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RESEARCH ARTICLE

Consumer preferences for an invasive species as a seafood option – evidence from discrete choice experiments

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Abstract

Lionfish, as an invasive species, significantly disrupts marine ecosystems. Promoting lionfish as eatable seafood among consumers may effectively reduce the lionfish population, alleviating its impact on marine ecosystems. The primary goal of this article is to assess lionfish's market potential and determine an effective policy instrument to nudge consumers' preference for lionfish. Discrete choice experiments are used to elicit consumer preferences for seafood dishes. In addition, we use a split-sample approach to test the effects of providing information about the ecological benefit of eating lionfish. Results indicate that consumer willingness-to-pays for other fish species were substantially higher than that of lionfish, even with the information treatment.

Keywords: Discrete choice experiment; invasive species; lionfish; seafood; willingness-to-pay

Introduction

Lionfish (*Pterois miles and P. volitans*) are marine fish native to the South Pacific and Indian Oceans. They consume prey that are more than half of their own size and are known to prey on more than 70 marine fish and invertebrate species. They have 18 venomous spines that are used against potential predators in their native habitats (FWC, 2023). Lionfish were first detected in Florida coastal waters in 1985. In the new habitats, lionfish have few to no predators, and warm waters allow them to reproduce year-round (FWC, 2023). Consequently, lionfish populations have grown exponentially. Figure 1 presents how lionfish distribution and range have changed between their first detection in 1985 and 2014. As lionfish populations grow, their impacts on native fish and coral reefs also grow, posing a significant threat to marine ecosystems. Albins and Hixon (2008) found that a single lionfish residing on a coral reef can reduce the recruitment of other native fish by 79 percent. As lionfish feed on herbivores that feed on algae from coral reefs, the health of coral reefs could be potentially impacted. Moreover, lionfish consume not only prey that is typically consumed by other commercial and recreational native fish

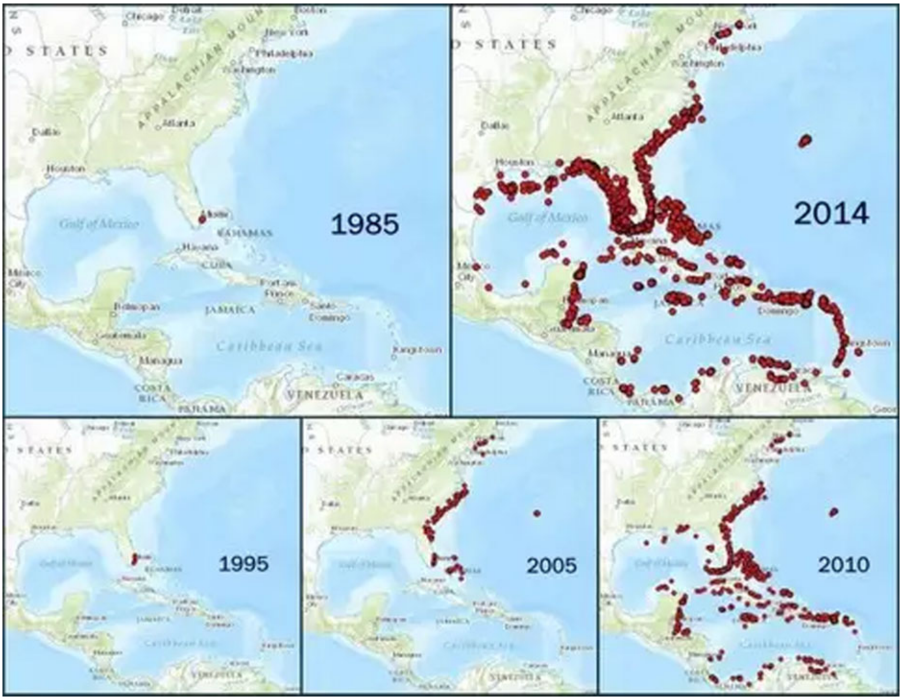

Figure 1. Lionfish population and distribution over time. Source: Florida Fish and Wildlife Conservation Commission.

species, such as snappers and groupers, but also the young of the commercial and recreational fish species (NOAA, 2023). For example, the estimated economic loss caused by lionfish on coral reefs in Jamaica due to reduced marine biodiversity was $11 million (Moonsammy, Buddo, and Seepersad, 2012).

