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Are Consumers Willing to Pay More for Sustainable Products? A Study of Eco-Labeled Tuna Steak

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Abstract: A high demand for seafood leads to overfishing, harms the long-term health of seafood stocks, and threatens environmental sustainability in oceans. Sustainability certification is one of the major sustainability movements and is known as eco-labeling. For instance, in the tuna industry, leading tuna brands have committed to protecting sea turtles by allowing the tracing of the source of their tuna "from catch to can." This paper relies on an Internet survey on consumers from Kentucky conducted in July 2010. The survey investigates household-level tuna steak (sashimi grade) consumption and examines consumer preferences for eco-labeling ("Certified Turtle Safe" (CTS) in this study) while mimicking individuals' seafood procurement processes. A random parameter logit model is utilized, and willingness-to-pay measures are calculated based on model estimation results. It was found that respondents on average preferred turtle-safe-labeled tuna steak and were likely to pay more for it; however, they were less likely to purchase wild-caught species, and insignificant results were found for pre-frozen. Moreover, significant heterogeneities were found across individuals regarding tuna steak purchases. The findings indicate evidence of public support for environmental friendliness, particularly with regard to eco-labeling.

Keywords: eco-friendly labeling; willingness-to-pay; mixed logit model

1. Introduction

Global catches of tuna and tuna-like commodity species increased from less than 0.6 million tons in the 1950s to 6.6 million tons in 2010 (2010 is the last year for which tuna fisheries provided data on nominal tuna catches by fishing gear, species, stock, country, and year) [1], including all seven principal species of tuna: albacore, bigeye, bluefin (3 species), skipjack, and yellowfin. The society is seeing more demand for fish than ever before, especially due to the widely known health benefits of fish. Both the industry as well as academic communities have gradually noticed the necessity of ensuring the long-term health of all tuna stocks. As a response, protective measures, such as eco-labels (or environmental sustainability labels) and traceability, have been taken to mitigate the overfishing problem.

Since 2009, global industry standards have been implemented that allow U.S. tuna companies to trace the source of all their tuna "from catch to can." Some leading U.S. tuna brands even work in partnership with governments worldwide, the scientific community, and leading globalized conservations or organizations, including the World Wildlife Fund (WWF), to maintain sustainable

tuna production. Economic studies have also investigated consumption and consumer preference regarding tuna; however, relatively little is known about eco-labels' impact on consumer demand for tuna despite a number of studies having been performed for fishery products [2–9]. Consequently, this study aims to examine consumer preference for tuna steak products, from which the results will provide empirical evidence for market design and policy-making.

As for our research interests and purpose, a household survey on the purchasing habits and preference for tuna of consumers from Kentucky in the U.S. is utilized for this paper. Kentucky is a typical midland state in the U.S., the residents of which are general consumers who might not face immediate environmental sustainability issues compared to those who live close to an ocean. The survey included a choice-based conjoint experiment to investigate consumers' choices between wild-caught (conventional) and farm-raised tuna fish, the results of which help to predict future markets and assist in policy-making.

Most importantly, the impact of environmentally friendly eco-labels is another key element in this study. Participants were asked both qualitative and quantitative questions for the "Certified Turtle Safe" (CTS) label [10] on tuna products. Prior to the choice experiment, respondents were instructed with the following information: "Certified Turtle Safe by definition is fish harvested by fisheries under stringent controls to avoid sea turtle by-catch."

2. Research Background

2.1. High Tuna Demands and Calls for Fishery Management

Tuna is one of the most popular seafoods because of its health benefits. For example, seafood is considered a good source of omega-3 fatty acids, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), and these nutrients have been proven to be beneficial compounds for heart health and early neurological development. Seafood is also low in fat and cholesterol, and rich in protein, vitamins, and minerals. According to the 2010 Dietary Guidelines for Americans [11], eating approximately 8 ounces per week of a variety of seafood, which provides approximately 250 mg intake per day of EPA and DHA, can help to reduce cardiac death among individuals with and without pre-existing cardiovascular disease.

Numerous published works have also shown the valuable effects of fish as a unique and rich food source of healthy nutrients [12–16]. Tuna species are on the top of the list for seafood choices. Their meat contains almost no fat and has all of the essential amino acids needed by the human body along with the B vitamins niacin, B1, and B6. Moreover, tuna is an oily fish that has high-quality protein and is a good source of omega-3 fatty acids. Hence, tuna's nutritious benefits uphold the high demand for it. The U.S. per capita consumption of canned tuna was 2.7 lbs in 2011 and was 2.6 lbs in 2010, and the U.S. has the second highest seafood consumption in the world [17].

However, a high demand for tuna leads to its overfishing. Tuna are fished in over 70 countries as the world's most valuable commercial species and then marketed in fresh, frozen, or canned form. Japan and the U.S. are the two largest tuna-consuming countries [14]. Among the seven principal tuna species in the world, 33.5% were estimated to be overexploited, 37.5% were fully exploited, and 29% were not fully exploited, as reported by the Food and Agriculture Organization (FAO) in 2012 [1]. In the long term, tuna stocks and, thus, tuna catches may deteriorate unless there are significant improvements in tuna fishery management or in the cultivation of a substantial tuna fishing and supply system. Due to overfishing, some tuna species are even at risk of extinction [18,19]. Recognizing the environmental emergency surrounding tuna, it requires conservation and the sustainable use of tuna species worldwide. One challenge is that tuna-fishing fleets and their catches have been growing, often unsustainably [20]. Consequently, restrictive measures are necessary to control potential overfishing.

2.2. Sustainability Issues and Eco-Labels

Tuna populations and resource sustainability issues directly influence the nature of tuna production and the fishing industry. Sustainability certification is one of the major sustainability movements. One type of sustainability certification is eco-friendly labels (also known as environmentally friendly, nature friendly, or green), which are also known as eco-labels [21]. These labels are intended to introduce environmental awareness for consumers who care about the environment and to help identify consumer products that are ecologically superior. Some labels quantify pollution or energy consumption by way of index scores or units of measurement; others simply assert compliance with a set of practices or minimum requirements for sustainability or reduction of harm to the environment [22]. Eco-labels were initiated in the 1990s and have been introduced in the fisheries sector, and they are increasingly being applied to tuna fisheries.

Theoretically, consumers are believed to derive eco-labels' utility from using products produced with specific processes, such as environmentally friendly practices, which are reflected with eco-labels [23]. Some researchers [22,24] found that the market success of eco-friendly food products requires not only environmental but other verifiable attributes, such as better taste or higher safety. Other researchers also noted that the adoption of eco-labels may earn a premium price for food products [25–27]. In this study, we will examine the impact of an eco-label, "Certified Turtle Safe," on consumer preference. This label is not yet seen on the market, but it may help alleviate one of the controversies associated with the tuna-fishing industry: sea turtles may be harmed or even killed during the fishing.

