The participant's dominant strategy was to answer yes and purchase oysters only if the listed price was less than the participant's true WTP. The experiment took approximately fifteen minutes.

## Econometric Models

We utilize a single-bounded dichotomous choice model (Bishop and Heberlein, 1979) to analyze the experimental results (see Kecinski et al. (2018) for the model's previous applications on experimental economics). The dichotomous-choice model D= {0, 1} for participants' purchase decisions allows us to place their true WTP for oysters in one of two intervals: $(-\infty, p)$ if D=0 or $[p, +\infty)$ if D=1, where $p$ is the posted price. The individual WTP outcomes are based on a random utility model in which the respondent maximizes utility by choosing to purchase a product at the associated price if and only if the utility derived from the product is greater than the utility derived from foregoing it. The probability of each outcome can be expressed as

$$Pr\left(Y=D\right)=\left\{\begin{array}{c} F\left(v\left(p,\mathbf{Z}\right)\right) \\ 1-F\left(v\left(p,\mathbf{Z}\right)\right) \end{array}\right\} \text{ for } D=\left\{\begin{array}{c} 0 \\ 1 \end{array}\right\} \tag{3}$$

where $F(\bullet)$ is a cumulative distribution function characterizing the components of utility, $v(p,\mathbf{Z})$ is the difference in indirect utility between purchasing the product at price $p$ and declining the price, and $\mathbf{Z}$ is a vector of characteristics that influence the indirect utility. The function $v(p,\mathbf{Z})$ in equation 4 for individual $i$ can be written as

$$v\left(p_{ij}, Z_{ij}\right)=\alpha+\rho' p_{ij}+\chi'\mathbf{O}_j+\lambda'\mathbf{X}_i, \quad i=1, 2, \ldots, n, \quad j=1, 2, \ldots, 8 \tag{4}$$

where $p_{ij}$ is the price of oyster $j$ offered to respondent $i$, $\mathbf{O}_j$ is a vector of specifications for oyster $j$, and $\mathbf{X}_i$ is a vector of observable characteristics of respondent $i$. The vector $\mathbf{O}_j$ consists of local, non-local, east coast, and west coast oysters and oysters harvested from low, moderate, and high nutrient waters with a baseline oyster with no nutrient or location specification. The vector $\mathbf{X}_i$ consists of a participant's gender, age, education, income, and political affiliation, and $\alpha$, $\chi$, $\rho$, and $\lambda$ are unknown parameters to be estimated.

The models test several hypotheses. First, we hypothesize that consumers react to eco-labels that differentiate the level of ecosystem service an oyster provides and that consumers' WTP for oysters increases with the level of ecosystem service provided. Second, we hypothesize that the treatment involving the Olympic rings and the textual nutrient information (T6) yields a greater premium for a high level of ecosystem service compared to the treatment involving the water drop and the textual nutrient information (T5). Finally, we hypothesize that participants are willing to pay more for local oysters than for non-local oysters and for east coast oysters than for west coast oysters.

The demographic characteristics of the participants are presented in Table 2. Of the 341 participants in the experiment, 46% were female and the average age was 40. Their political affiliations were diverse; 38% identified as politically moderate, 24% as conservative, and 28% as liberal. A relatively small percentage of the respondents had earned a bachelor's or advanced degree. In terms of income, most earned less than $75,000 annually.

## Results

We use a random-effects logit model to estimate the marginal effects of price, the level of ecosystem service provided by the oysters, and participants' demographic characteristics on the likelihood of an individual participant choosing to purchase a specific oyster option. As shown in Table 3, participants were less likely to purchase oysters when the price was relatively high, which is consistent with economic theory. Consumers preferred oysters that provided a high level of ecosystem service to oysters that provided a low level of service. Specifically, participants were 13% more likely to say "yes" to purchasing oysters that provide high ecosystem services compared to low services. Oysters providing a moderate level of service had a positive but insignificant effect on WTP. In general, participants were 10% most likely to purchase fried oysters. In terms of demographic factors, WTP for oysters decreased with participants' age while gender, income, and education had no significant effect on WTP.

