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Abstract

This paper empirically investigates consumer response to a traffic light advisory for environmentally sustainable seafood, which was implemented in the seafood department of a regional supermarket chain in the United States. Green meant 'best choice'; yellow meant 'proceed with caution'; red meant 'worst choice'. Using a unique product-level panel scanner data set capturing sales information for 2 treatment stores and 8 nearby control stores, we apply a difference-in-differences identification strategy to estimate the impact of color-coded labels on consumers' purchases. We find that the advisory leads to no significant difference in total seafood sales. Green sales significantly increase an average of 29% per week; yellow sales significantly decrease an average of 27% per week; red sales show no significant difference in sales. Green products on a mercury safe list had the greatest increase in sales whereas yellow products not on the mercury safe list had the largest drop in sales.

Key words: Sustainable seafood, Fisheries crisis; FishWise; Traffic light advisory, Mercury.

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1 Introduction

In confronting a global ‘fisheries crisis’, a variety of organizations have increasingly targeted consumers in the high income countries with market-based mechanisms such as environmental sustainability labels. These mechanisms are typically designed to stimulate demand for environmentally sustainable products, thereby providing firms with an incentive to produce and sell products with higher levels of socially desirable attributes. The Food and Agriculture Organization of the United Nations (FAO) estimates that there are now over 400 standards, certifications and ecolabels - public and private, third-party and industry-sponsored - related to wild fisheries and aquaculture[1]. Given the resources invested in developing them and the high expectations for their efficacy, it is thus critical to understand whether consumers understand and use the information provided in these programs.

This paper empirically investigates consumer response to one such environmental sustainability advisory implemented in the seafood department of a regional supermarket chain in the United States. The advisory informs consumers about the relative environmental sustainability of each seafood product using traffic light (TL) colors; green means ’best choice’, yellow means ’proceed with caution’, and red means ’worst choice’ (Figure 1). Our analysis takes advantage of a phased program introduction in a random subset of the chain’s stores to address the following research questions:

1. What is the impact of the advisory on total seafood sales?
2. What is the impact of the advisory on seafood sales by label color?
3. What is the impact of the advisory on seafood sales by label color and mercury content?

We use a unique, product- and store-level scanner data set containing five years of weekly information on the quantity and price sold of each seafood stock keeping unit (SKU). By merging this data with reconstructed information on the label color for each seafood SKU and focusing on the time periods immediately before and after implementation of the advisory, we are able to apply a difference-in-differences identification strategy to estimate the impact of the color-coded labels on consumers' purchase decisions. We first examine the effect of the labels by comparing the overall change in seafood sales from the pre-treatment to post-treatment period in the treatment stores to the change in seafood sales from the pre-treatment to post-treatment period in the control stores. We then dis-aggregate the impact depending on the label color and whether the seafood was included on the list of low mercury content fisheries in order to shed insight into the heterogeneous impacts of the advisory.

We find that the advisory leads to no significant difference in total seafood sales. We estimate different treatment effects depending on the label color Green sales significantly increase an average of 29% per week; yellow sales significantly decrease an average of 27% per week; red sales show no significant difference in sales. Green products on a mercury safe list had the greatest increase in sales whereas yellow products not on the mercury safe list had the largest drop in sales.

This paper uses information about consumers' behaviors via their actual purchases, rather than their stated preferences via survey questionnaires, to assess whether consumers understand and respond to environmental sustainability labels. Taking advantage of a field experimental design, this paper is the first study to empirically investigate consumer response to a third-party, TL labeling system in the United States.

The remainder of this paper is structured as follows: Section 2 provides background on the use of environmental sustainability labels in fisheries, Section 3 presents the empirical strategy, including a discussion of the experimental setting, data and econometric specifications; Section 4 presents the results of the analysis. Section 5 discusses these results and concludes.

2 Background

Seafood production is a massive, global industry in which demand is driven disproportionately, and increasingly, by consumers in high-income countries. The Food and Agriculture Organization of the United Nations (FAO) estimates that more than one-third of the total world seafood production was traded internationally in 2006, with total exports up more than 50 percent from a decade earlier. In 2006, three regions - Japan, the Unites States and the EU countries - imported three-quarters of all traded seafood biomass, and developing countries supplied more than half this seafood [1]. That same year, U.S. consumers spent $69.5 billion on fish and shellfish, with roughly half of this spending in retail outlets and the other half in restaurants [2]. Population growth and higher per capita consumption are expected to drive demand for an additional 30-40 million tonnes (21 - 28 percent growth) of seafood by 2020 [1, 3]. Yet at least since the mid-1980s, nearly all major wild fishery stocks have been declining worldwide, and most wild fisheries are now a small fraction of their original size [4, 5]. Large, predatory fish biomass, which includes swordfish and codfish, is estimated to be roughly 10 percent of pre-industrial levels [6]. In 2007, 28 percent of seafood stocks monitored by the FAO were yielding less than their maximum potential due to overfishing, and another 52 percent of seafood stocks were producing yields that were at or close to their maximum sustainable limits [2009]. The market share of aquaculture in global fish seafood supply increased to nearly 47 percent in 2006, and is expected to reach 60 percent by 2020 [1], but concerns about ecological impact, such the clearing of ecologically valuable mangroves for shrimp aquaculture, may ultimately limit the potential of aquaculture to fully substitute for wild fish stocks.

In confronting this 'fisheries crisis', governments and other public organizations have traditionally sought to regulate seafood production using tools that specifically target seafood production such as harvest quotas and specifications of fishing technology. Starting in the 1990s, a variety of organizations including governments, non-governmental organizations (NGOs), aquariums and other groups also began to target consumers in the high-income countries with market-based mechanisms. Market-based mechanisms are usually designed to provide information that helps consumers select products that better match their values, which results in greater direct utility for the consumer and provides firms with a market-based incentive to produce and sell products with higher levels of socially desirable attributes. One such mechanism is an environmental sustainability label, commonly referred to as an "ecolabel". Within fisheries, well-known ecolabels include the Earth Island Institute's Dolphin Safe Tuna label for sustainable tuna fishing and the Marine Stewardship Council's MSC certification for sustainable fisheries[1]. The FAO's definition of a seafood ecolabel is "a tag or label certifying that the fish product was produced in an environmentally friendly way. It provides information at the point of sale that links the product to the production process" [1].

