Heterogeneous Consumer Preference for Seafood Sustainability in Japan

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Abstract

This study estimates Japanese consumers' willingness to pay (WTP) for several components of seafood sustainability. A choice experiment via a web survey is conducted among Japanese seafood consumers. In order to estimate WTP, a latent class model is employed to treat heterogeneity of consumer preference in addition to a basic conditional logit model. The latent class model resulted in separating consumers into two characteristic groups: nature-oriented and human-oriented groups. Neither group was found to be willing to pay for seafood sustainability even though they are somewhat concerned about seafood sustainability. Specifically, the nature-oriented group, which comprised 51% of our consumer sample, negatively evaluated fisheries management and preservation of tradition and culture but highly evaluated the environment and ecosystems. Meanwhile, the human-oriented group, which comprised 49% of our consumer sample, positively evaluated fisheries management and regionality, but negatively evaluated the environment and ecosystems. The differences between the groups are unrelated to education or income, but are related to seafood expense, age, family structure, and knowledge of sustainability.

Keywords: best–worst scaling, choice experiment, consumer preference, seafood sustainability

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Introduction

In 1992, the Rio Declaration on Environment and Development was adopted by the United Nations Conference of Environment and Development. Since then, sustainable development has been promoted in many fields, including seafood industries. In 1995, the Food and Agriculture Organization of the United Nations (FAO) adopted a code of conduct for responsible fisheries as a guideline for fisheries to utilize the world's fisheries resources by considering future generations (FAO 1995). In 1997, Unilever and the WWF founded the Marine Stewardship Council (MSC), which is an independent organization to assess and certify sustainable fisheries via scientific assessment. The certified fisheries are able to apply the MSC logo—an ecolabel—to their fishery products.

This ecolabeling program motivates fisheries to be sustainable by rewarding certified fisheries (Gudmundsson and Wessells 2000). However, the motivation is functional on condition that there is consumer preference for seafood sustainability. As a result, there is a growing body of literature on consumer preference research for ecolabeling in order to investigate effective markets for sustainable seafood (Asche and others 2015, Johnston and others 2001, Roheim and others 2011, Uchida and others 2013, Bronnmann and Asche 2016, Wakamatsu and others 2017). These researches indicate that there is considerable demand for MSC-certified seafood, especially in northern Europe, which motivates fisheries to become sustainable fisheries. Actions taken toward sustainable fisheries are not limited to sustainable certification. For example, in 1997, Monterey Bay Aquarium launched the Seafood Watch project, which rates sustainable seafood and classifies it into three color-coded categories in traffic light colors: best choice (green), good alternative (yellow), and avoid (red). While there are many studies on ecolabeling, no research has been undertaken on the components of consumer preferences for sustainable seafood.

There are three major criteria for seafood sustainability used in the major certifications programs, including the MSC: status of stock, ecosystem/environment, and management/governance. Both the MSC and Seafood Watch programs are based on these three criteria to certify fisheries for sustainable fisheries because these criteria are critical for sustaining stocks. However, the FAO code of conduct for responsible fisheries stipulates that the principles underpinning the code's objectives should take into account "all their relevant biological, technological, economic, social, environmental and commercial aspects" p.2 (FAO 1995). Considering that the code is the main guideline for sustainable fisheries, it is important to integrate socio-economic and cultural aspects into sustainable standards. One of the organizations that has adopted such aspects is the Commonwealth Scientific an Industrial Research Organization, which has integrated socio-economic aspects into the health of Australian fisheries (Hobday and others 2016).

Among the various global contexts of seafood sustainability, Japan is one of the most important countries for sustainable fisheries. Japan is the largest seafood-importing country in the world and it has the highest per capita seafood consumption among top five seafood consuming countries (FAO 2014). Such a strong seafood demand in Japan drives the world fisheries to catch fish to export to Japan. Thus, whether Japanese seafood consumers care about sustainability is a crucial issue for the sustainability of global fisheries resources.

Several studies were undertaken in Japan on consumer preferences for sustainability through ecolabeling (Uchida and others 2014, Uchida and others 2013, Wakamatsu and others 2017). Both studies indicated that Japanese seafood consumers did not care about ecolabeled seafood at that time, but their preferences changed when they were fully educated about seafood sustainability, including the current severe status of fisheries stocks. Consequently, it was concluded that educational campaigns for seafood sustainability, especially about the status of world fisheries, would play an important role in instigating preferences for seafood sustainability. Sustainable seafood has recently been discussed before Tokyo Olympic and Paralympics in 2020. If proper and enough educational campaigns have been undertaken so far, it is possible that Japanese consumers have changed their consciousness about seafood sustainability.

