Can Household Consumers Save the Wild Fish? Analysis of a Seafood Sustainability Advisory in a U.S. Supermarket

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Abstract

Conservation organizations seeking to reduce over-fishing and promote better fishing practices have increasingly turned to market-based mechanisms such as environmental sustainability labels (eco-labels) in order to shift patterns of household consumption. The real-world evidence - increasing per capita seafood consumption and continued decline in the size of some of the very fisheries that have been certified - suggests that these mechanisms may be falling catastrophically short of their objectives. This paper explores this apparent paradox with an empirical analysis of consumer response to an advisory for sustainable seafood adopted by a supermarket in the United States. The advisory consisted of a label in which one of the three "traffic light" colors was placed on the pin tag of every fresh seafood product to inform consumers about the relative environmental sustainability of that product. Analogous to the food labeling system currently being proposed in the European Union, green meant "best" choice, yellow meant "proceed with caution", and red meant "worst choice". Using a unique product-level panel scanner data set of weekly sales data, we apply a difference-in-differences identification strategy to estimate the effect of the advisory on seafood sales. We find some evidence that the advisory led to a slight decline in overall seafood sales (-15.5%, $p<0.10$). We find strong evidence that the sale of yellow-labeled seafood significantly decreased (-31.3 to -34.9%, $p<0.01$). We fail to reject the null hypothesis of no change for green and red sales. Yellow products on a mercury safe list had the largest drop in sales (-41.3%, $p<0.05$). These results suggest that we need a much better understanding of whether and when eco-labels achieve their goals before continuing to make large investments in household consumers as a primary conservation tool.

Keywords: Food labels · traffic-light signposting · consumer decision-making · environmental sustainability · seafood · wild fish.

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1 Introduction

Conservation organizations are devoting considerable effort to shifting household consumption towards more environmentally sustainable products as a way to stop the destruction of natural ecosystems. In the seafood industry, groups seeking to reduce over-fishing and promote better fishing practices have increasingly turned to consumer-focused mechanisms such as educational campaigns and environmental sustainability labels ("eco-labels"[1]). The objective of these eco-labels is to help consumers select products better matching their values, resulting in greater direct utility for consumers and providing firms with a market-based incentive to produce and sell products with higher levels of attributes perceived as desirable by the public. Well-known eco-labels include the Earth Island Institute's Dolphin Safe Tuna label and the Marine Stewardship Council's MSC certification[2]. These approaches receive broad support from non-governmental organizations, governments, consumers, fish producers and marketers.

The real-world evidence suggests that these consumer-focused mechanisms may be falling catastrophically short of their objectives. In the United States, per capita consumption of seafood between 1998 and 2008 increased at an annual average rate of seven percent, from 14.9 pounds to 16.0 pounds (FUS 2008). After distributing more than a million wallet cards as part of its Seafood WATCH program, the Monterey Bay Aquarium conducted a study that showed no overall change in market demand and no decrease in fishing pressure for targeted species (Quadra 2004). In a review of 30 non-profit organizations with market-based sustainable seafood campaigns, the Bridgespan Group found no significant change in the buying

[1] The FAO's definition of a seafood eco-label 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" [7]

[2] 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 environmentally sustainable[33].

practices or fisheries policies of sensitive fish populations (Bridgespan xxxx). Scientists now believe that the biomass of Marine Stewardship Council certified Alaska pollock, the largest single-species food fish fishery in the world and one that is often cited as an example of a market-based approach helping to drive an industry towards sustainability, may be as much as 50% below last year's levels (Jacquet xxxx).

Given the stark contrast between the widespread support for and proliferation of these programs and the continued decline of the wold's fisheries (Sidebar), it is imperative to understand whether these eco-labels change consumption patterns in real-world settings. The availability of information about a product does not necessarily mean consumers will incorporate it into their decisions and alter their behavior [20, 17, 16, 13, 12][3]. Teisl et al.'s use of consumer purchase data to confirm that the dolphin-safe tuna label increased the market share of canned tuna using the label is one of the few such empirical analyses for the seafood industry [29]. A recent review of European research on consumer response to food labels concluded that there is an urgent need for more research studying consumers' use of food labels in real-world settings, and specifically, on whether the labels have an impact on product choices [11]. Existing literature explicitly focusing on consumer preferences in the context of information-based mechanisms like eco-labels relies largely on attitudinal and knowledge surveys, consumer choice experiments, and experimental auctions [15, 6, 10, 23, 21, 25, 28, 24, 3, 32]. 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.

This paper uses information about consumers' behaviors via their actual purchases, rather

[3]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 [30, 18, 5, 14]. 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 [9].

than their stated preferences via survey questionnaires, to assess whether consumers understand and respond to environmental sustainability labels. We investigate consumer response to an advisory for sustainable seafood that was adopted by a supermarket in the United States. The advisory consisted of a label placed on the pin tag of every fresh seafood product to inform consumers about the relative environmental sustainability of seafood products. Analogous to one of the food labeling systems currently being proposed in the European Union, the advisory coded the labels using a system of three traffic light (TL) colors; green meant "best choice", yellow meant "proceed with caution", and red meant "worst choice" (Figure 1). Using a unique store- and product-level panel scanner data set of weekly sales data and a quasi-experimental setup, we apply a differences-in-differences identification strategy to estimate the effect of the advisory on seafood sales. 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 some evidence that the advisory led to a slight decline in overall seafood sales (-15.5%, $p<0.10$). We find strong evidence that the sale of yellow-labeled seafood significantly decreased (-31.3% to -34.9% depending on the specification, $p<0.01$). We fail to reject the null hypothesis of no change in sales for green and red labeled seafood. Yellow labeled products on the mercury safe list had the largest drop in sales (-41.3%, $p<0.05$).

These results suggest that widespread support for eco-labels as a primary conservation tool in the seafood industry is premature. We need a much better understanding of whether and when eco-labels achieve their goals before continuing to make large investments in household consumers. Seafood conservation organizations may also want to explore other types of market-based interventions, work with the government to take actions that will make eco-labels more effective, and continue to use traditional forms of regulation as a complement to any consumer-focused efforts.

This paper is the first study to empirically investigate consumer response to a third-party, TL labeling system in the United States. We have identified only one other study on the impact of TL labels, using supermarket data from the UK, which found that the introduction of a system of four TL labels had no measurable effect on the healthiness of consumer purchases [26]. Given the lack of empirical research, the results from this study may be particularly timely in the European Union, where many different labeling systems are used, proposed legislation to require standard front of pack (FOP) nutritional labels has led to a dynamic debate about which label designs are the most effective and even about whether these labels change consumer behavior at all. The proposed EU legislation favors labels similar to guideline daily amounts, which tell consumers how much of a product to eat each day in order to stay healthy. The UK's Food Standards Agency, however, recommends a traffic light (TL) label consisting of four color-coded lights representing the levels of sugars, fat, saturated fat and salt in a product [8].

The remainder of this paper is structured as follows: Section 2 presents the empirical strategy, including a discussion of the experimental setting, data and econometric specifications; Section 3 presents the results of the analysis. Section 4 discusses the implications of these results and concludes.

2 Empirical strategy

2.1 Experimental setting and data

2.1.1 Experimental setting

This study uses point of sales data from a regional US supermarket retailer (the "Retailer") that operates ten stores in the San Francisco Bay Area, Northern California[4] (Figure 3).

[4]We do not name the Retailer in order to protect the confidentiality of the Retailer. Store locations: 4

In 2006, the Retailer partnered with a non-profit organization named FishWise to provide consumers with information about the environmental sustainability and healthiness of its fresh seafood products. Starting on May 17, the retailer piloted the FishWise Advisory for twelve weeks at two, randomly-chosen stores and then fully implemented the advisory at all stores on September 4[5]. The gradual phase-in of the program created a quasi-experimental setup with two treatment stores and eight control stores.

Table 1 provides descriptive statistics of store characteristics for the ten stores based on a twelve week pre-treatment period beginning on February 19, 2006 and ending on May 17, 2006 and a twelve week treatment period beginning on June 10, 2006 and ending on September 3, 2006. These time frames exclude a four week period over which the Retailer implemented the program. During the pre-treatment period, the treatment stores had slightly higher weekly store sales ($404,707 versus $397,769), meat department sales ($30,653 versus $25,964), seafood revenue ($16,259 versus $11,898), seafood sales (732 versus 541 lbs) and store traffic (14,449 versus 11,126 shoppers) than the control stores; although, the difference in means are not statistically significant. The median annual household income of the zip code in which the stores are located is $68,451, with a low of $38,613 at one of the Berkeley stores to a high of $142,459 at the Danville store. Shoppers at the control stores did have a significantly higher average household income than treatment store shoppers.