The availability of information about a product does not necessarily mean consumers will incorporate it into their decisions and alter their behavior [8, 9, 10, 11, 12]. Research from such fields as behavioral economics, psychology, and marketing has identified a variety of potential cognitive distortions in whether and how people use information. A partial list of these cognitive biases includes avoidance of outcomes that have highly emotional or negative consequences, risk aversion, cognitive limitations on the amount of information a person is able to process, and the overestimation of unlikely risks over which people have little control [13, 14, 15, 16]. Fung et al, reviewing a variety of government-mandated disclosure programs, argue that the information content, the format in which it is presented and the timing of information delivery must all be consistent with a consumer's decision process in order to work [17].

This paper makes a timely contribution. The proliferation of standards and certifications

[1] The Dolphin Safe Tuna Labeling program sought to stop the killing of dolphins inadvertently captured when schools of tuna were encircled in the nets used by tuna fisherman. The program created a government-defined environmental sustainability label that could be used by tuna producers to certify that their catch methods were dolphin-safe. The Marine Stewardship Council's MSC blue and white logo may be used by companies selling products from fisheries in which the MSC has verified that the entire chain of production is environmetally sustainable[7].

for fisheries and aquaculture has started to raise questions about their efficacy [18]. The Sub-committee on Aquaculture, a sub-committee of the FAO's Committee on Fisheries, has publicly commented that the proliferation of certification schemes may be confusing both producers and consumers, stating that there is "a need for more globally accepted norms for aquaculture production" [1]. In a 2005 poll conducted by the Seafood Choices Alliance, 79% of consumers say that environmental concerns are important in their seafood purchasing decisions, 30% of consumers say they have chosen not to purchase seafood that is unsustainably harvested, and 40% of consumers state they are willing to pay 5 to 10 percent more for products labeled as environmentally responsible [19]. Yet a 2008 survey of the top twenty supermarkets in the United States showed that they all of the supermarkets sold significant numbers of seafood deemed to be highly endangered [7].

In the EU and Australia, the extent to which consumers read back-of-package nutrition labels and what formats of front-of-package labels are most effective is much debated [20]. Even a seemingly simple program based on TL colors may be too complex for some consumers. The UK's Food Standards Agency (FSA) recommends a simple three-color traffic light system that includes descriptive terms for each color [21]. However, the European Food Information Council (EUFIC) recently reported that the majority of UK respondents understood the meaning of a green traffic light, but were confused about the meaning of amber and red traffic lights [2008]. Another, independent study recommends a simple tick logo on the front-of-pack based on research finding that more complex systems such as traffic lights take too much time to evaluate [23].

Existing literature explicitly focusing on consumer preferences in the context of information-based mechanisms relies largely on attitudinal and knowledge surveys, consumer choice experiments, and experimental auctions [24, 25, 26, 27, 28, 29, 30]. This work finds that that experts and novices have differential responses to product information; specifically, experts are more likely to be persuaded by complex information whereas novices react symmetrically [24]. Similarly, Wessels et al. [25] use a contingent choice survey to evaluate consumers' possible acceptance of an eco-labeling program for seafood products, concluding that a consumer's willingness-to-pay (WTP) for labeling is dependent upon her level of awareness of the environmental issues and an understanding of the connection between the purchase decisions and the sustainability of the fisheries. While these studies offer insight and valuable methodological approaches for more empirically-driven work, they are also vulnerable to the criticism that, at best, they capture consumers' stated preferences and not their actual behaviors.

To date, empirical studies of labeling have focused on three federal programs: the Nutrition Labeling and Education Act (NLEA), the USDA National Organic Program (NOP), and the dolphin-safe tuna label. Jin and Leslie[9] show that grade cards required by the NLEA cause restaurant health inspection scores to increase. Kiesel and Villas-Boas[10] conclude that consumers are willing to pay a slight premium for milk products with the USDA organic seal. Batte et al.[31] conclude that consumers are willing to pay a premium for products that are less than 100 percent organic. The closest related paper to this study is Teisl et al.[26] in which the authors use consumer purchase data to confirm that the dolphin-safe tuna label increased the market share of canned tuna containing the label.

3 Empirical Strategy

3.1 Experimental Setting and Data

3.1.1 Experimental Setting

The FishWise advisory was developed by an independent non-profit organization and licensed to the supermarket chain that provided the data for this study. Under the FishWise TL system, a color label is assigned to each fresh seafood SKU based on the seafood species, catch method, production method and country of origin. At the supermarkets in this study, each fresh seafood SKU was individually labeled, such that all fresh seafood SKUs in the display received a label. Each label contained the TL color as well as the name of the seafood, the country of origin, whether the seafood was farmed or wild, the price per pound and a small graphic meant to depict the catch method (Figure 1).

Adjacent to the seafood counter, the supermarket placed two posters that had been created by FishWise. The first poster listed the three colors of ratings and provided the descriptions. Green, 'best choice', means that the SKU is sustainable and fishing has little impact on the ecosystem. Yellow, 'proceed with caution', means that wild fish populations are healthy; however, other problems exist such as poor fishery management. Red, 'worst choice', means that the wild fish populations are overfished, and moreover, that other problems exist in the fishery such as habitat destruction. The second poster provided information on the SKUs of seafood that are likely to have low levels mercury and poly-chlorinated biphenyls (PCBs), two chemicals known to have harmful effects on humans (Figure 1). Inclusion on this list is meant to be good; excluded SKUs are assumed to have high levels of mercury and PCBs. Individual SKU color labels do not contain information on mercury or PCB content.

Due to implementation costs, the supermarket chain that provided the data for this study randomly chose two stores in which to pilot the FishWise advisory before rolling it out to all stores. Thus, there were a total of two treatment stores and eight control stores. The two treatment stores were in Walnut Creek and Berkeley, California . The eight control stores were located in the San Francisco Bay Area: Richmond, Sunnyvale, Palo Alto, San Francisco, San Rafael and three stores in Alameda county. The supermarket phased-in the FishWise advisory at the two stores starting on May 17, 2006. The supermarket then started to phase-in the FishWise program at all remaining eight stores on September 4, 2006 and officially launched the advisory the following month on October 9, 2006.

3.1.2 Data

This study used several unique time series data sets that we obtained by building close collaborations with the supermarket chain and FishWise. By merging the supermarket and FishWise data and focusing on the time periods immediately before and after implementation of the advisory, we are able to apply a difference-in-differences identification strategy to estimate the impact of the color-coded labels on consumers' purchase decisions. We use the full time series when verifying the robustness of our results. We also used the full time series in some early versions of the analysis that matched control and treatment stores.

