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Examining Citizens' Preferences for Aquaculture using Discrete Choice Experiments

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EXAMINING CITIZENS' PREFERENCES FOR AQUACULTURE USING DISCRETE CHOICE EXPERIMENTS

By

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An Abstract of the Thesis Presented
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Over the last few decades, discrete choice experiments (DCEs) have become increasingly popular across different subfields of economics as a way to elicit citizens' stated preferences for product and service attributes as well as various environmental and infrastructure features. The DCE framework could be seen as a time- and cost-effective alternative to the revealed preferences framework that is based on data obtained using transactions observed in real-world markets. DCEs offer the advantage over revealed preferences data because they allow learning about consumer preferences for hypothetical products or product attributes without bearing the costs of introducing new products to the market. Past research shows that despite being hypothetical in nature, stated preferences could serve as accurate forecasts of consumer behavior in the real world.

In our study, we use discrete choice experiments for elicitation of citizens' perceptions and preferences for the aquaculture industry in Maine. The rapid expansion of aquaculture has contributed to changes in seafood markets and the transformation of infrastructure along Maine's coast. The industry's growth has also led to a growing need for development of policies and effective coastal management programs that would support sustainable growth of the industry and help balance the interests of different groups in Maine's coastal areas.

This thesis describes two pilot studies that contribute to the body of knowledge about the use of the stated preference approach, and particularly, the discrete choice experiment method for analysis of citizens' preferences for aquaculture industry. The first chapter of the

thesis describes the analysis of citizens' preferences for different seafood attributes as well as the effect of product presentation strategy on consumer choice. The second chapter of the thesis explores the effect of proximity to different types of coastal usage on Maine citizens' willingness to pay for coastal homes. Both pilot projects described in this thesis contribute to the body of knowledge about the methodology and study design for elicitation of consumer preferences in the rapidly changing sectors such as the seafood and coastal infrastructure sectors.

The research work presented in this thesis was conducted as a part of the Sustainable Ecological Aquaculture Network (SEANET) which is a research grant that serves to promote sustainable aquaculture industry in Maine. The sustainable development of an industry could be characterized by multiple dimensions including environmental, social and economic sustainability. Sustainable development of aquaculture would demand balancing interests of different population groups, promoting industry-related products, services and coastal management programs that would be accepted and supported by general public. Employing the discrete choice experiment method to the analysis of consumer preferences for aquaculture may contribute to the efforts of understanding people's needs and wants and minimize the possibility of conflicts of interest in the sector. The findings of both studies described in this thesis could inform Maine's aquaculture industry stakeholders and policymakers of Mainers' preferences for seafood products and coastal usage, and could facilitate the development of seafood production, and certification standards and coastal management programs that could ensure sustainable expansion of aquaculture practices in Maine.

The results of both pilot studies confirm previous research findings about consumer preferences for seafood attributes and coastal usage. Particularly, consistent with previous studies on the topic, we find that Maine's consumers prefer wild caught over farm-raised products, locally grown seafood over products imported from other states and abroad, and certified products over non-certified products. Regarding coastal home owners' preferences for coastal usage, we find that Maine citizens tend to prefer undeveloped coastal areas to the areas of

coastal fishing and aquaculture, with aquaculture being the least preferred type of coastal usage. Our thesis generates interesting findings regarding Maine consumers' behavior in response to different product presentation strategies.

Furthermore, in our first study, we find that product presentation strategy may have an impact on consumer behavior in some cases, but not in others, and that there may be a link between consumers' familiarity with seafood products and their choices in response to different product presentation techniques. In our second study, we find that citizens may exhibit different preferences depending on whether or not they live within proximity to the ocean. Future research would be needed to test our findings on larger datasets, and examine the geographic variation of the trends that we observe.

Although both studies are built upon the principles of utility maximization framework and the assumption that individuals are rational and seek to maximize their utility, we acknowledge the complexity of human choice, the potential for respondents' irrational decision-making and the possibility of different choce outcomes in response to various choice format and environment characteristics. Such limitations are present in any behavioral experiments and do not diminish the usefulness and applicability of findings and lessons learned throughout this thesis work.

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CHAPTER 1

IMPACT OF PRODUCT PRESENTATION STRATEGY ON CONSUMER BEHAVIOR IN THE SEAFOOD MARKET

1.1 Introduction

The process of consumer choice depends on a variety of factors including shopping environment, product attributes, and consumers' personal characteristics, past experiences and cognitive state at the time of decision-making (Payne et al. 1991). Additionally, product presentation strategy may have a significant impact on the outcome of the decision-making process because it affects consumers' level of product understanding, emotional state, task motivation and time available to make a choice (Johnson et al. 2012). Learning more about consumer behavior in response to different product presentation techniques can better the design effective marketing strategies and ensure efficient communication between economic agents within a market (Sanko 2001; Chen 2009) This would help consumers improve their understanding of unfamiliar products and make purchase decisions that would maximize consumer welfare. Using the context of Maine's seafood sector, this study explores the interaction of different factors in consumer decision-making and the effect of product presentation strategy on consumer choice.

Over the last few decades, the internet has become one of the most popular and cost-efficient ways to deliver product information to customers and has led to the rapid and steady growth of online sales. Even during the Great Recession and the financial crisis that followed, online sales were rising at almost 15% per year (2007 - 2012), while total retail sales were growing only at the rate of 0.9% during the same period (Maritime Gateway 2013). This trend is expected to persist in the future: the share of online sales is projected to grow from 7.4% (2015) to 17.5% (2021) (Statista.com). The emergence and expansion of online shopping has been followed by an increased interest in online consumer behavior and the growing understanding that the decision-making of online consumers may differ from the decision-making of those

shopping in traditional stores (Andrews & Currim 2004; Dennis et al. 2009). For example, online shopping may be associated with limited product experience, the absence of interaction with other agents and therefore, more risk and uncertainty about the product quality (Dennis et al. 2009; Eggert 2010). Learning more about the differences in individuals' perceptions and understanding of product information in online and traditional shopping environments could facilitate the development of more effective ways to communicate product information to the customer (Jiang & Benbasat 2007; Chen 2009).

Consistent with McFadden's random utility maximization framework, we base our choice experiment on the assumption that consumers are rational economic agents seeking to maximize their utility (1973). We assume that individuals view products as combinations of characteristics and that consumers assign an implicit value to each product characteristic (Lancaster 1966; Regmi 2001). When faced with a set of product alternatives, consumers select the alternative that possesses the combination of characteristics that would maximize their utility (Lancaster 1966; Regmi 2001). As an example, in our study, we present seafood products as "packages" of the following characteristics: source of production (wild-caught vs. farm-raised), place of origin (local vs. imported from a different state or abroad), certification status (certified vs. non-certified), and price.

The discrete choice experiment method (DCEs) employed in this study is a type of stated preference method for elicitation of consumer self-reported attitudes and preferences as opposed to preferences revaled through choices in real-world markets. DCEs define product or service alternatives by its attribute at different levels and allow for comparison of relative importance of different product characteristics and trade-offs between these characteristics (Regmi 2001; Ryan et al. 2001). By asking consumers to select from a set of alternatives and varying some product characteristics while holding others constant, it may be possible to isolate

the economic effect of a characteristic of interest on consumer willingness to pay for a product or service (Regmi 2001).

The discrete choice experiment framework has a number of advantages and disadvantages compared to the revealed preferences data representing consumer' past or present choice behavior (Ben-Akiva et al. 1994). Discrete choice experiments allow for more flexibility and cost-efficiency in experiment design because they allow for testing of consumer preferences for new and hypothetical products or product combinations without introducing such products to the market. Such advantage of the DCE technique may be especially advantageous in rapidly changing sectors. Additionally, DCE experiments may sometimes be considered as a more convenient and time-effective alternative to revealed preference data because the design and mode of experiment administration are fully controlled by researchers (Pereira et al. 2007).

The disadvantages of DCEs relate to their hypothetical nature as well as potential biases due to the complexity of human choice and respondents' sensitivity to choice experiment design and presentation. Previous works have shown that participants' stated preferences may differ from their actual purchasing behaviors because choices made in a study context as opposed to the real-world market setting may be driven by different motives (Ben-Akiva et al. 1994). For example, Ben-Akiva and colleagues show that brand loyalty may be perceived differently in the real-world and survey settings (1994). Additionally, past research shows that participants' choices tend to be very sensitive towards response format, question phrasing and information provided in choice experiments (Ben-Akiva et al. 1994). Therefore, effective stated preference choice experiment design must be careful and informed by previous research, and analysis of elicited responses may require imposing additional structure on the utility framework (Earnhart 2002).

We will examine the effect of product presentation strategy (online vs. in-person) on the behavior of seafood consumers in Maine. Although purchasing seafood and other perishable

food items online is still not a common practice, it has been gaining popularity in recent years due to convenience, time-efficiency and the development of storage and transportation technologies (Corbett 2001). In the last years, over 20% of web sites offer seafood for purchase online, and this number is expected to increase (Corbett 2001; Hallman et al. 2015). Therefore, learning about differences in consumer behavior in response to the online and in-person product presentation modes may be especially useful at the time when the rate of online sales, and the range of products offered on the web is quickly expanding.

In our study, we will show that product presentation strategy may not have an impact on consumer choice when consumers are faced with familiar products, but may influence consumer willingness to pay for attributes of unfamiliar products. Studying the influence of product presentation mode on consumer behavior in the seafood market is necessary in order to understand "what to present to decision-makers and how to present it" to help consumers make more informed and sustainable decisions (Johnson et al. 2012).

The information about consumer preferences for different product attributes and consumer behavior in response to different product presentation techniques elicited with the help of discrete choice experiments can be directly applied to the design of choice architecture - the term that reflects the fact that the structure of a choice task or description of choice alternative affects an individual's decision-making process (Johnson et al. 2012). Choice architecture is based upon the understanding of the factors that affect human decision-making and the tools that can be used to highlight choice options in such a way that people's actions would be directed towards, or away from, making a particular choice (Johnson et al. 2012; Meder et al. 2018). For example, using the most effective product presentation strategy or highlighting the most important and attractive product attributes may help enhance the competitiveness of a product in the market.

