



## Japanese Consumer Preference For Raw Fish: Best–Worst Scaling Method

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## RESEARCH ARTICLE

# Japanese Consumer Preference for Raw Fish: Best–Worst Scaling Method

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### Abstract

Given the declining consumption of fish and shellfish in Japan, it is essential to better understand consumer needs to design policies that increase consumption. Therefore, we clarify the relative degree of importance Japanese consumers place on various attributes of raw fish during purchase based on a questionnaire survey employing best–worst scaling. We find that consumers prioritize freshness, price, taste, appearance, safety, seasonality, ease of cooking and eating, nutrition, origin, wild fish, and effect on natural environment and ecosystem, in that order. Wild fish has unexpectedly low importance, although Japanese consumers conventionally purchase captured fishery products rather than cultured ones. The effect on the natural environment and ecosystem is accorded the least importance; however, there is a growing trend of purchasing products with marine eco-label certification. To increase environmental sustainability while maximizing natural resource use, proactive actions are needed to change consumer attitudes. The results of a random parameter logit model reveal a comparatively higher preference heterogeneity for origin, ease of cooking and eating, and price. In other words, consumers concerned with origin and not concerned with ease of cooking and eating can be expected to purchase raw fish even at a higher price if the added value is appropriate.

**Keywords:** Raw fish, Best–worst scaling, Consumer preference, Japan

## 1. Introduction

The annual net per-capita supply of fish and shellfish in Japan has been declining since 2001 as consumers have been “shifting away from fish” (Fig. 1) [1]. The consumption of fish and shellfish—a substitute for animal protein—has been falling below meat consumption since 2011. More precisely, fish and shellfish (24.8 kg) accounted for approximately 78.5% of meat (31.6 kg) consumption in the 2016 annual net per-capita food supply.

Japan has implemented several policies to increase the consumption of fishery products in response to this decline. The 2017 *Basic Plan for Fisheries* details the development and supply of “easy-to-eat” and “fun-to-serve foods” to promote

the supply of seasonal and origin-specific products, as well as the consumption of local produce [2]. It also seeks to advance activities to promote a fish-eating culture by furthering consumers’ understanding of seafood characteristics (e.g., taste, health benefits, regionality, seasonality, resource situation) and encourage a fish eating culture. To enhance the supply of fishery products, several initiatives seek to differentiate seafood products to increase their consumption and added value; these include creating local brands, acquiring certifications for seafood safety, and obtaining marine eco-label certification [3].

Understanding consumer needs is important for formulating fishery policies that can expand consumption [2]. Moreover, it is difficult to transfer the

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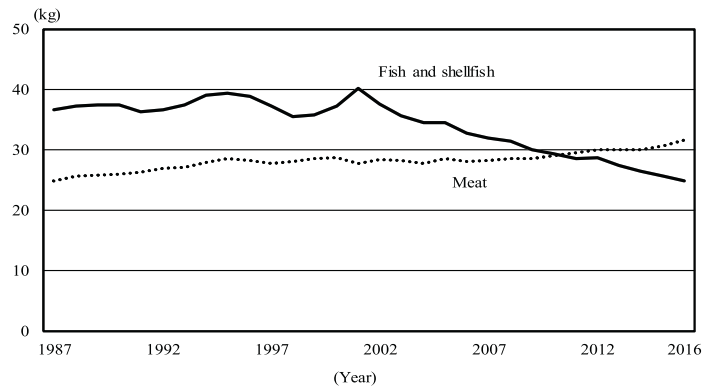


Fig. 1. Transition of the annual net food supply per citizen in Japan. Source: 'Food Balance Sheet' [1].

costs of creating local brands or obtaining certifications onto consumers without an accurate understanding of how their needs inform the differentiation of fishery products. Therefore, the government, relevant agencies, and supply-side policies must fully understand consumer preferences regarding seafood to accurately grasp their needs.