From the supermarket chain, we use a product- and store-level scanner data set containing five years of weekly information running from February 2004 to February 2009. This scanner data set contained weekly sales data by SKU: week, store number, seafood type (e.g. salmon), description, sales in pounds and dollars, full retail price per pound, discounted price per pound, marginal cost of each SKU, gross margin, and country of origin. The supermarket chain also provided scanned copies of weekly, product- and store-level records containing the dates and details of special advertisements and promotions for each SKU. After converting this information to database format, we merged this information with the scanner data set. Extracting the data from quarterly reports provided by FishWise, we then reconstructed a weekly record of the assignment of label colors by SKU as well as each of the individual variables that contributed to the color label: country of origin catch method, and production method. We verified that these color assignments matched a partial record of color assignments maintained by the supermarket, which had discarded earlier records of the color assignments. Finally, using quarterly reports provided by FishWise, we reconstructed a weekly record of seafood SKUs that were contained on a list of fisheries that had low levels of mercury and PCBs.

Average weekly seafood sales represent approximately 2-3% of total store sales (Table1). Salmon, shrimp and halibut are the top three types of seafood by sales, with salmon representing approximately three times more sales per store than shrimp (Figure 2). Overall, 53 seafood SKUs were sold in both the pre-treatment and the post-treatment periods at the treatment and control stores. The data set contains a total of 107 SKUs sold in at least one store during the 12 weeks covered by this data set. We conducted the analysis using the 53 SKUs of seafood on sale in both the pre-treatment and post-treatment periods, and we conducted robustness checks to evaluate the impact of including the additional SKUs on the parameter estimates.

3.2 Econometric Specifications

3.2.1 Specification One: Overall Effect

We apply specification one to the data in order to compare average sales in treated versus control stores. Specification one is a standard difference-in-differences estimator with store, product and week fixed effects.

$$ln(Q_{ist}) = \alpha + \beta_1 t_{it} + \beta_2 T_{is} + \theta\left(T_{is} * t_{it}\right) + \chi_{ist}\delta_{\chi} + \lambda\left(promo_{ist} * store_s * t_{it}\right) + \epsilon_{ist} \quad (1)$$

Q_{ist} are the ounces of seafood i sold in store s in week t. There are $i = \{1, ..., I\}$ differentiated products, $s = \{1, ..., S\}$ stores and $t = \{1, ..., T\}$ time periods. $t_{it}$is an indicator variable that is equal to one during the post-treatment period and zero during the pre-treatment period. T_{is} is an indicator variable that is equal to one for treatment stores - stores in which the labeling program had been implemented - and zero for control stores. χ_{ist} is a row vector containing eight variables: store, week and product fixed effects as well as variables for price, the presence of promotions, the presence of high levels of mercury, country of origin, catch method and production method. sku_i is a set of indicator variables for each stock keeping unit (SKU). $store_s$ is a set of indicator variables for each store. $week_t$ is a set of indicator variables for each week. $lprice_{ist}$ is the natural log of the unit price of seafood i in store s in week t. $promo_{ist}$ is an indicator variable equal to one if seafood i was on promotion at store s in week t and zero otherwise. $merc_{it}$ is an indicator variable that is equal to one if SKU i had low levels of mercury and poly-chlorinated biphenyls (PCBs) in week t and zero otherwise. coo_{it} is a set of indicator variables representing the country of origin. cm_{it} is a set of indicator variables representing the catch method. pm_{it} is a set of indicator variables representing the production method.

The parameter estimate for the post-treatment period captures any between-time differences in Q_{ist} that are identical across the control and treatment stores. The parameter estimate for treatment store captures any differences between the treatment and control stores that are identical across time. The interaction of t_t and T_s is the treatment effect, which is equal to one if SKU i is sold in the treatment store during the post-treatment period. The parameter estimate for B_3 represents the average effect of the labeling program across all label colors.

In all specifications, the dependent variable is the log of ounces sold of seafood i in store s during period t. Thus, the point estimates for the parameters associated with the treatment effect indicator can be interpreted as percentage changes. In all regressions, we use standard errors clustered at the seafood type level as conventional standard errors have been shown to perform poorly in the context of difference-in-difference estimators in the presence of arbitrary serial correlation within each cross-sectional unit (Bertrand et al. 2004).

3.2.2 Specification Two: Effect by Label Color

We apply specification two to the data in order to isolate the extent to which the color of the label influences demand. Specification two is a difference-in-differences estimator with additional co-variates that allow for variation in treatment effect by label color.

$$\begin{aligned} ln(Q_{ist}) &= \alpha + \beta_1 (color_{ist} * t_{it}) + \beta_2 (color_{its} * T_{is}) + \theta (color_{ist} * T_{is} * t_{it}) + \\ & \quad \chi_{ist}\delta_\chi + \lambda (promo_{ist} * store_s * t_{it}) + \epsilon_{its} \end{aligned} \tag{2}$$

$color_{ist}$ is a set of indicator variables for each of the label colors. The parameters of estimates for θ represent the effect for each of the label colors in the treatment stores relative to the control stores. The vector χ_{ist}contains the same variables as those described for χ_{ist} in specification one.

If the labels provide primarily environmental sustainability information to consumers, we would expect to see a heterogeneous effect from each of the different label colors sales. If, on the other hand, as we investigated with specification one, the labels act only to publicize seafood, then we should see an increase irrespective of the label color.

3.2.3 Specification Three: Effect by Label Color and Mercury Content

We apply specification three to the data in order to evaluate the heterogeneous impact of the labeling program by label color and whether the seafood type was included on the list of low mercury seafoods located adjacent to the fresh seafood counter. Specification four is a difference-in-differences estimator with additional covariates that allow for interactions between the label color and presence on the low mercury advisory.

$$\begin{aligned} ln(Q_{ist}) &= \alpha + \beta_1 \left(color_{ist} * mercury_i * t_{it}\right) + \beta_2 \left(color_{its} * mercury_i * T_{is}\right) + \\ & \theta \left(color_{ist} * mercury_i * t_{it} * T_{is}\right) + \chi_{ist}\beta_\chi + \lambda \left(promo_{ist} * store_s * t_{it}\right) + \epsilon_{its} \quad (3) \end{aligned}$$

where $mercury_i$ is an indicator variable for whether the seafood type was included on the low mercury advisory. The parameter estimates for θ represent the effect of each label color on seafood that was included on the advisory versus seafood not included on the advisory.

4 Empirical Results

We start with a graphical analysis (Figure 3). Figure 3 is a plot of sales by label color over time for the treatment and control stores. The supermarket phased-in the FishWise program over a 4-week period at the treatment stores, represented by the period between the two vertical lines on each graph. To the left of the first vertical line, this figure shows 12 weeks (between February 19 - May 16, 2006) of average weekly sales in the treatment and control stores before the FishWise pilot. To the right of the second line, this figure shows 12 weeks (between June 12 - September 3) of average weekly sales in the treatment and control stores when the chain was piloting FishWise. This graphical analysis suggests that green sales increased, yellow sales decreased and red sales remained constant when comparing treatment and control stores during the pre-treatment and post-treatment periods.