This study aims to investigate whether Japanese consumers are willing to pay for seafood sustainability at the present moment in time, as well as to estimate the following factors of consumer preferences for seafood sustainability: resource, environment, management, and regionality. In order to pursue these objectives, we conduct a choice experiment to estimate the willingness to pay (WTP) for each factor of seafood sustainability, and we employ best–worst scaling (BWS) to decompose the attributes of seafood sustainability. We employ not only a conditional logit model to estimate WTP, but also a latent class model (LCM) and random parameter model (RPM) to treat heterogeneity in consumer preferences.

The structure of the rest of this paper is as follows. The next section explains the material and method of this study, followed by the results and the discussion.

Method

Choice Experiment

Table 1 List of Attributes for the Choice Experiment

Attribute	Level	Traffic Color	Definition
Price	1	-	90% of conventional price
	2	-	Status quo (100% conventional price)
	3	-	110% of conventional price
	4	-	120% of conventional price
Resource	1	●Red = −1	40 (fail)
	2	●Yellow = 0	60 (conditional pass)
	3	●Green = 1	80 (pass)
	4	●Green = 1	100 (full score)
Environment	1	●Red = −1	40 (fail)
	2	●Yellow = 0	60 (conditional pass)
	3	●Green = 1	80 (pass)
	4	●Green = 1	100 (full score)
Management	1	●Red = −1	40 (fail)
	2	●Yellow = 0	60 (conditional pass)
	3	●Green = 1	80 (pass)
	4	●Green = 1	100 (full score)
Regionality	1	●Red = −1	40 (fail)
	2	●Yellow = 0	60 (conditional pass)
	3	●Green = 1	80 (pass)
	4	●Green = 1	100 (full score)

We conducted a web-based choice experiment and concomitant survey for seafood consumers in March 2016. Participants were recruited along the distribution of the Japanese demographic population (age, gender, and region) from a pool of participants. Table 1 shows the design of our choice experiment to reveal consumers' stated preference for each component of seafood sustainability. We assumed the four components are resource, environment, management, and regionality of seafood sustainability. Seafood was given a score out of 100 points for each component and the result was reflected using the three traffic light colors: red (less than 60), yellow (between 60 and 80), and green (more than 80). In addition, assuming the price of conventional seafood as the status quo (100%), we randomly varied the rate of prices between −10% and +20%. Although specific species are usually specified in a choice experiment, we did not specify fish species, but instead asked respondents to assume general seafood that they usually purchased in supermarkets. We assumed that sustainability was a common value beyond the quality or species of fish, and that it was proportional to the price of seafood (Uchida and others 2013).

Displaying scores from 0 to 100 is more informative than displaying simple traffic light colors, but displaying such colors influences consumer preferences more than scores do (Thøgersen and Nielsen 2016). In this study, we adopted both scores and colors to compare the effects of the results in the estimation process. If the traffic light colors influence consumer preferences more than the scores do, marketers can utilize colors to promote the sustainability of fish. Instead of scores, the traffic lights can be coded from −1 to 1, red as −1, yellow as 0, and green as 1.

100~80	Pass
79~60	Conditional pass
~59	Not pass

		1	2	3
		Fish A	Fish B	Fish C
1	Fish Price (%)	100	110	100
2	Resource score	60	40	60
3	Enviroment/Ecosystem score	100	100	60
4	Management score	60	40	40
5	Tradition/Culture score	80	60	100

Fig. 1 One Combination of Choice Sets

We designed the experiment by orthogonal array to randomize combinations of choice sets, as shown in Fig. 1. We recruited 2,000 participants through a web survey company, Cross-Marketing Ltd. A participant was asked to choose one fish product to purchase among a choice set eight times. The order of choice sets appeared randomly by computer program. In the experiment, we separated the participants into two groups. Each group faced a different combination of choice sets to lessen bias in the experimental design (Fig. A.1 in the Appendix). Before the participants started the survey, we gave them the minimum information on the four factors of seafood sustainability—resource, environment, management, and regionality—to enable them to judge which factors were important (Fig. A.2 in the Appendix). The participants then proceeded with the choice experiment.

Econometric Model

The econometric model is based on the random utility model. The utility function of individual i for the choice of seafood is as follows.

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \qquad (1)$$

where V_{ij} consists of the deterministic component $f(\boldsymbol{x}_{ij})$, $\mathbf{x}_{ij}$ is a vector of the alternatives with attributes: price and scores of resource, environment, management, and regionality, and ε is a disturbance. The probability of participant i choosing alternative j among the set of alternatives, C, is expressed as the conditional logit model, as follows:

$$\pi_i(j) = Prob(V_{itj} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik}, j \neq k, \forall k \in C). \quad (2)$$