Table 4 reports the results of regressions within each treatment using the same model. A high level of ecosystem service provision results in a positive effect that is statistically significant at the 1% level under all of the treatments. A moderate level of service provision, on the other hand, results in no statistically significant effect on WTP under any of the treatments. In addition, chi-square tests suggest that, compared to oysters that provide high level of ecosystem services, the WTP is significant lower for moderate service provision.

We next investigate how each treatment influences participants' valuations of oysters that provide a high level of ecosystem services by creating an ordinal variable, *Service*, that takes a value of 1 when an option represents oysters that provide *low* ecosystem services, 2 when the service level is *moderate*, and 3 when the service level is *high*. This variable allows us to capture the marginal effect of the level of ecosystem service provided on the likelihood of a participant choosing to purchase the oyster option. Table 5 reports the results of a random-effects logit model estimation with and without demographic variables included in the regression. The variable *T*_Service represents the interactions between the level of ecosystem service provided and each treatment where *T* = {T1 (water drop), T2 (Olympic ring), T3 (nutrient information), T4 (NOAA color code + information), T5 (water drop + nutrient information), T6 (Olympic ring + nutrient information)}. The results are robust with and without inclusion of the demographic variables. All of the treatments that distinguished the level of ecosystem services provided by the oysters in some way (T2–T6) had a positive effect, with the magnitude decreasing in the order of T3 (1.00), T5 (0.86), T6 (0.56), T4 (0.31), and T2 (0.23). These results show that labels that rate the level of ecosystem services provided are generally effective in terms of differentiating products. Providing participants with the Olympic rings or with the NOAA standard only yielded weaker effects in terms of magnitude and statistical significance.

Our experimental design allows us to identify the effect of each element in the tested eco-labels. Table 6 reports how each element influenced participants' preferences for a greater level of ecosystem service. As expected, presentation of the basis water drop label does not differentiate consumer WTP for different levels of eco-system service. The same is true for the color-coded NOAA bars presented in T4. However, inclusion of the color-coded rings around the water drop has a positive effect, indicating that participants were more likely to purchase oysters that provided a relatively high level of ecosystem service. Of all of the elements, the greatest individual effect was achieved by the text-only descriptions of nutrient levels in the water (T3). These results indicate that consumers respond more to specific claims about the effect of a green product than to the green category in general.

There is strong support in the economic literature for labels such as "green" and "local" on foods generating price premiums but little research on the reference points consumers use when make their purchasing decisions. The eight oyster options used in this study allow us to examine those reference points. Under each treatment, participants in the experiment were more willing to purchase oysters that provided relatively high levels of an ecosystem service compared to a baseline of oysters that provided a low level of benefit. But what if the service level is not specified? What range will consumer WTP fall into in that case? To shed light on these questions, we ran another regression with a baseline of oysters for which there is no information about the level of the ecosystem service provided. Those results are presented in Table 7.

In this case, the participants' WTP for oysters that provide low and moderate levels of ecosystem services is significantly lower compared to the oyster option that was not presented with any specification. A high level of ecosystem service provision has a positive but statistically insignificant effect. This result is somewhat surprising but is consistent with our results for other oyster characteristics. For instance, participants were significantly less likely to purchase non-local and west coast oysters while local and east coast oysters had positive but insignificant effects compared to the baseline option where no specification was presented.

A natural follow-up question is whether the economic outcomes are better or worse when the level-based eco-labels are introduced. Prior studies have examined similar questions using a dichotomous format. In a context of organic and growth-hormone-free milk, Kanter et al. (2009) found that promoting those products can simultaneously stigmatize conventional milk and that the net economic result can be negative because consumers reduce their WTP for the conventional product, which has the lion's share of the market. When differentiating the level of environmental services provided by green products, it is important to investigate how the resulting differences in WTP could affect the market.