We next present descriptive statistics for the pre-treatment (column pre) and post-treatment (column post) periods (Table 1). The pre-treatment period is 4 weeks, running from April 16 - May 16, 2006. Following a four-week phase-in period, the post-treatment period runs for 4 weeks from June 12 - July 8, 2006. This simple means differences in sales has the same pattern as the graphical analysis. While average seafood sales increase significantly in all stores, green sales increase by a greater amount in treatment than in control stores, yellow sales decline by a greater amount in treatment stores compared to control stores and red seafood sales decline in both treatment and control stores.

Table 1 also presents descriptive statistics for the prices of seafood overall and broken down by label color. Overall, a volume-weighted average of prices increases similarly in both the treatment and control stores.

In terms of the estimated average effect, we find no overall impact on overall seafood sales from the environmental sustainability advisory when comparing the changes in stores displaying the labels to changes in control stores not displaying the labels (Table 2). In all variations of this specification, the point estimate for the average treatment effect is not statistically significant from zero.

While overall seafood sales do not change, we find heterogeneous impacts from the advisory depending on label colors (Table 3). Sales of products with a green label significantly increase by an average of 29.3 percent of total mass of seafood sold per store and week across all seafood SKUs in treatment stores relative to the same unlabeled products in control stores. Sales of products with a yellow label significantly decrease by 27.5 percent. We fail to reject the null hypothesis of no impact on seafood sales for red labels SKUs.

We also find heterogeneous impact from the advisory depending on whether the seafood was included on the list of low-mercury fisheries (Table 4). For seafood on the low-mercury list, we find that green labeled seafood increases by an average of 29.7 percent of total mass of seafood sold per store and week across all seafood SKUs in treatment stores relative to the same unlabeled products in control stores. For seafood on the low-mercury list, we find that yellow labeled seafood decreased by an average of 24.3 percent of total mass of seafood sold per store an week across all seafood SKUs in treatment stores relative to the same unlabeled products in control stores. No seafood products received both a red label and inclusion on the low-mercury list. In comparison, for seafood not on the low-mercury list, green labeled seafood sales and red labeled seafood sales remained constant. Yellow labeled seafood sales decreased by an average of 53.1 percent.

These point estimates were robust to several alternative timeframes and sub-sets of the data (Table 6). The treatment effect of the yellow label is negative and statistically significant ($p<0.1$) in each alternative. While not statistically significant in all cases, the sign of the parameter estimates for the green and red labels are consistent with the earlier estimates. The alternative specifications included: robust standard errors rather than clustered standard errors (column 1), the use of twelve weeks of data before and after the start of the treatment and a four-week phase-in period (column 2), the use of eight weeks of data before and after the start of the treatment and a four week phase-in period (column 3), the use of four weeks of data before and after the start of the treatment and a two week phase-in period (column 4), a matched sample with stores five and four and four weeks of data before and after the start of the treatment (column 5), and finally a matched sample with stores four and five and four weeks of data before and after the start of the treatment (column 6).

We verified the supermarket's claim that they had not changed the pricing in the treatment stores relative to the control stores during the pre-treatment and post-treatment periods through a t-test of prices for each seafood SKU in the treatment and control stores. We verified the results by performing the analysis on a random sub-set of the control stores as well as at random moments in time prior to the implementation of the FishWise program.

5 Discussion and Conclusion

We identified a heterogeneous impact of the advisory depending on the label color and whether the fishery was included on the low mercury list. This finding indicates that consumers responded to the TL system and differentiated between the different types of information about both environmental and health information. Moreover, the results of this study indicate that there is an interaction effect between environmental and health information. A green label is a necessary but not sufficient condition for increasing sales of environmentally sustainable seafood. Sales of green labeled seafood increased only when that seafood was also included on the low-mercury list. Green labeled seafood not on the low-mercury list had no change in sales. Similarly, yellow labeled seafood that was on the low-mercury list had a smaller decrease in seafood sales than yellow labeled seafood not on the low-mercury list.

Consumers did not respond to the color-coded labels in the way intended by FishWise, which was to increase the sale of green labeled seafood and to decrease the sale of red labeled seafood. Several possible explanations exist. Consumers may not understand the meaning of the labels, and these consumers may have either not noticed or not taken the time to read the interpretive posters adjacent to the seafood counter, which explain the meaning of the label colors. Based on their research, the EUFIC reports that the majority of UK respondents correctly understood the meaning of a green traffic light; however, respondents were confused about the meaning of amber and red traffic lights [22]. The EUFIC found that respondents tended to exaggerated the meaning of the amber and red colors [22]. In order to help consumers interpret TL colors, the UK's Food Standards Agency recommends a TL system that includes descriptive terms for each color [21].

Research by Feunekes et al. supports the hypothesis that consumers may have been confused about the meaning of the yellow and red labels. Feunekes et al. tested the impact of 8 different front-of-pack nutrition labeling formats of varying complexity, finding that participants needed significantly less time to evaluate simpler front-of-pack labels (healthier choice tick, smileys and stars) than more complex labeling (multiple traffic lights, wheel of health and guideline daily amount). They observed only minor differences in consumer friendliness and usage intention. Based on these results, Feunekes et al. recommended a relatively simple "tick logo" on the front-of-pack labels for shopping environments in which consumers characteristically make quick decisions [23]. Although TL labeling sounds simple, the FishWise labels actually contain several pieces of information, including the catch method, country of origin, production method, environmental sustainability and price. The interpretion of a green label may be straightforward for a consumer - green is good - whereas the interpretation of the yellow and red labels may require too much cognitive effort.

Consumer behavior that is consistent with the EUFIC research would have resulted in a significant decrease of red labeled seafood sales, which we did not observe in our analysis. Thus, no significant change in red labeled seafood sales may not be due to confusion and instead may reflect real consumer demand for red labeled seafood. Empirical evidence suggests that this may be true. Based on a survey and interviews with chain restaurant decision-makers, chain retail seafood buyers and seafood wholesalers, the SCA reports that 80 percent of retailers say perceived demand is the second most important factor when making purchasing decisions on seafood - the quality of the fish available being the most important factor [2]. While the majority of chain restaurant decision-makers, chain retail seafood buyers and seafood wholesalers say that they have removed products from their product lines because of environmental concerns [2], all of the 20 top U.S. supermarkets reportedly sell significant numbers of the most environmentally unsustainable seafood [7].