2.3. Wild-Caught or Farm-Raised?

An alternative way of supplementing the supply of wild-caught fish (also known as commercial catches) is aquaculture or farm-raised fish [28,29]. Some consumers prefer wild-caught fish for higher quality and better taste than the farm-raised option [30], while other consumers are concerned with the negative impacts to the environment posed by aquaculture [28]. However, the benefits of aquaculture include lower cost and year-round availability compared to wild-caught fish [30,31]. As discussed above, a high demand for tuna has threatened tuna stock and the environment. Raising fish on a farm could be a solution to this problem. The first tuna farm was approved in Hawaii [21] and promised to create an environmentally friendly open-ocean farm for bigeye tuna. Consequently, this study would be the first to examine consumers' acceptance and willingness to pay for this new technique and to evaluate the market potential, especially before significant money and resources are implemented.

2.4. Other Tuna Attributes: Storage Mode and Price

According to Lancaster's "new theory of consumer demand" [32], consumers are not seeking to acquire goods *per se*, but their characteristics. Product demand is affected by attributes that may include flavor/taste, freshness, size, or fish form. Referring to freshness or storage mode, this survey attempts to compare consumers' preference between fresh, which is never frozen, and previously frozen tuna [33–35]. Secondly, two types of product processes are considered: farm raised and wild-caught [34,35]. Therefore, this study will examine consumer preference for the attributes of farm-raised tuna and contribute to an understanding of the future development of tuna farms. Finally, the prices of tuna are also included. A detailed description of the attributes used and the choice of experiment design are provided later in Section 4: Choice Experiment and Model.

3. Survey and Data

3.1. Survey Sample Statistics

For the purposes of this study, an online survey was utilized. It was conducted via the Internet in July 2010 through zoomerang.com, which is operated by a professional survey company called MarketTool, Inc. The survey participants were residents from a typical land-locked state in the

U.S.—the state of Kentucky. A total of 421 completed questionnaires were returned and usable for analysis in this study. The questionnaire was designed to examine household level tuna steak (sashimi grade) consumption and purchase preference, especially consumers' preference for eco-labeled food products and raising origins. The survey consisted of three parts: general seafood purchasing habit questions, aiming to establish a basic understanding of consumer demand and attract respondents' attention [23]; a choice experiment; and questions on demographics information. The descriptive statistics of the sample are provided in Table 1.

Table 1. Sample descriptive statistics.

Variable	Group	Dist.	Sample Mean	Kentucky Average *	Description
URBAN	-	-	0.55	-	Dummy Variable; = 1 if live in an urban area
FEMALE	-	-	0.71	51.60%	Dummy Variable; = 1 if female
AGE	-	-	52.2	48.5	Continuous Variable; in years
EDU	Less than High School High School Only Some College, no degree Associate's Degree Bachelor's Degree Master's Degree Professional Degree Doctorate	2.38% 25.42% 30.40% 11.88% 14.73% 10.93% 3.09% 1.19%	14	KY College Attainment Rate among adults aged 25–64 is 30.5% in 2009	Continuous Variable; in years
EMPLOY			0.50	55.30%	Dummy Variable; = 1 if employed
INCOME	0–$14,999 $15,000–$24,999 $25,000–$49,999 $50,000–$74,999 $75,000–$99,999 $100,000–$14,9999 >$150,000	7.13% 13.78% 40.14% 19.95% 11.40% 5.46% 2.14%	5.13	17.90% 13.20% 26.90% 17.80% 10.90% 8.90% 4.50%	Continuous Variable; in $10 k, of household income
WHITE	-	-	0.92	88.9%	Dummy Variable; = 1 if race is Caucasian
HHSIZE	-	-	2.60	2.48	Continuous Variable
COAST	-	-	0.09	-	Dummy Variable; = 1 if grew up within 50 miles of the seacoast

* Source: 2010–2014 KY State Average [36].

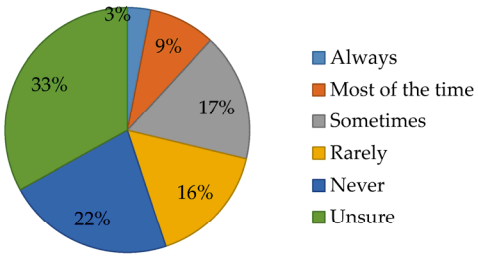
In general, the demographical statistics compare closely to the Kentucky state average. A total of 71% of the respondents were female, which was slightly more than the state average (56.6%) because it was acceptable that the survey participants were more likely to be female respondents who might be more interested in grocery shopping. The mean age for this sample was 52 years old, older than the 48.5-year-old state average. Almost half of the respondents were employed either full-time or part-time, which was close to the state average level (55.3%). In the U.S. Census, Kentucky's college attendance rate among adults aged 25–64 was 30.5% in 2009. In this sample, 30.40% of "some college experience" was observed. The median annual household income for Kentucky was $43,342 from 2010 to 2014, which was below the average in the U.S. Census. However, the income distribution was more closely representative. For example, 26.9% of the population had a household income ranging from $25,000 to $49,999, which was the largest group in the Kentucky according to the 2010 to 2014. In comparison, a larger portion (40.14%) was found to belong to this range in the sample, which was also the biggest group. A greater number of Caucasian respondents (92%) took the survey compared to the state average (88.9%). A household size of 2.6 members observed in the sample was consistent with the state average of 2.48. It was noted that the sample average was slightly different from the KY census statistics; however, this was within reason. Although the survey was conducted via the Internet,

individuals who were female, older, and wealthier—older individuals were more likely to be married, and their household incomes were thus on average higher than single individuals—were more likely to take the survey, which concerned grocery shopping, than males and younger individuals.

Consumers' household location was also examined and labeled as URBAN. This is a dummy variable indicating that respondents lived in either urban or suburban areas. In this survey, 55.11% of the respondents were urban residents, and 44.89% were rural residents. Childhood experiences concerning seafood were also considered with the item, "whether (they) grew up within 50 miles of the seacoast," and a dummy COAST was created if the answer was yes. Approximately 9% of the respondents lived near the coast during their early childhood years, which meant that the sample comprised mostly land-locked consumers in whom the study was initially interested.