Even for cultured fishery products, there are numerous certifications and initiatives overseen by the government and third-party organizations [4]. These include measures to expand consumption of fishery products that vary based on consumer preferences. For example, if consumers prioritize origin when purchasing fishery products, then retailers may offer a large assortment of fishery products from well-known origins and fishery products from certified local brands. Knowing how regional fishery products are differentiated in terms of production methods and quality may appeal to consumers. Fishery policies should strengthen efforts to protect local brands, increase awareness, and promote local produce. Understanding consumer priorities in purchasing fishery products could help in the development of appropriate marketing strategies and effective fishery policies to increase consumer satisfaction.

In terms of methodology, questionnaire surveys that employ the rating scale and choice experiment techniques are commonly used to study consumer preferences for fishery products in Japan. Some studies used analyses based on a rating scale to understand consumers' impressions and the attributes that they consider important when purchasing raw fish. Previous studies also analyzed the differences in the priorities of the attributes between consumers who can and cannot cook [5] as well as the image of fish based on the consumer's age and gender [6]. Studies that consider other competing protein sources analyzed the relative image of cultured yellowtail [7] and the different species of tuna, as well as their origins and methods of

production [8]. Some studies used analyses based on choice experiments to understand the effects of the differences in fish attributes on consumers' product choices. Taking cultured yellowtail as the subject of their analysis, Kitano and Yamamoto [7] revealed consumer preferences for various attribute levels (part, drip state, origin, price, eco-label, and fat content). Oishi et al. [9] revealed consumer preferences for the attributes of the origin, eco-label, and price of salmon. However, no studies have thus far analyzed the relative degree of the importance Japanese consumers attach to the various attributes of fishery products (freshness, origin, safety, etc.) during the purchase process.

Moreover, there are several limitations in survey methods that use rating scales and choice experiments. On the one hand, the rating scale method does not support a relative valuation among attributes, making comparison difficult. The degree of emphasis also differs depending on the respondent [10–14]. On the other hand, the choice experiment requires comparing profiles with multiple attributes, thus burdening respondents [15,16].

The best–worst scaling (BWS) method can be advantageous in this context; research on consumer preferences using this method has advanced in recent years and improved upon the rating scale and choice experiment methods. In the BWS method, survey respondents are presented with multiple choices and asked to select the one with the highest (best) and lowest (worst) degrees of importance. The preferences of the respondents are determined by changing the choices presented so the questions are repeated [10,11]. Respondents choose between two extremes—best and worst—in the BWS method which, compared with a rating scale, creates a difference in ratings between choices, thereby circumventing the issue of differing degrees of emphasis when making a valuation [10–14]. Moreover, unlike the choice experiment, the BWS is easy to answer and less burdensome on the respondent [15,16]. Finn and Louviere [10] were

the first to publish research on the BWS, and it is now widely used across industries and fields in marketing [11,13,17]. For example, Lusk and Briggeman [12] defined the value of food products based on 11 attributes. Using a BWS survey, they revealed the relative degree of importance consumers attached to these attributes when purchasing food products. Similar studies have applied the BWS to consumer surveys of individual food products; these works include a survey of wines by Bernabéu et al. [18], of livestock products by Lister et al. [19], and of rice by [15]. Furthermore, An et al. [20] used the BWS method to evaluate consumer preferences for country-of-origin labeling on food products. While there is existing literature on the use of the BWS method to evaluate consumer preferences for food products, there are no studies that have applied this method in the context of fishery products in Japan. Thus, we conduct a BWS survey to clarify the relative degree of importance Japanese consumers attach to each attribute of raw fish.

## 2. Materials and methods

### 2.1. Data collection

The data were collected in November 2018 through an online survey conducted by a research company, Cross Marketing Incorporated. The subjects of the survey were registered with the survey company and comprised persons aged 20 or above living in the Kanto (Tokyo, Kanagawa, Saitama, Chiba, Ibaraki, Tochigi, and Gunma prefectures) and Kansai (Osaka, Kyoto, Hyogo, Shiga, Nara, and Wakayama prefectures) regions. A screening survey was also conducted by targeting persons primarily responsible for purchasing seafood in the household. Data were collected from 1,000 people. The respondents' personal attributes are reported in Table 1.