We estimate the participants' mean WTP for an oyster following Hanemann (1984):

$$WTP = \frac{1}{\hat{\rho}}(\hat{\alpha} + \hat{\lambda}'\bar{X}). \tag{5}$$

We find that the consumers in our sample are willing to pay \$0.39 on average for one oyster. Table 8 reports the means and confidence intervals around the estimated marginal WTP for each variable calculated using the delta method (Greene, 2008), Compared to a baseline of oysters for which no ecosystem service information is provided, we estimate a premium of \$0.23 in WTP for oysters that provide a high level of ecosystem service. In contrast, for an oyster specified as providing a moderate level of ecosystem service, WTP decreases \$0.38. These results indicate that participants generally have a WTP for the baseline oyster that falls somewhere between those two options. For oysters that provide a low level of ecosystem service, WTP decreased by $0.54, indicating that some participants would not eat those oysters even when the price was zero. This is consistent with our findings on other oyster options. For instance, our respondents are willing to pay a $0.13 premium for local oysters, but the WTP discount for non-local oysters is larger (-$0.33).

In summary, relative to oysters with an unknown level of environmental benefit, WTP is higher for oysters that generate a high level of ecosystem service and lower for oysters that provide moderate and low levels of ecosystem service, and the size of the premium is smaller, on average, than the size of the discount. Our results suggest that level-based eco-labels can increase economic returns but are highly sensitive to the market structure for the specific product. Differentiation can increase economic returns if and only if the market shares of the high-level products are large enough to compensate for the economic loss associated with stigmatization of the low-service products.

**Conclusion**

Eco-labels have gained much attention from both commodity markets and economists. A number of studies have investigated how current forms of eco-labeling affect consumer preferences for environmentally-friendly products. Those labels have generally used a dichotomous format that identifies only whether the product is beneficial for the environment and provides no information for the public on the specific benefit provided or the degree to which it is provided. Products are simply "organic" or "bird friendly" (Messer et al. 2000). As the industry's ability to differentiate and classify products as providing various levels of environmental services, the type of information that best communicates to potential consumers will be a central question. Information plays important roles in consumer behavior. The right type and quantity can generate price premiums for products that provide environmental services. The wrong kind and/or too much can distract consumers. Empirical evidence is needed to identify effective approaches.

To shed light on this issue, we conduct a field experiment involving visitors to an east coast Department of Motor Vehicles. The experiment elicited WTP from 341 participants for a product that was heterogeneous only in the level of ecosystem service it provided using a single-bounded dichotomous-choice format and a survey that collected information about participants' demographic characteristics and purchase behaviors. We use a random-effects logit model to analyze the resulting data.

We find that participants are responsive to differentiation by the level of ecosystem service provided. On average, individuals are willing to pay more for a relatively high level of ecosystem service provision. This effect is larger when the label contains symbols that explicitly differentiate the levels, and the magnitude of the effect on WTP is further amplified when the label contains brief information on the basis for the levels.

Our results also suggest that the premium generated by a relatively high level of ecosystem service provision (a superior product) is less, on average, than the discount in WTP for a relatively low level of ecosystem service provision (an inferior product) in both magnitude and statistical significance. Therefore, whether labels that differentiate the level of an ecosystem service provided can increase economic returns is sensitive to the market share of each of the products and how different the levels of ecosystem services are. Moreover, these returns will also depend on other factors, which were not subject of our study, see for example Onozaka and Mcfadden (2011) who analyze the interactive effects of sustainable production labels and locality claims.

This study empirically examines the effect of level-based eco-labeling. The results provide a greater understanding of how consumers react to eco-labels, leading to several opportunities for future study. For instance, markets for various products vary significantly in terms of the shares of products providing high and low levels of environmental benefit. Policymakers could benefit from studies that identify the particular markets in which differentiated eco-labels would be effective. Another interesting question is how to avoid or mitigate stigma toward dominated products that provide a relatively low level of environmental benefit.

Tables

**Table 1. Treatment Design Overview**

| | Between-Subject Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Control** | **T1** | **T2** | **T3** | **T4** | **T5** | **T6** |
| | | **Water Drop** | **Olympic Ring** | **Nutrient Level Text** | **Nutrient Level Text + NOAA Color-code** | **Nutrient Level Text + Water Drop** | **Nutrient Level + Olympic Ring** |
| **Baseline Options** | (i) Oysters from Non-Specified Water<br>(ii) Oysters from the East/West Coast<br>(iii) Local/Non-Local Oysters | | | | | | |
| **Within-Subject Treatments** | Non-Specified Water | Non-Specified Water<br> | Non-Specified Water<br> | High Nutrient Water | High Nutrient Water<br> | High Nutrient Water<br> | High Nutrient Water<br> |
| | Non-Specified Water | Non-Specified Water<br> | Non-Specified Water<br> | Moderate Nutrient Water | Moderate Nutrient Water<br> | Moderate Nutrient Water<br> | Moderate Nutrient Water<br> |
| | Non-Specified Water | Non-Specified Water<br> | Non-Specified Water<br> | Low Nutrient Water | Low Nutrient Water<br> | Low Nutrient Water<br> | Low Nutrient Water<br> |

Note: The order of the within-subject treatments is randomized to control for potential order effects.