In addition to the TL color, each label contained the product name, the country of origin, the catch method and the price per pound. Thus, a typical label would inform the consumer that the product is named Petrale Sole, has a FishWise environmental sustainability rating of "yellow", was caught in California using a bottom trawl, and the price is $16.99 per pound (Figure 1). Since US law requires country of origin labeling for a fish and shellfish, labels in

stores in Berkeley, 1 store each in Danville, Los Altos, Palo Alto, San Francisco, San Anselmo, and Walnut Creek. Note that the Retailer sold its Danville store in August 2006 and closed its Walnut Creek store in December 2006.

[5]The Retailer began advertising the program in local newspapers on October 9, 2006.

non-participating stores would contain only the product name, country of origin and price (cite). The Retailer labeled all products sold at the fresh seafood counter. A consumer could therefore choose from a large number of seafood products, often had multiple label color options within a particular type of seafood (e.g. green, yellow and red salmon), and did not have an un-labeled seafood option. The retailer updated the labels weekly on Tuesday nights after the stores had closed.

The FishWise advisory was developed by an independent non-profit organization using assessment criteria from the Monterey Bay Aquarium 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 product 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 products 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.

FishWise uses multiple criteria to assign a TL color to each seafood product: species, catch method, production method, and country of origin[6]. Green, "best choice", means that these species are abundant and/or well managed and caught or farmed in environmentally friendly ways, Yellow, "good alternative", means that these species come from fisheries or farms with good quantities, but that there are still some environmental concerns. Red, "unsustainable", means that these species are caught or farmed in ways that cause substantial harm to the environment. FishWise updated the TL color assignment for each product on a quarterly basis.

The Retailer did not include the health information on the pin tag label. Instead, the health information was presented on a poster located immediately adjacent to the fresh seafood

[6] A seafood does not need to rank highly on all criteria to receive a green rating. A green rating, for example, could be given to a fishery with low wild stocks, but which has high ratings on all the other criteria.

counter. This poster contained a list of the seafood with low levels of mercury and polychlorinated biphenyls (PCBs), two chemicals known to have harmful effects on humans (cite). To be included on this list, a product must be both rated as either green or yellow in terms of environmental sustainability and also be low in mercury and PCB content. The list does not contain any red-labeled products. To be clear, inclusion on the list is good; excluded products are assumed to have high levels of mercury and PCBs. The retailer also displayed a second poster near the seafood counter containing an interpretive guide to the label colors and catch methods [figure x].

In this analysis, we assume that the Retailer's consumers obtain their information about the environmental sustainability and healthiness of their seafood products only from the FishWise advisory. However, starting in 1999, the Monterey Bay Aquarium's Seafood Watch program began distributing pocket guides and doing outreach to inform consumers about seafood sustainability. We do not have information about which consumers shopping at the Retailer also had access to these wallet cards. We discuss the potential impact that the availability of these cards, as well as other sources of information, could have on the estimates in the interpretation of the results and the robustness checks.

2.1.2 Data

The analysis for this study uses several unique panel data sets. From the Retailer, I obtained weekly product- and store-level scanner data for 2006. The scanner data set contained weekly sales data by product: date, store, seafood type (e.g. salmon), product name (e.g., King Salmon), unique product number, unit sales, dollar sales, units, unit returns, dollar returns, full retail price per unit, discounted price per unit, cost per unit, gross margin, and country of origin (N=7841). The Retailer provided scanned copies of weekly, product- and store-level records containing the dates and details of special advertisements and promotions for each product. 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 product 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 Retailer, which had discarded earlier records of the color assignments. Finally, using quarterly reports provided by FishWise, we reconstructed a weekly record of seafood products 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 revenue, with salmon representing approximately three times more revenue per store than shrimp (Figure 4).

There was no statistically significant difference in the number of seafood product choices for an average week and store in the pre-treatment and treatment periods. In an average week and treatment store during the pre-treatment period, customers could choose between 34 different fresh seafood products (Table 2). If these products had been labeled using the FishWise Advisory, 13 of the products would have been green, 9 of them would have been yellow and 11 of them would have been red. In an average week and control store during the pre-treatment period, customers could choose between 32 different fresh seafood products. If these products had been labeled using the FishWise Advisory, 12 of them would have been green, 10 of them would have been yellow and 11 of them would have been red. There is some evidence that the number of red products decreased in both treatment and control stores during the treatment period (11 to 9 products in the treatment stores and 11 to 10 products in the control stores). Otherwise, the number of products choices was similar between pre-treatment and treatment periods.

There was also no statistically significant difference in product characteristics for an average week and store in the pre-treatment and treatment periods. In an average week and treatment store during the pre-treatment period, 56.7% of the products would have been listed on the low-mercury list if the FishWise advisory had been in place, 30.4% of products were on sale, 52.2% of products were wild (versus farmed) and 36.6% of products were caught in the United States. These numbers are very similar to those for the control stores, and these figures do not vary much between pre-treatment and treatment periods.

These average weekly figures do disguise some variation between stores (Figure 5). While all stores sold the three label colors of seafood, average weekly sales for seafood during the pre-treatment period ranged from a low $3,176 to a high of $11,931. Moreover, seafood sales and the number of product choices appear to be positively correlated. Of note, stores 2 and 4 appear to have the lowest number of products and sales.

The Retailer stated that it did not adjust its pricing or promotional activity in response to the labels during the weeks immediately before and after implementation of the FishWise advisory. Table 3 evaluates this statement by comparing pricing for treatment and control stores during the pre-treatment and treatment period. During the pre-treatment period, the average (sales weighted) price for all seafood was $13.41 in the treatment stores versus $13.09 in the control stores. During the pre-treatment period in the treatment stores, the average price for green, yellow and red seafood was $13.22, $13.60 and $12.91 versus $12.10, $13.44 and $14.22 in the control stores. In addition to the overall figures and figures for green, yellow and red seafood, Table 3 provides average prices for the top ten products by revenue in both the control and treatment stores. Using the p-value of a simple t-test comparison of means, it appears that any price changes were consistent across both the treatment and control stores. That is, we do not find evidence of differential price manipulation between treatment and control stores.

2.2 Econometric specifications

In our choice of statistical models, we are particularly concerned about the possibility of unobserved product heterogeneity that may be correlated with observed regressors. Examples include possible correlation between unobserved product attributes such as seafood freshness and price, correlation between seafood appearance (e.g. the color of salmon) and price, and correlation between the color of the FishWise Advisory label and a product's counter placement (e.g. green labeled seafood products tend to be closest to the shopper). Unobserved heterogeneity correlated with explanatory variables would lead to omitted variables bias and inconsistent parameter estimates using the ordinary least squares estimator.

Our preferred econometric model is a product-specific fixed effects model, which allows each product to have a different intercept term that captures unobserved heterogeneity that is potentially correlated with observed, explanatory variables. Relative to the random effects estimator, the fixed effects estimator is less efficient; however, we are unwilling to make the necessary assumption for the random effects model that the composite error term is uncorrelated with the explanatory variables. The standard form of the Hausman test led us to strongly reject the null hypothesis that the random effects estimator provides consistent estimates (overall test statistic,χ^2, has $p = 0.000$).

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). The presence of serial correlation in errors for each product would mean that standard errors are biased downwards. In order to ensure valid statistical inference, we control for both serial correlated and heteroskedastic errors using clustered standard errors at the store level (allowing for residuals that are correlated for the observations in a store). In our robustness checks, we also use a pooled OLS estimator with clustered standard errors to obtain parameter estimates.

The following paragraphs explain the product-specific fixed effects models we use. Note that we have defined the panel variable as a store-product combination.

2.2.1 Average treatment effect

We start by using a product-specific fixed effects model with errors clustered at the store level in order to estimate the overall treatment effect of the FishWise Advisory (Table 4). Note that this FE estimator is the panel data version of the differences-in-differences (DID) estimator for two pooled cross sections. This sub-section describes the five specifications we use to estimate this overall effect. In all specifications, we regress the natural log of the quantity of seafood sold on an indicator variable for whether the product was in a treated store during the treatment period, a full set of store-product fixed effects, a full set of week dummies and additional covariates depending on the specification. In the basic model, specification one of Table 4:

$$ln(Q_{ist}) = \beta_0 + \beta_1 t_{it} + \beta_2 \left(T_{is} * t_{it}\right) + c_{is} + v_t + \epsilon_{ist} \qquad (1)$$

Q_{ist} are the ounces of seafood i sold in store s in week t. The model has $i = \{1, ..., I\}$ differentiated products, $s = \{1, ..., S\}$ stores and $t = \{1, ..., T\}$ time periods. The panel variable is a store-product, thus c_{is} is the store-product fixed effect. v_t is time-specific fixed effect. $t_{it}$is an indicator variable that is equal to one during the treatment period and zero during the pre-treatment period. T_{is} is an indicator variable that is equal to one for treatment stores and zero for control stores. The interaction of t_t and T_s is equal to one if product i is sold in the treatment store s during the treatment period. Thus, B_2 is the parameter of interest, representing the average effect of the FishWise Advisory across all three label colors. This parameter may be interpreted as the average percentage change in sales resulting from the implementation of the FishWise Advisory.