As an effort to control lionfish populations, the National Oceanic and Atmospheric Administration (NOAA) launched an "Eat Lionfish" campaign to promote lionfish as a sustainable seafood choice, and the Florida Fish and Wildlife Conservation Commission (FWC) provides the list of seafood restaurants that serve lionfish on their website (FWC, 2023; NOAA, 2023). NOAA claims that "an invasive lionfish food fish market is practical, feasible, and should be promoted" (NOAA, 2023). Carrillo-Flota and Aguilar-Perera (2017) conducted a survey to understand stakeholder perceptions in Mexico regarding lionfish as a potential seafood option. They found that 86 percent of the survey participants showed a high willingness to try lionfish. Simnitt et al. (2020) surveyed residents and tourists in the US Virgin Islands and estimated their wilingness-to-pay (WTP) for lionfish using the contingent valuation (CV) method. They found that residents were willing to pay $11.80 per pound (2016 US Dollars) for lionfish for home consumption and $17.70 for an entrée at a restaurant. Tourists were willing to pay $10.09 per pound for home/place of lodging consumption and $22.83 for an entrée at a restaurant. They found that the estimated WTPs were comparable with prices that local fishermen were willing to accept and concluded that a viable market for lionfish in the US Virgin Islands may exist. In the mainland U.S., Blakeway, Ross, and Jones (2021) surveyed residents in coastal areas in

Texas and found that those with a high level of concern for environmental problems posed by lionfish and those more knowledgeable about the fish were more willing to consume it. They also found that lionfish education programs would increase the residents' willingness to consume lionfish. Huth, McEvoy, and Morgan (2018) conducted an experimental auction to elicit consumer WTP for lionfish fillets. The experiment consisted of three treatments. In the baseline treatment, participants were provided with basic information about the fish, and their WTP was $6.28 (2015 US Dollars) for a 3-ounce lionfish fillet. In the second treatment, participants were informed about lionfish being an invasive species and that consumption of the fish could be used as a management strategy. Their WTP was $0.71 higher than that of the baseline treatment. When participants were told that native species could be extinct if lionfish populations continued to flourish, their WTP was $1.66 higher than that of the baseline treatment.

Despite the empirical findings that seem to agree with the NOAA's claim that lionfish is a viable seafood option, a robust market for lionfish has not been established in Florida. For example, entrepreneurs in Florida appeared on the popular reality television show "Shark Tank" in 2013, looking for an investment in their business to sell lionfish. However, they failed to secure an investment, and their company went out of business shortly after their presence on the show (Smith, 2023). Although a few grocery stores in the state, such as Publix and Whole Foods Market, sell lionfish fillets, and a small number of seafood restaurants are listed on the FWC website to serve lionfish on their menus, the effectiveness of promoting lionfish as a seafood option to control the population of the invasive species remains questionable.

The primary goal of this paper is to re-assess the lionfish's market potential in Florida. To our knowledge, Huth, McEvoy, and Morgan (2018) and Simnitt et al. (2020) are the only studies that estimated WTP for consumption of lionfish, and both studies focused on lionfish alone. In real-world market situations, however, consumers choose a seafood product amongst other seafood products. Therefore, we designed a discrete choice experiment (DCE), which included other conventional fish species such that consumer preferences for lionfish, relative to the conventional fish species were elicited. Because DCE simulates scenarios that mimic real-world situations where consumers choose a seafood product amongst other seafood products, our design allows us to test the more realistic market potential of lionfish compared to other fish species.