**Table 2. Summary Statistics for Demographic Variables**

| | |
|---|---|
| Number of respondents | 341 |
| Average age (years) | 40 |
| **Variable** | **Percent of Respondents** |
| Male | 54.30 |
| Female | 45.70 |
| Education (highest level) | |
| Some School | 6.23 |
| High school diploma | 33.83 |
| Some college | 36.21 |
| Bachelors' degree | 14.84 |
| Advanced degree or graduate degree | 8.90 |
| Household income (in 2015) | |
| Less than $10,000 | 13.93 |
| $10,000 to $24,999 | 16.46 |
| $25,000 to $34,999 | 19.46 |
| $35,000 to $74,999 | 28.47 |
| $75,000 to $99,999 | 8.98 |
| $100,000 to $149,999 | 8.98 |
| $150,000 or more | 4.19 |
| Political affiliation | |
| Conservative | 24.10 |
| Moderate | 37.95 |
| Liberal | 28.01 |
| Other | 9.94 |

**Table 3. Coefficient Estimates of the Explanatory Variables on Saying "Yes" to an Option**

| Parameter | Coefficient Estimate | | Standard Error | Marginal Effect | |
|---|---|---|---|---|---|
| Price | –0.61 | ** | 0.25 | -0.07 | *** |
| High ecosystem service | 1.14 | *** | 0.29 | 0.13 | *** |
| Moderate ecosystem service | 0.23 | | 0.30 | 0.03 | |
| Low ecosystem service (baseline) | — | | — | — | |
| Female | –0.34 | | 0.36 | -0.04 | |
| Age | –0.04 | *** | 0.01 | 0.00 | *** |
| Fried | 0.88 | ** | 0.38 | 0.10 | ** |
| Liberal | 0.87 | ** | 0.38 | 0.10 | ** |
| Income | 0.10 | | 0.22 | 0.01 | |
| Education | 0.27 | | 0.23 | 0.03 | |
| Income*Education | –0.03 | | 0.04 | 0.00 | |
| Constant | –1.56 | | 1.29 | — | |

*Note:* N = 681
Coefficients are estimated using a random-effects logit model.
Marginal effects are calculated using delta method.
* 10% significance level, ** 5% significance level, ***1% significance level.

**Table 4. Choice for Ecosystem Service Levels by Treatment**

| | T2 | T3 | T4 | T5 | T6 |
|---|---|---|---|---|---|
| **Treatment** / **Ecosystem Service Level** | **Olympic Ring** | **Nutrient Level Text** | **Nutrient Level Text + NOAA** | **Nutrient Level Text + Water Drop** | **Nutrient Level Text + Olympic Ring** |
| High ecosystem service | 1.07*** | 2.33*** | 1.23*** | 1.13*** | 0.90*** |
| Moderate ecosystem service | –0.14 | 0.70 | 0.18 | 0.15 | –0.11 |
| Low ecosystem service (baseline) | — | — | — | — | — |

*Note:* Coefficients are estimated using a random-effects logit model.
The coefficient estimates between high and moderate ecosystem services are positively significant for all treatments at 5% or lower.
* 10% significance level, ** 5% significance level, *** 1% significance level.