Taking a linear functional form of this probability, the probability can be rewritten as

$$L_i(j|\beta) = \frac{exp(\beta xi)}{\sum_{k\in C} exp(\beta xi)}. \quad (3)$$

The estimate of β_s denotes a preference parameter. Let $y_{ij} = (y_{11}, \ldots, y_{ij} \ldots, y_{IJ})$ be a vector of alternatives chosen by participant i. Then, the probability of participant i choosing the j-th alternative can be expressed as

$$K_i(y_i|\beta_s) = \prod_t L_{ij}(y_{ij}|\beta_s). \quad (3)$$

The probability that participant i belongs to Class s is

$$P_i(\theta) = \sum_s \boldsymbol{\pi_{is}} K_i(\boldsymbol{y_i}|\beta_s), \quad (4)$$

where $\sum_{s=1}^{S} \pi_{is} = 1$ and θ is a parameter to be estimated. Assuming that the class membership function consists of the vector of alternatives, π_{is} takes the form of a fractional multinomial logit model (Pacifico and Yoo 2013). The likelihood function that joints all individuals is written as follows:

$$L = \prod_{i=1}^{I} \prod_{s=1}^{S} \boldsymbol{\pi_s} f\left(y_{ij}|\mathbf{x}_{it}, \boldsymbol{\beta}_k\right)^{d_{is}}. \quad (5)$$

Transforming equation (5) to the log-likelihood function form, the parameters were estimated. In the LCM, it is necessary to pre-specify the total number of classes (S) for estimation. We started the number of latent classes at $S = 1$, which is a homogeneous model. We then increased the size of classes until we obtained the best statistics of model fit.

$$\ln L = \sum_{i=1}^{I} \sum_{s=1}^{S} d_{is} \ln(K_n) + \sum_{i=1}^{I} \sum_{s=1}^{S} d_{is} \ln(\pi_{is}). \quad (6)$$

Bayes' rule predicts the class membership, $\widehat{\boldsymbol{P}}_{\mathbf{is}}$, how likely an individual i is categorized into Class s, as follows,

$$\widehat{\boldsymbol{P}}_{\mathbf{is}} = \frac{\boldsymbol{\pi}_{\mathbf{is}} K_i\left(\boldsymbol{y_i}|\widehat{\boldsymbol{\beta}_s}\right)}{\sum_{s=1}^{S} \boldsymbol{\pi}_{\mathbf{is}} K_i\left(\boldsymbol{y_i}|\widehat{\boldsymbol{\beta}_s}\right)}, \quad (7)$$

where $\sum_{k=1}^{K} \widehat{\boldsymbol{P}}_{\mathbf{ik}} = 1$. We were able to compare the differences in consumer preferences and socio-demographics between each class. The differences between the classes were statistically tested using both parametric and non-parametric tests. Dummy variables were tested by Chi-square test and rank–sum test, categorical data were tested by rank–sum test, Chi-square test, and t-test, and continuous data were tested by t-test and rank–sum test.

This study employed expectation-maximization (EM) algorithms to maximize the log of likelihood function (6), because Bayes' theorem is more appropriate when the sample size is scarce (Mitchell 1977). In addition, the EM algorithm is more suitable than other algorithms in terms of accuracy of class membership probabilities (Kuriyama and others 2010). This study used the *lclogit* package in STATA to estimate the models (Pacifico and Yoo 2013).

The random parameter model (RPM) was estimated to compare the result with that of the LCM so that heterogeneity was well treated. The attribute of price was fixed and all other attributes were assumed to be normally distributed across participants. This study used the *mixlogit* package in STATA to estimate this model (Hole 2007).

To determine the best model, the Akaike information criterion (AIC) and consistent Akaike information criterion (CAIC) were calculated (Jedidi and others 1993): $AIC=2J-2ln(LnL)$ and $CAIC=J(ln(n)+1)-2\ ln(LnL)$.

Table 2 List of Sub-components for Respective Attributes

Attributes		Sub-components
Resource	a)	Catch limit
	b)	Stock recovery
	c)	Bycatch protection
	d)	Gear restriction
Environment	a)	Eco-friendly gear usage
	b)	Protection of endangered species
	c)	Protection of spawning ground
	d)	Prevention of dumping in duty
Management	a)	Direct regulation
	b)	Autonomous governance
	c)	Scientific management
	d)	Prevention of illegal fishing
Regionality	a)	Satoumi (managed ecosystem)
	b)	Traditional fisheries management
	c)	Historic management
	d)	Sustainability of business

Best–Worst Scaling

This study decomposed the attributes into sub-components, as shown in Table 2. Resource was assumed to include a) catch limit, b) stock recovery, c) bycatch protection, and d) gear restriction, environment contained a) eco-friendly gear, b) protection of endangered species, c) protection of spawning ground, and d) prevention of dumping in duty, management covered a) direct regulation, b) autonomous governance, c) scientific management, and d) prevention of illegal fishing, and regionality included a) Satoumi (managed ecosystem), b) traditional fisheries management, c) historic management, and d) sustainability of fisheries business. The sub-components in each attribute were scaled using BWS to identify which sub-components consumers prefer. All combinations were included in one question and there was no need to design a survey by balanced incomplete design, since there were only four sub-components in each attribute and BWS was conducted within respective attributes (Fig. 2). The participants were asked to choose the best and worst components in each attribute. These questions were asked in the survey before the choice experiment began, but after information was given.