Survey instrument and data

The survey instrument was developed based on Lancaster's consumer choice framework (Lancaster, 1972). Following the previous studies in the literature that identified attributes affecting preferences for seafood consumption in DCEs (e.g, Zhang, Fang, and Gao, 2020; Nguyen, Gao, and Anderson, 2022), we identified four attributes that might affect consumer choices for seafood: fish species, cooking method, dish type, and price. The three non-price attributes included three levels each. More specifically, the levels for the fish species attribute included lionfish, tilapia, and mahi-mahi. Tilapia and mahi-mahi were chosen because they are popular "lower-end" and "higher-end" fish species for consumption, respectively. For example, the average dockside price of tilapia and mahi-mahi in 2023 in Florida was $0.7 per pound and $2.67 per pound, respectively (FWC, 2025). The levels for the cooking method attribute included three cooking methods generally available at seafood restaurants in Florida: grilled, blackened, and fried. The dish type attribute also included three of the common seafood dish types widely available at seafood restaurants: fillet, taco, and sandwich. Given the price attribute is generally treated as a continuous variable when analyzing DCE data (e.g., Petrolia, Interis, and Hwang, 2016; Petrolia and Hwang, 2020; Zhang, Fang, and Gao, 2020; Nguyen, Gao, and Anderson, 2022; Hwang and Lee, 2024), it included five levels rather than three. Moreover, Nguyen et al. (2022) showed that the type of dining (casual dining vs. fine dining) affects consumer WTP for seafood options. Therefore, to ensure that respondents evaluate the choice tasks at the homogeneous dining type, we asked the respondents to make choices as if they were dining in at a mid-scale seafood restaurant. Given the price ranged from $12.99 to $20.99 for casual dining and from $20.50 to $43.50 for fine dining in Nguyen et al. (2022), we set our price levels as $11.99, $15.99, $19.99, $23.99, and $27.99, assuming the price of the mid-scale dining falls somewhere between that of the casual and fine dining.

An efficient DCE design was generated in the Ngene software, which minimizes the D-Error to estimate the coefficients with as low as possible standard errors from the multinomial logit (conditional logit) model (ChoiceMetrics, 2021).[1] A total of 20 choice tasks were included in the design, and the 20 choice tasks were divided into two blocks such that participants answered 10 choice tasks. The initial design assumed arbitrary values as the “priors” for the attribute coefficients to be estimated. The priors were then updated with the actual estimated coefficients obtained from a pretest of the survey that included 100 participants.

Qualtrics was contracted to administer the survey with the target population of Florida residents who were 18 or older and consumed seafood. The initial screening question asked how often they consume seafood, and those who chose “Never” were terminated. The pretest was administered in May 2023, and the final survey was administered between June and July 2023. A total of 5,480 invites were sent out, and 2,807 responded (51.2 percent). Of the respondents, 207 were disqualified as they indicated that they never consume seafood, and 1,426 were removed by Qualtrics based on their quality screening and demographic quotas. As a result, a total of 1,174 completed responses were provided by Qualtrics, which yielded an incident rate of 41.8 percent.

Information in each choice task was presented in the menu to mimic the real-world seafood choice scenario. Figure 2 presents examples of the menu. Each menu presented two seafood dishes (A and B) and indicated that all dishes come with 8 oz. of fish for consistency. Participants were asked to indicate which dish they would like to order. Three alternatives were provided; “I would like to order Dish A.,” “I would like to order Dish B.,” and “I would not order either dish.”

The survey also utilized information treatments. In treatment 1, no additional information about lionfish was provided to participants. In treatment 2, menus that contained lionfish provided information about the ecological benefit of lionfish consumption (second example in Figure 2). Each treatment consisted of 256 participants.[2] Table 1 presents demographic comparisons between our samples and the Florida population.