Consumers who purchase the least environmentally sustainable seafood may not derive any direct utility from environmentally friendly seafood. In fact, some of these consumers may even have a significant dis-utility. For example, a consumer could have planned to serve a particular type of seafood at a dinner party, swordfish for example, which rarely has a green or yellow labeled type and would have to alter their menu if they purchased a green alternative. This second explanation finds support in the SCA's 2005 poll, where they observe that 79% of consumers say that environmental concerns are important in their seafood purchasing decisions, yet only 30% of consumers say they have chosen not to purchase seafood that is unsustainably harvested [19]. Consumers' education levels and environmental awareness may have influenced these results. Shimshack et al. identified education as a key factor determining the responsiveness of consumers to a US national FDA advisory about the risks of methyl-mercury poisoning from store-bought fish. In that study, Shimshack et al. viewed education as a proxy for a person's ability to obtain and assimilate knowledge, and they consequently evaluated the difference in impact between readers and non-readers. Targeted consumers, those most likely to be aware of and understand the advisory, significantly reduced their fish consumption on average. Large groups of consumers, including the least educated, were not responsive to a US national FDA advisory about the risks of methyl-mercury poisoning from store-bought fish [32].

The supermarkets in which this experiment was conducted are high end and serve one of the most politically progressive regions of the United States. On average, these supermarkets' customers have more years of education, higher income levels, and a higher probability of belonging to either the democratic or green parties than the national average. Individuals who are concerned about environmental sustainability may already have researched their product choices and may already be purchasing environmentally sustainable seafood - seafood that is labeled green under the FishWise program. For these consumers, learning that a seafood they currently consume has some damaging environmental impacts may be enough to motivate them to substitute from a yellow labeled to a green labeled option. Those people who are less likely to derive any direct utility from consuming seafood they know to be environmental sustainable are already purchasing red-labeled seafood. The purchasing behavior of this latter group would be unlikely to change as a result of the red label color.

From the operational perspective of an organization seeking to alter consumers' buying practices, the fact that there is no change in sales of red labeled seafood is problematic for FishWise. Profit-driven retail grocery stores are likely to continue stocking red labeled seafood as long as demand for it exists. More aggressive measures by the stores - such as actively dissuading consumers from purchasing red labeled seafood - are not likely to be adopted by stores. Yet sales of these red labeled seafood lead to significant ecological impacts.

This discussion highlights the need for additional research. More exploration of the interaction between environmental sustainability information and health information is warranted, with the goal of understanding this interaction better and identifying methods for conveying both sets of information to consumers in a simple, clear manner. Other studies suggest that such health-related information may be an important factor in people's decisions [2]. Other areas of promising investigation include evaluating whether environmental sustainability labels influence own-price and cross-price elasticities of products and how consumers substitute between products with different label colors, research into how the number of available options influences consumer's substitution of one product for another, how the presence of a three versus two or even one-color scheme would influence consumption, and the impact of the different content and format of information on the labels on sales. Looking beyond consumer reactions to information, research is needed that looks at the link between buyer's purchasing patterns and the environmental sustainability of the production systems supplying those seafood products.

Figure 1: **Examples of FishWise Graphics**

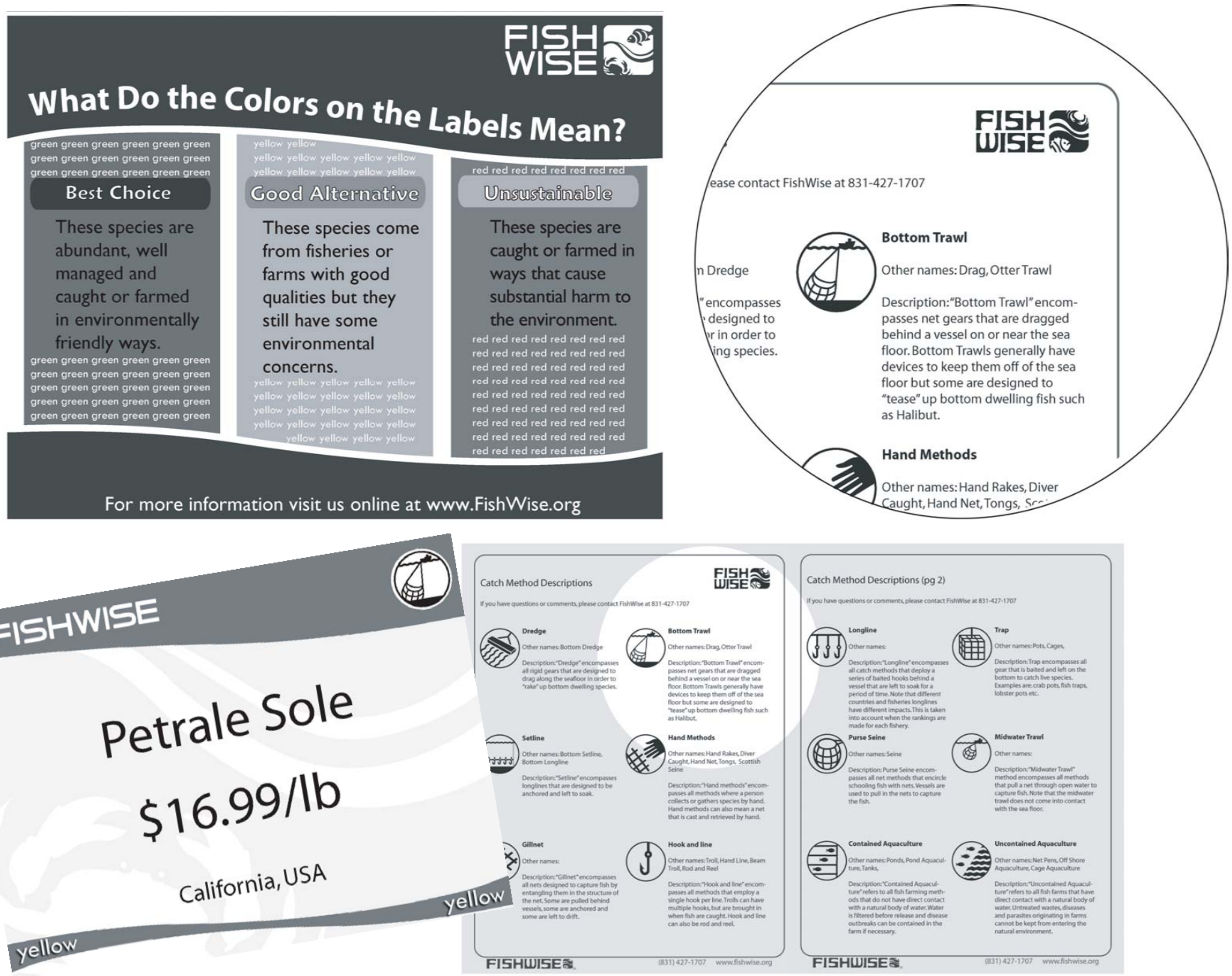


Figure 1 contains examples of the FishWise graphics that can be found at retail grocery store locations. Lower left: label for individual products. Top left: interpretive poster usually visiable behind seafood counter. Right: explanation of catch methods. Photo credit: Fred Lippert.