Louviere and Woodworth (1991) first developed BWS, which takes a similar approach to the random utility model. In addition, Finn and Louviere (1992) developed an econometric model for BWS. The probability of individual i making the best and worst choices, $\delta_{nm} + \varepsilon_{nm}$, out of a possible choice set D is expressed as follows:

$$P(nm/D) = P[(\delta_{nm} + \varepsilon_{nm}) > Max(\delta_{pq} + \varepsilon_{pq})]$$

Assuming the disturbance of this probability is subject to Gumbel distribution, a multinomial logit model is constructed as follows,

$$P(nm/D) = exp(\delta_{nm}) \,/\, \sum_{pq} exp(\delta_{pq})$$

Aizaki and others (2014) developed the BWS package, *support.BWS*, in R, which was used for the estimation.

Results

Choice Experiment

Conducting the estimation with a conditional logit model (Base), an LCM, and an RPM, we obtain the respective estimates with scores and traffic light in Table 3 and Table 4. The CAIC in the both models shows the best model fit in 2 LCM. Although 2 LCM is adopted in this study, all estimated models are shown for comparison.

The results in the model using scores (Table 3) show that the price estimate is either insignificant or positively significant. This suggest that there be something wrong with the model design using scores. The results in the model using traffic lights (Table 4) show that all the price estimates are insignificant or negatively significant, which makes more sense in estimation. Presumably, in responding the choice sets, the participants

Table 3 Estimates of Each Model with Score

	1 Class	2 LCM		3 LCM			RPM
	Base	Class 1	Class 2	Class 1	Class 2	Class 3	
Price	0.0015	-0.007	0.0038 ***	-0.007	-0.0004	0.007 **	0.002 **
	(0.0010)	(0.004)	(0.001)	(0.004)	(0.004)	(0.003)	(0.001)
Resource	0.0000	-0.014 ***	0.0026 ***	-0.014 ***	0.003	0.002	0.000
	(0.0005)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.000)
Environment	0.006 ***	-0.015 ***	0.0100 ***	-0.016 ***	0.013 ***	0.007 ***	0.006 ***
	(0.000)	(0.003)	(0.001)	(0.003)	(0.002)	(0.002)	(0.000)
Management	-0.002 ***	0.012 ***	-0.0045 ***	0.013 ***	0.001	-0.009 ***	-0.002 ***
	(0.000)	(0.003)	(0.001)	(0.003)	(0.002)	(0.002)	(0.000)
Regionality	-0.001	0.001	-0.0015 ***	0.001	0.003	-0.005 ***	-0.001
	(0.000)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.000)
Class Shares	100%	17%	83%	16%	42%	0.421	100%
Log likelihood	-17,476.1	-17,417.6			-17,411.2		-17,449.0
AIC	34,962.2	34,857.2			34,856.4		34,916.0
CAIC	35,011.1	34,964.8			35,022.7		35,004.0

Note: ** and *** denote the level of statistical significance at 5% and 1%, respectively. Standard errors are in parentheses.

focused on the traffic light, rather than scores, which might have biased the model using scores. Thus, we focus on the traffic light model.

In Table 4, 2 LCM shows that 51% of respondents are categorized in Class 1, and 49% in Class 2. Although the price estimates in both classes are insignificant, other attributes are significant. Since, this result is consistent with that of RPM, the estimates in this model are considered to be robust. Class 1 positively evaluates “Resource” and “Environment,” but negatively evaluates “Management” and “Regionality.” This means that when the traffic light color is green, “Resource” and “Environment” are preferred, but when it is red, “Management” and “Regionality” are preferred in Class 1. Accordingly, consumers in Class 1 emphasize the nature aspect, such as resource and environment, and those in Class 2 emphasize human-related aspects, such as management, tradition, and culture.

Table 4 Estimates of Each Model with Traffic Light Colors

	1 Class	2 LCM		3 LCM			RPM
	Base	Class 1	Class 2	Class 1	Class 2	Class 3	
Price	0.000	-0.003	0.002	0.001	0.001	-0.010 **	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Resource	-0.039 ***	0.145 ***	-0.188 ***	0.118 **	-0.197 ***	-0.068	-0.036 ***
	(0.01)	(0.05)	(0.03)	(0.06)	(0.04)	(0.09)	(0.01)
Environment	0.125 ***	0.395 ***	-0.114 ***	0.215 ***	-0.202 ***	0.607 ***	0.144 ***
	(0.01)	(0.05)	(0.04)	(0.06)	(0.06)	(0.11)	(0.01)
Management	-0.027 **	-0.254 ***	0.151 ***	-0.356 ***	0.211 ***	0.149 *	-0.030 ***
	(0.01)	(0.04)	(0.04)	(0.05)	(0.06)	(0.09)	(0.01)
Regionality	-0.051 ***	-0.187 ***	0.047	-0.266 ***	0.081 *	0.127	-0.048 ***
	(0.01)	(0.04)	(0.03)	(0.05)	(0.04)	(0.08)	(0.01)
Class Shares	100%	51%	49%	42%	35%	23%	100%
Log likelihood	-17501.8	-17,445.7		-17,432.8			-17471.1
AIC	35,013.5	34,913.4		34,899.6			34,960.2
CAIC	35,062.4	35,021.0		35,065.9			35,048.2

Note: ** and *** denote the level of statistical significance at 5% and 1%, respectively. In addition, standard errors are in parentheses.