As DCEs utilize choices made in hypothetical situations, no actual payments are made. Consequently, WTP estimates may suffer from hypothetical bias, where the estimates are greater than they would have been if actual payments had been made. To mitigate potential hypothetical bias, a “cheap talk” script inspired by Cummings and Taylor (1999) was presented prior to the valuation questions. The script stated that “Previous research has shown that participants’ choices in a hypothetical scenario, such as what we present here, can be different from their choices in real-life situations. Please make choices as if you are actually dining in at a mid-scale seafood restaurant.” Also, the choice tasks were randomized to avoid potential order effects (Nguyen, Gao, and Anderson, 2022).

[1]See ChoiceMetrics (2021) for more information about efficient DCE designs.

[2]There were two other treatments which consisted of 256 participants each, to test effects of omission of an attribute. Observations from these treatments are not used in this paper.

Please indicate which seafood dish you would like to order.

Menu

All dishes come with 8 oz. of fish

Dish A	Dish B
Grilled Mahi-mahi Tacos	Blackened Lionfish Fillet
$23.99	$15.99

- I would like to order dish A.
- I would like to order dish B.
- I would not order either dish.

Please indicate which seafood dish you would like to order.

Menu

All dishes come with 8 oz. of fish

Dish A	Dish B
Grilled Mahi-mahi Tacos	Blackened Lionfish Fillet*
$23.99	$15.99

*Consumption of lionfish helps protect the ecosystem in Florida waters.

- I would like to order dish A.
- I would like to order dish B.
- I would not order either dish.

Figure 2. Choice task examples.

Econometric methods

As mentioned before, data was obtained from two treatments. Following the random utility model, a consumer *i*'s utility of choosing a dish *j* at choice task *t* in a treatment *s* can be represented as

$$U^s_{ijt} = \boldsymbol{\beta}^{s\prime}_i \mathbf{x}^s_{ijt} + \varepsilon^s_{it},$$

where the superscript s denotes sample or treatment $s = \{1, 2\}$, $\boldsymbol{\beta}^s$ is a vector of parameters, $\mathbf{x}^s_{ijt}$ is a vector of attributes of dishes and ε^s_{ijt} is the error term. The deterministic component of the utility function can be further specified as

$$V^s_{ijt} = a^s_{i1} + \beta^s_{i1} Tilapia_{ijt} + \beta^s_{i2} Mahi_{ijt} + \beta^s_{i3} Blackened_{ijt} + \beta^s_{i4} Fried_{ijt} + \beta^s_{i5} Tacos_{ijt} + \beta^s_{i6} Sandwich_{ijt} + \gamma^s Price_{ijt},$$

where a^s_{i1} is an alternative-specific constant (=1 if either dish A or B was chosen; =0 if neither was chosen) which captures the effect of the omitted attribute levels (i.e., lionfish, grilled, and fillets) (Adamowicz et al., 1997), and each parameter represents the marginal utility of the corresponding attribute relative to the base category.

Table 1. Demographic comparisons between treatments and census

	Treatment 1 (No information)	Treatment 2 (Ecological benefit information)	Florida Population[1]
Female	0.50	0.54	0.51
White	0.76	0.74	0.77
Black	0.16	0.19	0.17
Bachelor's degree or higher	0.41	0.41	0.32
Median household income	\$68,862.75	\$71,407.48	\$72,056.63[2]

[1]Source: US Census Florida Quick Facts.
[2]Adjusted to 2023 USD.