Figure 2: **Average Total Weekly Sales by Seafood Type**

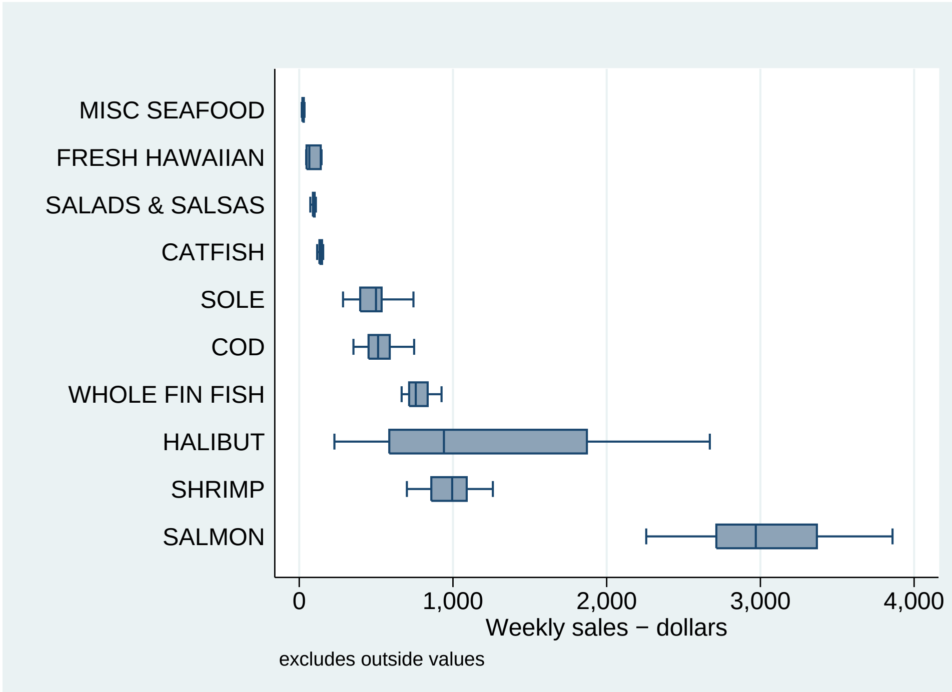


Figure 2 shows the average weekly dollar value of fresh seafood sales by seafood type averaged across all stores during the pre-treatment period (April 16, 2006 - May 16, 2006). The lower and upper boundaries of the boxes represent 25th and 75th percentile, respectively. We excluded smoked fish and re-classified prawns as shrimp.

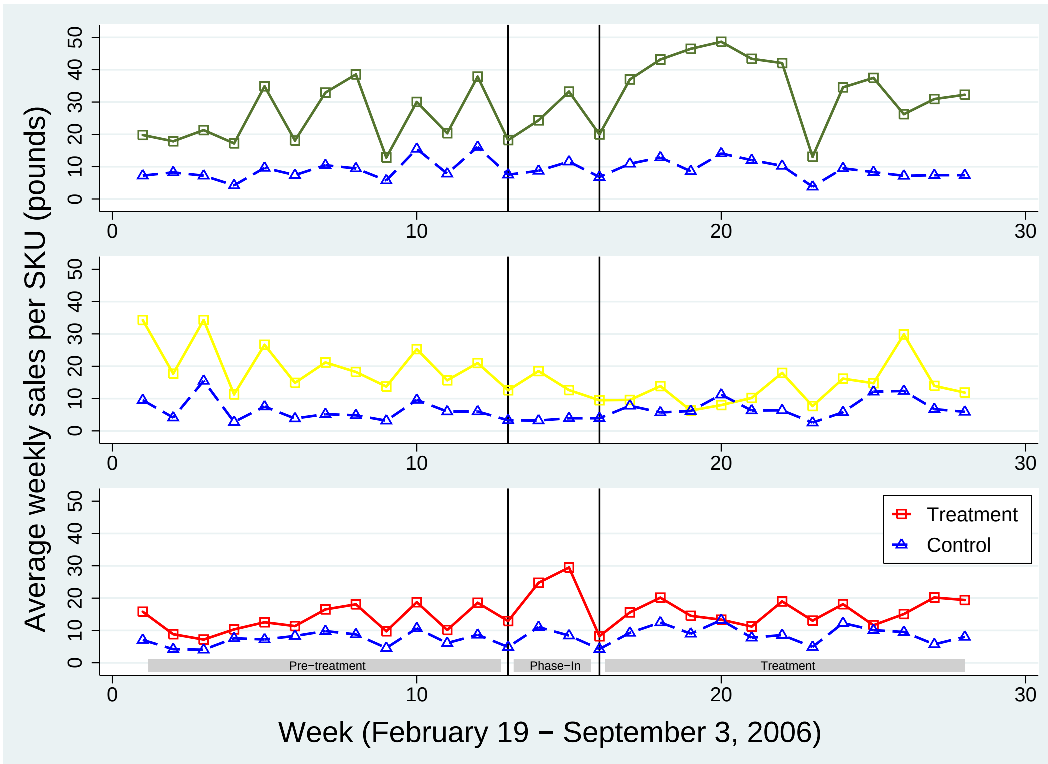
Table 1: **Descriptive Statistics**

Unless otherwise noted, all figures are weekly. Pre and post refer to the pre-treatment and post-treatment periods.