The previous specification will capture any constant, unobserved product characteristics that may be correlated with the observed regressors. In specification two, we include an interaction term of week and seafood type (e.g. salmon, halibut) to account any time variant (seasonal) characteristics of different types of seafood.

$$ln(Q_{ist}) = \beta_0 + \beta_1 t_{it} + \beta_2 \left(T_{is} * t_{it}\right) + \beta_3 (f_i * w_t) + c_{is} + v_t + \epsilon_{ist} \qquad (2)$$

Specifications three to five contain a combination of additional covariates.

$$ln(Q_{ist}) = \beta_0 + \beta_1 t_{it} + \beta_2 (T_{is} * t_{it}) + \beta_3 (f_i * w_t) + x_{ist}^{'} \theta + c_{is} + v_t + \epsilon_{ist} \tag{3}$$

x_{ist} is a row vector containing some combination of the following variables, depending on the specification: natural log of price ($ln(price)$), an indicator variables for the presence of a product promotion at the store level ($promo_{ist}$), the percentage discount off the full retail price ($discount_{ist}$), the fraction of total store sales and fraction of total meat department sales generated by the fresh seafood counter ($p - totalsales_{st}$ and $p - meatsales_{st}$), the fraction of seafood products in a store on the low mercury list ($p - mercury_{st}$), and the fraction of green, yellow and red products ($p - green$, $p - yellow$, $p - red$).

Specification three includes the price-related regressors to control for store-level price variation.The Retailer did not systematically manipulated pricing in the control and treatment stores during the pre-treatment or treatment time frames. However, the Retailer's pricing policy did allow store-level discounting to move expiring product and a very limited number of store-level promotions. Our estimates for price are actual prices, obtained by dividing total sales by total pounds of seafood sold for that week. Our estimate for each product's discount is the percentage difference between actual price and list price. We obtained information on the location and timing of promotions from the Retailer's database.

Specification four includes the covariates for the fraction of total store sales and fraction of total meat department sales generated by the fresh seafood counter. Although store-level fixed effects will account for any unobserved differences across the stores, this covariates will capture the impact of any weekly variation in sales. For example, weeks with a relatively larger proportion of sales might attract a subset of the population that is less educated about seafood sustainability than the customer population in lower revenue weeks.

Specification five includes the covariates for the fraction of seafood products in a store on the low mercury list and the fraction of green, yellow and red products. Figure 5 shows that all ten stores sold a mix of green, yellow and red seafood in each week; however, this figure also suggests a correlation between the average number of products sold and average weekly sales. The Retailer stated that the same products were available in all stores. Since we cannot verify the accuracy of this statement, these covariates to address the possibility that any variation in the availability of each color seafood as well as seafood on the mercury safe list might affect sales.

2.2.2 Treatment effect by label color

Next, we estimate the treatment effect of the FishWise Advisory by the color of the pin tag label (Table 5). Specifications six to ten add a set of indicator variables for each of the label colors to the product-specific fixed effects model previously described.

$$\begin{aligned} ln(Q_{ist}) &= \alpha + \beta_1\,(color_{ist} * t_{it}) + \gamma\,(color_{ist} * T_{is} * t_{it}) + \\ &\quad +\beta_3(f_i * w_t) + x^{'}_{ist}\theta + c_{is} + v_t + \epsilon_{ist} \end{aligned} \tag{4}$$

$color_{ist}$ is a set of indicator variables for each of the label colors. β_2 is the variable of interest. x_{ist} contains the same variables as those described in the estimation of the average treatment effect.

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. We would expect to see a similar change irrespective of the label color if the labels act only to publicize seafood. In this latter case, note that the sign of the treatment effect could be either positive or negative. The FishWise Advisory could cause a negative publicity effect if the labels and information dissuade consumers from purchasing fresh seafood.

2.2.3 Treatment effect by label color and health information

Finally, we estimate the treatment effect of the FishWise Advisory by the color of the pin tag label and whether the product was on the list of low mercury seafood (Table 6). Specifications eleven and twelve apply the final specification developed to evaluate the treatment effect by label color to a) a data set with only those products on the low mercury list, and b) a data set with only those products not on the low mercury list.

2.2.4 Robustness checks and placebos

We perform a set of robustness checks and placebos using specification ten, the preferred fixed effects estimator for heterogeneous effects by color label. In our interviews, the Retailer stated that the treatment stores were randomly chosen. The internal validity of this analysis hinges, however, on whether the control and treatment stores that would have had similar sales trends without the implementation of the label, or conversely, with the implementation of the label. We are likely to obtain biased point estimates if the Retailer selected the treatment stores because consumers in these stores were expected to behave differently than consumers in the control stores. For example, if control store consumers were not really fish consumers, we would expect an upward bias in our estimates. Our results would also be likely to be biased if customers at treatment and control stores had substantially different awareness and information about seafood sustainability prior to the implementation of the program. One way in which the latter might happen is if customers at each store were influenced by different media outlets. For example, editorials in the San Francisco Chronicle might have preferentially altered consumers' behavior in the city of San Francisco relative to customers in the East Bay. Unfortunately, due to the fact that the stores implemented this program prior to our obtaining the data, we do not have access to exit interviews or any other information about store customers, their prior knowledge or the extent to which they read and utilize information posted in stores. Thus, to address the two concerns just described, we ran specification ten for two sub-sets of stores: only stores located in the East Bay and only for the eight stores whose observable characteristics were most similar (Table 7, columns two and three).

Another potential issue with our analysis is that there may be time-varying elements of the customer populations that impact seafood sales differently between treatment and control stores. The included store-product fixed effects may not capture all relevant information regarding these time-varying elements of the population. In turn, the week fixed effects will only capture those time varying elements that have a similar effect for all stores. In order to evaluate whether these time-varying elements bias our results, we run specification ten for eight and four weeks of pre-treatment and treatment data.

As an additional robustness check, we ran specification ten on three types of placebos: time, label color and store. As the time placebo, we ran the specification ten on randomly selected twenty-eight week intervals prior to the pilot. As the label color placebo, we ran specification ten after randomly re-assigning the product label colors. Finally, as the store placebo, we dropped the two treatment stores from the data set and then re-ran specification ten after randomly assigning two stores to be the treatment stores.

As a final robustness check, although we are concerned about unobservable product characteristics that are correlated with the explanatory variables, we ran the ordinary least squares on the pooled cross-sectional data in order to estimate the general differences-in-differences estimate (Table 8).

3 Empirical results

We start with a graphical analysis in which we plot weekly sales by color label for store five and store one, two stores that are similar based on observable characteristics (Figure 6). 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. 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. This figure has two important features. One, the pre-treatment trends in the control and treatment groups appear to be similar. That is, the difference between treatment and control groups is relatively constant over time, suggesting that indeed a differences-in-differences estimator is appropriate for this analysis. Two, the figure suggests that sales of yellow labeled seafood in treated stores declined relative to sales of yellow labeled seafood in the control stores during the treatment period. In comparison, sales of green and red labeled seafood appear to maintain the same difference between treatment and control store during the pre-treatment and treatment periods.

We begin the regression analysis by estimating the average treatment effect of the FishWise Advisory on total seafood sales. Table 4 presents the results of using the fixed effects estimator described previously to an unbalanced panel data set in which the panel variable is store-product and the panel includes twenty-four weeks of weekly data (N=7841). The dependent variable for all regressions is the natural log of the number of pounds of seafood i sold in store s in week t, thus the parameter estimates for the treatment effect are interpreted as the percentage change in sales resulting from the FishWise labeling treatment. Note that this table does not report estimates for the treatment store dummy because this is time invariant and consequently drops out of the fixed effects regression.

The regression results presented in this Table 4 provide some, albeit weak, evidence that the FishWise Advisory had a significant and negative effect on overall seafood sales. The estimated treatment effects across the five specifications vary from -11.9 to -15.3%; however, only this last point estimate is statistically significant ($p<0.10$). Specification one contains treatment period dummies, treatment effect dummies (the interaction of the treatment store and and treatment period dummies), store-product and week fixed effects. Specification one will capture any constant, unobserved product characteristics. The inclusion of an interaction term for week and seafood type (specification two) to control for seasonality in the availability and characteristics of different types of seafood (e.g. wild, locally caught salmon) has little impact on the point estimates or standard error of the treatment effect. It does, however, substantially increase the variance explained by the model (0.0013 to 0.1130). The addition of price-related covariates (specification three), the fraction of store sales driven by fresh seafood sales (specification four) and the fraction of products labeled as green, yellow and red (specification five) all cause very slight changes in the treatment effect point estimates and standard errors.