WTP for the k^{th} attribute represents how much participants are willing to pay for the k^{th} attribute, and it is calculated as $\frac{-\beta_{ik}^{s}}{\gamma^{s}}$. The utility function above is estimated in three different ways. The conditional logit (Clogit) model estimates parameters for the attributes that do not vary by consumer. In other words, it assumes that consumers have homogenous preferences. The random parameters logit (RPlogit) model relaxes this restriction by allowing the parameters to vary by consumer. We assume that each of the parameters, excluding that of price, follows the normal distribution.[3] The price parameter is fixed to guarantee the normal distribution of WTP estimates (Gao and Schroeder, 2009; Train 2009; Khachatryan et al., 2016; Zhang, Fang, and Gao, 2020). Furthermore, tilapia and mahi are attribute levels associated with fish species; blackened and fried are attribute levels associated with cooking methods, and tacos and sandwiches are attribute levels associated with dish type. Therefore, the corresponding parameters associated with each attribute (fish species, cooking method, dish type) are likely to be correlated with each other. To account for potential correlations between the parameters, the correlated random parameters logit model (CRPlogit) is estimated. The correlated random parameters are specified as $\boldsymbol{\beta}_i^s = \boldsymbol{\beta}^s + \boldsymbol{\Gamma}\mathbf{v}_i^s$, where $\boldsymbol{\Gamma}$ is the Cholesky matrix. More specifically, $\boldsymbol{\Gamma}$ is specified in a way where correlations between β_{i1}^s and β_{i2}^s, β_{i3}^s and β_{i4}^s, and β_{i5}^s and β_{i6}^s are allowed. The ASC is allowed to be correlated with all six random parameters as it is associated with the base level for all three attributes. When all the parameters are uncorrelated, the model simplifies to the conventional random parameter logit (ChoiceMetrics, 2021).

Market potential for Lionfish

Given consumers are less familiar with lionfish, compared to tilapia and mahi-mahi, we hypothesize that $WTP_{tilapia} > 0$ and $WTP_{mahi} > 0$. Further, given tilapia and mahi-mahi are considered "lower-end" and "higher-end" fish, respectively, we hypothesize that $WTP_{mahi} > WTP_{tilapia}$. We also hypothesize that the information treatment affects consumer WTPs for fish species. More specifically, we expect that treatment 2 will yield results where lionfish appears to be "less undesirable" than that of treatment 1, given the

[3]We also estimated the RPlogit models with uniform and triangular distributions. The results were consistent across the distribution specifications. The results are available from the authors upon request.

additional information about the ecological benefit of eating lionfish. Therefore, we hypothesize that $WTP^1_{tilapia} > WTP^2_{tilapia}$ and $WTP^1_{mahi} > WTP^2_{mahi}$.

Results

Tables 2 and 3 present the Clogit, RPlogit, and CRPlogit model results by treatment. Overall, coefficients on the fish species are positive and statistically significant for all cases, indicating that participants are less likely to choose a dish with lionfish. The log-likelihood value improves from the Clogit model to the RPlogit model and from the RPlogit model to the CRPlogit model, indicating that preference heterogeneity and correlations exist between the preference for seafood attributes in our data. Table 4 presents the estimated correlation matrix from the CRPlogit model. For treatment 1, tilapia and mahi are positively correlated (0.737), and ASC which is the utility associated with the base levels (lionfish, grilled, and fillets), is negatively correlated with tilapia (–0.553) and mahi-mahi (–0.286). For treatment 2, however, tilapia and mahi are negatively correlated (–0.788), and ASC is positively correlated with tilapia (0.628) and is negatively correlated with mahi-mahi (–0.472). These results imply that the ecological information is more likely to be effective for tilapia consumers rather than mahi-mahi consumers. Below, we discuss the results of WTP so that more direct comparisons across the models and treatments can be made.

Table 5 presents the estimates of WTP measures relative to the base level: lionfish, grilled, and fillets. Overall, we find that WTPs for tilapia and mahi-mahi are positive, and their magnitudes are quite large. These findings indicate that consumers are willing to pay substantially less for lionfish compared to the conventional fish species. We also find that WTP for mahi-mahi is higher than WTP for tilapia in all cases, implying that consumers are willing to pay more for the "higher-end" fish.