In the BWS survey, respondents were first presented with 11 items that are considered important when purchasing raw fish (Table 2).

These 11 items are based on Lusk and Briggeman [12], who assessed the relative value of emphasized attributes when purchasing food products. Additionally, we drew upon the works of Ogawa et al. [6], Sajiki et al. [21], the Fisheries Agency [3,22,23], and Kitano and Yamamoto [7] for the attributes considered important when purchasing raw fish in Japan.

The data were collected by presenting the items in Table 2 to the respondents in the form of questions, shown in Fig. 2. In the BWS, respondents' preferences are determined by asking the same question repeatedly while changing the choice set of the

items. Prior to the choice set in Fig. 2, the following question was displayed:

“When purchasing raw fish at the supermarket for household use, what do you consider to be the ‘most important item’ and what do you consider to be the ‘least important item’?”

The form of the raw fish (whole fish, half of a fish, fillet, etc.) does not matter (Choose one option that is applicable for each)”

We programmed the survey such that respondents could not make the same selection for both the “most important item” and “least important item.” Furthermore, we applied the balanced incomplete block design (BIBD) to create the choice sets, which were presented to respondents by combining the 11 items in Table 2 [11]. By using the BIBD, each item appears the same number of times and in the same number of combinations with respect to other items in the choice sets. We then created 11 choice sets, with each one comprising five items (Table 3). Each item appeared five times across all choice sets; the respective combinations of each item with other items appeared once. Each respondent was asked the question 11 times based on the 11 choice sets. However, as the order in which choice sets are presented may influence responses, the sequence of choice sets was randomized [14,20].

### 2.2. Evaluation using best–worst scaling

The BWS method can be categorized into three types depending on the characteristics of the choices subject to evaluation: object case (Case 1), profile case (Case 2), and multi-profile case (Case 3) [11]. We used the object case (Case 1), which is appropriate for understanding the relative degree of importance of the various characteristics of raw fish during purchase. The data obtained using the object case (Case 1) BWS method revealed consumer preferences through simple aggregation or econometric estimation methods. In other words, the results obtained using the object case (Case 1) are intuitively understandable and available for analysis using more complex models [20].

We thus apply the conditional logit model (CL) and random parameter logit model (RPL) as econometric estimation methods. We provide an overview of the CL and RPL models below based on prior studies [11,12,14,17,20,24,25].

The CL assumes that all respondents have homogeneous preferences. Where a single choice set contains  $J$  choices, there are a total  $J(J-1)$  combinations of “best” and “worst.” In this study, there are

Table 1. Respondents' attributes

Personal attributes		Number of responses	(%)
Gender	Male	391	(39.1)
	Female	609	(60.9)
Age	20s	127	(12.7)
	30s	158	(15.8)
	40s	188	(18.8)
	50s	147	(14.7)
	60s	281	(28.1)
	70s or over	99	(9.9)
Number of household members	1 Person	324	(32.4)
	2 Persons	322	(32.2)
	3 Persons	206	(20.6)
	4 Persons	111	(11.1)
	5 Persons	27	(2.7)
	6 Persons or more	10	(1.0)
Children (Elementary school-age or younger)	Present	158	(15.8)
	Not present	842	(84.2)
Household annual income	Less than 2 million yen	162	(16.2)
	More than 2 million yen and less than 4 million yen	257	(25.7)
	More than 4 million yen and less than 6 million yen	253	(25.3)
	More than 6 million yen and less than 8 million yen	145	(14.5)
	More than 8 million yen and less than 10 million yen	94	(9.4)
	More than 10 million yen and less than 15 million yen	69	(6.9)
	More than 15 million yen	20	(2.0)
<b>Total</b>		<b>1,000</b>	<b>(100.0)</b>