3.2. Perceptions and Attitudes Statistics

Beyond demographics, the questionnaire also inquired about respondents' perceptions and attitudes regarding seafood consumption. For instance, respondents were asked whether they were able to "differentiate between wild-caught and aquaculture/farm-raised fish, aside from labeling, either pre- or post-consumption." According to the results, only 3% of the respondents self-reported that they could always recognize wild-caught and farm-raised fish, and another 26% were able to differentiate either "most of the time" or "sometimes," compared to the 33% unsure. Figure 1 shows the details. In the subsequent sections, a dummy variable was created to examine how such a perception of fish could affect consumers' patron preference and willingness to pay. The dummy variable was created as variable "DIFFER" with a value of 1, indicating "being always able to differentiate wild-caught and farm-raised fish," "most of the time," or at least "sometimes."



DIFFER=1 if choose "Always", "Most of the time", "Sometimes";
0 if choose "Rarely", "Never" and "unsure".

Figure 1. "Are you able to differentiate between wild-caught and farm-raised fish?"

Secondly, respondents were asked whether they "have noticed supermarket labels specifying whether seafood is farm-raised or wild-caught." Feedback from this question would provide references and suggestions for future labeling designs for both tuna marketers and policy makers. According to the results, 41% of the respondents had noticed labels specifying that seafood was farm-raised or wild-caught. However, a larger portion (42% "had not" and 17% were "unsure") reported that they had not or were unsure about such information when purchasing seafood. The dummy variable "Labelnotice" was then generated (Figure 2).

In addition to perception issues, the survey also asked for information on consumers' attitudes toward seafood labels. Figure 3 gives a summary of their answers as to "whether labels on a product will affect your decision to purchase seafood," and the variable "Labelinfluence" was generated for later econometric analysis. One third (34.68%) of the respondents reported a neutral attitude on this issue, and a fourth (23.04%) indicated that they cared a great deal about labels when buying seafood. However, 13.78% of the respondents stated that labels do not affect their purchasing decisions at all.

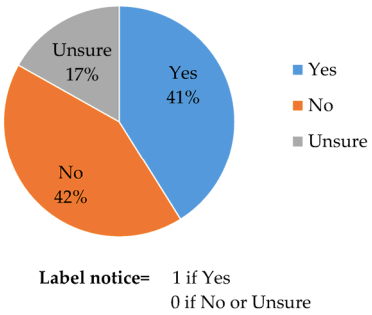


Figure 2. "Have you noticed supermarket labels specifying whether seafood is farm-raised or wild-caught?"

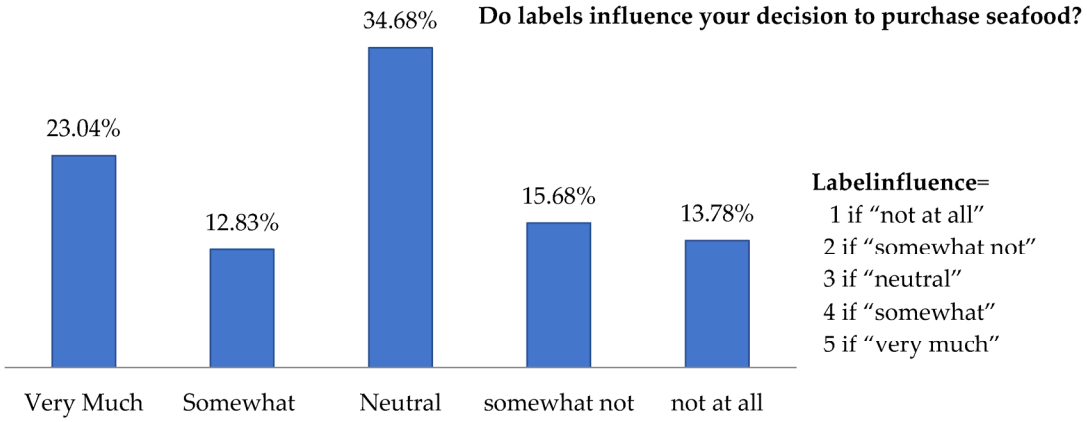


Figure 3. "Do labels influence your decision to purchase seafood?"

Lastly, environmental friendliness factors (dummy variables "Env Friendly_WC" and "Env Friendly_FR") were also created. Respondents revealed their attitudes when answering the Likert scale question ranging from 1 (not at all) to 5 (very important). Over 40% of the respondents said that environmental friendliness was a "very important" attribute. Meanwhile, 23.52% considered it an "important" attribute, and another 23.75% believed it was moderately important. Figure 4 shows the details.

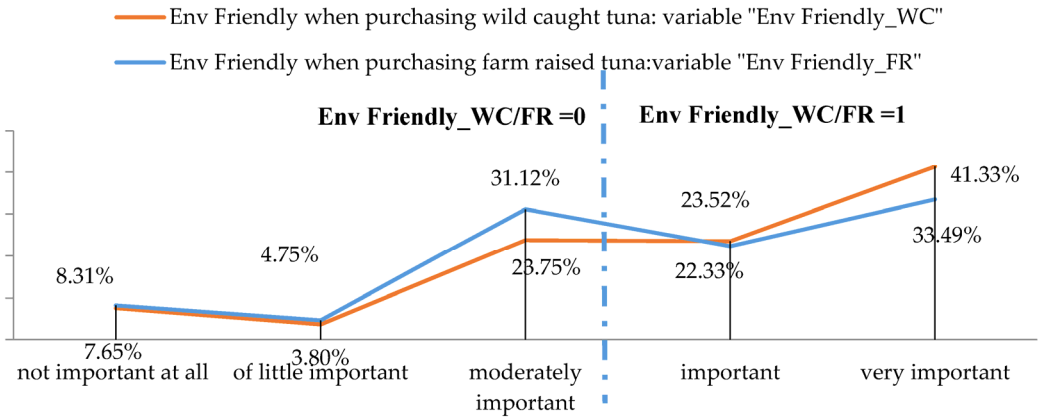


Figure 4. Environmental friendliness when purchasing tuna.

4. Choice Experiment and Models

4.1. Choice Experiment

A choice experiment was employed in this survey that is widely used to elicit consumers' preferences for food products [37–42]. It presented consumers/respondents with a set of alternatives that differed in tuna steak attributes and asked consumers to choose an alternative they prefer. The responses were used to elicit Willingness-to-Pay (WTP) for different tuna steak attributes, as discussed in Section 2.2 through 2.4. Table 2 provides descriptions of the attributes and levels.

Table 2. Tuna (steak form and sashimi grade) attributes and levels.