Additionally, this study aims to examine the preferences of Maine's seafood consumers for different seafood characteristics, including the source of production ("wild-caught" vs. "farm-raised"), product origin ("local" vs. "imported") and certification status ("sustainably-harvested" vs. "non-certified" for wild-caught products and "organic" vs. "non-certified" for farm-raised products). The seafood industry is a unique and interesting sector for research about consumer decision-making. The industry's changing nature is caused by a quickly increasing proportion of aquaculture products in the total supply of seafood, the rise of internet and rapid development of food processing technologies.

Between 1980 and 2011, the share of farm-raised fish products in the global seafood supply has increased from 9 to 48 percent (FAO 2013). As a result, the source of seafood production (wild-caught vs. farm-raised) has become an additional factor for consumers to account for when purchasing seafood (Davidson et al. 2012). Furthermore, the rise of internet in the last three decades has led to the rapid growth of online sales and the increasing number of seafood consumers looking for product information online. Ultimately, technological advances have made seafood production safer and more sustainable. However, technological innovation has only had a limited effect on consumer choices in the seafood sector due to the outdated perceptions of processing and freezing technologies and lack of knowledge of modern transportation and certification standards and practices in the seafood industry (Roheim et al. 2012).

Although advancing the knowledge of the factors that affect consumer understanding and perceptions of seafood will facilitate growth of the seafood industry in general, it will be especially valuable for the domestic aquaculture industry that suffers from low levels of public acceptance (Bacher 2016). Using the knowledge about consumers' perceptions and preferences for different seafood attributes may help fish farmers, and aquaculture industry stakeholders and policy-makers design more effective marketing techniques that could help enhance the

competitiveness of the domestic aquaculture sector (Baltussen et Niessen 2006). Additionally, learning about product characteristics that are perceived as the most important or most attractive by seafood consumers may inform the development of production and certification standards that would allow supplying products that are liked by consumers and that maximize consumer welfare.

1.2 Background and Research Questions

This study will address two different research objectives in the following order: first, the study will use the context of Maine's seafood market to test hypotheses about consumer preferences (elicited as willingness-to-pay values) for the following seafood attributes: source of production, certification status and origin. Second, we will use our estimates of consumers' willingness-to-pay values for the online and in-person samples to examine the effect of product presentation strategy (online vs. in-person shopping setting) on consumer choice in Maine's seafood market.

To test our research hypotheses, we employ the discrete choice stated-preference experiments (DCE) method which is widely used in marketing, psychology and public policy studies to learn about and forecast individuals' choices among product alternatives in the absence of revealed choices that can be observed in the real-world markets (Mangham et al. 2008. DCEs mirror the bundles of competing product and service alternatives that are found in real-wolrd markets such as wild-caught and farm-raised seafood, local and imported products and certified and non-certified products. Therefore, DCEs allow making assumptions about consumer willingness to pay for different product attributes and the extent to which individuals are willing to trade one product attribute for another (Drummond et al. 2005; Sackett 2012). Previous research suggests that the information about consumer preferences elicited using the revealed preference approach (the information collected by observing real-world transactions data) is the "gold standard" for learning about consumer behavior because it based on actual, rather than

hypothetical choices (Morikawa et al. 1994). However, conducting analysis based on real-world data may be challenging or impossible, especially when a larger sample is required, or when researchers are interested in consumer preferences for products that have not yet been introduced in the real-world markets (Sanko 2001). Although stated-preference DCEs are hypothetical in nature, they may still be an accurate and effective alternative way to predict consumer behavior (Verhoef and Frances 2003).

Previous studies have examined consumer preferences for seafood attributes with the help of choice experiments administered via online and in-person surveys of participants (Davidson et al. 2012; Tomic et al. 2017). In these studies, researchers combined the data from the online and in-person samples for a joint analysis of collected information. However, currently, very little is known about the differences in consumer decision-making in the contexts of the traditional and online seafood shopping experiences. As mentioned earlier, the online and face-to-face product presentation strategies place consumers in very different environments for decision-making process. Online and traditional shoppers may perceive differently certain aspects of their shopping experience including product attributes, pricing and level of task difficulty (Koyuncu & Lien, 2003). Yet, the lack of research about the differences in consumer responses to different ways of product presentation limits possibilities for effective choice architecture used for marketing of American seafood produce as well as for effective policy-making within the industry. Addressing such a gap may have an application beyond the context of the seafood industry and may enrich the body of knowledge about effective choice architecture in other food sectors.

1.2.1 Research question 1

Developing the U.S. seafood market and increasing the demand for domestic aquaculture produce is important for the national economy. Increasing aquaculture production in the U.S. would help reduce the U.S.' commercial seafood trade deficit of 11 billion dollars,

generate tens of thousands of new jobs in coastal areas, promote food security and restore struggling marine species and habitats (NOAA 2019). Over the past few decades, marine aquaculture has become a rapidly growing sector in the U.S., yet the industry has been facing a number of challenges due to development pressures and lack of public acceptance of aquaculture operations and products (U.S. Commission on Ocean Policy 2004; Bacher 2016). Given that the aquaculture sector is promoted as a sustainable alternative to wild-catch fisheries, the expansion of aquaculture operations in coastal communities may generate conflicts of interests, especially in areas with developed traditional fishing practices (Brennan 1999). Additionally, general public may associate aquaculture operations with negative environmental externalities such as diminished viewscape, noise, water pollution, etc (Whitmarsh & Seijo 2009).

Promoting the sustainable growth of domestic aquaculture implies the need to increase the supply of farm-raised seafood products while maintaining their relative prices constant (Kinnican et al. 2003). Such a change is unlikely to occur without improving public understanding and acceptance of the aquaculture industry and production processes. As noted in the National Oceanic and Atmospheric Administration (NOAA) Sea Grant's "10-Year Aquaculture Vision", a better understanding of consumer decision-making in the seafood market could be an important tool to help increase the demand for domestic aquaculture produce and thereby increase profitability of the U.S. aquaculture businesses (NOAA Sea Grant, 2016).

Past studies have made assumptions about consumer preferences for seafood products using consumers' willingness-to-pay values for product attributes such as certification status (sustainably certified vs. non-certified and organic vs. inorganic), product origin (local vs. imported from another state or abroad), method of production (wild-caught vs. farm-raised) and product price (Brayden et al., 2018; Quagrainie et al., 2008; Mauracher et al., 2013). Based on the review of past research, we have formulated hypotheses regarding Maine residents' preferences for the following attributes of seafood products: source of production (wild-caught

vs. farm-raised), origin (locally-produced vs. imported) and certification status (certified vs. non-certified). These hypotheses are presented below:

1.2.1.a Hypothesis 1

In the literature, there are mixed findings about consumers' self-reported preferences for wild-caught vs. farm-raised seafood. There have been a handful of studies conducted to examine consumer preferences for farm-raised and wild-caught seafood, and often, the preference for wild-caught seafood is considered to be a frequent and "typical" finding in the field (Rickertsen et al. 2017). Consumers may prefer wild-caught fish over farmed fish due to their perception that wild-caught products may be more ecologically sustainable, and have higher levels of nutritional value, taste and quality (Bacher 2016; Davidson et al. 2012). Additionally, some consumers choose wild-caught over farm-raised seafood products because they may associate farmed products with the potential for the use of growth hormones, antibiotics, and pesticides in fish farming (Bacher 2016).

Furthermore, previous studies have reported geographic variation in consumer preferences for seafood production source (Meas and Hu 2014; Zhou et al. 2016). Particularly, the residents of land-locked U.S. states such as Kentucky may have a higher level of acceptance towards farm-raised seafood (Zhou et al. 2016). There are a few potential explanations to this finding. First, people living in land-locked areas may be less familiar with seafood products in general and therefore, less likely to see significant differences in the taste or quality of wild-caught and farm-raised products (Zhou et al. 2016). Second, those living in land-locked areas may favor locally produced farm-raised seafood due to the belief that such products may be perceived as fresher than frozen wild-caught products transported from coastal areas (Roheim et al. 2012). In contrast, those living in coastal areas are more likely to prefer wild-caught products to farm-raised counterparts because they may associate wild-caught products with higher standards for taste and quality (Cardoso et al. 2013; Davidson et al. 2012; Ratliff 2017). Since

historically Maine has been known as a developed seafood market with high rates of seafood production and consumption, one may expect Mainers to prefer wild-caught products to farm-raised products.

1.2.1.b Hypothesis 2

There have been multiple studies about consumer preferences for certified and non-certified wild-caught and farm-raised products (Wessells et al. 1999; Haghiri 2014; Brayden et al. 2018). Past research shows that regardless of the source of production (wild-caught or farm-raised), consumers tend to favor certified seafood products as they associate such products with higher levels of product safety, environmental sustainability and quality control (Roheim et al. 2012). Interestingly, this finding suggests that consumers may lack familiarity with production processes utilized in wild-catch fisheries and aquaculture farms and may not recognize the differences between the standards for certification for wild-caught and farm-raised products (Roheim et al. 2012).

1.2.1.c Hypothesis 3

Generally, consumers tend to prefer local seafood, which could be largely explained by the preference for fresh over frozen seafood and the commitment to support local economy (Darby et al. 2008; Conner et al. 2010; Roheim et al. 2012). Additionally, locally produced seafood does not require transportation from producer to the market and therefore may be seen as more environmentally-friendly and associated with lower prices (Zepeda et al. 2004). Consistent with past research, we will define as "local" those seafood products that are produced within state borders (Darby et al. 2008; Meas et al. 2013; Hartman [remove G]2008).We will expect Mainers to pay a higher price for locally grown seafood due to the common belief that local produce may be fresher (compared to imported products that are more likely to be frozen before transportation), more sustainable, environmentally-friendly and associated with economic

growth of local communities (Chen et al. 2017; Yang & Leung 2016; Darby et al. 2008; Roheim et al. 2012).

1.2.2 Research Question 2

As mentioned above, in the first stage of our analysis, we are estimating consumer willingness-to-pay values for production source, origin and certification status separately for the online and in-person samples. In the second stage, we will compare the willingness-to-pay values from the two samples in order to learn about the effect of product presentation strategy on consumer choice.