Table 2. Important considerations when purchasing raw fish

No.	Item
1	Origin: A favorite or a well-known origin
2	Price: The price is low (per 100 g)
3	Appearance: The product is attractive in terms of color, luster, etc.
4	Ease of cooking and eating: Easy to cook (no head or internal organs), or easy to eat (the fish has few bones)
5	Freshness: Little time has passed since landing and the fish is, therefore, fresh
6	Seasonality: The fish is in season, the period in which it tastes the best
7	Nutrition: Contains nutritional elements such as fat, proteins, and vitamins
8	Taste: You or the members of your household enjoy the taste
9	Wild fish: Not farmed
10	Effect on natural environment and ecosystem: Produced in a way that does not burden the natural environment and ecosystem excessively
11	Safety: No harmful effects on the body

20 (5 × 4) combinations. The respondents are assumed to consider the differences in importance for all possible combinations of choices present in a choice set, thus choosing the pair with the largest difference as “best” and “worst.” Assuming λ to be the parameter indicating the importance of each choice, the probability that a respondent will choose choice *j* as “best” and choice *k* as “worst”

from among *J* choices is expressed using CL in Equation (1):

$$P_{jk} = \frac{e^{\lambda_j - \lambda_k}}{\sum_{l=1}^J \sum_{m=1}^J e^{\lambda_l - \lambda_m} - J'} \tag{1}$$

where parameter λ<sub>*j*</sub> in Equation (1) is estimated using the maximum likelihood method.

The RPL does not assume homogenous preferences, but allows for valuations to differ among individuals. It, therefore, assumes parameter η for each individual to have a continuous distribution according to a probability distribution, and then estimates the mean μ and standard deviation σ of the probability distribution. The probability that a respondent will select choice *j* as “best” and choice *k* as “worst” is taken to be *L<sub>jk</sub>(η)*. Since the parameter η of each individual is unobservable, it is considered the integral of a CL model for the density of parameter η. Taking the probability density function of η to be *f(η|Ω)*, and letting Ω be a parameter of mean μ and standard deviation σ, which expresses the features of η of probability density function, the choice probability in RPL can be formulated as:

$$P_{jk} = \int L_{jk}(\eta) f(\eta|\Omega) d\eta, \tag{2}$$

Most important	Item	Least important
<input type="checkbox"/>	1 Appearance: The product is attractive in terms of color, luster, etc.	<input type="checkbox"/>
<input checked="" type="checkbox"/>	2 Ease of cooking and eating: Easy to cook (no head or internal organs), or easy to eat (the fish has few bones)	<input type="checkbox"/>
<input type="checkbox"/>	3 Seasonality: The fish is in season, the period in which it tastes the best	<input type="checkbox"/>
<input type="checkbox"/>	4 Wild fish: Not farmed	<input type="checkbox"/>
<input type="checkbox"/>	5 Effect on natural environment and ecosystem: Produced in a way that does not burden the natural environment and ecosystem excessively	<input checked="" type="checkbox"/>

Fig. 2. An example of a choice set.

Table 3. Choice sets

No.	Item				
1	Appearance	Ease of cooking and eating	Seasonality	Wild fish	Effect on natural environment and ecosystem
2	Price	Freshness	Seasonality	Taste	Wild fish
3	Origin	Ease of cooking and eating	Taste	Wild fish	Safety
4	Origin	Appearance	Freshness	Taste	Effect on natural environment and ecosystem
5	Freshness	Nutrition	Wild fish	Effect on natural environment and ecosystem	Safety
6	Origin	Price	Appearance	Nutrition	Wild fish
7	Price	Ease of cooking and eating	Nutrition	Taste	Effect on natural environment and ecosystem
8	Appearance	Seasonality	Nutrition	Taste	Safety
9	Origin	Price	Seasonality	Effect on natural environment and ecosystem	Safety
10	Origin	Ease of cooking and eating	Freshness	Seasonality	Nutrition
11	Price	Appearance	Ease of cooking and eating	Freshness	Safety

Since RPL cannot be solved algebraically, we use an approximate calculation using simulations to estimate the mean of the probability distribution,  $\mu$ , and standard deviation,  $\sigma$ . For the simulation, assuming the parameter follows a normal distribution, we attempted 100 Halton draws. To estimate the coefficients for CL and RPL, it is necessary to set any one variable as a criterion variable. In this study, we take the item with the smallest value when subtracting the number of times that variable is chosen as the “worst” from the number of times that it is chosen as the “best” as a criterion variable

to estimate the coefficients expressing the relative valuation with other variables.