Attribute	Alternatives	Variable Name	Descriptions
Origin	Wild-Caught Farm-Raised	Wild-Caught	Refers to the origin where the tuna was raised.
Storage Mode	Previously Frozen Fresh and Never Frozen	Pre-Frozen	Refers to the method used for storage.
Eco-labeled	Certified Turtle Safe * None	Turtle Safe	Refers to whether the tuna is labeled as turtle safe or not.
Price($/lb)	8.99 14.49 19.99 25.49	PRICE	Refers to tuna steak price (in sashimi grade) in the retail grocery store where the respondent typically shops.

* Certified turtle safe by definition is fish harvested by fisheries under stringent controls to avoid sea turtle by-catch.

As presented, tuna fish may be wild-caught or farm-raised. Additionally, storage mode can be either "previously frozen" or "fresh and never frozen". The eco-label "Certified Turtle Safe" may be used for a product. Finally, price was also included as an attribute, which is critical for future WTP estimates. Four price levels were used that were obtained after researching comparable products at regular chain retail markets in Lexington, KY: $8.99/lb; $14.49/lb; $19.99/lb; and $25.49/lb. These price levels were chosen to ensure that they covered the lowest and highest possible prices. Corresponding variables for these attributes are Wild-Caught (hereinafter, WC), Pre-Frozen (Pfr), Turtle Safe (TS), and PRICE, as given in Table 1.

Using an orthogonal design and adding the "buy neither" option, four choice situations were generated. In each choice situation, respondents were asked to choose one from options A, B, and C in each scenario. Then, a dummy variable BUYNO was used to indicate the third alternative in each choice set. The choice experiment was designed using an orthogonal design (with SPSS software) in which eight choice sets and four situations were created (Origin (2) × Storage Mode (2) × Eco-labeling (2) × Prices (4) = 32). A pilot study was also conducted in August 2009 in which 17 respondents from Charlie's Fresh Seafood Market in Kentucky were targeted. An example of the choice scenario is displayed in Figure 5. The respondents were told before entering the choice scenarios, for example, that the two options (please refer to option A and B in Figure 5) were identical for all other characteristics rather than those described and instructed not to compare across scenarios. These were important assumptions for our later model specifications.

Figure 5. The Choice Question Example. Note: * Turtle Safe: Fish harvested by fisheries under stringent controls to avoid sea turtle by-catch.

4.2. Theoretical Framework

Supposing individual i faces a choice consisting of different attributes and chooses j (where, j = 1, 2, 3, . . . , J) among all the alternatives in the t-th choice situation, the attributes can be represented by x_{ijt} (x = BUYNO, WC, Pfr, TS, PRICE). It is assumed that the consumer will choose alternative j if and only if the associated utility is greater than or at least equal to any other alternatives, *ceteris paribus*. Mathematically, utility can be represented in a random utility framework (McFadden, 1974), namely,

$$U_{ijt} = \boldsymbol{X}_{ijt}\boldsymbol{\beta} + \varepsilon_{ijt}, \tag{1}$$

where U_{ijt} refers to the indirect utility obtained by individual i, which is a linear function of the observable vector of attributes $\boldsymbol{X}_{ijt}$ and their coefficients, vector $\boldsymbol{\beta}$, which are to be estimated; and ε_{ijt} represents the random error that captures all other unobservable factors that influence the choice process. McFadden showed that, if the error terms follow an *i.i.d.* maximum extreme value Type I distribution, the utility maximization process leads to the choice probability of alternative j chosen in choice set t:

$$P_{ijt} = \frac{\exp\left(\boldsymbol{X}_{ijt}\boldsymbol{\beta}\right)}{\sum_{k=1}^{J}\exp\left(\boldsymbol{X}_{ikt}\boldsymbol{\beta}\right)}. \tag{2}$$

This is the form of the conditional logit model; however, it suffers from two major limitations: (1) It cannot represent random taste variation, and (2) it does not avoid the restrictive substitution pattern suggested by the property of Independence of Irrelevant Alternatives (IIA) [43]. A mixed logit model addresses these limitations. Recent improvements in the computational package have promoted empirical applications of mixed logit, and this study used STATA 12.

Following Train (2003) [43], the parameters in vector $\boldsymbol{\beta}$ are assumed as random variables and may vary across individuals in the sample rather than fixed coefficients in conditional logit. Supposing the distribution of $\boldsymbol{\beta}$ is specified as $\boldsymbol{\beta} \sim \mathbf{H}(\boldsymbol{\theta}, \Delta)$, H can be the individual probability distribution function, and parameters $\boldsymbol{\theta}$ and Δ are the mean and variance. Benefits from the mixed distribution is that unobserved variation can be represented in the form of any appropriate distribution by specifying the form of function H. Among the commonly used distributions are normal, lognormal, and uniform distributions. Given the random parameter context, the choice probability is updated as:

$$P_{ijt} = \int \frac{\exp\left(\boldsymbol{X}_{ijt}\boldsymbol{\beta}\right)}{\sum_{k=1}^{J}\exp\left(\boldsymbol{X}_{ikt}\boldsymbol{\beta}\right)} h\left(\boldsymbol{\beta}\right) d(\boldsymbol{\beta}), \tag{3}$$

where $h\left(\boldsymbol{\beta}\right)$ is the (jointly) density function of H for parameters $\boldsymbol{\beta}$. The integral can be approximated by simulation. Consequently, instead of $\boldsymbol{\beta}$, parameters $\boldsymbol{\theta}$ and Δ are to be estimated.

In addition to product attribute variables in a basic mixed logit model, other factors may also affect the decision process. A natural extension of the model would be to consider respondents' individual demographic characteristics [38] and their perceptions and attitudes. Therefore, our specification of the mixed logit model can be augmented with interactions:

$$U_{ijt} = V_{ijt}(\boldsymbol{X}_{ijt}, \boldsymbol{D}, \boldsymbol{P};\ \boldsymbol{\beta}, \boldsymbol{\gamma}) + \varepsilon_{ijt}\ , \tag{4}$$

$$V_{ijt} = \boldsymbol{X}_{ijt}\boldsymbol{\beta} + \boldsymbol{\gamma}^{D}\left(\boldsymbol{X}_{ijt} * \boldsymbol{D}_{i}\right) + \boldsymbol{\gamma}^{P}\left(\boldsymbol{X}_{ijt} * \boldsymbol{P}_{i}\right), \tag{5}$$

$$\boldsymbol{X}_{jt} = \left[BUYNO,\ WC,\ Pfr,\ TS,\ PRICE\right]_{jt}, \tag{6}$$

$$\boldsymbol{D}_{i} = Demograpics, \text{and} \tag{7}$$

$$\boldsymbol{P}_{i} = perceptions\ /\ attitudes\ variables. \tag{8}$$

The choice probability function is:

$$P_{ijt} = \int \frac{\exp\left(\boldsymbol{X}_{ijt}\boldsymbol{\beta}+\gamma^{D}\left(\boldsymbol{X}_{ijt}*\boldsymbol{D}_{i}\right)+\gamma^{P}\left(\boldsymbol{X}_{ijt}*\boldsymbol{P}_{i}\right)\right)}{\sum_{k=1}^{J}\exp\left(\boldsymbol{X}_{ijt}\boldsymbol{\beta}+\gamma^{D}\left(\boldsymbol{X}_{ijt}*\boldsymbol{D}_{i}\right)+\gamma^{P}\left(\boldsymbol{X}_{ijt}*\boldsymbol{P}_{i}\right)\right)} h\left(\boldsymbol{\beta}\right) d\left(\boldsymbol{\beta}\right) \quad \boldsymbol{\beta} \sim \mathbf{H}(\boldsymbol{\theta}, \Delta)\,. \tag{9}$$

The marginal value or WTP for an attribute is given by the ratio of the attribute coefficient to the price coefficient, which is set to be fixed as above, such that:

$$Marginal\ Value\ /\ WTP = -\frac{\boldsymbol{\beta}_{X} + \gamma_{X}^{D} * \boldsymbol{D} + \gamma_{X}^{P} * \boldsymbol{P}}{\boldsymbol{\beta}_{PRICE} + \gamma_{PRICE}^{D} * \boldsymbol{D} + \gamma_{PRICE}^{P} * \boldsymbol{P}}\,. \tag{10}$$

In this study, we assume the coefficients for BUYNO and PRICE are fixed parameters for ease of calculation. Other coefficients for tuna attributes are specified as random parameters, including WC, Pfr, and TS. Therefore, the denominator in the calculation of WTP contains fixed coefficients only. The numerator is identified as random, which includes random coefficients and interaction terms between attributes and demographic or perception variables. The standard errors of WTP measures incorporate both mean and standard deviation results, providing a better description of WTP distribution. An alternative approach is to report the distribution of the WTP as the distribution of the attributes or interactions coefficient scaled by the fixed price coefficient rather than a single representative WTP when holding demographics and other factors at sample average levels [44].

5. Estimation Results and Discussions

Tables 3 and 4 show the results from mixed logit models that were with and without interactions. Both models specified all random coefficients as normally distributed, namely variables WC, Pfr, and TS. We used 200 Halton draws per iteration in the simulated maximum likelihood estimation. Model fitness criteria identified improvement by adding interactions between attributes and other decision-making factors. Overall, the model presented in Table 4 with demographics and perception/attitude variable interactions obtains a higher log likelihood value (from −1398.6354 to −1307.0789) and lower AIC score but a higher BIC score. The McFadden R-squares were also reported in both tables.

Table 3. Mixed logit model results.

	Coef.		Std. Err.	*p* Value
MEAN				
PRICE	−0.2098	***	0.0178	0.00
BUYNO	−2.2710	***	0.2135	0.00
Wild-Caught	−1.0077	***	0.2233	0.00
Pre-Frozen	−0.0630		0.2030	0.76
Turtle Safe	1.1899	***	0.2421	0.00
Std. Dev.				
Wild-Caught	2.2589	***	0.2877	0.00
Pre-Frozen	3.1139	***	0.3031	0.00
Turtle Safe	2.6780	***	0.2804	0.00
Log Likelihood	−1398.6354			
McFadden R^2	0.3146			
AIC	2813.27			
BIC	2865.49			
Obs	1684 [a]			

*** represents the 1% significant level. [a] # of Obs = 421 respondents × 4 situations per respondent.

Table 4. Mixed logit model results with interactions.

	Coefficient		Std. Err.	*p* value
MEAN				
PRICE	−0.3466	***	0.0291	0.00
BUYNO	−2.5464	***	0.2295	0.00
Wild-Caught	−1.9861		1.8709	0.29
Pre-Frozen	0.0426		1.8677	0.98
Turtle Safe	3.9285	**	1.7898	0.03
Demographic Interactions				
WC × URBAN	−0.1238		0.3851	0.75
WC × FEMALE	−0.1482		0.4245	0.73
WC × AGE	−0.0281		0.0192	0.14
WC × EDU	0.0410		0.0808	0.61
WC × EMPLOY	−0.2818		0.4080	0.49
WC × INCOME	0.0653		0.0577	0.26
WC × WHITE	0.6206		0.7274	0.39
WC × HHSIZE	−0.1015		0.1781	0.57
WC × COAST	1.7324	***	0.5790	0.00
Pfr × URBAN	−0.6464	*	0.3964	0.10
Pfr × FEMALE	−1.4963	***	0.4456	0.00
Pfr × AGE	0.0146		0.0190	0.44
Pfr × EDU	0.0335		0.0823	0.68
Pfr × EMPLOY	0.0801		0.4191	0.85
Pfr × INCOME	0.0156		0.0622	0.80
Pfr × WHITE	−0.0487		0.7175	0.95
Pfr × HHSIZE	0.1721		0.1803	0.34
Pfr × COAST	−0.5906		0.6718	0.38
TS × URBAN	−0.0176		0.3695	0.96
TS × FEMALE	−0.7748	*	0.4162	0.06
TS × AGE	−0.0375	**	0.0182	0.04
TS × EDU	−0.0157		0.0770	0.84
TS × EMPLOY	−0.2972		0.3919	0.45
TS × INCOME	0.0583		0.0577	0.31
TS × WHITE	0.3036		0.6796	0.66
TS × HHSIZE	−0.1632		0.1727	0.35
TS × COAST	1.1347	*	0.5941	0.06
(con't)				
Differ Ability				
WC × Differ	0.2611		0.4335	0.55
Pfr × Differ	0.4036		0.4487	0.37
TS × Differ	−0.3116		0.4544	0.49
PRICE × Differ	0.0662	***	0.0166	0.00
Whether Notice Labels When Purchasing				
WC × Labelnotice	0.3610		0.4402	0.41
Pfr × Labelnotice	0.3342		0.4519	0.46
TS × Labelnotice	0.2162		0.4572	0.64
PRICE × Labelnotice	0.0282	*	0.0157	0.07
Whether Label Influences Purchase Decision				
WC × Labelinfluence	0.4038	**	0.1693	0.02
Pfr × Labelinfluence	−0.4099	**	0.1741	0.02
TS × Labelinfluence	−0.2554		0.1806	0.16
PRICE × Labelinfluence	0.0249	***	0.0065	0.00

Table 4. *Cont.*

	Coefficient		Std. Err.	*p* value
	Environmental Priority			
WC × Env Friendly_WC	−0.3226		0.4493	0.47
Pfr × Env Friendly_WC	0.2187		0.5531	0.69
Pfr × Env Friendly_FR	0.8429		0.5306	0.11
TS × Env Fri × ndly_WC	1.5643	***	0.5795	0.01
TS × Env Friendly_FR	−0.4191		0.5487	0.45
PRICE × Env Friendly_WC	0.0192		0.0201	0.34
PRICE × Env Friendly_FR	0.0010		0.0191	0.96
Std. Dev.				
Wild Caught	2.1166	***	0.2742	0.00
Pre Frozen	3.0787	***	0.2996	0.00
Turtle Safe	2.5399	***	0.2761	0.00
Log Likelihood	1307.0789			
McFadden R^2	0.3439			
AIC	2722.158			
BIC	3074.645			

*, **, *** represents 10%, 5% and 1% significant levels, respectively.