1.2.2.a Hypothesis 4

Past research shows that product attributes could be divided into "hedonic" and "utilitarian" (Kakar 2017). Utilitarian attributes are associated with product functionality, practicality and represent user's cognitive and reasoned preferences (Wertenbroch & Dhar 2000; Kakar 2017). At the same time, hedonic attributes are associated with fun and aesthetics and represent users' affective and emotional preferences (Wertenbroch & Dhar 2000; Kakar 2017). Previous studies have shown that presenting products in a way that increases the vividness of consumer experience may enhance consumer preferences for hedonically superior choice alternatives and their willingness to pay for such alternatives as such presentation strategy may trigger consumers' emotional response (Roggeveen, 2015). In the context of our study, we may assume that if hedonic characteristics (wild-caught, local and certified) are preferred as favorable, these characteristics will be associated with higher willingness-to-pay values for the in-person sample due to the higher level of vividness associated with the in-person setting.

Furthermore, past research suggests that the impact of the vividness of product presentation on consumer preferences for hedonic products is positively correlated with consumers' level of familiarity with products and negatively correlated with the level of cognitive effort associated with decision-making process (Chau & Tam 2000). Consumers may

be more likely to choose hedonically superior goods when they are choosing in the environment that limits their access to "processing resources" such as time, attention and cognitive effort (Shiv & Fedorikhin 1999). In the context of our study, we expect consumers to have a relatively limited access to processing resources when making a choice in-person as opposed to online. The traditional in-person environment is more likely to inhibit one's cognitive abilities and limit processing resources due to the presence of distraction in the form of other people, the awareness of being observed (and therefore, respondents' desire to make socially responsible choices), the need to make choices quicker in order to let other respondents participate, etc. At the same time, in the online choice experiment, the respondents are likely to have a better access to processing resources thanks to a quieter setting, the lack of the need to make socially-, and environmentally-conscious choices (since other people may not observe the choice), the opportunity to take more time for decision-making, etc.). Thus, we may expect the respondents from the in-person group to have a higher willingness to pay for hedonically superior products due to the relatively more restricted availability of processing resources compared to the online shopping setting.

1.3 Empirical Model

A discrete choice model used in this study is based on the assumption that individuals are rational and select the products that maximize their utility (Farrell 1993). We will model participants' preferences with the help of a multinomial conditional logit model. This is a type of model that is widely used in marketing, psychology and public policy studies for analysis of polychotomous choice situations, "when a choice among alternatives is treated as a function of the characteristics of the alternatives, rather than (or in addition to) the characteristics of the individual making the choice" (Hoffman et al. 1998). The multinomial conditional logit model allows estimation of the relationship between the characteristics of various alternatives and individual choice among them. The conditional logit model allows grouping observations by blocks (e.g. by participant ID number) and thereby account for the fact that observations are not

independent within a block corresponding to the same individual. The model is based on the assumption that individuals derive utility from intrinsic characteristics (or attributes) of goods, rather than directly from the goods (Lancaster 1966). This assumption suggests that when facing a choice, individuals "rank collections of characteristics", and they thereby "rank collections of goods indirectly through the characteristics that the goods possess" (Lancaster 1966).

In our study, a separate conditional logit model is estimated for each choice scenario in order to learn about the variation in willingness to pay (WTP) values across three different seafood attributes (source of production, certification status and product origin) and two different samples (online and in-person). In the model, the utility U_{ij} that an individual *i* derives from selecting alternative *j* can be expressed as:

$$U_{ij}=\beta_i X_j+\varepsilon_{ij},$$

where X_j is a vector of observable seafood characteristics of alternative *j*;
β_i captures individual-level taste variation (individual *i*'s marginal utility for each attribute), and ε_{ij} is an independent and identically distributed random utility component capturing the unobserved component of individual utility (εij is Type 1 extreme values distribution).

Instead of estimating preference parameters in the attribute space, we estimate the model directly in the WTP space which implies that the distributions of coefficients are derived from the estimates of WTP distributions (Train & Weeks 2005). Estimating the model directly in the WTP space allows for smaller variances in WTP and therefore appears to be an optimal choice given the relatively small sizes of our study samples (N=72 for the online sample, and N=86 for the in-person sample), (Train & Weeks 2005; Sonnier et al. 2003). In our model, the price parameter is held constant. Dependent on the price of the product, the utility can be presented in the following form:

$U_{ij} = \beta_i X_j + \beta_p p + \varepsilon$ where X is a vector of observable characteristics of the product, and p is the price parameter.

The change in the value of the utility that an individual derives from the product could be presented as

$$\Delta U_{ij} = \beta \Delta X_j + \beta_p \Delta p + \varepsilon;$$

Conditional on observing β_i, the probability that an individual *i* selects alternative *j* takes the standard conditional logit form:

$$\Pr[Choice = j] = \frac{e^{\beta X_{ij}}}{\sum_{j=1}^{J} e^{\beta X_{ij}}};$$

The distribution of WTP for seafood product with product attributes X takes the form:

$$\frac{\Delta p}{\Delta x}|_{\Delta U=0} = -\frac{\beta}{\beta_p} = WTP;$$

$$U = -\beta_p \left(-\frac{\beta}{\beta_p} X + p\right) + \varepsilon;$$

If $\frac{\beta}{\beta_p} = \omega_x$, the the expression for utility in the WTP space takes the following form:

$$U = -\beta_p (\omega_x X + p) + \varepsilon .$$

1.4 Data

1.4.1 In-person choice experiment

The dataset was generated based on an in-person choice experiment (N=86) conducted at the University of Maine in Orono, Maine U.S. in July 2016. The in-person choice experiment simulated a shopping experience in which survey participants were asked to choose between two alternative seafood products of the same type but associated with different product attributes, with the option not to "purchase" either product.

Participants had to make five consecutive choices (since five seafood categories were used in the study). Each choice scenario included one type of seafood from the following: oysters, soft-shell clams, mussels, scallops, or seaweed salad. Participants were provided with handouts that contained the information on product attributes: source (wild-caught and farm-raised), certification (organic for farm-raised products, sustainably-harvested for wild-caught products, or non-certified), product origin (local, U.S.-produced, or imported), and price. During the experiment, the seafood products were laid out on the table in front of the participants. However, participants could not touch, smell, or taste the products. Product attributes that described each of the choice alternatives were listed on paper hand-outs provided to participants.

1.4.2 Online choice experiment

The online dataset was obtained through a nation-wide online survey conducted in July 2016 using Amazon's MTurk – a crowdsourcing marketplace platform that allows individuals and businesses to use human intelligence to perform tasks that computers are currently unable to do. The online choice experiment was designed using the Qualtrics survey platform. For the purposes of this study, we will only use the subset of participants who identified themselves as Maine residents (N=72). Similar to the in-person choice experiment, online participants were provided with choice scenarios that included the following seafood categories: oysters, soft-shell clams, mussels, scallops, and seaweed salad. Each product was described with the help of a picture and a list of attributes. Each individual saw 2 choice scenarios per each type of seafood – in total, 10 choice scenarios presented in a random order. Figure 1 in the appendix demonstrates a sample choice experiment scenario.

1.4.3. Description of product attributes in the choice experiment

During both the online and in-person choice experiments, participants were provided with definitions for "farm-raised" ("the product is cultivated in an ocean or river under

monitored conditions") and "wild-harvested" ("the product is taken from its natural habitat") (Brayden et al. 2018). Likewise, participants were provided with definitions for "organic" ("the product is certified as organic") and "sustainably harvested" ("the product is certified as harvested in a manner that considers the long-term vitality or well-being of the species, oceans and rivers) (Brayden et al. 2018). In the context of this study, only farm-raised seafood products were labeled as certified organic, and only wild-caught products were labeled as sustainably harvested. Furthermore, participants were given the definitions of three different categories of product origin: "imported" ("indicates that a product came from a country outside of the U.S."), "U.S." ("indicates that a product came from the U.S. water"), and "home state" ("indicates that a product came from the water of a participant's home state") (Brayden et al. 2018). Price was indicated in the U.S. dollars, representing the price per unit sold of the product (Brayden et al 2018). In the online and in-person choice experiments, price levels represented a two-standard deviation window specific for each seafood category: $1.00 for scallops, $0.50 for clams, mussels and seaweed salad, and $0.25 for oysters). The average price was determined based on the information about market prices collected during visits to multiple seafood stores across New England as well as using the information on online prices nationwide (Brayden et al. 2018). The average prices used for the online and in-person choice experiment were not statistically significant. Each product characteristic was randomized across products and choice scenarios.

At the data analysis stage of the study, the data indicating "neither" as a respondent's choice were dropped from the choice experiment, and responses across choice scenarios were treated as independent.

1.4.4 Comparison of samples

Both the online and in-person samples are Maine-based, and have been collected during the same time frame in order to minimize variance across the samples. The demographic comparison of the two samples has shown that the in-person sample is relatively older and

relatively better educated compared to the online sample. This means that in order to isolate the effect of product presentation strategy on consumer choice, we will need to control for the demographic differences between the samples.

1.5. Results

Table 4 provides the parameter estimates for the conditional logit model. These estimates represent the willingness-to-pay values for the source, certification and origin attributes for each of the five types of seafood products considered in the study. These values could be interpreted as premium values for wild-caught products (with farm-raised product prices being used as a base), certified products (with non-certified product prices being used as a base), and local products (with imported product prices being used as a base). All reported willingness-to-pay estimates are statistically significant at the 10% level or higher, except for the WTP values for certified clams (both in the online and in-person samples), the WTP value for wild-caught mussels (in the in-person sample), the WTP value for locally-produced oysters (in the online sample), and the WTP value for wild-caught seaweed salad (in the online sample). Since all premium values reported in the table 4 are positive, we may conclude that participants from both the online and in-person samples preferred wild-caught, local and certified products.

Table 5 presents the estimates for the t-tests on the difference between the reported willingness-to-pay values for seafood attributes in the online and in-person samples. The standard error values are reported in parentheses. The differences in premium estimates for wild-caught products are not statistically significant at the 10% level for clams, mussels, and oysters. However, the t-values are statistically significant for wild-caught scallops (at the 10% level) and wild-caught seaweed salad (at the 5% level). The differences in premium estimates for certified products are not statistically significant for any seafood category considered in the study. The differences in premiums for local products are not statistically significant for any seafood categories except for oysters where the t-value is significant at the 2.5% level. The information

from Table 5 allows to conclude that there is no statistically significant difference in consumer willingness-to-pay values between the in-person and online samples for any product attributes, except for the source of production in the case of scallops and seaweed salad, and the place of origin for oysters.