	Treatment stores			**Control stores**		
	pre	**post**	**delta**	**pre**	**post**	**delta**
Avg seafood sales in balanced sample ($)	8,051	11,336	41%	6,071	8,029	32%
Avg seafood sales in unbalanced sample ($)	10,902	12,721	17%	7,945	9,432	19%
Avg store sales ($)	399,512	411,026	3%	332,335	335,946	1%
Avg seafood sales as % of total	2.7%	3.1%		2.4%	2.8%	
Avg seafood sales (lbs)	631	838	33%	606	670	11%
Avg green seafood sales (lbs)	339	660	95%	372	417	12%
Avg yellow seafood sales (lbs)	165	71	-57%	115	155	35%
Avg red seafood sales (lbs)	127	107	-16%	120	98	-18%
Avg price overall ($/lb)	12.82	14.13	10%	13.22	14.22	8%
Avg price of green seafood ($/lb)	12.03	14.26	19%	12.16	14.44	19%
Avg price of yellow seafood ($/lb)	14.31	14.16	-1%	15.57	13.48	-13%
Avg price of red seafood ($/lb)	13.41	13.46	4%	13.29	13.81	4%
Total number of seafoof SKUs (balanced)	53	53		53	53	
Total green SKUs	24	24		24	24	
Total yellow SKUs	17	17		17	17	
Total red SKUs	12	12		12	12	
Total number of seafood SKUs (unbalanced)	64	59		107	107	
Total green SKUs	23	21		35	33	
Total yellow SKUs	18	18		28	26	
Total red SKUs	23	20		44	48	
Number of stores	2	2		8	8	
Number of obs. (balanced)	256	223		886	779	

The pre-treatment period is 4 weeks, running from April 16 - May 16, 2006. Following a four-week phase-in period, the post-treatment period runs for 4 weeks from June 12 - July 8, 2006. SKU refers to 'stock keeping units'. The "balanced" panel includes only seafood SKUs sold in both periods and all stores. Average prices are weighted by pounds of seafood sold. Average sales are an average of total weekly sales for each store.

Figure 3: **Sales Comparison by Label Color in Paired Treatment and Control Store**



The retail chain phased in the FishWise program over a 4-week period at treatment stores, represented by the period between the two vertical lines in these graphs. To the left of the first vertical line, this graph shows 12 weeks (between February 19 - May 16) of average weekly sales in the treatment and control stores before the FishWise program had been piloted. To the right of the second line, this graph shows 12 weeks (between June 12 - September 3) of average weekly sales in the treatment and control stores during the pilot of FishWise.

Table 2: **OLS Results - Specification One (Average Treatment Effect)**

Dependent variable: Ln (pounds) sold of seafood i in store s during period t.

	OLS (1)	OLS (2)	OLS (3)
Constant	4.661	7.319	8.916
	(.216)***	(1.356)***	(.896)***
Post-treatment period	.360	.623	.356
	(.170)**	(.243)**	(.145)**
Treatment store	.174	.219	-.245
	(.063)***	(.045)***	(.123)**
Treatment effect	-.057	-.008	.048
	(.076)	(.091)	(.126)
SKU dummy	No	Yes	Yes
Fish type dummy	No	Yes	Yes
Discount	No	Yes	Yes
Week dummy	No	Yes	Yes
Low mercury dummy	No	Yes	Yes
Catch method dummy	No	Yes	Yes
Production method dummy	No	Yes	Yes
Country of origin dummy	No	Yes	Yes
Promotion* Store * Time	No	No	Yes
Number of observations	2144	2144	2144
R-squared	.02	.439	.502

Standard errors are shown in parentheses. * indicates that a point estimate is significant at a 10 percent level; ** indicates that a point estimate is significant at a 5 percent level; *** indicates that a point estimate is significant at a 1 percent level. This table reports the treatment effect of the FishWise advisory on seafood sales per fish SKU by comparing the change in sales in treatment stores displaying the labels to changes in control stores not displaying the labels.

Table 3: **OLS Results - Specification Two (by Label Color)**

Dependent variable: ln(ounces) sold of seafood i in store s during period t.

	OLS (1)	OLS (2)	OLS (3)	OLS (4)
Constant	4.386	3.584	6.626	9.735
	(0.288)***	(0.119)***	(0.889)***	(1.149)***
Green * Post-treatment period	0.411	0.262	0.248	0.049
	(0.21)*	(0.228)	(0.237)	(0.167)
Yellow * Post-treatment period	-.015			
	(0.127)			
Red * Post-treatment period	0.489	0.249	0.285	0.084
	(0.121)***	(0.199)	(0.207)	(0.267)
Green * Treatment store	0.118	0.174	0.176	-.070
	(0.159)	(0.092)*	(0.089)**	(0.092)
Yellow * Treatment store	0.171	0.243	0.233	0.003
	(0.073)**	(0.13)*	(0.125)*	(0.107)
Red * Treatment store	0.245	0.273	0.274	
	(0.051)***	(0.035)***	(0.035)***	
Green * Treatment effect	0.132	0.212	0.216	0.293
	(0.077)*	(0.147)	(0.148)	(0.127)**
Yellow * Treatment effect	-.225	-.333	-.324	-.275
	(0.14)	(0.1)***	(0.1)***	(0.137)**
Red * Treatment effect	-.130	-.070	-.073	0.074
	(0.097)	(0.089)	(0.087)	(0.162)
Color dummy	Yes	Yes	Yes	Yes
SKU dummy	No	Yes	Yes	Yes
Week dummy	No	Yes	Yes	Yes
Catch method dummy	No	Yes	Yes	Yes
Production method dummy	No	Yes	Yes	Yes
Country of origin dummy	No	Yes	Yes	Yes
Low mercury dummy	No	Yes	Yes	Yes
Discount dummy	No	No	Yes	Yes
Promotion dummy	No	No	Yes	Yes
Price	No	No	Yes	Yes
Store * Promotion	No	No	No	Yes
Store * Promotion * Time dummy	No	No	No	Yes
Number of observations	2144	2144	2144	2144
R-squared	0.067	0.443	0.445	0.505

Standard errors are shown in parentheses. * indicates that a point estimate is significant at a 10 percent level; ** indicates that a point estimate is significant at a 5 percent level; *** indicates that a point estimate is significant at a 1 percent level. This table reports the treatment effect of the FishWise advisory on sales per fish SKU for each label color by comparing the changes in treatment stores displaying the labels to changes in control stores not displaying the labels.

Table 4: **OLS Results - Specification Three (by Label Color and Mercury Content)**

Dependent variable: ln(ounces) sold of seafood i in store s during period t.