Without the ecological benefit information about eating lionfish, WTP for tilapia is $27.06 – $40.17, depending on the model specification, indicating that consumers are willing to pay that much less for a dish with lionfish than for a dish with tilapia. WTP for mahi-mahi is $39.44 – $46.63, depending on the model specification, indicating that consumers are willing to pay that much less for a dish with lionfish than for a dish with mahi-mahi. These results suggest that consumers dislike lionfish so much that they are willing to pay substantially higher prices to substitute it with other fish species or avoid eating it.

With the ecological benefit information, we find that WTPs for tilapia and mahi-mahi are generally lower than the WTPs obtained without such information. From the Clogit, WTP for tilapia with the information is $22.43, whereas it is $36.75 without the information. WTP for mahi-mahi with the information is $31.99, whereas it is $46.04 without the information. These results indicate that consumers are willing to pay more for lionfish when they are informed about the ecological benefit of eating lionfish. However, they are still willing to pay substantially less for lionfish than other fish species. When the preference heterogeneity is accounted for (RPlogit), WTP for tilapia with the information is $20.94, whereas it is $27.06 without the information. WTP for mahi-mahi is $33.21 with the information, whereas it is $39.44 without the information. When the correlations between the attributes are accounted for, however, we find that the effect of the information is extremely marginal. WTP for tilapia is $35.49 with the information, whereas it is $40.17 without the information. WTP for mahi-mahi is $45.52 with the information, whereas it is $46.63 without the information. Our findings suggest that consumers are still willing to pay substantially less for lionfish, even if the ecological benefit of eating lionfish is presented.

Table 2. Conditional logit, random parameters logit, and correlated random parameters logit regression results for treatment 1 (no information)

Random parameters	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Tilapia	1.065***	0.073	1.601***	0.175	2.536***	0.293
Mahi	1.334***	0.077	2.334***	0.184	2.944***	0.287
Blackened	0.098	0.066	0.053	0.129	0.021	0.132
Fried	0.026	0.066	−0.063	0.103	−0.067	0.106
Tacos	−0.211***	0.068	−0.335***	0.114	−0.293**	0.124
Sandwich	−0.131**	0.066	−0.173	0.108	−0.059	0.124
ASC	0.491***	0.116	2.038***	0.342	2.114***	0.486
Fixed parameter						
Price	−0.029***	0.005	−0.059***	0.007	−0.063***	0.008
Standard deviations of the random parameters						
Sd_Tilapia			2.253***	0.217	2.725***	0.223
Sd_Mahi			1.912***	0.168	2.715***	0.193
Sd_Blackened			1.093***	0.164	0.997***	0.206
Sd_Fried			0.731***	0.143	0.605***	0.152
Sd_Tacos			0.814***	0.155	1.011***	0.179
Sd_Sandwich			0.695***	0.153	1.009***	0.140
Sd_ASC			4.284***	0.486	4.863***	0.286
Diagonal values in Cholesky matrix						
Ns_Tilapia					2.725***	0.223
Ns_Mahi					1.835***	0.164
Ns_Blackened					0.997***	0.206
Ns_Fried					0.558***	0.166
Ns_Tacos					1.011***	0.179
Ns_Sandwich					0.956***	0.144
Ns_ASC					1.412***	0.265
Below diagonal values in Cholesky matrix						
Mahi: Tilapia					2.001***	0.249
Fried: Blackened					−0.236	0.177
Tacos: Sandwich					0.321	0.212
ASC: Tilapia					−2.689***	0.283
ASC: Mahi					0.877***	0.217
ASC: Blackened					1.902***	0.312
ASC: Fried					−2.427***	0.332

(*Continued*)

Table 2. (*Continued*)

Random parameters	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
ASC: Tacos					1.176***	0.303
ASC: Sandwich					1.661***	0.449
Log-likelihood	−2,505.123		−1,897.114		−1,830.756	
N	2,560					

Note: *, **, and *** denote 10%, 5%, and 1% significance level, respectively.