Estimation results are reported in two parts in Table 3: mean and standard deviation (SD hereinafter). Variable BUYNO stands for the alternative specific constant for the no-choice option. A statistically significant negative coefficient for BUYNO (−2.2710, significant at 1% confident level) suggests that consumers would encounter a loss in utility if they did not choose any products offered in a choice set. Consumers would choose nothing only when the first two alternatives were undesirable. The PRICE variable also had a significantly negative coefficient, indicating that consumers were likely to choose products with a lower price while all other factors were held constant.

All tuna attribute variables revealed significant results except the variable Prf (Pre-frozen seafood). For instance, respondents were less likely to purchase wild-caught tuna than farm-raised species, which could be explained by the fact that Kentuckians living in a land-locked area preferred farm-raised seafood to wild-caught seafood. The coefficient for CTS tuna (1.1899) was significantly positive at the 1% level. Consumers supported this environmentally friendly labeled product. Heterogeneity existed for all three tuna attributes according to the results shown in the group of SD because all estimates were significantly different from zero at the 1% level.

WTP derived from a basic mixed logit model was summarized in Table 5. If an individual chose the BUYNO option, s/he would lose $10.82 per pound. Distributions of WTP for tuna attributes are also displayed in the table. A significant price premium of $5.67 per pound was found for tuna products if they were labeled as "Certified Turtle Safe." However, negative WTP were observed for both the wild-caught and pre-frozen attributes, which were −$4.80 and −$0.30 per pound, respectively. The results in both Tables 3 and 4 show a heterogeneous preference across individuals. Further analysis is necessary to delve into consumers' taste heterogeneities, and interactions were created between tuna attributes and consumer demographics as well as their perception and attitudes.

Table 5 demonstrates mixed logit model results when tuna attribute variables interacted with respondents' demographic information as well as their perceptions or attitudes towards seafood. The estimate included not only the main effect of the attributes but also the effects of interaction. Moreover, standard deviation estimates were statistically significant at the 1% level, which is consistent with the previous results in Table 3.

Table 5. Willingness-to-Pay (WTP) estimates.

	WTP		Std. Dev.	*p* Value	(95% Conf. Interval)	
BUYNO	−$10.82	***	$0.46	0.00	−$11.73	−$9.92
Wild-Caught	−$4.80	***	$1.10	0.00	−$6.95	−$2.66
Pre-Frozen	−$0.30		$0.97	0.76	−$2.20	$1.60
Turtle Safe	$5.67	***	$0.99	0.00	$3.73	$7.61

*** represents the 1% significant level.

5.1. Interactions with Demographics

Demographic characteristics played a somewhat important role in differentiating consumers based on their taste preference for seafood, especially tuna. For example, gender, age, location of residence, and whether consumers grew up near the coast were all significant with respect to consumers' seafood consumption. Younger consumers preferred tuna products labeled as "Certified Turtle Safe" more than older consumers. Moreover, compared to male consumers, female consumers were less likely to purchase or pay more for tuna that was either labeled "Certified Turtle Safe" or pre-frozen. However, females were not significantly different from males concerning the choice of wild-caught tuna. Recalling the descriptive results, the majority of the respondents were female because the main grocery shoppers tended to be female. Therefore, our findings that female individuals were less likely to purchase pre-frozen tuna imply that opening or investing more shelves for fresh seafood in stores would positively influence profit.

Consumers were asked whether they grew up within 50 miles of the seacoast, and less than 10% replied "yes." Nevertheless, the childhood memories still have a significant effect on current purchasing attitudes. Those who had a coastal childhood were more likely to choose CTS-labeled tuna as well as wild-caught tuna, the coefficients of which are significant at 5% and 1%, respectively. No significant result is observed for pre-frozen tuna, but present location was shown to matter. Individuals living in urban or suburban areas are less likely to choose pre-frozen tuna. These findings provide useful information for future market segmenting.

5.2. Interactions with Perception/Attitude

In addition to demographics, this study also examines the interactions between tuna attributes (WS, Pfr, TS) and consumers' perceptions/attitudes. The previous section introduced four groups of consumers' perception and attitude information. Consequently, four dummies were created as follows: Differ, Labelnotice, Env Friendly_WC/Env Friendly_FR, and a Likert scale variable Labelinfluence. Consumers were then segmented according to their perception or attitude.

In the results, respondents were more sensitive to the retail price of tuna when they were able to differentiate between wild-caught and farm-raised seafood. Consumers were also more sensitive to price when they noticed labels indicating that seafood was wild-caught/farm-raised than those who never noticed labels. Additionally, respondents who self-reported that labeling would influence their final decision to purchase seafood were also associated with a strong sensitivity to price. As shown in the model analysis results, the more that labeling influenced decision to purchase, the greater the probability was that the consumer would also purchase wild-caught tuna, but the probability that the consumer would purchase pre-frozen tuna was lower. This study also investigates consumers' preferences for environmentally friendly and eco-labeled products. The coefficient for the interaction term Turtle Safe × Env Friendly_WC is strongly significant at 1% in the results, which implies that individuals who claim that environmental friendliness is an important attribute for wild-caught seafood are more likely to choose tuna labeled as "Certified Turtle Safe."

5.3. WTP Distributions

After determining consumers' purchasing preferences from the mixed logit model in Tables 6–8 it was natural to investigate willingness-to-pay estimates for associated tuna attributes. Based on the results from mixed logit model, WTP can be inferred from nonlinear combinations of coefficients of non-price variables over the price variable, calculated with the STATA command (nlm). The results are divided into three parts: WTP distributions for interaction with perception/attitude; interaction with demographics; and tuna attributes only, corresponding to Table 5 and presented in Tables 6–8.