	OLS (Not on low mercury list)	OLS (On low mercury list)
Constant	-1.586	7.872
	(7.450)	(1.051)***
Green * Post-treatment period	0.906	0.217
	(0.24)***	(0.201)
Yellow * Post-treatment period	0.148	0.278
	(0.186)	(0.188)
Red * Post-treatment period	0.574	
	(0.204)***	
Green * Treatment store	0.017	0.085
	(0.274)	(0.19)
Yellow * Treatment store		0.141
		(0.173)
Red * Treatment store	0.117	
	(0.128)	
Green * Treatment effect	0.099	0.297
	(0.144)	(0.147)**
Yellow * Treatment effect	-.531	-.243
	(0.138)***	(0.144)*
Red * Treatment effect	0.066	
	(0.155)	
Number of observations	1082	1062
R-squared	0.557	0.515

Standard errors are shown in parentheses. * indicates that a point estimate is significant at a 10 percent level; ** indicates that a point estimate is significant at a 5 percent level; *** indicates that a point estimate is significant at a 1 percent level. The 'low mercury list' refers to whether the seafood was included in a list of low-mercury seafood displayed on a poster to the side of the seafood counter. This table reports the treatment effect of the FishWise advisory on average sales by fish SKU by whether the seafood was included on the low-mercury list by comparing the changes in treatment stores displaying the labels to changes in control stores not displaying the labels.

Table 5: **OLS Results - Robustness Checks**

Dependent variable: ln(ounces) sold of seafood i in store s during period t.

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
Constant	9.400	5.582	7.012	9.582	12.332	4.021
	(1.689)***	(2.021)***	(1.356)***	(0.663)***	(1.811)***	(0.811)***
Green * Post-treatment period	-.075	-.0007	0.029	-.029	0.03	0.231
	(0.114)	(0.165)	(0.127)	(0.177)	(0.426)	(0.217)
Yellow * Post-treatment period	-.089	-.140	-.128	0.122	-.198	0.632
	(0.125)	(0.117)	(0.088)	(0.19)	(0.553)	(0.297)**
Red * Post-treatment period		-.023	0.05	0.188		0.772
		(0.202)	(0.127)	(0.225)		(0.242)***
Green * Treatment store	-.113	-.036	-.023	-.273	-.243	-.576
	(0.179)	(0.053)	(0.153)	(0.168)	(0.277)	(0.486)
Yellow * Treatment store		0.009		0.093		
		(0.094)		(0.139)		
Red * Treatment store	0.011		0.036		-.291	-.550
	(0.181)		(0.137)		(0.229)	(0.523)
Green * Treatment effect	0.335	0.021	0.057	0.602	0.185	0.372
	(0.174)*	(0.068)	(0.112)	(0.287)**	(0.138)	(0.344)
Yellow * Treatment effect	-.347	-.302	-.241	-.356	-.658	-1.032
	(0.198)*	(0.118)**	(0.139)*	(0.185)*	(0.361)*	(0.544)*
Red * Treatment effect	0.052	-.083	-.168	0.138	-.070	-.240
	(0.206)	(0.098)	(0.105)	(0.206)	(0.203)	(0.281)
Number of Observations	2271	6383	4375	1688	475	436
R-squared	0.52	0.463	0.483	0.548	0.632	0.639

Table 4 contains alternative specifications to evaluate the robustness of the parameter estimates in specification two. Standard errors are shown in parentheses. * indicates that a point estimate is significant at a 10 percent level; ** indicates that a point estimate is significant at a 5 percent level; *** indicates that a point estimate is significant at a 1 percent level. OLS(1): robust regression instead of clustering by class code; OLS(2): 12 weeks before/after and 4-week phase-in; OLS(3): 8 weeks before/after and 4-week phase-in; OLS(4): 4 weeks before/after and 2-week phase-in; OlS(5): Store 5 and 6 with 4 weeks before/after; OLS(6): Store 5 and 4 with 4 weeks before/after.

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6 Appendix

This appendix presents time and store placebos for the seafood program.

Table 6: **Time Placebo**

Dependent variable: Ln (pounds) sold of seafood i in store s during period t.

	OLS (1)	OLS (2)	OLS (3)
Constant	6.669	3.681	8.950
	(6.184)	(7.746)	(1.897)***
Green * Treatment period	0.348	0.272	0.098
	(0.145)**	(0.251)	(0.203)
Yellow * Treatment period			-.066
			(0.17)
Red * Treatment period	-.046	0.039	0.399
	(0.204)	(0.322)	(0.273)
Green * Treatment store	-.008	0.094	0.051
	(0.094)	(0.159)	(0.069)
Yellow * Treatment store	0.011		-.192
	(0.149)		(0.162)
Red * Treatment store		-.030	
		(0.132)	
Green * Treatment effect	0.244	-.099	-.022
	(0.167)	(0.172)	(0.136)
Yellow * Treatment effect	-.070	-.171	0.08
	(0.112)	(0.197)	(0.158)
Red * Treatment effect	-.010	-.096	-.076
	(0.059)	(0.113)	(0.086)
Number of observations	2403	1536	2355
R-squared	0.514	0.461	0.477

Standard errors are shown in parentheses. * indicates that a point estimate is significant at a 10 percent level; ** indicates that a point estimate is significant at a 5 percent level; *** indicates that a point estimate is significant at a 1 percent level. This table reports the treatment effect of the FishWise advisory on seafood sales per fish SKU when arbitrarily applying Specification Three to Pre-treatment periods. OlS(1) applies to the period starting January 1, 2006. OLS(2) applies to the period starting January 5, 2006. OLS(3) applies to the period starting February 19, 2006.

Table 7: **Store Placebo**

Dependent variable: Ln (pounds) sold of seafood i in store s during period t.

	OLS (1)	OLS (2)	OLS (3)
Constant	8.128	7.472	9.069
	(1.175)***	(0.643)***	(0.939)***
Green * Treatment period	-.008	-.023	-.150
	(0.188)	(0.157)	(0.201)
Yellow * Treatment period		-.163	-.140
		(0.15)	(0.147)
Red * Treatment period	0.106		
	(0.321)		
Green * Treatment store	-.359	0.113	0.055
	(0.28)	(0.198)	(0.14)
Yellow * Treatment store			0.023
			(0.291)
Red * Treatment store	-.215	-.050	
	(0.189)	(0.257)	
Green * Treatment effect	0.169	0.013	-.011
	(0.175)	(0.127)	(0.134)
Yellow * Treatment effect	-.092	0.004	-.195
	(0.218)	(0.153)	(0.222)
Red * Treatment effect	0.041	-.040	-.011
	(0.278)	(0.182)	(0.164)
Number of observations	1563	1713	1740
R-squared	0.485	0.521	0.506

Standard errors are shown in parentheses. * indicates that a point estimate is significant at a 10 percent level; ** indicates that a point estimate is significant at a 5 percent level; *** indicates that a point estimate is significant at a 1 percent level. This table reports the treatment effect of the FishWise advisory on seafood sales per fish SKU when applying Specification Three to an arbitrary selection of control stores. In OlS(1), store numbers 1 and 2 are the treatment stores. In OLS(2), store numbers 3 and 6 are the treatment stores. In OLS(3), store numbers 3 and 9 are the treatment stores.