Table 3. Conditional logit, random parameters logit, and correlated random parameters logit regression results for treatment 2 (ecological benefit information)

	Clogit		RPlogit		CRPlogit	
Random parameters	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Tilapia	0.578***	0.067	0.889***	0.177	1.474***	0.237
Mahi	0.824***	0.071	1.410***	0.180	1.891***	0.254
Blackened	−0.071	0.063	−0.025	0.114	−0.097	0.122
Fried	−0.024	0.063	−0.071	0.095	0.008	0.101
Tacos	0.064	0.064	0.041	0.098	0.000	0.107
Sandwich	−0.002	0.064	−0.076	0.102	−0.023	0.115
ASC	0.863***	0.112	2.710***	0.347	2.357***	0.394
Fixed parameter						
Price	−0.026***	0.004	−0.042***	0.007	−0.042***	0.007
Standard deviations of the random parameters						
Sd_Tilapia			2.217***	0.191	3.186***	0.258
Sd_Mahi			2.409***	0.188	3.323***	0.262
Sd_Blackened			0.816***	0.161	0.906***	0.188
Sd_Fried			0.568***	0.123	0.775***	0.133
Sd_Tacos			0.464***	0.171	0.682***	0.189
Sd_Sandwich			0.752***	0.137	0.932***	0.146
Sd_ASC			4.323***	0.372	4.923***	0.464
Diagonal values in Cholesky matrix						
Ns_Tilapia					3.186***	0.258
Ns_Mahi					2.045***	0.175
Ns_Blackened					0.906***	0.188
Ns_Fried					0.727***	0.142
Ns_Tacos					0.682***	0.189
Ns_Sandwich					0.679***	0.126
Ns_ASC					2.372***	0.325

(*Continued*)

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Table 3. (*Continued*)

	Clogit		RPlogit		CRPlogit	
Random parameters	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Below diagonal values in Cholesky matrix						
Mahi: Tilapia					−2.620***	0.271
Fried: Blackened					0.270	0.196
Tacos: Sandwich					0.639***	0.182
ASC: Tilapia					3.091***	0.586
ASC: Mahi					0.183	0.218
ASC: Blackened					0.977***	0.291
ASC: Fried					1.915***	0.246
ASC: Tacos					1.178***	0.412
ASC: Sandwich					−1.737***	0.291
Log-likelihood	−2584.737		−1999.426		−1920.410	
N	2,560					

Note: *, **, and *** denote 10%, 5%, and 1% significance levels, respectively.

Table 4. Correlation matrix from the CRPlogit, by treatment

	Tilapia	Mahi	Blackened	Fried	Tacos	Sandwich	ASC
Treatment 1 (No information)							
Tilapia	1.000	0.737	0.000	0.000	0.000	0.000	−0.553
Mahi	0.737	1.000	0.000	0.000	0.000	0.000	−0.286
Blackened	0.000	0.000	1.000	−0.390	0.000	0.000	0.391
Fried	0.000	0.000	−0.390	1.000	0.000	0.000	−0.612
Tacos	0.000	0.000	0.000	0.000	1.000	0.318	0.242
Sandwich	0.000	0.000	0.000	0.000	0.318	1.000	0.401
ASC	−0.553	−0.286	0.391	−0.612	0.242	0.401	1.000
Treatment 2 (Ecological benefit information)							
Tilapia	1.000	−0.788	0.000	0.000	0.000	0.000	0.628
Mahi	−0.788	1.000	0.000	0.000	0.000	0.000	−0.472
Blackened	0.000	0.000	1.000	0.348	0.000	0.000	0.199
Fried	0.000	0.000	0.348	1.000	0.000	0.000	0.434
Tacos	0.000	0.000	0.000	0.000	1.000	0.685	0.239
Sandwich	0.000	0.000	0.000	0.000	0.685	1.000	−0.093
ASC	0.628	−0.472	0.199	0.434	0.239	−0.093	1.000