**Table 5. Coefficient Estimates of the Explanatory Variables on Saying "Yes" to an Option using a Random-effects Logit Model**

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| **Parameter** | **Coefficient Estimate** | **Standard Error** | **Coefficient Estimate** | **Standard Error** |
| Price | –0.65 *** | 0.26 | –0.75 *** | 0.26 |
| Olympic | 0.83 | 1.11 | 1.08 | 1.12 |
| Olympic + Nutrient Info | 0.30 | 1.08 | 0.64 | 1.11 |
| Nutrient | –1.12 | 1.20 | –0.59 | 1.20 |
| Water Drop + Nutrient | 0.37 | 1.11 | 0.85 | 1.12 |
| NOAA (Baseline) | — | — | — | — |
| Olympic x Higher Service | 0.23 | 0.33 | 0.25 | 0.33 |
| (Olympic + Nutrient) x Higher Service | 0.56 * | 0.31 | 0.55 * | 0.31 |
| Nutrient x Higher Service | 1.00 *** | 0.36 | 0.96 *** | 0.35 |
| (Water + Nutrient) x Higher Service | 0.86 *** | 0.32 | 0.87 *** | 0.32 |
| NOAA_Nutrient x Higher Service | 0.31 | 0.33 | 0.28 | 0.32 |
| Female | –0.41 | 0.36 | | |
| Age | –0.04 *** | 0.01 | | |
| Fried | 0.91 ** | 0.39 | | |
| Liberal | 0.90 ** | 0.39 | | |
| Income | 0.04 | 0.22 | | |
| Education | 0.25 | 0.23 | | |
| Income*Education | –0.02 | 0.05 | | |
| Constant | –1.71 | 1.31 | –2.22 | 0.53 |
| | N=681 | | N=729 | |

*Note:* Coefficients are estimated using a random effects logit model.
* 10% significance level, ** 5% significance level, *** 1% significance level.
Numbers of observations differ in the two models because some participants did not complete the demographic survey.

**Table 6. Marginal Effect of Elements in Eco-labels on Preferences for Higher Ecosystem Services using a Random Effects Logit Model**

| Parameter | Coefficient Estimate | | Standard Error |
|---|---|---|---|
| Price | –0.74 | *** | 0.26 |
| Olympic Effect | 0.26 | * | 0.16 |
| Water Drop Effect | 0.25 | | 0.21 |
| Nutrient Effect | 0.41 | *** | 0.16 |
| NOAA Effect | –0.04 | | 0.29 |
| Constant | – 2.01 | *** | 0.51 |

*Note:* N = 729.
Coefficients are estimated using a random-effects logit model.
* 10% significance level, ** 5% significance level, *** 1% significance level.

**Table 7. Coefficient Estimates of the Explanatory Variables on Saying "Yes" to an Option using a Random-effects Logit Model**

| Parameter | Coefficient Estimate | Standard Error |
|---|---|---|
| Price | –1.67 *** | 0.15 |
| Local | 0.21 | 0.21 |
| Non local | –0.55 ** | 0.23 |
| West coast | –0.54 ** | 0.23 |
| East coast | 0.16 | 0.21 |
| High ecosystem service | 0.37 | 0.25 |
| Moderate ecosystem service | –0.64 ** | 0.28 |
| Low ecosystem service | –0.87 *** | 0.28 |
| Female | –0.50 | 0.31 |
| Age | –0.03 *** | 0.01 |
| Fried | 0.33 | 0.33 |
| Liberal | 0.48 | 0.33 |
| Income | 0.10 | 0.19 |
| Education | 0.39 ** | 0.21 |
| Income*Education | –0.04 | 0.04 |
| Constant | –0.02 | 1.06 |

*Note:* N = 2,592.
Coefficients are estimated using a random effects logit model.
* 10% significance level, ** 5% significance level, *** 1% significance level.

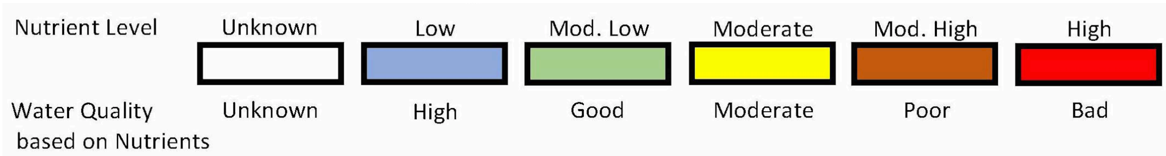
**Table 8. Willingness to Pay for Different Oyster Options**

| | Marginal WTP | Lower Bound | Upper Bound |
|---|---|---|---|
| No Specification | 0.39 | –0.14 | 0.91 |
| Local | 0.13 | –0.12 | 0.39 |
| Non-local | –0.33 ** | –0.59 | –0.05 |
| West coast | –0.33 ** | –0.59 | –0.05 |
| East coast | 0.10 | –0.15 | 0.35 |
| High ecosystem service | 0.23 | –0.06 | 0.54 |
| Moderate ecosystem service | –0.38 ** | –0.70 | –0.04 |
| Low ecosystem service | –0.54 *** | –0.86 | –0.19 |

*Note:* * 10% significance level, ** 5% significance level, *** 1% significance level.
Lower and upper bounds calculated for the 95% confident interval.