Table 5 MWTPs for Each Model with Traffic Light Colors (unit: yen per score)

	Base	2 LCM		3 LCM			RPM
Items		Class 1	Class 2	Class1	Class2	Class3	
Resource	-79.6	51.5	122.9	-199.3	159.2	-6.6*	-57.8
Environment	256.1	140.3	74.8	-363.4	163.6	58.7***	232.3
Management	-54.4	-90.4	-98.4	602.3	-170.5	14.4**	-49.1
Regionality	-105.2	-66.5	-30.9	450.2	-65.4	12.3**	-76.9
Class Proportion	100%	51%	49%	42%	35%	23%	100%

Note: ** and *** denote the level of statistical significance at 5% and 1%, respectively. In addition, standard errors are in parentheses. A joint test was conducted with price and each item in Class 3 of 3 LCM.

In Table 5, the marginal willingness to pay (MWTP) is estimated by dividing the coefficients of attributes by those of price with a negative sign (MWTP = $-\beta_{attributes}$ / β_{price}). All of MWTP but Class 3 of 3 LCM are shown as a reference because price is unrelated to consumers' decision making in most of the models. When MWTP is significant, the values are more realistic in Class 3 of 3 LCM. In this column, consumers are willing to pay 58 yen for environment, 14 yen for management, and 12 yen for regionality, but not for resource. These results indicate consumers do not care about fisheries resources.

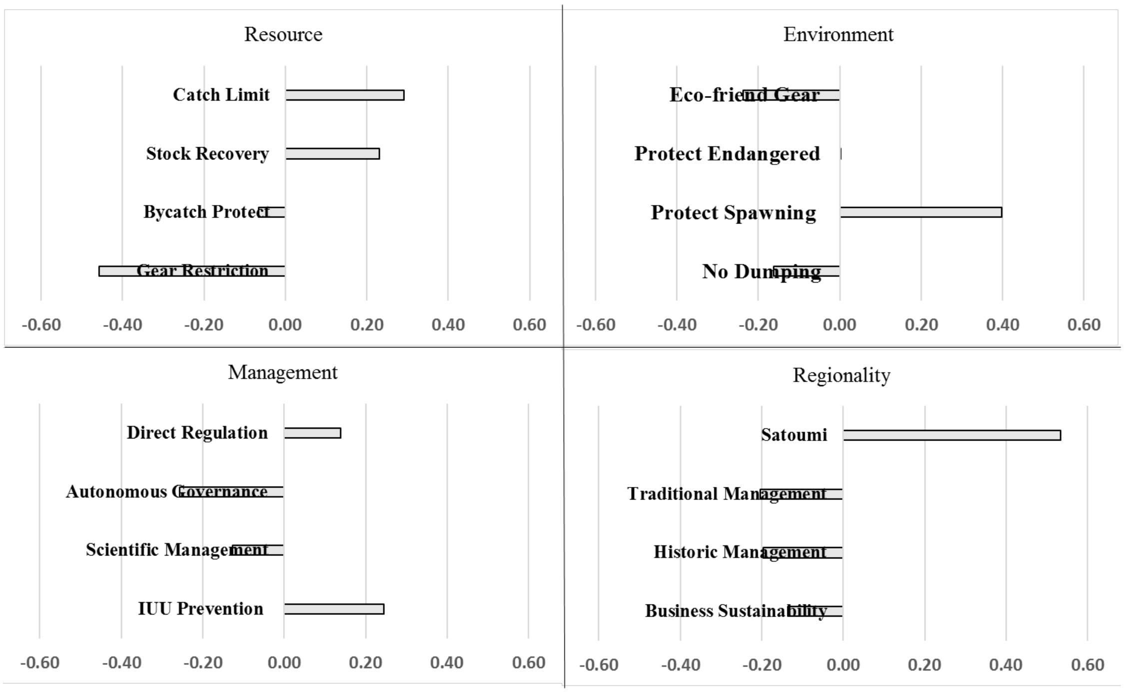

Fig. 3 Scores of Best–Worst Scaling

Best–Worst Scaling

Fig. 3 shows the BWS scores. This estimation decomposes consumer preference into pieces and shows the detailed consumer preferences within each attribute. For the attribute of "Resource," participants valued "Catch limit" the most, followed by "Stock recovery." On the other hand, they placed the least value on "Gear restriction" followed by "Bycatch protect." For the attribute of "Environment," the participants valued "Protecting spawning ground" the most, and they devalued all others, except "Protect endangered" (protection of endangered species). They were indifferent to the protection of endangered species. For the attribute of "Management," "IUU protection" (prevention of illegal fishing) was the most valued followed by "Direct regulation," but they devalued "Autonomous governance" and "Scientific management." For the attribute of "Regionality," "Satoumi," or human-balanced ecosystems, was mostly highly evaluated, and all the others were negative and did not differ markedly from each other. "Business sustainability" was relatively under-estimated compared to "Traditional management" and "Historic management."