1.6. Discussion

This study contributes to the body of research on consumer behavior in the seafood market. The topic is especially relevant today given the efforts to promote the growth of aquaculture and develop effective methods for the analysis of consumer decision-making in response to different product presentation techniques. When interpreting the findings of the study, it is important to acknowledge several factors that may affect the interpretation of the results. This study was conducted using relatively small samples (N=72 for the online sample, and N=86 for the in-person sample) which has placed a number of constraints on the econometric analysis of the data. Furthermore, the differences in demographic characteristics between the online and in-person samples could be seen as a confounding factor in examining the effect of product presentation strategy on participants' decision-making process. The online sample is a representative of the state of Maine while the in-person sample includes only the participants of the Bangor area (Maine). Additionally, as the statistical comparison of the two samples shows, the participants from the in-person sample are relatively older and better educated compared to the participants from the online sample.

For both the online and in-person samples, premium values for wild-caught products are positive. This means that the participants from both samples were willing to pay more for wild-caught products. This is consistent with our hypothesis 1 that as residents of a coastal region, Mainers would favor wild-caught products over farm-raised counterparts. Likewise, all premium values for certified products are positive (Table 3). This means that the respondents from both the online and in-person samples preferred certified over non-certified seafood products. This is

consistent with our hypothesis 2 that consumers generally prefer certified seafood due to their belief that such products are associated with higher levels of quality and nutritional value. Consistent with our hypothesis 3, respondents from both the online and in-person samples were willing to pay a positive premium for locally-produced seafood (compared to products imported from other states within the U.S., or abroad). Participants' qualitative comments about their choices revealed that concerns about product freshness and nutrition quality, and the ecological impact of fish farming are some of the major drivers in consumer decision-making.

Our hypothesis 4 was only weakly supported by the results of this study. We have not observed a statistically significant difference in the premium values for consumers' preferred product characteristics between the online and in-person samples except for "wild-caught" in the case of scallops and seaweed salad and "local" in the case of oysters (Table 9). In these three cases, the respondents from the in-person sample reported higher willingness-to-pay values compared to the participants from the online sample.

The impact of consumer familiarity with the product on their decision-making process could be seen as a potential explanation to this finding. Indeed, the aquaculture practices used for the production of clams, oysters and mussels are widespread in Maine and are therefore relatively familiar to Maine seafood consumers. In fact, Maine is one of the leading states in the farming of clams, oysters and mussels, and Maine's supply of these types of seafood is projected to increase in the upcoming decades (GMRI 2016). At the same time, the aquaculture practices employed for the production of scallops may not be familiar to Maine residents because over 90% of Maine's scallop produce is coming from wild-catch fisheries (GMRI 2016). Likewise, the processes associated with the production of seaweed salad may not be familiar to Maine residents because the production volumes of seaweed salad (wild and aquaculture-grown) are relatively low in Maine (Redmond et al. 2015). Thus we may assume that Mainers may be

relatively more familiar with aquaculture-produced clams, mussels and oysters and less familiar with aquacultured scallops and seaweed salad.

Furthermore, historically, Maine oysters have been seen as produce of a superior quality due to the "high-quality perception of cold water oysters" and were sold at a premium compared to the oysters produced in other states. Therefore, Maine residents may be more familiar with locally-grown oysters, than imported oysters, and are likely to assign a higher value to local produce. (GMRI 2016).

As shown in previous studies in the food sector, the degree of familiarity with a product influences consumer behavior (Ha & Jang 2010). Particularly, hedonic characteristics may be more important to consumers with a lower degree of product familiarity compared to utilitarian characteristics (Ha & Jang 2010). This could be explained by the fact that consumers with a lower degree of familiarity are more likely to use extrinsic cues (such as certification status, place or origin, etc.) when making purchase decisions (Ha & Jang 2010). As the level of familiarity increases, consumers become less influenced by the hedonic characteristics of the product and base their decision-making on their past experience with the product (Ha & Jang 2010). Since "wild-caught" and "local" could be seen as preferred, hedonic characteristics in our study, we may expect these features to have a stronger impact on consumer decision-making when consumer level of familiarity is lower. Consistent with past research, the impact of hedonic features on consumer willingness to pay is likely to be intensified with increased vividness and experiential aspects of product presentation. Since the in-person presentation mode is associated with a more vivid product experience, in this setting we may expect consumers to report higher willingness to pay for the hedonic features of seafood products compared to the online sample.

1.7. Conclusion

The results of our study could have a direct application to the consumer behavior research in the food market and more specifically, to the research work conducted in the effort to promote sustainable aquaculture practices in Maine. Particularly, this study contributes to the body of knowledge about consumer preferences for seafood certification status and product origin – the areas that are still underdeveloped in the aquaculture sector (Brayden et al. 2017). Using the results of this study, we may conclude that developing labeling practices in the aquaculture sector may help improve the efficiency of aquaculture products marketing and make aquaculture products more competitive.

Furthermore, the finding that the vividness of product presentation strategy may affect consumer attitudes towards unfamiliar products may benefit the effort to raise competitiveness of the aquaculture industry. This may be especially relevant for marketing of seafood products that are still supplied mostly from wildcatch fisheries.

Further research should be conducted in order to gain a better understanding of the effect of product presentation on consumer decision-making. To improve the reliability of the results, it is important to use larger samples in order to achieve a higher level of statistical significance of estimates. Additionally, it would be important to use the samples that would be identical in terms of geographic and demographic characteristics. This would allow achieving the condition of *ceteris paribus* and isolating the impact of product presentation strategy on consumer decision-making. At the same time, the results obtained in our pilot study as well as lessons learned about the methodology employed in our work could be useful for effective design of future studies about consumer behavior in the seafood market.

CHAPTER 2
CITIZENS' PREFERENCES FOR COASTAL USAGE: STATED PREFERENCE ANALYSIS

2.1 Introduction

Global population growth and economic development led to the expansion in the commercial, residential and tourist sectors and increased demand for coastal infrastructure (Bulleri & Chapman 2010). Consistent with the global trend, Maine's coastal infrastructure has been rapidly changing over the past few decades due to the development of aquaculture and wild-catch fisheries, expansion of the transportation system, tourism, recreational and nature conservation areas, construction of new housing communities and power production operations. Aquaculture has been one of the fastest growing sectors that has transformed the environmental, economic and social outlook of Maine's coastal areas. Although the delivered landed value of the aquaculture industry to Maine's economy was estimated to be only about $6.5 million in 2016, there is a potential to significantly accelerate growth and to organically grow the landed value to over $30 million by 2030 (Gulf of Maine Research Institute 2016).

Coastal zones are very complex socio-economic and ecological systems, and human interventions in such systems may have long-term effects on local ecology, marine resources and coastal residents' welfare (White et al. 2007). The expansion of coastal infrastructure introduces new socio-economic and environmental risks including the increasing demand for regulation of coastal zones, increasing pressure on coastal biodiversity, higher rates of near-shore water pollution and overharvesting of marine species (Bulleri & Chapman 2010; Naylor et al. 2012; Evans et al. 2017).

A deep understanding of different components of coastal socio-ecological systems and their interactions would help promote effective coastal planning and alleviate some of the sustainability issues associated with coastal areas (Delgado-Serrano & Ramos 2015; Luisetti et al. 2014). Given the growing scarcity of coastal land and resources, especially in the areas that

are most favorable for development of new infrastructure projects, informed coastal planning and management could be a solution to potential conflicts of interests between different sectors and different population groups (Tol et al. 1995). With about 40% of Americans living in counties directly on the shoreline, learning about public preferences for different types of coastal usage and coastal infrastructure could be important in order to promote coastal management programs that would be accepted and supported by different groups of population (NOAA 2013; Evans et al. 2017).

Over the last few decades, aquaculture has been the fastest growing food-production sector in the world and one of the major drivers of coastal infrastructure change (Subasinghe et al. 2009). By supplying nutritious products that are high in protein, vitamins and amino acids, aquaculture is expected to play a major role in promoting global food safety and security in the future (Subasinghe et al. 2009). Besides improved food security, the expansion of domestic aquaculture in the U.S. may carry other significant environmental and socio-economic benefits. The expansion of aquaculture may help create jobs in coastal areas, reduce the U.S. seafood trade deficit of 12 billion dollars, and protect struggling marine species and habitats (NOAA 2016). At the same time, the initiatives to expand aquaculture operations often lack support within coastal communities due to public perceptions that aquaculture operations may be associated with nutritional risks, lower quality of feed and the use of antibiotics as well as negative environmental externalities such as detrimental effects on ocean and shore ecology, water pollution, and noise from farm operators (Murray and D'Anna 2015). The lack of public acceptance of and support for aquaculture may impede the development of the industry by lowering the sales volumes of aquaculture products and raising community resistance towards the development of aquaculture-related infrastructure along the coast (Mazur 2004).

This paper uses an online choice experiment of Maine coastal residents to examine citizens' preferences for alternate forms of coastal development related to food production, particularly, aquaculture and commercial harvest. The U.S. is among countries with the highest

potential for development of aquaculture and could expect to see the rapid transformation of coastal infrastructure due to aquaculture operations in the upcoming years (Knapp & Rubino 2016). Learning about public preferences for aquaculture is important in order to facilitate effective policy-making within the industry and ensure its sustainable development. Learning about public preferences for aquaculture and traditional coastal fishing allows for comparison of the attitudes towards the emerging aquaculture industry and the traditional mode of seafood production which may still be seen as "the status quo" in seafood communities.
Given that the trends of growing coastal population and expanding aquaculture practices are typical for the majority of the U.S.' coastal regions (Subasinghe et al. 2009; NOAA 2013), the findings of our study could be useful beyond the context of Maine.

2.2. Background and Research Hypothesis

The goal of this study is to elicit public preferences for different types of coastal usage by examining the economic impact of coastal infrastructure on residential property values in coastal areas. In particular, we are interested in the following types of coastal usage: aquaculture, areas of coastal fishing and undeveloped coastal areas. The choice of these three types of coastal usage could be explained by the growing research interest in understanding public perceptions and acceptance of the aquaculture industry that is expected to play a major role in Maine's economic development in the upcoming decades as well as the interest in comparing citizens' attitudes towards aquaculture and traditional coastal fishing activities. In 2015, there were 107 aquaculture business entities in Maine that included marine grow-out farms, marine hatcheries, freshwater grow-out farms, freshwater hatcheries, landbased aquaculture, and aquaponics (University of Maine Aquaculture Research Institute 2017). The average acreage held by an aquaculture business entity was approximately 14.3 acres with the majority of businesses holding Limited Purpose Aquaculture Licenses (LPAs) (University of Maine Aquaculture Research Institute 2017). In 2017, Maine's aquaculture had the economic impact of $73.4 million in

output, 571 in employment, and $35.7 million in labor income, and this impact is expected to increase in the future (University of Maine Aquaculture Research Institute 2017).