## Figures

**Figure 1. NOAA Standard**



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## Appendix A – Experiment Roadmap

**Step 1.** Experimental questions design. This step included input from stakeholders, such as industry experts, restaurant owners and policymakers.

**Step 2.** Location scouting: We coordinated with the Delaware Division of Motor Vehicles (DMV) to set up an indoor recruitment booth, an outdoor tent for oyster handling, and designated research areas. The experiment took multiple days at the DMV, with the same set-up every day. We arranged for professional oyster shucking services, which accompanied us to the experiment each day.

**Step 3.** Design implementation using dichotomous choice experiments. 341 Participants responded either "yes" or "no" to 8 dichotomous choice questions.

a. Participants were set up with $10.
b. Participants preselected the number of oysters they would want to purchase (3, 6, 9 or 12) and how they would like the oysters prepared (raw, fried or in a bag of ice for take-home).
c. Participants made 8 dichotomous choice decisions.
d. Participants filled out a demographic survey.
e. Random selection of one of the participant's choice decision – a roll of the dice determined which one of the eight decisions would be implemented (ensured incentive compatibility).
f. If random draw selected a "yes" decision, the participants paid for the oysters and would receive the oysters as indicated in their pre-selection; if the random draw resulted in a "no" decision, the participant would receive the $10 and no oysters.

## Appendix B - Experiment Instructions

*Please read these instructions carefully and do not communicate with any other participants while you are making your decisions.*

- We will give you $10 that you may use to purchase oysters in this study or you may keep**.**
- Depending on the choices you make, you may receive a combination of cash and oysters. There is the possibility of you owing us money if the cost of your oysters is greater than $10. In such case, you can pay with cash, check or credit card for the oysters.
- Your decisions are just like the ones you make in a store, you either buy at the listed price or you don't.

**Guidelines:**

1. Decide how many oysters you want to buy (3, 6, 9 or 12)
2. Decide how you would like your oysters prepared (raw on the half shell, fried, in a bag with ice)
3. Decide if you want to buy the oyster options at the listed price by selecting 'Yes' or 'No'
4. Fill out a short survey
5. Roll a digital die to determine which oyster option will be implemented (only one will be implemented)

**Example 1:** If you selected 'Yes' for an oyster option that costs $7 and this option is implemented, you will receive the oysters and $3 cash ($10 - $7 = $3).

**Example 2:** If you selected 'No' for an oyster option and this option is implemented, you will receive $10 and will not receive any oysters.

**Example 3:** If you selected 'Yes' for an oyster option that costs $15 and this option is implemented, you will receive the oysters and owe $5 ($10 - $15 = -$5).

**The following information comes from the Marine Biological Laboratory, the United States Geological Survey, the National Oceanic and Atmospheric Administration.**

- Nutrients, such as Nitrogen and Phosphorous, are naturally occurring elements that are essential for growth and reproduction in both plants and animals.
- Excess levels of nutrients, however, can cause overstimulation of growth of aquatic plants and algae, leading to algal blooms, oxygen depletion, clogged water intakes, fish kills, a general loss of key habitats, and affect the use of water for fishing, swimming, and boating.
- Oysters are filter feeders. They consume free-swimming algae and improve water quality.

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The department's research in these areas is part of the organized research program of the Delaware Agricultural Experiment Station, College of Agriculture and Natural Resources. Much of the research is in cooperation with industry partners, the USDA, and other State and Federal agencies. The combination of teaching, research, and service provides an efficient, effective, and productive use of resources invested in higher education and service to the public. Emphasis in research is on solving practical problems important to various segments of the economy.

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