### 3. Results

Table 4 shows the results of a simple aggregation of all responses received (11,000) from 1,000 respondents questioned 11 times. “Best” at the top indicates the number of responses selecting the item considered most important in each choice set, while “Worst” indicates the number of times the least emphasized item was selected.

B–W is the value obtained by subtracting “Worst” from “Best,” whereas B/W is the ratio of “Best” to “Worst.” The items in Table 4 are arranged such that the B–W values follow a descending order.

The B–W is positive for freshness, price, taste, appearance, safety, seasonality, and ease of cooking and eating, that is, the number of “Best” responses exceeded the number of “Worst” responses for these attributes. Freshness has the highest B–W and was, therefore, valued most highly by the respondents. The B–W is negative for nutrition, origin, wild fish, and effect on natural environment and ecosystem, that is, the number of “Worst” responses exceeded the number of “Best” responses. In particular, the B–W is lowest for the effect on natural environment and ecosystem, implying that it was least valued.

Table 5 shows the results of the estimation using CL and RPL. In the estimations, the effect on natural environment and ecosystem—which has the lowest B–W value in the simple aggregated results obtained using BWS (Table 4)—was set as a reference.

Table 4. Results of a simple aggregation using BWS

Item	Best	Worst	B–W	B/W
Freshness	2,301	189	2,112	12.1746
Price	1,770	773	997	2.2898
Taste	1,374	410	964	3.3512
Appearance	1,119	511	608	2.1898
Safety	1,042	551	491	1.8911
Seasonality	953	670	283	1.4224
Ease of cooking and eating	1,206	970	236	1.2433
Nutrition	343	1,039	–696	0.3301
Origin	508	1,290	–782	0.3938
Wild fish	195	2,261	–2,066	0.0862
Effect on natural environment and ecosystem	189	2,336	–2,147	0.0809

Table 5. Estimated results

Variable	Conditional logit model		Random parameter logit model			
	Coefficient	t-value	Mean		Standard deviation	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Freshness	2.2796***	64.3808	2.7681***	42.0953	0.5153***	3.9057
Price	1.6915***	49.0462	2.1129***	34.4974	1.8074***	24.1132
Taste	1.6808***	48.5501	2.0445***	38.0470	0.6655***	7.3938
Appearance	1.5013***	43.8441	1.8153***	36.6723	0.3642***	2.7108
Safety	1.4611***	42.4899	1.7674***	35.9282	0.3788***	3.1759
Seasonality	1.3105***	38.3696	1.5925***	33.4141	0.6050***	6.9243
Ease of cooking and eating	1.3070***	38.3463	1.5812***	30.9399	1.3967***	20.5858
Nutrition	0.7946***	23.8404	0.9615***	24.2566	0.0083	0.0969
Origin	0.6997***	21.4962	0.8464***	20.8225	0.8517***	11.4675
Wild fish	0.0542*	1.6721	0.0506	1.3721	0.6118***	5.9439
Number of samples	11,000		11,000			
log-likelihood	–28,733		–28,369			

Note: \*\*\* and \* denote significance at the 1% and 10% levels, respectively.

Therefore, each coefficient represents a relative valuation against this attribute.

The coefficients estimated using CL are all positive at the 1% and 10% levels of significance. Each item was rated as significantly more important than the effect on the natural environment and ecosystem when purchasing raw fish. The most important item when purchasing raw fish is freshness, followed by price, taste, appearance, safety, seasonality, ease of cooking and eating, and nutrition. Furthermore, the least important items, in descending order, are origin, wild fish, and effect on natural environment and ecosystem, which was set as the standard in the estimates.

The results of the RPL estimates and their coefficients are all positive. They are all significant at the 1% level, with the exception of the mean parameter for wild fish and the standard deviation parameter for nutrition. For the estimated mean parameters, the order of the coefficients is the same as for those estimated using the CL.