Table 6 Demographics Sorted by Latent Classes

Variable	Nature-related (Class 1) Obs	Mean	Std.Dev		Human-related (Class2) Obs	Mean	Std.Dev	Difference Tests T	RS	Chi2
Socio-demographics										
Gender	1073	1.51	0.50		927	1.49	0.50	NA		
Age	1073	46.21	13.59	>	927	45.03	13.47	**	*	NA
Married	1073	0.66	0.47		927	0.66	0.47	NA		
Presence of child	1073	0.53	0.50	>	927	0.48	0.50	NA	**	**
Consumption pattern	1073	4.21	1.54		927	4.19	1.54			
Recognition of information	1072	3.88	0.98	<	927	4.00	0.99	***	***	
Information is important	1073	2.16	0.75	<	927	2.25	0.85	***	**	
Age of youngest child	567	20.18	12.38	>	449	18.86	11.99	**	*	NA
Education	1066	3.18	0.98		916	3.13	1.00			
Income	1073	4.37	2.93		927	4.25	2.87			
Housewife	1073	0.18	0.38	>	927	0.15	0.36	NA		***
Executive board	1073	0.06	0.24	<	927	0.08	0.27	NA		**
Lawyer, doctor, accountant	1073	0.03	0.16		927	0.02	0.15	NA		
Seafood expense (store)	1073	1,683	1,983	<	927	1,875	2,067	**	**	NA
Seafood expense (restaurants)	1073	766	1,762	<	927	976	2,195	***		NA
Recognition										
MSC certification	1073	0.06	0.24	<	927	0.08	0.28	**	*	
MEL-Japan	1073	0.06	0.24	<	927	0.10	0.29	***	***	
ASC certification	1073	0.05	0.22	<	927	0.07	0.26	**	**	
Predicted estimates										
Price	1073	102	3.26	<	927	103	2.86	**	***	NA
Resource score	1073	82	6.96	>	927	78	6.66	***	***	NA
Environment score	1073	82	6.22	>	927	73	6.62	***	***	NA
Management score	1073	68	9.41	<	927	69	8.10	***	**	NA
Regionality score	1073	73	7.55	<	927	77	7.02	***	***	NA
BWS results										
Resource Catch limit	1073	0.32	0.61	>	927	0.26	0.66	**	*	***
Stock recovery	1073	0.25	0.61	>	927	0.20	0.65	**		*
Bycatch protect	1073	-0.09	0.71	<	927	-0.04	0.73	*		*
Gear restriction	1073	-0.49	0.58	<	927	-0.42	0.57	***	***	***
Environment Eco-friendly gear	1073	-0.27	0.70	<	927	-0.20	0.72	**	*	
Protect endangered	1073	-0.03	0.58	<	927	0.03	0.60	**	**	
Protect spawning	1073	0.44	0.67	>	927	0.35	0.70	***	***	
No dumping	1073	-0.15	0.66	>	927	-0.18	0.65			
Management Direct regulation	1073	0.11	0.68	<	927	0.17	0.68	**	*	
Auto-governance	1073	-0.26	0.74	<	927	-0.25	0.75			***
Sci. management	1073	-0.12	0.68	>	927	-0.13	0.69			***
IUU protection	1073	0.26	0.60		927	0.22	0.60			
Regionality Satoumi	1073	0.59	0.60	>	927	0.47	0.65	***	***	
Traditional Mgt	1073	-0.23	0.59	<	927	-0.17	0.65	**	*	
Historic fishery	1073	-0.21	0.60	<	927	-0.18	0.61			
Business Sust.	1073	-0.15	0.69	<	927	-0.12	0.69			

Note: T, RS, and Chi2 denote t-test, rank–sum test, and Chi square test, respectively. *, **, and *** denote the level of statistical significance at 10, 5, and 1%, respectively.

Posterior Probability Diagnosis

Using estimated parameters in 2 LCM, equation (7) predicts the probabilities of the participants belonging to either Class 1 or Class 2. Table 6 shows the socio-demographics, recognition of seafood ecolabels, predicted estimates of MWTP for each attribute of sustainability, as well as BWS scores sorted by the separated classes. According to the difference, Class 1 and Class 2 seem to represent nature-related and human-related sustainability groups.