Despite favorable geographic and environmental conditions, the aquaculture industry has been growing slower in Maine than in other parts of the U.S. and the world (Conkling 2000). Current regulatory environment and the lack of public support for aquaculture are some of the major factors impeding the growth of aquaculture in the U.S. Northeast and in Maine (Conkling 2000; Duff et al. 2003). In Maine, public hearings are required in order for an aquaculture lease to be approved. The fact that the input of public opinion is important to successful implementation of coastal management programs and policies in Maine implies that increasing public support for the industry may have a meaningful positive impact on its development. On the contrary, the lack of public support may prevent an aquaculture entrepreneur from obtaining a lease and thereby, over time discourage future investments in aquaculture within this industry sector or in a given geographic area (Brennan 1999). Informing industry stakeholders and policy-makers of public perceptions of, and preferences for aquaculture in the time of the industry's rapid growth and development may help design policies that will be supported by coastal population.

In our study, we employ the stated preference approach that mimics the revealed-preference hedonic pricing analysis, and particularly, the hedonic property model, that is a popular technique for valuation of environmental and infrastructure amenities and disamenities (Rosen 1974; Ready et al. 2003; Huggett et al. 2008). To provide background, the hedonic method is based on the assumption that consumers treat goods as "packages of characteristics" and that the utility that consumers derive from goods could be seen as a sum of utilities associated with each attribute of the good (Rosen 1974). Each characteristic of the product has an implicit price that can be revealed to researchers using differentiated products with specific amounts of characteristics associated with each product (Rosen 1974). In the hedonic pricing

model, each class of differentiated products is described by a vector of objectively measured characteristics (Rosen 1974).

The hedonic property model allows observing how the price of property changes in response to the change in one of its characteristics, when other characteristics are held constant (Huggett et al. 2008). Observing purchasing decisions made by households in the market for houses with differing portfolios of characteristics and prices allows elicitation of the marginal willingness to pay (MWTP) values for an additional unit of each housing characteristic (Huggett et al. 2008). Particularly, according to the hedonic property model, a housing alternative could be decribed as a combination of neighborhood, structural and environmental attributes (Freeman 2003). Neighborhood attributes include locational and socio-economic characteristics such as median income, population density, crime rate, etc. Structural characteristics may include the age of the house, interior square footage, number of bathrooms, lot size, and others (Lupi et al., 1991; Do and Grudnitski, 1995; Thorsnes, 2002). Environmental characteristics usually include environmental or infrastructure amenities and disamenities that are located within proximity to the house (Huggett et al. 2008; WERF 2008).

Unlike hedonic analysis that is based on real-world data, our study employs the discrete choice experiment (DCE) method to elicit the impact of residential property's proximity to different types of coastal infrastructure on property values. DCEs are a stated preferences method that is commonly used in environmental economics for elicitation of public preferences for environmental amenities and disamenities (Hoyos 2010). Discrete choice experiments that mimic the revealed-preference hedonic property model provide participants with a set of housing alternatives described by a list of housing attributes and ask participants to choose from a set of alternatives (Earnhart 2001; Sackett 2012). The price of each choice experiment alternative is assumed to be a function of its characteristics (Earnhart 2001; Sackett 2012).

Previous research suggests that although the information elicited using the stated preference approach is hypothetical in nature, it could be a reliable predictor of consumers' real-

world behavior (Verhoef & Franses 2003). Although the discrete choice and hedonic frameworks serve to model a similar selection process, they assume different economic models and treat the utility function differently. Unlike the hedonic pricing model, discrete choice experiments do not assume the existence of market equilibrium. While the hedonic framework assumes that marginal prices are endogenous and depend on the levels of attributes consumed, in the discrete choice framework, prices are exogenous and imposed by researchers. This allows reducing errors in measuring marginal prices, if the utility function is specified correctly (Cropper et al. 1993). To the best of our knowledge, no previous study has been done to elicit Maine residents' stated preferences for different types of coastal usage.

2.2.1. Hypothesis

Although aquaculture has been practiced in the Gulf of Maine for over a century (including both finfish and shellfish culture) marine aquaculture as an industry, is relatively new to the state and is believed to have been started in the early 1970s (Brennan 1999). Many Mainers are still reluctant to expansion of the aquaculture industry due to environmental and cultural reasons as well as to the idea of transforming Maine's coastline for controlled modes of production in coastal waters (Conkling 2000). This could be explained by the fact that for many decades, Maine has been known as an established market for high-quality wild-caught seafood. Even today, despite downturns in traditional coastal fisheries caused by the depletion of marine species and habitats, very few fishermen choose to shift to aquaculture, largely due to barriers caused by the aquaculture industry's entry and operation costs as well as high level of competition in the sector (Asche & Tveteras 2009). Given the fact that in the aquaculture sector, firms with larger financial resources often gain competitive advantage by having access to more efficient production and processing technologies, higher-quality feed, and better transportation and equipment, starting a business in the aquaculture sector may be very challenging for businessmen with insufficient financial resources (Asche & Tveteras 2009) Historically,

Maine's wildcatch fisheries owners (particularly, lobstermen) have been politically active and played an important role in the formulation of the state's coastal zoning regulations and coastal management programs. As the aquaculture industry could be seen as a competitor for the wildcatch fisheries sector, the lack of public support for aquaculture is a tangible problem in Maine where some of coastal communities have traditionally been fishing communities (Conkling 2000).

The expansion of aquaculture may introduce tensions and conflicts of interests into coastal communities (Marshall 2001). Aquaculture stakeholders may look for opportunities to gain more control over the usage of coastal areas and contribute to the establishment of new coastal property regimes and ownership patterns that would benefit aquaculture businesses (Marshall 2001). For example, the introduction of licenses and quotas that seems to be necessary to efficiently regulate aquaculture activity on the coast may also be seen as a constraint for wild-catch fisheries as it may limit access to common fishery resources (Marshall 2001).

Furthermore in small coastal communities, aquaculture operations that are often owned by large domestic or international aquaculture firms may be perceived as a threat to local culture where family-owned wild-catch fisheries have operated for decades (Marshall 2001). In such circumstances, citizens' negative perceptions towards aquaculture may be associated with the fear of potential issues that aquaculture may bring to coastal communities, rather than with the direct negative impact of aquaculture sites on coastal residents' experiences.

Additionally, negative attitudes towards aquaculture may come from Maine residents that purchase residential property in coastal areas to have the opportunity to enjoy scenic coastal views and access to coastal and water recreation (Conkling 2000). Therefore, Maine's coastal residents may be opposed to aquaculture development because the aesthetic impact of aquaculture operations may negatively affect their coastal experience as well as lower the value of coastal property located within proximity to aquaculture operations.

Therefore, since undeveloped coastal areas may be perceived as the most aesthetically pleasing and may provide more room for coastal recreation compared to the coastal fishing and aquaculture areas, we may expect the participants of our survey to choose undeveloped coastal areas as their preferred coastal feature. Furthermore, since historically, the coastal fishing activity has been better known and more accepted in the region, we may expect the participants of our choice experiment to choose coastal fishing areas are their second-preferred coastal feature with aquaculture being the least preferred.

Additionally, our study will examine the effect of residence proximity to the ocean on respondents' preferences for different types of coastal usage. The question is underexplored, yet it is especially relevant today, at the time of accelerated gentrification of Maine's coast (Thompson 2016). Depending on household proximity to the ocean, citizens may have different information about, and different attitudes towards coastal infrastructure. Additionally, depending on past experiences, citizens may value differently the access to the ocean from their property. Past research suggests that in Maine's coastal communities, many community members, including fishermen, have lost access to the ocean due to gentrification. Therefore, the question of the effect of household proximity to the ocean on citizens' preferences for different types of coastal usage may reflect cultural changes in coastal communities and attitudinal responses to socio-economic conflicts of interests caused by gentrification (Thompson 2016).

Although this goes beyond the scope of this study, in the future, it would be interesting to compare the differences in Maine citizens' stated and revealed preferences for proximity of coastal property to aquaculture operations as well as the potential changes in such preferences over time.

2.3. Empirical Model

Consistent with theory, this study employs the random utility framework to model individuals' choices. We base our model on the core assumptions that (1) consumers are rational

agents and seek to maximize their utility and (2) that consumers perceive a product as a bundle (or vector) of attributes and that by ranking the attributes, consumers choose the bundles that provides them with the highest level of utility (Farrel 1993; Lancaster 1966). According to the random utility framework, an individual *n* chooses a housing alternative that yields the highest utility of all alternatives in the feasible set K_n (Cardell 1989; Earnhart 2002). We use the framework for analysis of individuals' discrete choices of housing alternatives that was suggested by Earnhart in his study about the comparison of revealed and stated preference approaches for analysis of consumer decision-making regarding house purchases (2002). In the model, the overall utility U_{in} that an individual *n* derives from selecting the housing alternative i can be expressed in the following form:

$U_{in} = V_{in} + e_{in}$ where V_{in} is a sum of the deterministic component and e_{in} is the sum of a random component. V_{in} could be interpreted as an indirect utility function conditional on the vector of observed housing attributes Z_i, the monthly mortgage payment associated with the housing alternative P_i, and parameter vector β. Therefore, the deterministic component of an individual's utility function takes the following form:

$V_{in} = V(P_i, Z_i, \beta)$.

Employing the assumption that the error terms in an individual's utility model are independently and identically distributed with the scale parameter μ, we obtain the following expression of probability that an individual *n* chooses housing alternative *i* rather than *j*:

$\pi_n(i) = P(V_{in} + e_{in} \geq V_{jn} + e_{jn} : \forall j \in K_n) = \exp(\mu V_{in}) / \sum_{j \in K} \exp(\mu V_{jn})$.

Although the estimation of the model does not allow identifying μ, it allows identifying the product $\mu\beta$ which is sufficient to further calculate the WTP value associated with each housing option as a function of attribute coefficient and price (monthly mortgage payment) for each housing alternative (Scarpa and Rose 2008).

$$\frac{\Delta p}{\Delta x} = \frac{\beta_k}{\beta_{price}} = WTP$$

Since we use nine types of coastal usage in our choice experiment, we compute WTP values for eight types of coastal usage with the "Undeveloped - Undeveloped" type being used as the base for comparison. We estimate two conditional logit models: with and without the interaction between the coastal feature and ocean variables.