Table 6. WTP Estimates: interactions with perception/attitude.

	WTP		Std. Err.	P Value	(95% Conf. Interval)	
Differ Ability						
WC × Differ	$1.66		$2.72	0.54	−$3.66	$6.98
Pfr × Differ	$2.56		$2.85	0.37	−$3.03	$8.16
TS × Differ	−$1.98		$2.94	0.50	−$7.74	$3.78
Whether Notice Labels When Purchasing						
WC × Labelnotice	$2.29		$2.77	0.41	−$3.15	$7.73
Pfr × Labelnotice	$2.12		$2.87	0.46	−$3.51	$7.75
TS × Labelnotice	$1.37		$2.89	0.64	−$4.30	$7.04
Whether Label Influences Purchase Decision						
Labelinfluence = 5						
WC × Labelinfluence	$12.82	**	$5.52	0.02	$1.99	$23.65
Pfr × Labelinfluence	−$13.02	**	$5.63	0.02	−$24.06	−$1.98
TS × Labelinfluence	−$8.11		$5.70	0.16	−$19.28	$3.06
Labelinfluence = 3						
WC × Labelinfluence	$7.69	**	$3.31	0.02	$1.20	$14.19
Pfr × Labelinfluence	−$7.81	**	$3.38	0.02	−$14.43	−$1.19
TS × Labelinfluence	−$4.87		$3.42	0.16	−$11.57	$1.83
Environmental Priority						
WC × Env Friendly_WC	−$2.05		$2.89	0.48	−$7.71	$3.61
Pfr × Env Friendly_WC	$1.39		$3.52	0.69	−$5.50	$8.28
Pfr × Env Friendly_FR	$5.35		$3.41	0.12	−$1.33	$12.03
TS × Env Friendly_WC	$9.93	***	$3.74	0.01	$2.60	$17.27
TS × Env Friendly_FR	−$2.66		$3.51	0.45	−$9.55	$4.22

*, **, *** represents the 10%, 5%, and 1% significant levels, respectively.

Table 6 displays the WTP for variables that are interacting tuna attributes with consumer perceptions or attitudes, which aim to differentiate consumers by their attitude toward labels as well as by their environmental awareness. If an individual rates the influence of labels for seafood purchase at 5, where a Labelinfluence of 5 is very important, then s/he may pay $12.82 more per pound for wild-caught tuna compared to consumers with a neutral attitude, as shown in Table 6. However, s/he would pay $13.02 less for pre-frozen compared to the fresh fish. Moreover, if an individual cares about the environmental friendliness feature of seafood, s/he would likely pay $9.93 more for CTS tuna.

Table 7 summarizes the WTP distributions for attributes when interacting with demographics. The sample average for age is 52.2 years; for education, 14 years, obtaining an associate's degree. Distributions are displayed for 25, 35, and 55 years old. Education can also be used to segment consumers; in this study, the results are grouped as 13 years (some college, no degree), 16 years (master's degree), and 22 years (doctoral degree). Taking attribute CTS (Certified Turtle Safe) as an example, female consumers would pay $4.92 per pound less for eco-labeled tuna. In addition, consumers aged 55 years would pay $13.10 less for eco-labeled than non-labeled tuna, and a younger consumer aged 25 years will also pay less but only $5.96 less. Surprisingly, the higher the individual's

education, the less s/he would pay for eco-labeled tuna. Respondents who lived in a coastal area during their childhood would pay more for CTS tuna, approximately $7.21 per pound.

Table 7. WTP Estimates: interaction with demographics.

	WTP		Std. Err.	*P* Value	(95% Conf. Interval)	
Average AGE = 52.2 years, EDU = 14 years Associate Degree						
WC × URBAN	−$0.79		$2.44	0.75	−$5.58	$4.00
WC × FEMALE	−$0.94		$2.70	0.73	−$6.23	$4.34
WC × AGE: *25 years old*	−$4.45		$3.07	0.15	−$10.47	$1.56
35 years old	−$6.24		$4.30	0.15	−$14.66	$2.19
55 years old	−$9.80		$6.75	0.15	−$23.04	$3.44
WC × EDU: *Some College*	$3.38		$6.67	0.61	−$9.70	$16.46
Bachelor's Degree	$4.16		$8.21	0.61	−$11.93	$20.26
Doctoral Degree	$5.72		$11.29	0.61	−$16.41	$27.85
WC × EMPLOY	−$1.79		$2.60	0.49	−$6.88	$3.30
WC × INCOME	$2.13		$1.89	0.26	−$1.57	$5.82
WC × WHITE	$3.94		$4.61	0.39	−$5.10	$12.98
WC × HHSIZE	−$1.93		$3.40	0.57	−$8.60	$4.73
WC × COAST	$11.00	***	$3.76	0.00	$3.64	$18.37
Pfr × URBAN	−$4.10		$2.56	0.11	−$9.13	$0.92
Pfr × FEMALE	−$9.50	***	$3.09	0.00	−$15.56	−$3.45
Pfr × AGE: *25 years old*	$2.32		$3.02	0.44	−$3.59	$8.24
35 years old	$3.25		$4.22	0.44	−$5.03	$11.53
55 years old	$5.11		$6.64	0.44	−$7.90	$18.12
Pfr × EDU: *Some College*	$2.77		$6.80	0.68	−$10.56	$16.09
Bachelor's Degree	$3.40		$8.37	0.68	−$13.00	$19.81
Doctoral Degree	$4.68		$11.51	0.68	−$17.87	$27.24
Pfr × EMPLOY	$0.51		$2.66	0.85	−$4.71	$5.73
Pfr × INCOME	$0.99		$3.95	0.80	−$6.76	$8.74
Pfr × WHITE	−$0.93		$13.67	0.95	−$27.72	$25.86
Pfr × HHSIZE	$3.28		$3.46	0.34	−$3.50	$10.05
Pfr × COAST	−$3.75		$4.28	0.38	−$12.13	$4.63
TS × URBAN	−$0.11		$2.35	0.96	−$4.71	$4.49
TS × FEMALE	−$4.92	*	$2.71	0.07	−$10.23	$0.39
TS × AGE: *25 years old*	−$5.96	**	$2.95	0.04	−$11.74	−$0.17
35 years old	−$8.34	**	$4.13	0.04	−$16.43	−$0.24
55 years old	−$13.10	**	$6.49	0.04	−$25.82	−$0.38
TS × EDU: *Some College*	−$1.29		$6.36	0.84	−$13.75	$11.16
Bachelor's Degree	−$1.59		$7.82	0.84	−$16.92	$13.74
Doctoral Degree	−$2.19		$10.75	0.84	−$23.27	$18.89
TS × EMPLOY	−$1.89		$2.49	0.45	−$6.78	$3.00
TS × INCOME	$3.70		$3.69	0.32	−$3.54	$10.94
TS × WHITE	$5.78		$12.96	0.66	−$19.62	$31.19
TS × HHSIZE	−$3.11		$3.31	0.35	−$9.59	$3.37
TS × COAST	$7.21	*	$3.83	0.06	−$0.31	$14.72

*, **, *** represents the 10%, 5%, and 1% significant levels, respectively.