Class 1 values the human side, as shown by the MWTP for "Management" and "Regionality" being greater than that for Class 2 in Table 5. On the contrary, Class 2 values the nature side, as shown by the MWTP for "Resource" and "Environment" being greater than that for Class 1. Predicted scores of "Resource" and "Environment" are significantly higher in Class 1, while those of "Management" and "Regionality" are higher in Class 2. As for BWS scores sorted by the latent classes, the attribute of "Stock recovery" in "Resource" is higher than the "Environment," while gear restriction is lower in Class 2. In "Environment," protecting spawning ground is significantly lower in Class 1. The Class 2 group regards scientific management and prevention of illegal fishing as more important factors than the Class 1 group does, but simultaneously, the Class 2 group undervalues self-management compared with the Class 1 group. For "Regionality," Class 2 values "Satoumi" more highly than Class 1 does, but Class 2 devalues "Traditional management" compared with Class 1.

There is no significant difference across gender, education, income, marital status, and frequency of seafood consumption. However, Class 1 spends more money on seafood than Class 2 does. The test result shows that there are significantly more Class 1 consumers who regard the given information about sustainability as more important than do Class 2 consumers. In addition, there is a slight difference in demographics in that the proportion of housewives in Class 1 is higher than that in Class 2, and the proportion of executive board members in Class 2 is higher than that in Class 1.

Discussion

The study found that the 2 LCM model treats participants' preference heterogeneity best in estimation. At any rate, price was unrelated to consumer preference for sustainability. The result in this study provides supportive evidence that Japanese consumers prefer cheaper seafood regardless of the status of world fisheries (Uchida and others 2013). However, the LCM was successful to categorize consumers into two characteristic groups.

Posterior probability analysis demonstrates that Class 1 (51% of the participants) supports nature-related sustainability, such as management and regionality, but Class 2 (49% of participants) support human-related sustainability, such as resource stocks and ecosystem/environment. In addition, Class 1 tends to spend less on seafood than Class 2 does. Among the Class 1 group, consumers respect sustainability of the environment and ecosystems a lot more than they do sustainability of the resource. This is presumably because they are not sufficiently exposed to education or knowledge about the sustainability of the resource while they have been educated in some way about the environment and ecosystems in Japan, including the issue of global warming (Sampei and Aoyagi-Usui 2009).

It is interesting to observe that consumers in Class 2 with higher expenses on seafood have greater knowledge about seafood sustainability and seafood ecolabels, and regard these sustainable issues as more important than do Class 1 consumers, but they evaluate sustainability of the resource and environment, including ecosystems, lower than do Class 1 consumers. One possible reason is that they spend more on seafood in their daily lives, which drives them to demand inexpensive seafood in reality. There may be other reasons that the low seafood expense group prefers nature-related sustainability (resource and environment) and that the high seafood expense group prefers human-related sustainability (management and regionality). Further research needs to be undertaken to explore this point.

This study found that Japanese consumers are not yet willing to pay for seafood sustainability. Previous studies on WTP for seafood ecolabeling in Japan did not find significant result without educational campaign, and this study also found no consumer preferences for sustainability (Uchida and others 2014, Uchida and others 2013).

The results in this study suggest that even though some environmental and consumer groups as well as retailers have actually promoted sustainable seafood (AEON Environmental and Social Report www.aeon.info/, WWF Annual Review www.wwf.or.jp/), the educational campaign has not been effective to generate consumer preference for sustainable seafood as of 2016 when the survey was conducted in this study. While there are many studies conducted on WTP for seafood ecolabeling, estimates WTP for seafood sustainability. However, this study did not compare the seafood sustainability with and without ecolabels on seafood. Further studies are required to investigate ecolabels are necessary for consumers to be willing to pay for seafood sustainability.

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Appendix

100～80 ● 合格
79～60 ● 条件付き合格
59～ ● 不合格

Choice Set 1

Group A

	1 魚A	2 魚B	3 魚C
1. 魚の値段(%)	110	90	100
2. 資源の点数	40	100	100
3. 環境･生態の点数	100	60	100
4. 漁業管理の点数	40	60	80
5. 伝統･文化の継承	60	60	60

Group B

	1 魚A	2 魚B	3 魚C
1. 魚の値段(%)	100	110	100
2. 資源の点数	60	40	60
3. 環境･生態の点数	100	100	60
4. 漁業管理の点数	60	40	40
5. 伝統･文化の継承	80	60	100

Choice Set 2

Group A

	1 魚A	2 魚B	3 魚C
1. 魚の値段(%)	90	100	120
2. 資源の点数	100	60	100
3. 環境･生態の点数	100	60	40
4. 漁業管理の点数	100	40	40
5. 伝統･文化の継承	40	100	40

Group B

	1 魚A	2 魚B	3 魚C
1. 魚の値段(%)	120	120	100
2. 資源の点数	40	100	100
3. 環境･生態の点数	100	40	80
4. 漁業管理の点数	60	40	40
5. 伝統･文化の継承	100	40	100