The parameter estimates for the additional regressors offer additional insight into the drivers of the Retailer's seafood sales. Pricing-related parameter estimates are consistent with our expectations. Although not statistically significant, price is inversely correlated to sales and has a relatively small impact, which we expect given that the Retailer's strategy of not manipulating price during the pre-treatment or treatment periods. Promotions have a significant positive effect on sales ($p<0.01$). Later in the analysis, we return to the surprising result that inclusion on the mercury safe list has a significant negative effect. The parameter estimates for the treatment period dummy are not statistically significant from zero, indicating that overall sales were similar during the pre-treatment and treatment periods.

We then extend the regression analysis to evaluated whether the FishWise Advisory had a heterogeneous effect by the color label (Table 5). As described previously, the parameter values of interest in these five specifications are those on the interaction of the label color with the treatment effect (eq 4). Otherwise, the additional regressors in each equation are the same as those we used to evaluate the average treatment effect. These parameter estimates for these regressions provide strong evidence that the treatment effect does vary by color label, which is consistent with the labels providing primarily environmental sustainability information to consumers. Across the five specifications, we estimate a statistically significant decline in sales of yellow labeled seafood ranging from -31.1% to -34.9% ($p<0.01$). We fail to reject the null hypothesis of a statistically significant difference for green labeled or red labeled seafood.

As with the average treatment effect regressions, inclusion of interaction terms for week and seafood type significantly increases the variance explained by the model without substantially altering the point estimates (specification seven) . We interpret this result to mean that cyclicality of unobserved characteristics related to each seafood type is not correlated with other covariates related to the treatment effect. The parameter estimates for price are positive, but not statistically different from zero. The additional control variables for the fraction of store sales driven by the seafood department (specification nine) and the fraction of products on the low mercury list and receiving either a red, yellow or green label (specification ten) have a negligible effect on the point estimates and standard errors for the treatment effect. We interpret specification nine as evidence that weekly variation in seafood sales relative to total store sales was not correlated with substantially different customer populations who might respond differentially to the FishWise Advisory. We interpret specification ten as evidence that, conditional on the observed availability of seafood products of each color type (all stores had all three colors in all weeks), the fraction of seafood of each color type also did not have a significant impact on the effect of the FishWise Advisory. Unlike the average treatment effect regressions, the parameter estimates for the interaction of label color by treatment period suggest that sales of yellow and red labeled seafood declined across all stores between the pre-treatment and treatment period.

In the final part of the analysis we return to the question of why the parameter estimate for the low mercury list dummy variable was significantly negative by evaluating whether the FishWise Advisory had a heterogeneous impact depending on whether the seafood was included on the list of low-mercury fisheries (Table 6). For seafood on the low-mercury list, we find that sales of yellow labeled seafood significantly decreased by 41.3% ($p<0.05$) in treatment stores relative to the same unlabeled products in control stores. We fail to reject the null hypothesis of no effect for green and red labeled seafood. For seafood not on the low-mercury list, we find no statistically significant change in any of the label colors. This result, which is consistent with the significant negative parameter estimates for the low mercury list, suggests that it is the effect of the FishWise Advisory on sales of yellow labeled seafood that are also on the low mercury list that is driving the overall effect on yellow labeled seafood sales.

These point estimates for the treatment effect are robust to several alternative time frames and sub-sets of the data (Table 7), the specifications for which are discussed in the previous section. In comparison to the preferred specification for evaluating the heterogeneous effect of the labels (column one), limiting the set of control stores to those in the East Bay has minimal effect on the treatment effect point estimates and standard errors (column two). We interpret this result of evidence that store populations in the East Bay and San Francisco areas were not significantly different in some unobserved way. Similarly, excluding the two stores (store two and store four) most different from the treatment stores in terms of their observable characteristic had little effect on the parameter estimates and standard errors for the treatment effect (column three). We interpret this result as evidence that treatment stores with significantly higher sales was not indicative of substantially different behavior by those store customers. Using a shorter time frame for the panel data set (columns four and five) also does not significantly effect the point estimates; although, limiting the panel data set to only four weeks of pre-treatment and treatment period data does cause the standard errors for the yellow labeled seafood treatment effect to increase considerably. We interpret the results of these two panel durations as evidence that we are not failing to capture important, time varying elements of the store populations.

The placebo regressions for treatment store assignment, time frame of analysis and label color assignment all led to parameter estimates for the treatment effects that were not statistically different from zero, further substantiating the claim from this analysis that the effect we observe is the result of the FishWise Advisory.

4 Implications and conclusion

This study suggests that consumers understood and responded to the TL advisory, and moreover, that consumers differentiated between environmental and health information. These results do not support previous findings about TL advisories; although, the results are consistent with other studies suggesting that health-related information is an important factor in consumption choices [2]. The EUFIC, for example, reports that the majority of EU consumers in their study correctly understood the meaning of green labels but tended to exaggerate the meaning of both amber and red labels [10]. Consumer behavior consistent with the EUFIC research would have resulted in a significant decrease of both yellow and red labeled seafood sales, or at least comparable patterns for yellow and red labeled seafood, which we did not observe within the time frame of our study.

At least in part because of this confusion, the UK's Food Standards Agency recommends a TL system that includes descriptive terms for each color [7]. Similarly, based on a study testing the impact of 8 different front-of-pack nutrition labeling formats of varying complexity, Feunekes et al. recommend a relatively simple "tick logo" on front-of-pack labels for shopping environments in which consumers characteristically make quick decisions [6].

The lack of change in red labeled seafood sales likely reflects real consumer demand for red labeled seafood. All of the 20 top U.S. supermarkets, for example, reportedly sell significant numbers of the most environmentally unsustainable seafood [33], reflecting the market reality that demand for red products exists [2]. Consumers who purchase red labeled seafood may not derive any direct utility from consuming environmentally sustainable seafood, and in fact, might experience significant dis-utility if asked to purchase a substitute. For example, a consumer could have planned a dinner menu around a particular type of seafood such as Chilean sea bass. That consumer would have to alter the menu if an acceptable alternative was unavailable - whether because of taste, quality or price.

The study location, and the presence of a large group of consumers with prior access to information about seafood sustainability, may help explain the pattern of results that we observe. All of the supermarket's stores are located within a 200 mile radius of the Monterey Bay Aquarium, which first developed a list of sustainable seafood as part of an exhibit in 1997 and subsequently produced the Seafood Watch pocket guides to sustainable seafood, which have been widely available in California for approximately 10 years. In the study region, individuals concerned about environmental sustainability may have already shifted their consumption patterns to seafood that is labeled either green or yellow under the FishWise program. However, learning that a product was environmentally unsustainable would not cause a consumer to shift away from a red product, since presumably that consumer already had at least some prior information about the sustainability of that product and still chose to continue consuming the red product.

The study location may have influenced the results in other ways as well. On the one hand, consumer access to prior sustainability information would mean that this study likely underestimates the impact of the labeling program. On the other hand, consumers' higher-than-average education levels and environmental awareness in the study region mean that we are likely to overestimate the impact of the program. On average, these supermarket's 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. Shimshack et al. identified education as a key factor determining the responsiveness of consumers to a United States' Food and Drug Administration advisory about 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. However, the least educated group of consumers were not responsive to the advisory [27].

The FishWise program serves as an educational tool for store staff in the sense that the labeling program and interactions with the FishWise staff during training cause staff to become better informed about the sustainability of seafood. If subsequent conversations between the seafood counter staff and consumers are influencing consumers' choices, we are likely to have overestimated the impact of the labels and underestimated the impact of better informed personnel.

From an environmental perspective, the optimal outcome of the FishWise advisory would be for green labeled seafood sales to increase and yellow labeled and red labeled seafood sales to decrease. Although consumption of red labeled seafood did not change, the increase in green labeled seafood and the decrease in yellow-labeled seafood still represents a net ecological benefit from the FishWise program. From a commercial perspective, although we do not include profit margin information in this study, no overall change in seafood sales suggests the program is financially neutral for the retailer.

From the perspective of altering consumptive patterns that cause environmental damage, the fact that at least some subset of consumers choose not to respond to red labeled seafood present a significant obstacle to change. Profit-driven retail grocery stores are likely to continue stocking red labeled seafood as long as demand for it exists. For this reason, sustainable seafood organizations may want to explore complementary solutions, which could include (1) transitioning consumers to comparable alternatives for red products, particularly those with similar culinary properties (e.g. in the example above, Chilean sea bass to Sablefish (green)), (2) finding individual producers who use best practices, among the main practices in industries, and conferring benefit to these players, and (3) in order to confer this benefit, promoting the use of third party certification for fisheries and aquaculture products based on rigorous social and environmental standards (e.g. the Marine Stewardship Council and the nascent Aquaculture Stewardship Council), and (4) focusing on the supply side and working closely with retailers to help them source viable alternatives for their products.