Lastly, willingness-to-pay distributions for tuna attributes are provided in Table 8. The results are higher than those in Table 5. For instance, buying nothing, as referred to by the BUYNO option, is associated with a loss of utility compared to choosing any of these two hypothetical products. In the previous basic mixed logit model, the dollar amount for this loss is $10.82 per pound. However, the new estimate when considering heterogeneity and when integrated with interactions results in a higher amount, $16.17, if the BUYNO option is chosen. Willingness-to-pay for tuna attributes is also demonstrated in the rest of the table rows. If consumers have a neutral attitude toward labels, where the variable Labelinfluence equals 3, a positive WTP is observed for CTS-labeled tuna, while it is negative for pre-frozen fish. If there is a higher score for Labelinfluence, the WTP is also higher

for wild-caught seafood and has a distribution range from -$0.70 to $16.84. However, it becomes insignificant for pre-frozen products, while the WTP is diminishingly positive for CTS-labeled tuna, as shown in the results.

Table 8. WTP Estimates: main effect.

	WTP		Std. Err.	P Value	(95% Conf. Interval)	
BUYNO	−$16.17	***	$1.67	0.00	−$19.45	−$12.90
Wild-Caught						
Labelinfluence = 1	−$2.19		$5.31	0.68	−$12.60	$8.23
Labelinfluence = 3	$2.94		$4.39	0.50	−$5.65	$11.54
Labelinfluence = 5	$8.07	*	$4.48	0.07	−$0.70	$16.84
Pre-Frozen						
Labelinfluence = 1	$3.55		$5.74	0.54	−$7.70	$14.80
Labelinfluence = 3	−$1.66		$4.92	0.74	−$11.31	$7.99
Labelinfluence = 5	−$6.86		$5.07	0.18	−$16.80	$3.08
Turtle Safe						
Labelinfluence = 1	$17.17	***	$5.31	0.00	$6.77	$27.57
Labelinfluence = 2	$15.55	***	$4.75	0.00	$6.23	$24.87
Labelinfluence = 3	$13.93	***	$4.43	0.00	$5.24	$22.61
Labelinfluence = 4	$12.31	***	$4.39	0.01	$3.70	$20.91
Labelinfluence = 5	$10.68	**	$4.64	0.02	$1.60	$19.77

*, **, *** represents the 10%, 5%, and 1% significant levels, respectively.

All coefficients for willingness-to-pay for CTS tuna are positive and statistically significant, implying that respondents strongly favor tuna labeled as "Certified Turtle Safe." More interestingly, if an individual reports a higher score for Labelinfluence, then s/he would likely pay $10.68 more per pound for eco-labeled tuna. However, the amounts for WTP decrease as the scores increase. For example, the WTP of a neutral individual for CTS-labeled tuna is $13.93 per pound. However, if an individual believes that the label does not affect his/her seafood purchasing and the score for this is therefore lower, s/he will likely pay $17.17 more for eco-labeled tuna. Furthermore, the distribution for this group of consumers is presented at a 95% confidence interval, from $6.77 to $27.57 per pound.

6. Conclusions

This paper relies on an Internet-based survey, representing household-level tuna steak (sashimi grade) consumption and purchase preference in a midland state in the U.S. Each respondent was asked about his/her seafood purchasing habits over the past two months as well as his/her demographic information. This study also investigated consumer preference for the attributes of tuna and the impact of eco-labels, particularly CTS labels, on consumer demand. Additionally, this study examined individuals' perceptions and attitudes toward farm-raised and wild-caught tuna species.

A choice-based conjoint experiment was employed in the survey as a series of hypothetical choices between pairs of products and a third choice to purchase neither product. These alternatives were provided in the context, which differed in major product attributes (wild-caught, farm-raised, eco-label, price, and previously frozen or not). To fulfill the objective of this study to assess consumer preferences concerning eco-friendly labeling, a CTS label was introduced as one of the product attributes. A mixed logit model was utilized to examine purchasing propensities, and the estimation results were used to elicit willingness-to-pay. The interactions between tuna attributes and individual-specific information may serve to identify consumer segments.

It was found that participants on average preferred CTS-labeled tuna steak and were likely to pay more for it but were less likely to purchase wild-caught species, and insignificant results were found for pre-frozen. This may lead to a better understanding of the relationship between consumers' behavioral tendencies and purchasing preference for tuna steak. For instance, consumers' favoring of

eco-labeled (turtle safe in this study) products promises a niche market for the industry and provides optimistic support for ocean sustainability movements via the promotion of more eco-labeling.

These results supplied evidence of public support for environmental friendliness, particularly for eco-labels ("Certified Turtle Safe" in this study), and explored and unearthed market potential for tuna eco-labeling. Additionally, an econometric analysis presented quantitative and monetary estimates for specific tuna attributes, which can be beneficial not only for marketing strategies but also for policy evaluation.

This study based on consumers from a land-locked state adds to the general discussion of preferences and the consumption culture surrounding seafood. One of the main contributions of this study is to provide perspectives on consumer demand for commercial tuna fish. Comparison between wild-caught and farm-raised species also contributes to evaluating consumer perceptions of product sources pertaining to environmental concerns. The results of the study can inform tuna producers and marketers about future product marketing strategies and promotions. In addition, the premium on eco-friendly labeling suggests consumers' growing desire for ecological well-being and sustainability.

This study also has several limitations. Firstly, the study was based on a stated preference method that, like any study using a similar method, may suffer from hypothetical bias. It asked hypothetical questions about hypothetical products, mostly unmarketed goods, as we examined in this study. There is a series of non-hypothetical methods that can be used for food marketing analysis. Even though these methods are generally more difficult to apply in a case where products that do no exist on the market are examined, applying such methods may prove useful. Secondly, the mixed logit model compiles a large number of attributes and interaction terms. This may reduce the efficiency of the model to some extent, especially when the research was designed to investigate a relatively wide range of issues of interest. In the future, a piece-wise estimation process may be used to offer more targeted estimates of the various effects.

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