2.4. Data

This dataset is based on the sample of 245 Maine coastal residents that participated in an online survey in January and February 2019. The sample was based on an online survey, and the link to the survey was mailed to 6,000 coastal Maine addresses. 3,000 addresses were provided to us by Maine Multiple Listing Service (MMLS) and represented Maine homeowners that purchased their homes between 2012-2014. The other 3,000 addresses were obtained through the Inforgroup database and represented Maine homeowners that purchased their homes between 2015-2018. At the beginning of March, we had 270 responses recorded which was equivalent to 4.5% response rate. Furthermore, 25 observations with the reported household income level below $35,000 were removed from the analysis. This allowed controlling for the fact that participants' reported willingness to pay values for home lot alternatives constituted at most 35% of their annual household income. Although removing the group of low-income participants was necessary given the study's choice experiment design, this has created sampling bias in the analysis that needs to be accounted for when interpreting the results of our work. Since the selection of addresses was random, households were more likely to be located in areas with higher population density. As a result, approaximately half of observations in our sample of 245 residents were coming from Southern Maine. The characteristics of the sample described above should be accounted for when considering generalizability of the study.

The survey was administered via the online platform Qualtrics and included five different sections. The choice experiment was included in the second section. The choice experiment consisted of 3 independent choice scenarios that each asked participants to choose from a set of

four home lots alternatives. Each choice scenario was presented on a new webpage to ensure independence (or minimize the correlation) in responses among different choice scenarios. Each choice scenario included 4 choice alternatives. Each choice alternative consisted of (1) the name of the current feature associated with the house ("Aquaculture", "Coastal fishing", or "Undeveloped"); (2) an image representing the coastal feature within proximity to the house; (3) the "duration" variable representing the number of years before any changes to the coastal feature take place, (4) the name of the "new feature" representing the coastal feature that will replace the "base feature" at the end of the time period indicated in the duration variable ("Aquaculture", "Coastal fishing", or "Undeveloped"), (5) an image representing the coastal feature within proximity to the house, and (6) "monthly payments" that represented the monthly mortgage payment associated with the house and were based on a 15-year mortgage (Figure 2). We chose $1200, $1800 and $2300 as monthly mortgage payment amounts because these values are near the first, second and third quartiles of monthly mortgage payments in Maine's housing market (source?). The choice experiment was coded using the JavaScript programming language in such a way that no more than two of the same coastal features could appear in the choice experiment at the same time.

In order to account for the rapidly-changing nature of coastal infrastructure, similar to Earnhart (2006), we are employing the concept of duration in our choice experiment. As noted earlier, duration represents the time period between the current coastal feature and future coastal feature. Employing two coastal features associated with each house and introducing the concept of duration to our choice design allows controlling for the effect that infrastructure change may have on citizens' willingness to pay for a house. Furthermore, following Earnhart (2006), we vary the baseline feature within bins and across the sample in order to remove the possibility of anchoring bias.

We created efficient choice design for our choice experiment in STATA and generated 36 possible choice alternatives. These choice alternatives were divided into three bins, 12 choice

alternatives per bin. Within each bin, we created three possible combinations of choice alternatives (four choice alternatives per scenario) in order to ensure the presence of trade-offs between attributes of choice alternatives. The sample of survey participants was divided into three bins where each bin was associated with twelve unique housing alternatives. The order of choice scenarios and the order of choice alternatives within choice scenarios were completely randomized across participants within each of the three bins.

Since the choice experiment in our study asked participants to choose from a set of homes with the yearly mortgage payment amounts equivalent to $14,400, $21,600, and $27,600, we only used the subset of participants with the reported yearly income equal to, or above $35,000 (N=245). [Compare with coastal Maine] The demographic analysis of the study sample has shown that survey participants were richer and relatively more educated compared to an average Maine resident. Particularly, the "average" respondent in the sample is 50.9 years old while the mean age of Maine population is 44.5 years of age (World Population Review 2019). Additionally, although in the state of Maine, only 29.3% of population have completed a bachelor's degree or higher (Statistical Atlas 2019), in our sample, 89.29% of respondents have at least a bachelor's degree. Therefore, our sample should not be seen as a representative of Maine's population (Table 10). Maine's coastal population is likely to be richer and more educated compared to the overall population of the state of Maine and would therefore be more similar to the sample used for this study.

To answer our second research question about the impact of property proximity to the ocean, we used the data elicited from our survey that asked whether participants: (1) Can see the ocean from the address to which the survey was mailed; (2) Can access the ocean from the address to which the survey was mailed; (3) Can see the ocean from another owned property; (4) Can access the ocean from another owned property; (5) Neither can see nor access the ocean from any of their properties. Based on their responses to this question, participants were divided into two groups: (1) those that reported being able to see or having access to the ocean from the

property where they reside, or any other property that they own (N=158), and (2) those that reported not being able to see or having no access to the ocean from any of their properties (N=87). It is important to note that these two groups of respondents are characterized by slightly different age, gender and income distributions, but are similar in their education characteristics (Tables 13-16).

2.5 Results

Tables 11 and 17 provide the output for the conditional logit models estimated with and without the interaction terms between the coastal feature variable and the ocean variable. In the model with no interaction terms, the coastal feature "Undeveloped - Undeveloped" is being used as a base for comparison. In the model with no interaction terms included, "Undeveloped-Undeveloped" with "Access to ocean"=0 is being used as a base for comparison. Tables 12 and 18 provide willingness to pay (WTP) estimates for models with and without interaction terms, respectively. These WTP values could be interpreted as premium values that respondents are willing to pay for the following combinations of coastal features: (1) "Aquaculture - Aquaculture", (2) "Aquaculture - Coastal Fishing", (3) "Aquaculture - Undeveloped", (4) "Coastal Fishing - Aquaculture", (5) "Coastal Fishing - Coastal Fishing", (6) "Coastal fishing - Undeveloped", (7) "Undeveloped - Aquaculture", and (8) "Undeveloped - Coastal Fishing". In each combination, the first feature represents the "current coastal feature" in the choice experiment, and the second feature represents the "new coastal feature" in the choice experiment. The "Undeveloped - Undeveloped" combination is used as a base for comparison in all three models.

In both the model with interaction terms and the model without interaction terms, price coefficients are negative and statistically significant at 1% which means that in both models, we observe a negative relationship between price and the probability of respondents' choice (Tables 11 and 17). Furthermore, in the model with no interaction effects, the coefficients for all coastal

features are negative and statistically significant at 10%. WTP values reported in Table 12 are all negative which means that respondents preferred the "Undeveloped – Undeveloped" feature over all other features in the model. Interestingly, the pairs of coastal features that include "Aquaculture" as either the base feature or the new feature generate negative WTP values that are larger in their absolute value than to the rest of the features. This result is consistent with our hypothesis that undeveloped coastal areas would be the preferred feature among the participants of the choice experiment, coastal fishing areas would be the second preferred feature, and aquaculture would be the least preferred feature. It is important to note that reported WTP values are significantly larger than expected based on literature review (Earnhart 2002, Earnhart 2006; Table 12). The potential causes of inflated WTP values will be discussed in the discussion section of this paper.

In the model estimated with interaction terms between the coastal feature and the ocean variable, the coefficients are negative for all interaction terms, except for "Undeveloped – Undeveloped" #(Ocean=1) (Table 17). This means that for both the respondents who had access to ocean from their homes and the respondents who did not, "Undeveloped – Undeveloped" was a preferred feature and that the respondents that had access to ocean were willing to pay more for this feature. In the model with interaction terms, all coefficients are statistically significant at 10% level or higher except for "Coastal Fishing" for both groups (the respondents that had and those that did not have access to ocean), as well as the "Undeveloped – Undeveloped" feature for those respondents that had access to ocean. Similar to the model without interaction terms, our estimated WTP values are significantly larger than it would be expected based on review of past research (Table 18).

Comparison of the WTP values for different coastal features reported by the group with access to ocean and the group without access to ocean differ significantly for certain coastal features (Table 18). As an example, for "Aquaculture-Aquaculture", the group with access to ocean reports the WTP value of --$563.39 while the group without access to ocean reports the

WTP value of -$831.69 which is a difference of -47% if the former is used as a base for comparison. Qualitatively, the direction of change in WTP values between the group with access to ocean and the group with no access to ocean seems to be uncorrelated with the presence of a particular coastal feature (Aquaculture, Undeveloped or Coastal Fishing) in the choice alternative. Further work would be needed to study the differences between the WTP values of the two groups.

The duration feature did not seem to have a significant effect on the WTP values for coastal features neither in the model with interaction terms, nor in the model without interaction terms (Table 17). Our robustness check confirmed that there are no significant effects of duration on respondents' WTP values, which is consistent with Earnhart (2006).

2.6 Discussion

This study contributes to the body of knowledge about the use of discrete choice experiments for elicitation of citizens' stated preferences for different types of coastal usage. This topic is relevant today given the rapidly-changing coastal infrastructure in many U.S. regions and the efforts of policy-makers and stakeholders to find time-, and cost-effective ways to understand citizens' perceptions and preferences related to such changes.

It is important to acknowledge a number of limitations in the design of the choice experiment used in this study, and the data obtained for analysis. First of all, the results of the study should be interpreted qualitatively rather than quantitatively due to the inflated WTP values obtained from the estimated model. As it was explained in the methods section, the choice experiment provided participants with housing alternatives that were identical in all characteristics except for coastal features, duration and monthly mortgage payments. Therefore, the variation of monthly mortgage payment amounts in the choice experiment is reflected solely in respondents' willingness to pay for a coastal feature and duration associated with each alternative. Although monthly mortgage payment levels used in the study ($1200; $1800, and

$2300) are based on the distribution of monthly mortgage payments typical for Maine's housing market, reflecting the variation in these amounts in coastal feature WTP values only leads us to obtain very large WTP values. Therefore, one of the key takeaways from this study is that in discrete choice experiments mimicking hedonic property analysis, it is necessary to include several levels across multiple housing attributes. This would allow introducing trade-off between different housing attributes and ensuring that the exogenous variation in housing prices is absorbed in several attributes as opposed to only the attribute of interest. Such conclusion is supported by Earnhart (2006) who states that while an individual's socio-economic characteristics may not have a statistically significant effect on their marginal WTP for environmental features (with the exception of the effect of income level which will be discussed below), housing attributes such as age, interior space and others may significantly impact WTP values.