This discussion highlights the need for additional research, including: testing the FishWise advisory in other areas where consumers have not had as much prior information on seafood sustainability, quantifying consumers' substitution patterns between types of seafood, quantifying the impact of the TL advisory on own- and cross-price elasticities of demand for products, better understanding the interaction between sustainability and health information, better understanding how the adoption of a labeling program influences consumers' perception of an entire brand or store, conducting ethnographic research that interviews consumers about their experience with the FishWise ratings to reveal additional dynamics and uncover insights about the health and environment interaction, and better understanding the appropriate scale for measuring change in consumer choices and behavior. On the final point, experience with seat belts, smoking advisories, and recycling indicate that it can take many years for people to change their behavior. Relatively complex advisories such as FishWise may provide the foundation for larger and more permanent change, particularly if accompanied by other complimentary inputs such as documentaries and news articles. On a more tactical level, additional research would also help improve the effectiveness of seafood labeling. This research could include testing alternative labeling approaches such as only labeling the subset of green products, using two label colors rather than the current set of three colors, and including health-related information directly on product labels.

Table 1: **Eco-labels and the Global "Fisheries Crisis"**

In what scientists now widely view as a "global fisheries crisis", nearly all major seafood stocks have been declining since the mid-1980s and are now a fraction of their original size [34, 19, 22, 31]. Large, predatory fish biomass, which includes swordfish and codfish, is estimated to be roughly 10% of pre-industrial levels [19]. The decline in seafood is particularly harmful for the estimated 2.6 billion people worldwide who depend on fish as a source of animal protein and the 200 million people who earn part or all of their income from activities related to fishing [7].

The market share of aquaculture in global seafood supply increased to nearly 47% in 2006, and is expected to reach 60% by 2020 [7], but concerns about ecological impact such as the overfishing of wild forage fisheries in order to feed farmed fish may ultimately limit the potential of aquaculture to fully substitute for wild fish catches [7, 1].

Consumers are implicated in the decline of wild seafood stocks. Seafood production is a massive, global industry in which demand is driven disproportionately, and increasingly, by consumers in high-income countries. For example, in 2006, 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, with total exports up more than 50% from a decade earlier. In 2006, 3 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 . 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% growth) of seafood by 2020 [7, 4].

In confronting the fisheries crisis, governments and other organizations have traditionally sought to regulate the seafood industry using tools that specifically target production such as catch limits, gear restrictions and fishing capacity reductions. Starting in the 1990s however, both governmental and non-governmental organizations began to target consumers in the high-income countries with market-based mechanisms such as environmental sustainability labels to stimulate demand for more sustainable seafood [7]. The Food and Agriculture Organization of the United Nations estimates that there are now over 400 such standards, certifications and labels related to wild fisheries and aquaculture [7].

Figure 1: **Example of Retailer's FishWise Pin Tag**

This is an example of the Retailer's FishWise pin tag for Petrale Sole Starting from the top left and moving clockwise, the elements of the label are: FishWise logo, symbol for the catch method (the method shown on this tag means "bottom trawl"), product name, price per pound, country of origin, and color. In the retail setting, these labels are colored; the gray sections at the top and bottom of this label would be yellow. The Retailer updated these tags weekly on Tuesday nights. Note that FishWise works with each Retailer to design this tag; the tags for each participating Retailer may have a different format or layout, but will contain the same information.

Figure 2: **Example of FishWise's Low Mercury List**

This is an example of the FishWise January 2008 low mercury list. To be included on this list, it must be safe for a 154 pound adult to eat an eight ounce portion once a week based on Environmental Protection Agency standards and currently available data on mercury and poly-chlorinated biphenyls (PCBs). This information about mercury content was not included on the product pin tag. Instead, it was available to consumers as paper handouts at the seafood counter. To be included on this list, a product also had to be rated as either green or yellow in terms of environmental sustainability; the list does not contain any red-labeled products.

Figure 3: **Store Locations**

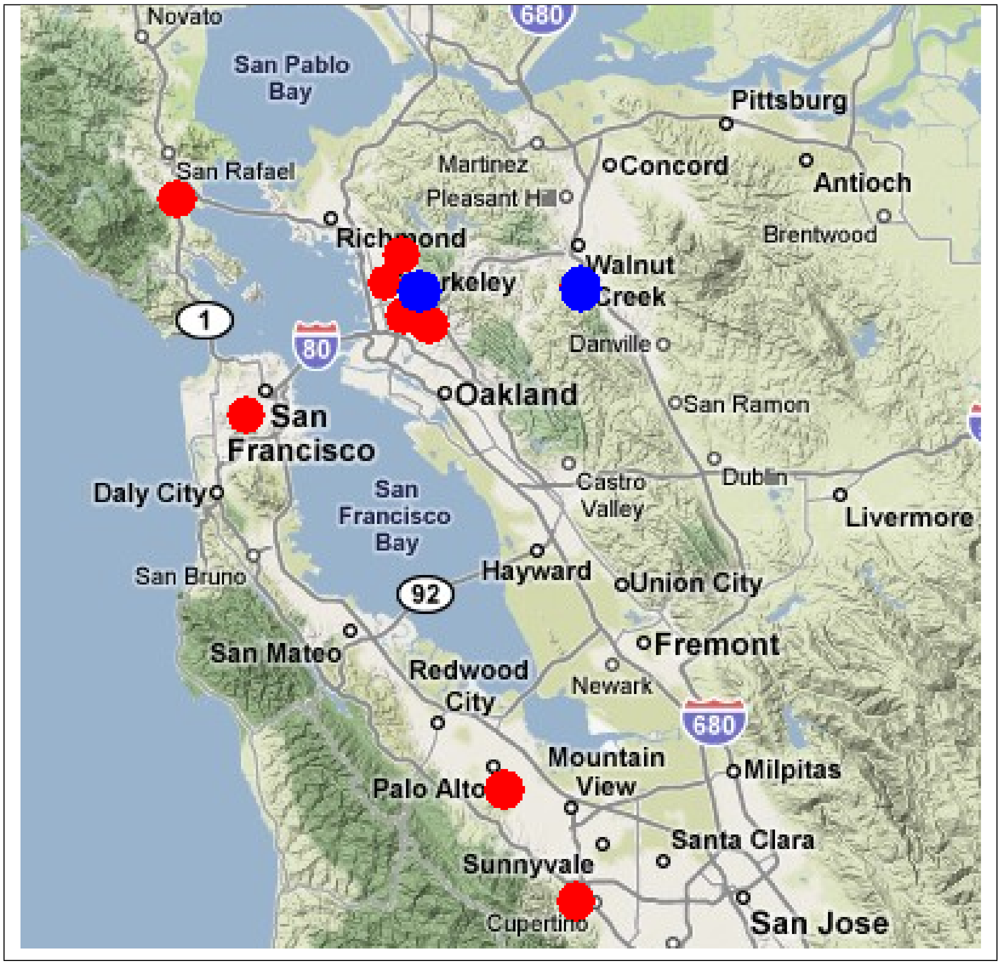


Figure 3 shows the Retailer's ten store locations. The Retailer piloted the FishWise advisory in two randomly-selected stores between February 19 - May 17 , 2006 before implementation in all stores. Locations of treatment stores shown in blue, and locations of control stores shown in red.

Table 2: **Store Characteristics**

	Treatment stores			**Control stores**		
	pre-treat	**treat**	**delta**	**pre-treat**	**treat**	**delta**
Weekly store sales ($)	404,707	397,769	-1.7%	338,822	326,430	-3.8%
	(125,318)	(112,912)		(120,515)	(109,707)	
Weekly meat sales ($)	30,653	29,525	-3.8%	25,954	25,408	-2.1%
	(7,977)	(6,664)		(11,542)	(10,889)	
Weekly seafood sales ($)	16,259	14,901	-9.1%	11,898	11,264	-5.6%
	(2,051)	(1,572)		(4,715)	(4,607)	
Weekly seafood sales (lbs)	732	718	-1.9%	541	551	1.9%
	(210)	(177)		(229)	(213)	
Weekly store traffic (shoppers)	14,449	14,649	1.4%	11,126	11,384	2.3%
	(3,159)	(3,349)		(2,586)	(2,532)	
Median annual HH income ($)	45,015	45,015	0.0%	78,842	78,842	0.0%
	(6,540)	(6,540)		(26,434)	(26,434)	
Number of stores	2	2		8	8	

Standard deviations in parentheses. Table 1 provides descriptive statistics of store characteristics for all ten Retailer stores for a twenty-four week period between February 19 - September 3, 2006. The pre-treatment period is twelve weeks starting on February 19, 2006 and ending on May 17, 2006. The post treatment period is twelve weeks starting on June 10, 2006 and ending on September 3, 2006. Unless noted otherwise, all figures are weekly averages. Sales and customer traffic data were obtained from the Retailer's scanner data. Median household income was obtained from US Census data, which is why the median annual household income is constant across both the pre-treatment and treatment periods.