With the exception of nutrition, preference heterogeneity exists in all attributes, as evident from the significant standard deviation parameters. In other words, the evaluation of each item other than nutrition differs from person to person. Next, the ratio of the mean parameter to the standard deviation parameter is calculated for each item except nutrition and wild fish, which show no significance. The items with comparatively large values are origin (1.0063), ease of cooking and eating (0.8833), and price (0.8554). Relatively large variations in individual valuations are shown for these three items.

#### 4. Discussion

We now discuss the results of the relative valuation of attributes considered important by Japanese

consumers when purchasing raw fish (Table 5) to offer insights for fishery policy and supply-side initiatives to increase consumption. The top four items emphasized by Japanese consumers when purchasing raw fish, in descending order, are freshness, price, taste, and appearance. Freshness has also been cited in earlier studies as the highest-ranked item by Japanese consumers purchasing raw fish [5,21]. Thus, consumption can be expanded by emphasizing the freshness of the fish. This can be done by highlighting the technologies used to preserve the freshness of fish on ships and after landing (e.g., using *ikejime*<sup>1</sup> and ice and water during transportation), and presenting the methods of procurement, such as by-passing wholesale markets by offering direct delivery in high-consumption regions. Next, while Japanese consumers prioritize price, there is a relatively higher preference heterogeneity regarding this attribute. In other words, the assessment of price varies by individual. While some consumers value low prices when purchasing raw fish, others will still purchase raw fish at high prices when the added value is higher [7,26].

We also find that Japanese consumers attach high importance to taste. Despite our results, Japan's consumption of fishery products is declining (Fig. 1). Ensuring adequate opportunities for households to learn about the taste of various fish dishes would be difficult. Promotional activities to encourage fish-rich diets, such as cooking classes to identify different flavors of fish, education through school meals, fish sampling services, and supply of recipes by retailers, could be conducted in response to this decline [22]. The attribute of appearance will likely require a response from retailers. Responses to improve appearance include judgments by buyers when procuring raw fish, diligent transportation to retailers to ensure the fish are not damaged in transit, use of ice to preserve the original color and luster of live fish in storage, and use of color in containers reflecting the appearance of fish fillets.

The mid-ranking items of importance (numbers 5–8) when purchasing raw fish are safety, seasonality, ease of cooking and eating, and nutrition. The outbreak of bovine spongiform encephalopathy in Japan in 2001 and the consequent falsified labeling of the origin of beef by major food manufacturers, spurred a shared social recognition of the need for

food safety [27]. Other incidents, such as the falsified labeling of eel products in 2002 and the discovery of formalin use to control parasites in puffer fish in 2003, have increased society's concern regarding the safety of fishery products. To ensure food safety, the supply process of fishery products now includes certifications such as Hazard Analysis and Critical Control and Good Aquaculture Practice [28], and a traceability system. Thus, it will be important to raise awareness on these safety measures and ensure consumers are aware of how they contribute to food safety.

Regarding seasonality, the National Federation of Fisheries Co-operative Associations of Japan collects and shares information on fishery products that fishermen themselves confidently recommend in each region and for each season. This initiative is known as the “Pride Fish” [29] and drives consumer awareness of the seasonality for various types of raw fish, thereby contributing to fish-rich diet promotion activities.

There is a relatively higher preference heterogeneity regarding the ease of cooking and eating as well. Some consumers do not mind the hassle of cooking and eating fish, while others enjoy handling fish or cooking whole fish.

Regarding nutrition, the various health benefits of consuming fish should be communicated more effectively to consumers. For example, fish protein contains a good balance of the nine essential amino acids for maintaining human health. It is also easily digested and absorbed by the body [3]. Providing information on the health benefits of each species of fish compared with other foods may be effective in increasing consumption.