Additionally, past research shows that high-income individuals may report significantly higher WTP values for environmental and infrastructure features compared to mid-, and low-income individuals (Earnhart 2006). As noted earlier, our sample is richer, and better-educated compared to Maine's coastal population. Such sample may contribute to the inflation of WTP values obtained in the study.

2.7. Conclusion

The findings of this study could be useful for stakeholders and policy-makers that work to promote effective and sustainable coastal management programs in Maine. Particularly, learning about that citizens have a higher level of acceptance towards undeveloped coastal areas and areas of coastal fishing activity could be a starting point for further research about causes of citizens' negative perceptions of aquaculture. Some citizens may exhibit lower levels of acceptance towards the aquaculture industry due to their past experiences of living or recreating within proximity to aquaculture operations while others may form their opinions and perceptions based the information about aquaculture obtained from media sources and other community

members. Revealing and addressing the causes of negative attitudes towards aquaculture operations would be important to ensure effective and sustainable development of the industry.

Although this study carries a number of limitations due to sampling bias and challenges in choice experiment design, the takeways and lessons learned over the course of this work could be helpful for researchers and analysts working to develop effective research approaches for effective elicitation of citizens' preferences for environmental and infrastructure amenities and disamenities. Advancing knowledge about efficient choice design in the field of environmental economics would help to raise effectiveness and accuracy of techniques used to measure citizens' preferences for different types of environmental features. These methods may gain importance in the future as governmental agencies and stakeholders begin to recognize that public input into policy decisions may be necessary in order to develop policies and programs that would ensure sustainable development of the industry (Evans et al. 2017).

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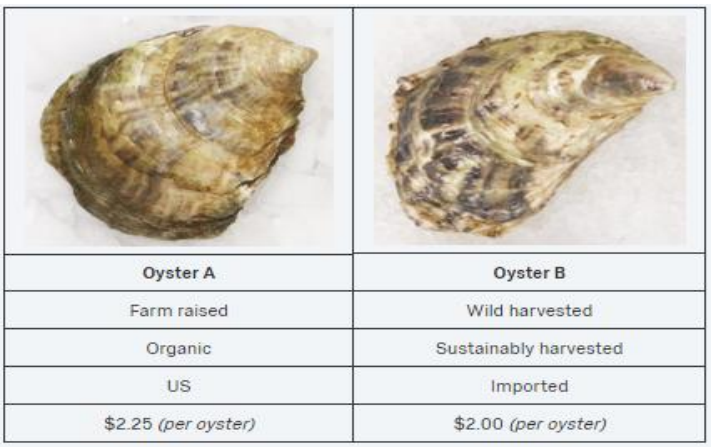
APPENDIX

Figure 1. Example of a choice alternative in the online choice experiment.



Oyster A	Oyster B
Farm raised	Wild harvested
Organic	Sustainably harvested
US	Imported
$2.25 *(per oyster)*	$2.00 *(per oyster)*

Table 1. Sample demographics. Online choice experiment sample (N=72) of Maine residents and in-person choice experiment sample (N=86) of Maine residents.

Variable	**Online sample**	**In-person sample**
Age		
<18	1%	-
18-25	22%	23%
26-34	32%	18%
35-54	39%	31%
55-64	1%	21%
65+	6%	6%
Gender (male)	38.89%	38.55%
Years in state (mean)	25.4	27.9
Education		
Some high school	<1%	1.18
HS Diploma/GED	34.72%	35.29
Associate's Degree	25%	9.41
Bachelor's Degree	31.94%	31.76
Master's degree	8.33%	15.29
Doctorate	<1%	7.06

Table 2: Test on the difference in age characteristics of the online and in-person samples.

	In-Person Sample		**Online Sample**	
Age category	**Actual Frequency**	**Expected Frequency**	**Actual Frequency**	**Expected Frequency**
>18	1	0.5	0	0.46
18-25	20	19.6	16	16.4
25-34	15	20.7	23	17.3
35-54	27	29.9	28	25.1
55-64	18	10.3	1	8.7
65+	5	4.9	4	4.1
Total	86		72	

$$\chi 2=\sum\frac{(actual-expected)^2}{expected}=17.5$$

Degrees of freedom (DOF)=5. The $\chi 2$ value is significant at the 1% level (which is larger than the table value=15.9 for DOF=5). We may conclude that there is a statistically significant difference in age characteristics between the in-person and online samples.

Table 3. Test on the difference in education characteristics of the online and in-person samples.

	In-Person Sample		**Online Sample**	
Edu category	**Actual Frequency**	**Expected Frequency**	**Actual Frequency**	**Expected Frequency**
Some high school	2	1.1	0	0.9
HS Diploma/GED	30	29.9	25	25
Associate's Degree	8	14.2	18	11.8
Bachelor's Degree	27	27.2	23	22.8
Master's Degree	13	10.3	6	8.7
Doctorate	6	3.3	0	2.7

Table 3 (cont.)

Total	86		72	

$$\chi 2=\sum\frac{(actual-expected^2)}{expected}=14.08$$

Degrees of freedom (DOF)=5. The $\chi 2$ value is significant at the 5% level (which is larger than the table value=11.07 for DOF=5). We may conclude that there is a statistically significant difference in education characteristics between the in-person and online samples.

Table 4. Comparison of gender proportions in the online and in-person samples. Standard errors are reported in the parentheses.

Gender	Online sample	In-person sample
Male	0.3888889 (0.4876109)	0.3855422 (0.4868209)

t=0.006

We may conclude that there is no statistically significant difference between the gender proportions in the online and in-person samples.

Table 5. Comparison of "years in state" mean values in the online and in-person samples. Standard errors are reported in the parentheses.

	Online sample	In-person sample
Years in state	25.43056 (13.66559)	27.8869 (17.45703)

t=0.11

We may conclude that there is no statistically significant difference between the mean number of years values lived in the state in the online and in-person samples.

Table 6. Comparison of mean sample price values for seafood categories in the online and in-person samples. Standard deviation values for the mean values are reported in the parentheses.

Type of Seafood	**Online Sample**	**In-person Sample**
Oysters	$3.69 (2.671)	$3.66 (2.662)
Clams	$2.35 (1.762)	$2.32 (1.735)
Mussels	$1.17 (0.875)	$1.17 (0.875)
Scallops	$15.28 (10.882)	$15.33 (10.911)
Seaweed salad	$2.33 (1.748)	$2.34 (1.748)

Table 7. Product attribute levels used for the online and in-person choice experiment.

Attribute	**Levels (one per product)**
SOURCE	Farm-raised; wild-harvested
CERTIFICATION	Certified (organically certified or sustainably-harvested); non-certified
ORIGIN	Local (produced in Maine); imported (from another state or abroad)
PRICE: Oysters (per oyster)	$1.25 - $2.25 ($0.25 increments)
PRICE: Clams (per 1 lb. clams)	$4.50-$6.50 ($0.50 increments)
PRICE: Mussels (per 1 lb. mussels)	$2.50-$4.50 ($0.50 increments)
PRICE: Scallops (per 1 lb. scallops)	$21.00-$25.00 ($1.00 increments)
PRICE: Seaweed Salad (per salad	$2.50-$4.50 ($0.50 increments)

Table 8. Conditional logit model estimates (premium values in U.S. dollars) for the online and in-person samples with the base of SOURCE=”farm-raised”, CERTIFICATION=”non-certified”, and ORIGIN=”imported”. Standard errors are reported in parentheses.

	SOURCE		**CERTIFICATION**		**ORIGIN**	
Seafood type	**Online (1)**	**In-person (2)**	**Online (3)**	**In-Person (4)**	**Online (5)**	**In-Person (6)**
Clams	0.81** (0.327)	0.83** (0.358)	0.02 (0.367)	0.40 (0.291)	1.70*** (0.357)	2.35*** (0.411)
Mussels	0.80** (0.373)	0.36 (0.323)	0.76** (0.327)	0.46* (0.261)	1.51*** (0.412)	1.73*** (0.357)
Oysters	0.53** (0.271)	1.4*** (0.363)	0.73** (0.295)	0.62** (0.264)	0.25 (0.400)	1.66*** (0.293)
Scallops	1.53*** (0.442)	2.47*** (0.536)	0.99** (0.440)	1.64** (0.370)	3.18*** (0.512)	3.71*** (0.548)
Seaweed salad	0.13 (0.316)	1.05*** (0.395)	0.58* (0.328)	0.88*** (0.281)	1.09*** (0.404)	1.43*** (0.338)

*** - significant at 99%; ** - significant at 95%; * - significant at 90%

Table 9. T-values for the t-test on the difference in premium values for wild-harvested seafood products in the online and in-person samples.

	T-test values		
Seafood Type	**SOURCE**	**CERTIFICATION**	**ORIGIN**
Clams	0.036 (0.486)	0.820 (0.229)	1.1937 (0.149)
Mussels	0.889 (0.187)	-0.725 (0.254)	0.3925 (0.357)
Oysters	0.204 (0.419)	-0.266 (0.402)	3.0523*** (0.0189)

Table 9 (cont.)

Scallops	1.347* (0.089)	1.130 (0.161)	0.7032 (0.260)
Seaweed salad	1.827** (0.034)	0.680 (0.267)	0.6498 (0.2756)

*** - significant at 99% level; **-significant at 95% level; *-significant at 90% level

Figure 2. Example of a choice experiment.

"Suppose you needed to leave your current home and are moving into a new housing development in your current city/town. You have already picked out the model home and are now selecting a home lot. The four home lots that you are considering are located within the same housing development but near different coastal features and are associated with different monthly payments.

As Maine's coastline continues to develop, coastal features near home lots may change over time. The expected change in ocean views and the number of years before these changes occur are shown for each lot. For some lots, there may be no change in view (denoted below). While there is information available on how coastal development will impact these lots over the next 15 years further changes beyond this are not known. The monthly payments shown below represent monthly mortgage payments assuming a 15-year mortgage. Differences in monthly payments across home lots reflect anticipated changes in ocean views.

Considering the four alternatives, which would you choose?"