Table 3: **Summary Statistics**

	Treatment stores			Control stores		
	pre-treat	**treat**	**delta**	**pre-treat**	**treat**	**delta**
Sales by weight (%)						
Green	68.9	60.8	-8.2%	60.1	62.0	1.9%
	(5.4)	(10.3)		(10.8)	(10.4)	
Yellow	13.3	13.8	0.5%	14.8	15.3	0.4%
	(2.8)	(2.8)		(3.7)	(4.0)	
Red	17.8	25.5	7.7%	25.1	22.8	-2.3%
	(5.3)	(11.9)		(10.6)	(9.3)	
Number of choices						
Green	13.2	13.8	4.4%	11.6	13.3	14.6%
	(2.1)	(2.3)		(2.5)	(2.9)	
Yellow	9.3	10.3	10.8%	9.5	9.7	2.4%
	(1.6)	(1.8)		(2.4)	(2.6)	
Red	11.2	8.5	-24.5%	11.1	9.9	-10.7%
	(1.9)	(2.1)		(2.5)	(2.9)	
Label characteristics (%)						
Low mercury	56.7	55.2	-1.6%	53.5	50.3	-3.2%
	-4.5	-3.4		-6.4	-5.6	
On sale	30.4	28.5	-1.9%	31.6	27.2	-4.5%
	-6.0	-3.5		-7.9	-5.9	
Wild	52.2	55.2	2.9%	53.9	57.5	3.7%
	-5.1	-4.5		-6.4	-5.6	
Caught in the U.S.	36.6	41.2	4.6%	33.9	40.9	7.0%
	-2.6	-3.8		-6.8	-6.5	
Number of observations	807	779		3,092	3,163	

Table 2 provides descriptive statistics for the data set used in the discrete choice analysis. “Pre-treat” refers to the pre-treatment period, which covers twelve weeks starting on February 19, 2006 and ending on May 17, 2006. “Treat” refers to the treatment period, which covers twelve weeks starting on June 10, 2006 and ending on September 3, 2006. All figures are weekly averages except for the number of observations, which is a total for the entire period. The number of choices refers to the number of product options available to a consumer at the point of purchase. Label characteristics refers to the percentage of products with each of these characteristics. Pricing is weighted by sales in pounds.

Table 4: **Pricing Comparison for the Pre-treatment and Treatment Periods**

	Pre-treat	**s.d.**	**Treat**	**s.d.**	**p val**
Pricing - treat stores (average, $)					
Overall	13.41	1.02	14.43	1.37	0.11
Green	13.22	1.38	14.54	1.05	0.05
Yellow	13.60	2.25	13.93	1.81	0.75
Red	12.91	2.23	13.90	2.39	0.41
Thailand farmed tiger shrimp	10.48	1.02	10.68	0.46	0.63
USA wild king salmon fillet	23.12	1.55	15.99	0.00	0.00
USA wild halibut steak	11.66	0.47	13.92	1.15	0.00
USA wild petrale sole fillet	15.65	0.22	15.99	0.01	0.00
USA wild halibut fillet	14.34	0.93	16.94	1.13	0.00
Vietnam farmed basa basa fillet	7.89	0.87	7.76	0.93	0.77
USA wild cod fillet	9.99	0.00	9.98	0.02	0.33
Canada wild pacific red snapper	8.99	0.00	8.99	0.00	0.32
Equador farmed tilapia fillet	9.98	0.90	7.79	2.55	0.04
USA farmed trout whole	4.99	0.00	3.39	0.90	0.01
Pricing - control stores					
Overall	13.09	1.21	13.81	1.42	0.03
Green	12.10	1.64	13.74	1.81	0.00
Yellow	13.44	1.40	13.77	1.69	0.41
Red	14.22	3.17	13.63	1.64	0.36
Thailand farmed tiger shrimp	10.39	1.02	10.63	0.46	0.24
USA wild king salmon fillet	22.95	1.38	16.86	1.57	0.00
USA wild halibut steak	11.58	0.46	13.78	1.13	0.00
USA wild petrale sole fillet	15.62	0.20	15.99	0.01	0.00
USA wild halibut fillet	14.17	0.92	16.79	1.12	0.00
Vietnam farmed basa basa fillet	7.81	0.82	7.84	0.91	0.93
USA wild cod fillet	9.99	0.00	9.99	0.01	0.06
Canada wild pacific red snapper	8.99	0.00	8.99	0.01	0.17
Equador farmed tilapia fillet	9.96	0.83	8.01	2.40	0.00
USA farmed trout whole	4.99	0.00	4.09	1.02	0.00

Table 3 compares pricing for in the twelve week pre-treatment and twelve week treatment periods for treatment and control stores. The products listed in the table were the ten highest revenue products sold in the pre-treatment period, representing approximately 54% of seafood sales across all ten stores in an average week. This table is based on a twelve-week period pre-treatment and a twelve-week treatment period. Weighted averages were first computed for each week, and then the simple average was taken across weeks.

Figure 4: **Average Weekly Store Sales by Seafood Type**

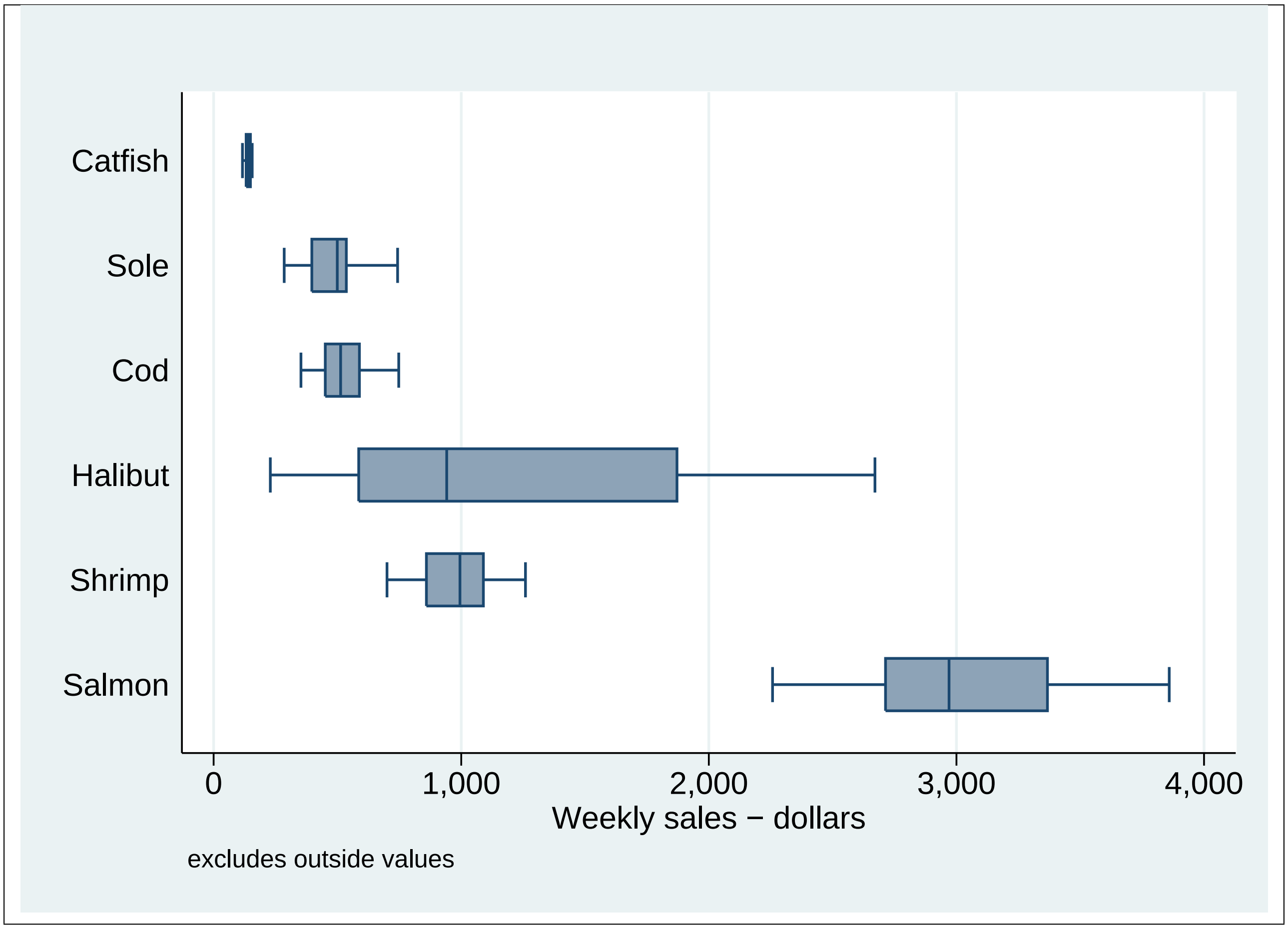
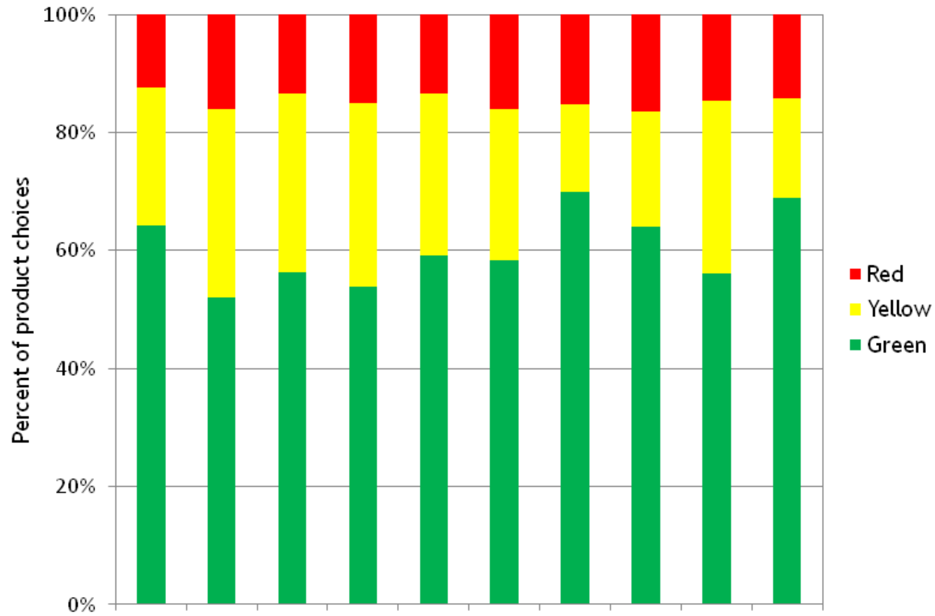