The lowest-ranking items (numbers 9–11) considered important when purchasing fish are origin, wild fish, and effect on natural environment and ecosystem. The relatively low valuation of origin shows that consumers are less particular about labels like “produced in Japan” or “domestically produced.” This may be partly because the Atlantic and trout salmon produced through Norwegian and Chilean marine farming for raw consumption have been imported into Japan since the 1990s [3]. There is, however, a relatively higher preference heterogeneity for origin among Japanese consumers [21,26]. Consumers who attach

<sup>1</sup> *Ikejime* is a technique wherein the freshness of fish is retained by driving a spike directly into the hindbrain, making the fish braindead.





importance to origin should be made aware of how fishery products are differentiated; this can be done through sales promotions of local fishery products, local brand promotion, and the use of geographical indication protection systems. Dietary education for children may also be effective in changing consumer attitudes and placing an emphasis on the origin of raw fish. The *Third Basic Plan to Promote Dietary Education* promotes the consumption of local produce, including setting a target for the use of at least 30% of local products in school lunches [30].

Wild fish is the tenth most important item when purchasing raw fish, with a low relative valuation. In a survey by the Ministry of Agriculture, Forestry and Fisheries in 2014, 76.4% of consumers chose to purchase captured fishery products over cultured ones [23]. Therefore, the weakening consumer attachment to wild fish is a new and unexpected discovery. We already know that consumers often believe incorrect information on the use of excessive additives in the feed of cultured fish and pharmaceutical drugs to treat diseases [23]. Our results suggest that the extent of this misinformation has reduced. Furthermore, as stated above, the consumption of imported salmon has become a fixture in Japan, which may have improved the image of cultured fish. With the consumption of such imported salmon, salmon farming in Japan has also been expanding.

Finally, the effect on the natural environment and ecosystem is the lowest-rated item. A marine eco-label is a generic term for labels that provide information to consumers about the sustainable use of resources and environmentally-friendly production of fishery products. Four marine eco-labels are used in Japan: Marine Stewardship Council, Aquaculture Stewardship Council, Marine Eco-Label Japan, and Aquaculture Eco-Label. Obtaining marine eco-label certification is said to be helpful in expanding the sales channels of fishery products, including exports [3]. To increase consumers' relative valuation of the effect on the natural environment and ecosystem, proactive steps are necessary. These steps include facilitating consumers' understanding of why natural resource use and production need to be maximized sustainably.

## 5. Conclusions

Effective marketing strategies and fishery policies should reflect consumer preferences if the consumption of fishery products is to be expanded within budgetary constraints. We therefore clarified the relative importance of predetermined attributes

of raw fish for Japanese consumers. The results show that freshness, price, taste, appearance, safety, seasonality, ease of cooking and eating, nutrition, origin, wild fish, and effect on natural environment and ecosystem are considered important, in that order. These results could accordingly inform policy and marketing decisions. It may also be more effective to combine relatively highly-rated attributes to appeal to consumers. For example, when selling fishery products, rather than only targeting consumers who are particular about origin, local brands could differentiate their products from those of competitors in terms of freshness, taste, and safety.

The relative valuations of origin, wild fish, and effect on the natural environment and ecosystem are low. The results reflecting how consumer preference for wild fish is low, as noted in Section IV, are particularly noteworthy. To further increase the relative valuations of origin and effect on the natural environment and ecosystem, schools can consider serving local products in children's lunches. Meanwhile, other activities to further dietary education include educational programs and the promotion of ethical and eco-friendly consumption.

The results of the RPL estimates identified attributes with preference heterogeneity. In this regard, it may be beneficial to clarify the consumer attributes causing this heterogeneity. Determining if these differences are based on consumer age and gender or whether the consumer has children may be significant for planning and implementing targeted measures to increase the consumption of fishery products. Reducing regional disparities in the quantities of fish species purchased by Japanese households has also been noted in prior studies [3]. Nevertheless, regional characteristics, including fish-eating culture, remain firmly rooted in Japan's seafood consumption. Therefore, clarifying consumer preferences by fish species and region could be effective in increasing the consumption of fishery products.

## Author contributions

Conceptualization, T.S.; formal analysis, T.S. and Y.-H.L.; data curation, Y.-H.L.; writing—original draft preparation, T.S.; writing—review and editing, T.S. and Y.-H.L.; project administration, T.S.; funding acquisition, T.S. All authors have read and agreed to the published version of the manuscript.

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## Declaration of competing interest

The authors declare no conflict of interest.

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