	HOME LOT A	HOME LOT B	HOME LOT C	HOME LOT D
Current type of coastal usage	Undeveloped	Aquaculture	Undeveloped	Undeveloped
Current view				
Years in current view	5	15 (no change in view)	15 (no change in view)	10
Future type of coastal usage	Coastal fishing	Aquaculture	Undeveloped	Aquaculture
Future view				
Monthly payments	$1,800	$1,200	$1,800	$2,300

Table 10. Sample demographics: comparison of respondents from the sample (N=245) with Maine coastal population

Variable	**Mean for Coastal Maine**	**Mean for the Sample**
Age	35.3	50.9
Education (GED or higher)	93%	100%
Median household income	$49,813	$113,550

Table 11. Conditional logit model estimates (no interaction between the coastal feature and access to ocean variables included). N=245.

	Coef.	**Std. Err.**	**z**	**P>z**
Price	-.0012775	.0001135	-11.25	0.000
Feature				
Aquaculture Aquaculture	-.842403	.2104566	-4.00	0.000
Aquaculture Coastal fishing	-1.00737	.1866028	-5.40	0.000
Aquaculture Undeveloped	-1.183711	.2363736	-5.01	0.000
Coastal fishing Aquaculture	-1.265999	.2001412	-6.33	0.000
Coastal fishing Coastal fishing	-.3618286	.2007861	-1.80	0.072
Coastal fishing Undeveloped	-.6050231	.1956063	-3.09	0.002
Undeveloped Aquaculture	-1.145581	.1899702	-6.03	0.000
Undeveloped Coastal fishing	-.8673969	.1984796	-4.37	0.000
Duration	-.0771683	.0875123	-0.88	0.378
Duration#Duration	.0033902	.0043182	0.79	0.432

Table 12. Willingness to pay values for the model with no interaction between the coastal feature and ocean variables included (N=245).

Feature	WTP
Aquaculture-Aquaculture	-659.40
Aquaculture -Coastal Fishing	-788.53
Aquaculture -Undeveloped	-926.56
Coastal Fishing-Aquaculture	-990.97
Coastal Fishing-Coastal Fishing	-283.22
Coastal Fishing-Undeveloped	-473.59
Undeveloped-Aquaculture	-896.71
Undeveloped-Coastal Fishing	-678.96

Table 13. Sample demographics. Comparison of respondents with access to ocean from their property (N=158), and without access to ocean from their property (N=87).

Variable	**Access to Ocean**	**No Access to Ocean**
Age		
<18	-	-

Table 13 (cont.)

18-25	-	1.15%
26-34	10.6%	5.75%
35-54	53.8%	39.08%
55-64	18.35%	21.84%
65+	17.09%	32.18%
Gender		
Male	48.1%	60.92%
Female	51.90%	39.08%
Income		
$35,000 - $49,999	6.96%	9.20%
$50,000 - $74,999	22.78%	12.64%
$75,000 - $99,999	25.32%	22.99%
$100,000 - $149,999	30.38%	28.74%
$150,000 - $199,999	8.86%	11.49%
More than $200,000	5.70%	14.94%
Education		
High school graduate or GED	1.27%	1.15%
Some college	7.59%	10.34%
College graduate (Bachelor's degree)	46.20%	36.78%
Postgraduate degree (Master's, doctorate, etc.)	44.94%	51.72%

Table 14. Test on the difference in age characteristics of respondents with access to ocean (N=158), and respondents without access to ocean (N=87).

	Access to Ocean		**No Access to Ocean**		
Age category	**Actual Frequency**	**Expected Frequency**	**Actual Frequency**	**Expected Frequency**	**Total**
>18	-		-		-
18-25	-	0.64	1	0.36	1
25-34	17	14.19	5	7.81	22
35-54	85	76.74	34	42.26	119
55-64	29	30.96	19	17.04	48
65+	27	35.47	28	19.53	55
Total	158		87		245

$$\chi 2 = \sum \frac{(actual - expected)^2}{expected} = 11.89$$

DOF=4. The $\chi 2$ value is significant at the 2.5% level (which is larger than the table value=11.14 for DOF=5). We may conclude that at 2.5%, there is a statistically significant difference in age characteristics between the group of respondents with access to ocean and the group with no access.

Table 15. Test on the difference in income characteristics of respondents with access to ocean (N=158), and respondents without access to ocean (N=87).

Income category	**Actual Frequency**	**Expected Frequency**	**Actual Frequency**	**Expected Frequency**	**Total**
$35,000 - $49,999	11	12.25	8	6.75	19

Table 15 (cont.)

$50,000 - $74,999	36	30.31	11	16.69	47
$75,000 - $99,999	40	38.69	20	21.31	60
$100,000 - $149,999	48	47.08	25	25.92	73
$150,000 - $199,999	14	15.48	10	8.52	24
More than $200,000	9	14.19	13	7.81	22
Total	**158**		**87**		**245**

$$\chi 2 = \sum \frac{(actual - expected)^2}{expected} = 9.29$$

DOF=5. The $\chi 2$ value is significant at the 10% level (the calculated value is larger than the table value= 9.29 for DOF=5). We may conclude that at 10%, there is a statistically significant difference in age characteristics between the group of respondents with access to ocean and the group with no access.

Table 16. Test on the difference in education characteristics of respondents with access to ocean (N=158), and respondents without access to ocean (N=87).

Education category	**Actual Frequency**	**Expected Frequency**	**Actual Frequency**	**Expected Frequency**	**Total**
High school graduate	2	1.93	1	1.07	3
Some college	12	13.54	9	7.46	21

Table 16 (cont.)

College Graduate	73	67.71	32	37.29	105
Postgraduate degree	71	74.81	45	41.19	116
Total	158		87		245

$$\chi 2 = \sum \frac{(actual - expected)^2}{expected} = 2.21$$

DOF=3. The $\chi 2$ value is not statistically significant (it is smaller than the value of the 25% significance level (2.77)). We may conclude that there is no statistically significant difference in education characteristics between the group of respondents with access to ocean and the group with no access.

Table 17. Conditional logit model estimates (with interaction between the coastal feature and access to ocean variables included). N=245.

	Coef.	Std. Err.	z	P>z
Price	-.0012824	.0001139	-11.26	0.000
Feature#(Ocean=1 or Ocean=0)				
Aquaculture Aquaculture#0	-1.06656	.3740534	-2.85	0.004
Aquaculture Aquaculture#1	-.7224853	.2810759	-2.57	0.010
Aquaculture Coastal fishing#0	-.8626049	.2973291	-2.90	0.004
Aquaculture Coastal fishing#1	-1.068335	.2581547	-4.14	0.000
Aquaculture Undeveloped#0	-1.231561	.3591188	-3.43	0.001
Aquaculture Undeveloped#1	-1.132194	.2855312	-3.97	0.000
Coastal fishing Aquaculture#0	-1.056793	.3106434	-3.40	0.001
Coastal fishing Aquaculture#1	-1.368884	.2640858	-5.18	0.000
Coastal fishing Coastal fishing#0	-.1161462	.3240883	-0.36	0.720
Coastal fishing Coastal fishing#1	-.5103354	.	.	.
Coastal fishing Undeveloped#0	-.7891209	.3153405	-2.50	0.012
Coastal fishing Undeveloped#1	-.4842929	.2548451	-1.90	0.057
Undeveloped Aquaculture#0	-1.236982	.3061867	-4.04	0.000
Undeveloped Aquaculture#1	-1.080508	.255798	-4.22	0.000
Undeveloped Coastal fishing#0	-.6831668	.3070815	-2.22	0.026
Undeveloped Coastal fishing#1	-.9456009	.2683374	-3.52	0.000
Undeveloped Undeveloped#1	.0132565	.2565933	0.05	0.959
Duration	-.0734237	.0876604	-0.84	0.402
c.duration#c.duration	.0032706	.0043249	0.76	0.450

Table 18. Willingness to pay values for the model with interaction between the coastal feature and ocean variables included.

Feature	WTP
Aquaculture-Aquaculture#(No Access to Ocean)	-831.69
Aquaculture -Aquaculture#(Access to Ocean)	-563.39
Aquaculture -Coastal Fishing#(No Access to Ocean)	-672.65
Aquaculture -Coastal Fishing#(No Access to Ocean)	-833.07
Aquaculture -Undeveloped#(No Access to Ocean)	-960.36
Aquaculture –Undeveloped#(Access to Ocean)	-882.87
Coastal Fishing-Aquaculture#(No Access to Ocean)	-824.07
Coastal Fishing-Aquaculture#(Access to Ocean)	-1067.44
Coastal Fishing-Coastal Fishing#(No Access to Ocean)	-90.57
Coastal Fishing-Coastal Fishing#(Access to Ocean)	-397.95
Coastal Fishing-Undeveloped#(No Access to Ocean)	-615.35
Coastal Fishing-Undeveloped#(Access to Ocean)	-377.65
Undeveloped-Aquaculture#(No Access to Ocean)	-964.58
Undeveloped-Aquaculture#(Access to Ocean)	-842.57
Undeveloped-Coastal Fishing#(No Access to Ocean)	-532.73
Undeveloped-Coastal Fishing#(Access to Ocean)	-5.33
Undeveloped-Undeveloped#(Access to Ocean)	10.337

BIOGRAPHY OF THE AUTHOR

Olga Alekseyevna Bredikhina was born in Moscow, Russia on November 5th, 1994. She graduated from Moscow High School 1420. Olga moved to the United States in January 2013 as she received full athletic scholarship to compete for the University of Maryland's NCAA Division 1 tennis team. In December 2016, Olga graduated from the University of Maryland *summa cum laude* and Phi Beta Kappa with a Bachelor of Arts degree in Economics and a minor in French Studies. At the University of Maryland, Olga was named twice to the University of Maryland's Distinguished Dean's List of Outstanding Students and received the Senior Marshal award that recognizes high academic achievements, leadership and contribution to the University's community.

Olga enrolled in the University of Maine School of Economics in August 2017. At UMaine, Olga worked as a graduate research assistant with the National Science Foundation grant Sustainable Ecological Aquaculture Network (SEANET). Her research interests included consumer decision-making, choice experiments and product presentation strategy. At the University of Maine, Olga served as a senator from the School of Economics to the Graduate Student Government and was a member of the Innovate for Maine Fellowship class 2018-2019, Olga was recognized as the Most Outstanding Graduate Student in May 2019. Olga graduated with a Master's of Science degree in Economics in May 2019.