Figure 4 shows average weekly store sales (in dollars) by seafood type during the twelve-week pre-treatment period (February 16, 2006 - May 16, 2006). The lower and upper boundaries of the boxes represent 25th and 75th percentile, respectively. Lower and upper lines represent lower and upper adjacent value.

Figure 5: **Product Mix by Label Color and Store**



Store ID	1	2	3	4	5	6	7	8	9	10
SKUs sold	45	42	62	39	50	45	46	43	49	49
Weekly sales ($)	9,722	4,072	11,931	3,176	11,887	9,100	8,545	6,683	10,526	10,399

Figure 5 shows the average product mix, number of product choices (SKUs) and average weekly sales for Retailer stores during the pre-treatment period.

Figure 6: **Weekly Sales by Color Seafood in Paired Treatment and Control Store**

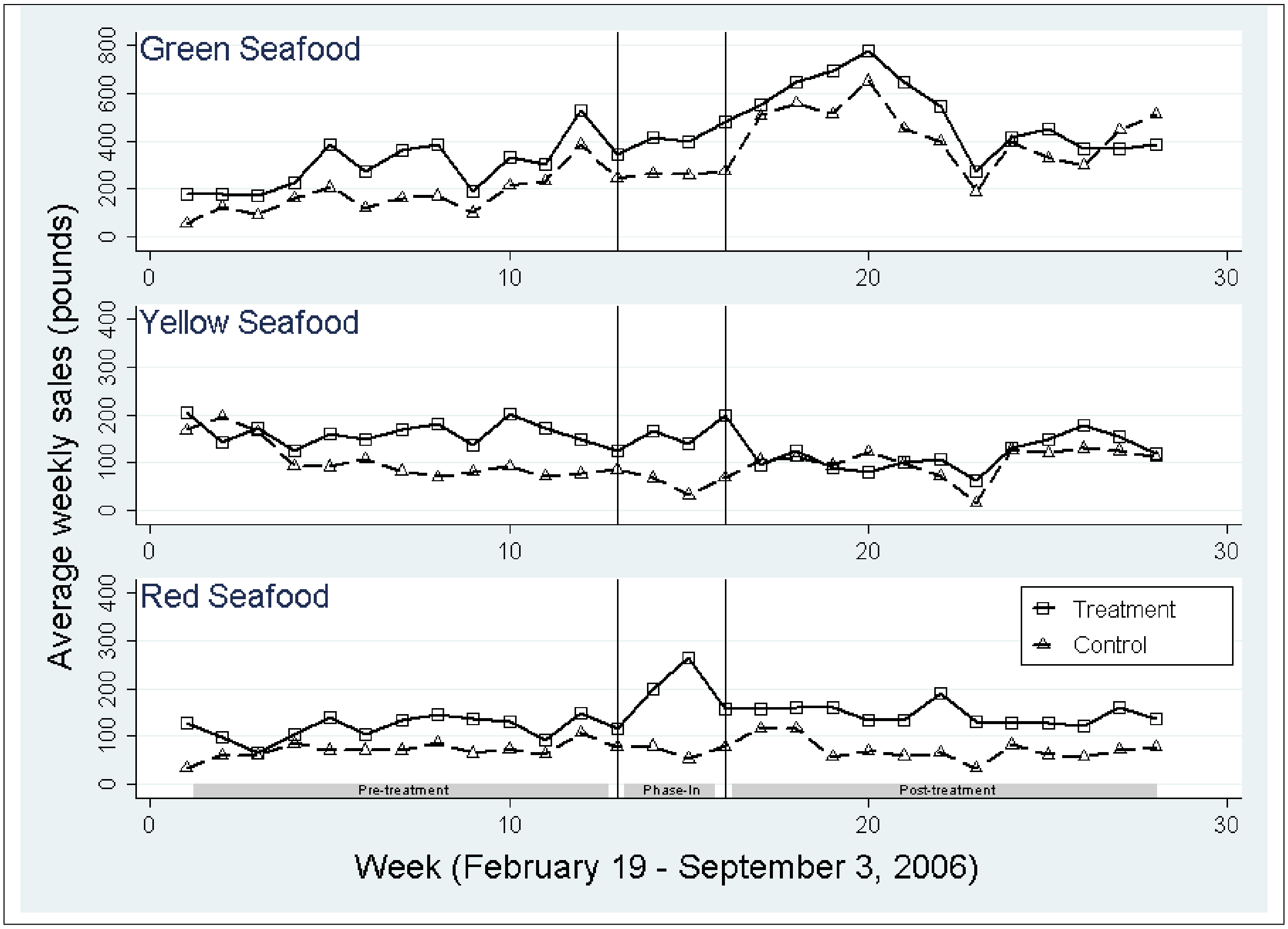


Figure 6 shows total weekly sales for store five (treatment) and store one (control). We present these two stores, rather than an average across all control and treatment stores, to facilitate a visual comparison of the trends. The graph covers 28 weeks between February 19, 2006 - September 3, 2006. The twelve-week pre-treatment period, during which neither store had implemented the FishWise Advisory, is to the left of the first vertical line. The twelve-week treatment period, during which store give had implemented the Advisory, is to the right of the second vertical line. The four-week period between the two vertical lines is the time that it took for the Retailer to phase in the FishWise Advisory.

Table 5: **Average Treatment Effect (FE Estimator)**

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

	(1)	(2)	(3)	(4)	(5)
Treatment period dummy	-0.0201	0.1438	-0.0488	-0.0741	-0.1386
	(0.0515)	(0.1503)	(0.1678)	(0.1754)	(0.1898)
Treatment effect	-0.1298	-0.1187	-0.1321	-0.1451	-0.1530*
	(0.0818)	(0.0818)	(0.0820)	(0.0825)	(0.0759)
Ln(price)			-0.0228	-0.0197	-0.0114
			(0.8056)	(0.8031)	(0.8013)
Promotion indicator			0.6297***	0.6285***	0.6247***
			(0.0716)	(0.0728)	(0.0726)
Fish share (of meat)				1.6773**	1.6536**
				(0.6444)	(0.5949)
Mercury list share					-0.6803**
					(0.2695)
Yellow share					-0.0068
					(0.3209)
Red share					-0.7017
					(0.5613)
Constant	4.8230***	5.1287***	5.0106**	4.7395*	5.2898**
	(0.0217)	(0.0731)	(2.0076)	(2.1042)	(2.0524)
Week by seafood type		yes	yes	yes	yes
Discount dummy			yes	yes	yes
Observations	7841	7841	7841	7841	7841
r2	0.0013	0.1130	0.1574	0.1578	0.1584

Standard errors in parentheses: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Table 4 reports the treatment effect of the FishWise advisory on seafood sales per fish by comparing the change in sales in treatment stores displaying the labels to changes in control stores not displaying the labels. All coefficient estimates represent results of applying a fixed effects estimator to an unbalanced panel data set in which the panel variable is a store-product and the data set covers twenty-four weeks of weekly data.