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Table 5. WTP estimates

WTP	Clogit Treatment 1	Clogit Treatment 2	RPlogit Treatment 1	RPlogit Treatment 2	CRPlogit Treatment 1	CRPlogit Treatment 2
Tilapia	\$36.75	\$22.43	\$27.06	\$20.94	\$40.17	\$35.49
	[24.31, 49.18]	[13.46, 31.40]	[18.86, 35.25]	[10.45, 31.43]	[27.24, 53.10]	[17.59, 53.40]
Mahi	\$46.04	\$31.99	\$39.44	\$33.21	\$46.63	\$45.52
	[31.72, 60.37]	[21.07, 42.92]	[30.14, 48.73]	[21.15, 45.27]	[33.48, 59.78]	[26.01, 65.03]
Blackened	\$3.38	–\$2.75	\$0.90	–\$0.59	\$0.34	–\$2.34
	[–1.42, 8.19]	[–7.92, 2.43]	[–3.54, 5.33]	[–6.09, 4.92]	[–3.84, 4.51]	[–8.38, 3.71]
Fried	\$0.90	–\$0.94	–\$1.06	–\$1.67	–\$1.06	\$0.18
	[–3.79, 5.60]	[–6.01, 4.12]	[–4.53, 2.41]	[–6.18, 2.83]	[–4.43, 2.30]	[–4.82, 5.18]
Tacos	–\$7.27	\$2.48	–\$5.66	\$0.97	–\$4.64	–\$0.01
	[12.61, –1.93]	[–2.75, 7.71]	[–9.79, –1.54]	[–3.70, 5.64]	[–8.84, –0.45]	[–5.31, 5.29]
Sandwich	–\$4.52	–\$0.09	–\$2.93	–\$1.78	–\$0.93	–\$0.55
	[–9.48, 0.44]	[–5.16, 4.98]	[–6.69, 0.83]	[–6.84, 3.28]	[–4.91, 3.04]	[–6.33, 5.24]

Notes: The WTP estimates are relative to the base levels: lionfish, grilled, and fillets. Confidence intervals are in the brackets. Confidence intervals were obtained following Krinsky and Robb (1986), using 20,000 draws.

Discussion

Natural resource managers have been trying to market lionfish as a delicacy and encourage its consumption in an effort to control the fish population. However, little is known about the market potential, consumer preferences, and WTP for the fish. A lack of such information may discourage restaurant owners from including lionfish on their menus. To our knowledge, only two studies in the literature measured WTP for lionfish, and their findings seemed to provide empirical support for the effort to promote the lionfish market. However, the studies focused on lionfish and did not consider other fish species. Our DCE included other fish species such that consumer preferences for lionfish were elicited relative to the conventional other fish species. Our results indicated that consumers are willing to pay substantially less for lionfish than for tilapia and mahi-mahi. In fact, consumers dislike lionfish so much that they are willing to pay \$20.94 – \$35.49 more and \$31.99 – \$45.52 more to substitute a dish with lionfish with tilapia and mahi-mahi, respectively, even when they were informed about the ecological benefit of eating lionfish.

Given restaurants are profit-maximizers, they need to assess the profitability of serving lionfish on their menu. For example, those who are interested in purchasing lionfish from local divers can contact FWC to obtain wholesale pricing (FWC, 2023). With the wholesale pricing information and findings from this study, they may calculate the expected profit from a lionfish dish and compare that to other fish dishes to gauge the profitability of a lionfish dish on their menu. Our findings suggest that consumers are not willing to pay for lionfish dishes, and restaurants are unlikely to serve lionfish on their menu unless the cost for restaurants to purchase lionfish is significantly lower than that of other fish species. Based on our results, it seems that using the seafood market as a tool to control the population of the invasive species is unlikely to be effective. More promotion campaigns or educational programs may be needed to make lionfish an economically feasible fish dish in restaurants."

Data availability statement. The dataset generated during and/or analyzed during the current study is available from the corresponding author on reasonable request.

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