Choice Set 3

Group A

	1 魚A	2 魚B	3 魚C
1. 魚の値段(%)	100	90	120
2. 資源の点数	100	60	60
3. 環境･生態の点数	100	40	80
4. 漁業管理の点数	80	80	100

Group B

	1 魚A	2 魚B	3 魚C
1. 魚の値段(%)	100	90	110
2. 資源の点数	100	100	100
3. 環境･生態の点数	80	100	40
4. 漁業管理の点数	40	100	60

Choice Set 4

Group A

	1 魚A	2 魚B	3 魚C
1.	110	120	100
2. 資源の点数	40	100	100
3. 環境･生態の点数	100	60	80
4. 漁業管理の点数	40	100	40
5. 伝統･文化の継承	60	80	100

Group B

	1 魚A	2 魚B	3 魚C
1.	100	100	90
2.	100	60	100
3.	100	100	60
4.	100	60	60
5.	100	80	60

Choice Set 5	Group A 1 魚 A	Group A 2 魚 B	Group A 3 魚 C	Group B 1 魚 A	Group B 2 魚 B	Group B 3 魚 C
1. 魚の値段(%)	100	120	100	90	110	110
2. 資源の点数	60	60	100	100	40	80
3. 環境･生態の点数	60	80	100	100	100	60
4. 漁業管理の点数	40	100	100	100	40	100
5. 伝統･文化の継承	100	60	100	40	60	100

Choice Set 6	Group A 1 魚 A	Group A 2 魚 B	Group A 3 魚 C	Group B 1 魚 A	Group B 2 魚 B	Group B 3 魚 C
1. 魚の値段(%)	100	120	100	110	90	100
2. 資源の点数	100	100	80	100	100	100
3. 環境･生態の点数	100	60	40	40	60	80
4. 漁業管理の点数	80	100	100	60	60	40
5. 伝統･文化の継承	60	80	60	100	60	100

Choice Set 7	Group A 1 魚 A	Group A 2 魚 B	Group A 3 魚 C	Group B 1 魚 A	Group B 2 魚 B	Group B 3 魚 C
1. 魚の値段(%)	100	90	120	110	100	90
2. 資源の点数	100	60	60	80	60	60
3. 環境･生態の点数	100	40	80	60	60	40
4. 漁業管理の点数	100	80	100	100	40	80
5. 伝統･文化の継承	100	100	60	100	100	100

Choice Set 8	Group A 1 魚 A	Group A 2 魚 B	Group A 3 魚 C	Group B 1 魚 A	Group B 2 魚 B	Group B 3 魚 C
1. 魚の値段(%)	100	90	90	100	90	100
2. 資源の点数	100	100	100	40	80	80
3. 環境･生態の点数	80	60	100	60	100	80
4. 漁業管理の点数	40	60	100	80	40	60
5. 伝統･文化の継承	100	60	40	40	80	40

Fig. A.1 All Combinations of Choice Sets for Choice Experiment

Suppose a public entity has ranked fish species caught by environmentally- or ecologically-friendly methods. The criteria for the evaluation are categorized into four groups: **1. influence on the fish stock, 2. influence on the environment/ecosystem, 3. fisheries management, and 4. succession of tradition and culture**.

Influence on the fish stock
A fish stock increases every year by reproduction, but the stock will decrease when we catch more fish than the amount of increment. We need to manage the fish stock sustainably by catching the same amount of fish as the increment every year. Accordingly, we need to know how much the stock will increase in a year, the size of the stock in total, and how much we catch every year. If the catch is more than the increment, we should reduce our catch for sustainable management. Otherwise, the fish stock may be depleted eventually.

Influence on environment/ecosystem
There is some harmful fishing gear to the environment. If a spawning ground is destroyed by a harmful fishing method, the fish stock will no longer increase. In addition, dumping garbage and fishing gear will pollute the ocean. We need to fish using an environmentally-friendly method. Sometimes, we happen to catch what we do not target—this is called bycatch. Catching unnecessary fish is bad for the fish stock and will disturb the ecosystem. Thus, we need to choose the method that minimizes environmental and ecosystem impact.

Fisheries management
In order to put the above into practice, we need to set rules for fishing and abide by them. We need to set rules using laws and regulations in fisheries and to enable fishers to abide by the rules to protect resources, environment, and ecosystems. In addition, we need to set penalties when fishers violate the rules. When a stock is endangered, we ban the fishery and set some target for the stock recovery. Voluntary rules among fishers are more effective than mandated rules and should be prioritized.

Tradition/culture
Regional traditional fisheries and food culture should be important and protected unless they are destructive for fish stocks or the environment. Regionally, traditional fisheries tend to be cooperative among fishers and there is traditional common pool management, which preserves fish stocks effectively.

Fig. A.2 Information on Four Attributes of Seafood Sustainability Given to Participants