Table 6: **Treatment Effect by Label Color (FE Estimator)**

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

	(6)	(7)	(8)	(9)	(10)
Green: treatment period	0.1023	-0.1027	-0.3125	-0.3080	-0.3907
	(0.0763)	(0.2293)	(0.2075)	(0.2115)	(0.2380)
Yellow: treatment period	-0.2045***	-0.3780*	-0.5471**	-0.5433**	-0.6243**
	(0.0526)	(0.1904)	(0.1722)	(0.1776)	(0.1998)
Red: treatment period	-0.0184	-0.1727	-0.3928**	-0.3904**	-0.4701**
	(0.0694)	(0.1235)	(0.1337)	(0.1375)	(0.1667)
Green: treatment effect	-0.0705	-0.0572	-0.0670	-0.0809	-0.0883
	(0.1034)	(0.1057)	(0.1286)	(0.1308)	(0.1229)
Yellow: treatment effect	-0.3233***	-0.3113***	-0.3286***	-0.3416***	-0.3490***
	(0.0606)	(0.0457)	(0.0407)	(0.0340)	(0.0330)
Red: treatment effect	-0.0705	-0.0653	-0.0774	-0.0904	-0.0993
	(0.1593)	(0.1521)	(0.1042)	(0.1015)	(0.0975)
Ln(price)			0.0534	0.0585	0.0642
			(0.8284)	(0.8253)	(0.8233)
Constant	4.8273***	5.1360***	4.8281**	4.5592*	5.0993**
	(0.0209)	(0.0716)	(2.0630)	(2.1596)	(2.1034)
Week by seafood type		yes	yes	yes	yes
Price			yes	yes	yes
Discount dummy			yes	yes	yes
Promotion dummy			yes	yes	yes
Fraction of store sales				yes	yes
Fraction low mercury list					yes
Fraction red, yellow and green					yes
Observations	7841	7841	7841	7841	7841
r2	0.0074	0.1162	0.1599	0.1604	0.1609

Standard errors in parentheses: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Table 5 reports the treatment effect of the FishWise advisory on sales of each label color by comparing the changes in treatment stores displaying color labels to changes in control stores not displaying color labels. All coefficient estimates represent results of applying a fixed effects estimator to an unbalanced panel data set in which the panel variable is a store-product and the data set covers 24 weeks of weekly data. Regression (1) contains only the covariates whose coefficients are shown. Regressions (2) - (5) contain the additional covariates listed in the table.

Table 7: **Treatment Effect by Label Color and Health Information (FE Estimator)**

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

	(All products)	(Mercury safe)	(Not mercury safe)
Green: treatment period	-0.3907	-0.3718	1.5802***
	(0.2380)	(0.2752)	(0.2663)
Yellow: treatment period	-0.6243**	-0.3004	0.0000
	(0.1998)	(0.2947)	.
Red: treatment period	-0.4701**	0.0000	0.7160***
	(0.1667)	.	(0.1247)
Green: treatment effect	-0.0883	-0.0017	-0.2144
	(0.1229)	(0.1231)	(0.1880)
Yellow: treatment effect	-0.3490***	-0.4126**	-0.1961
	(0.0330)	(0.1594)	(0.4711)
Red: treatment effect	-0.0993	0.0000	-0.0775
	(0.0975)	.	(0.0643)
Ln(price)	0.0642	-0.3590	-0.8564
	(0.8233)	(1.1259)	(1.3675)
Constant	5.0993**	6.9037**	6.8582
	(2.1034)	(2.3976)	(3.7900)
Observations	7841	3516	4325
r2	0.1609	0.1547	0.2324

Standard errors in parentheses: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Table 6 reports the treatment effect of the FishWise advisory on sales of seafood by label color and whether the seafood was included on the low-mercury list (Figure xx) by comparing the changes in treatment stores displaying the labels to changes in control stores not displaying the labels. Specification (1), the base case, is the same as regression (5) in Table x. "Mercury/PCB safe" means the product was included in a list of low-mercury seafood displayed on a poster to the side of the seafood counter.

Table 8: **Robustness Checks I (FE Estimator)**

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

	(1)	(2)	(3)	(4)	(5)
Green: treatment period	-0.3907	-0.5959**	-0.3140	-0.3088	0.2917
	(0.2380)	(0.1485)	(0.2649)	(0.2593)	(0.1990)
Yellow: treatment period	-0.6243**	-0.8682***	-0.6348**	-0.6239***	-0.1965**
	(0.1998)	(0.1327)	(0.2310)	(0.1838)	(0.0699)
Red: treatment period	-0.4701**	-0.8256***	-0.4543**	-0.4595***	0.0000
	(0.1667)	(0.0914)	(0.1771)	(0.1377)	.
Green: treatment effect	-0.0883	-0.1637	-0.1137	-0.0958	0.0619
	(0.1229)	(0.1414)	(0.1271)	(0.1376)	(0.1362)
Yellow: treatment effect	-0.3490***	-0.3356***	-0.3535***	-0.3502***	-0.3050
	(0.0330)	(0.0385)	(0.0434)	(0.0392)	(0.2191)
Red: treatment effect	-0.0993	-0.0447	-0.1049	-0.1394	-0.0550
	(0.0975)	(0.0835)	(0.0968)	(0.0945)	(0.0834)
Ln(price)	0.0642	0.2570	0.3151	0.0669	-0.7947
	(0.8233)	(1.1510)	(0.9902)	(0.7715)	(1.1047)
Constant	5.0993**	3.4864	3.8177	4.2992*	5.7599*
	(2.1034)	(2.7282)	(2.8292)	(1.9875)	(2.8590)
East Bay stores only		yes			
Drop most dissimilar stores			yes		
Sixteen weeks of data				yes	
Eight weeks of data					yes
Observations	7841	4590	6466	5257	2706
r2	0.1609	0.1805	0.1669	0.1753	0.1827

Standard errors in parentheses: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Table 7 contains alternative specifications to evaluate the robustness of the parameter estimates for the treatment effect of each color label. Specification (1), the base specification, is the same as specification (5) from Table xx, in which we applied a fixed effects estimator to an unbalanced panel data set in which the panel variable is a store-product and the data set covers twenty-four weeks of weekly data. Regressions (2) - (5) contain the additional variations listed in the table. Specification (2) includes only East Bay stores. Specification (3) drops the two stores with the lowest seafood sales as a fraction of total store sales. Specification (4) covers sixteen weeks of weekly data. Specification (5) covers eight weeks of weekly data.

Table 9: **Robustness Checks II (DID with Pooled OLS)**

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

	(1)	(2)	(3)	(4)	(5)
Green: treatment period	-0.3923***	-0.4076	-0.5515**	-0.5680**	-0.7018**
	(0.1186)	(0.2707)	(0.2787)	(0.2788)	(0.2835)
Yellow: treatment period	-0.7573***	-0.7262***	-0.8784***	-0.8948***	-1.0287***
	(0.1228)	(0.2706)	(0.2784)	(0.2792)	(0.2832)
Red: treatment period	-0.6001***	-0.4501*	-0.6956***	-0.7122***	-0.8464***
	(0.1211)	(0.2537)	(0.2673)	(0.2681)	(0.2728)
Yellow: treatment store	-0.0951	-0.0860	-0.0683	-0.0684	-0.0689
	(0.1152)	(0.1129)	(0.1089)	(0.1089)	(0.1090)
Green: treatment store	-0.0150	-0.0292	-0.0403	-0.0406	-0.0422
	(0.1097)	(0.1039)	(0.1017)	(0.1017)	(0.1017)
Green: treatment effect	-0.0619	-0.0197	-0.0412	-0.0469	-0.0714
	(0.0973)	(0.0913)	(0.0904)	(0.0916)	(0.0931)
Yellow: treatment effect	-0.2800**	-0.2979**	-0.3254***	-0.3315***	-0.3567***
	(0.1218)	(0.1196)	(0.1170)	(0.1179)	(0.1200)
Red: treatment effect	-0.1456	-0.1471	-0.1545	-0.1604	-0.1868
	(0.1154)	(0.1160)	(0.1132)	(0.1139)	(0.1159)
Ln(price)			1.8000**	1.8037**	1.8215**
			(0.8672)	(0.8677)	(0.8673)
Constant	-0.2644	0.0488	-2.3501	-2.4157	-2.8574
	(0.4181)	(0.4740)	(2.5669)	(2.6008)	(2.6210)
Week by seafood type		yes	yes	yes	yes
Price			yes	yes	yes
Discount dummy			yes	yes	yes
Promotion dummy			yes	yes	yes
Fraction of store sales				yes	yes
Fraction low mercury list					yes
Fraction red, yellow and green					yes
Observations	4856	4856	4856	4856	4856
r2	0.4849	0.5351	0.5514	0.5514	0.5519

Standard errors in parentheses: * p<0.10, ** p<0.05, *** p<0.01.

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