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ASSESSING CONSUMER PREFERENCES FOR SUSTAINABILITY, EQUITY, AND WELFARE IN THE AQUARIUM TRADE

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ASSESSING CONSUMER PREFERENCES FOR
SUSTAINABILITY, EQUITY, AND WELFARE

IN THE AQUARIUM TRADE

BY

LARYNN CUTSHAW

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

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MASTER OF ARTS THESIS

OF

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ABSTRACT

Each year millions of fish and invertebrates are traded to support the home aquaria industry. Aquarium keeping is a popular hobby worldwide and the trade has the potential to provide socio-economic benefits to reef-adjacent communities while promoting environmental stewardship by consumers. However, current practices are negatively impacting the industry as the supply chain can be environmentally unsustainable and socially inequitable. Poor industry practices compromise the welfare of the organisms, leading to immense supply chain losses which exacerbate the sustainability and equity issues. Since the trade is demand-driven, consumers can play a role in addressing poor industry practices by using their substantial market power to endorse sustainably, equitably, and ethically sourced organisms. To better understand the consumer population and explore purchasing behaviors, an online survey of 304 aquarium hobbyists was conducted. Both saltwater and freshwater aquarists were targeted, making this the first known study to include freshwater hobbyist preferences with consideration for their potential entrance to the marine aquaria market. Results indicate that consumers have strong preferences for organisms with attributes that positively reflect sustainability, equity, and welfare in the aquarium trade. Aquarium hobbyists are knowledgeable about their organisms as well as the supply chain that produces them and are willing to offer at least 20% more than the commercial price of an animal to have these attributes realized. This study does not evaluate the consumers' explicit attitudes toward a certification scheme, but instead uses respondents' stated values as implicit support for a market-based reform of the industry. The preferences and associated price premiums indicated by hobbyists can be useful in leveraging consumer

market power to reduce the environmental and socio-economic impacts of the aquarium trade through a certification scheme.

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CHAPTER 1

INTRODUCTION

1.1 Introduction and context of the aquarium trade

The marine aquarium trade has gained recent interest from a sustainable development perspective as fish and invertebrates that are harvested for the trade are often sourced from coral reef-dependent communities characterized by high levels of poverty, particularly in Southeast Asia (Ferse et al., 2012b). These human communities, coral reefs, and organisms sourced for the marine aquarium trade comprise a productive, dynamic social-ecological system. While the trade can be highly lucrative for fishers, it places immense pressure on ecological systems due to destructive and unsustainable collection practices, making the future integrity of the coral reef and its associated ecosystem services uncertain (Frey and Berkes, 2014).

Consumer demand is the primary determinant of the trade and the industry is volume-driven (Rhyne and Tlusty, 2012). The 2018-2019 National Pet Owners Survey projects that 15 million households in the United States own aquariums with 2.5 million of these being saltwater (Springer, 2018). The industry has demonstrated continuous growth since the 1980s as expansion of global trade networks alongside advances in technology have allowed home aquaria to evolve from fish-only tanks to those that represent miniature ecosystems (Rhyne and Tlusty, 2012). To stock these aquaria, tens of millions of organisms are harvested from coral reefs worldwide to be sold in the live ornamental market. The U.S. alone imports more than eleven million fish each year (excluding corals and other invertebrates) with 5.8 million (55%) and 3.3 million (31%)

originating from the Philippines and Indonesia, respectively (Rhyne et al., 2012).

Although retail price for some organisms can reach hundreds of dollars per individual, fishers receive only cents for each fish caught (Dykman, 2012). Yet, many rural communities have entered a poverty trap in relation to ornamental fisheries; few alternatives are available, so they rely on the productivity of the trade to supplement their economies (Ferse et al., 2012b).

In order to maintain functionality of the fragile social-ecological system created by the aquarium trade, a better understanding of the role of the consumer is necessary to promote a more sustainable supply chain. This study investigates consumer preferences for aquarium organisms to explore the potential of leveraging hobbyist market power to reform the aquarium industry in the interest of sustainability, equity, and welfare.

1.2 Issues of sustainability, equity, and welfare

The world's coral reef systems are under immense threat from anthropogenic stressors, including rising sea surface temperature, acidification, pollution, and more (Thornhill, 2012). The coral reef wildlife (i.e. marine aquarium or marine ornamental) trade can be considered another serious threat to the productivity and resilience of coral reef systems across the globe. With more than 40 million organisms harvested annually, represented by more than 2,000 species of fish, corals, and other invertebrates (Rhyne et al., 2012; Thornhill, 2012), the marine aquarium trade involves a tremendous amount of diversity and volume of animals. Since very few of these species can be reared in captivity, the vast majority (approximately 95%) are taken directly from coral reefs in the most biodiverse regions of the world (Thornhill, 2012). Three mechanisms act as the

main drivers for coral reef degradation caused by the marine aquarium trade: over-exploitation, high selectivity, and destructive fishing.

Since the industry is highly demand-oriented, the preferences of consumers impact the reef as fishers selectively harvest organisms with high demand to maximize profit. Specifically, consumers demonstrate strong preferences for aesthetics or functionality in their aquariums. Aesthetically, consumers prefer animals that are attractive or otherwise unusual in appearance. Fishers will not only select for this appeal on a species level but will also target juvenile and male conspecifics that flaunt bright colors. For corals, species with bright colors or unusual growth forms are highly desirable and therefore favored by collectors (Thornhill, 2012). Additionally, species perceived as rare will retrieve the highest prices in the market, therefore placing more pressure on already-vulnerable species (Dykman, 2012; Rhyne et al., 2012). Functionally, consumers prefer organisms that will serve the same purpose in a home aquarium as in the natural reef, particularly that of parasite cleaners and herbivores. Overexploitation of these animals can have significant effects on the parasite loads and algal cover of reefs and associated organisms. Further, mass removal of low-trophic organisms can have ecosystem-wide effects (Thornhill, 2012).

While over-exploitative and selective behaviors alone can be detrimental to the reef, the most significant ecological impacts caused by the aquarium trade are the widespread use of destructive fishing practices, namely cyanide fishing. Cyanide is a preferred method of fishing for the ornamental trade because its anesthetic properties allow for quick and efficient collection of a large number of fish (Thornhill, 2012). However, the effects of the chemical can be devastating to a reef ecosystem. When

diffused on the reef, cyanide affects all non-target animals, including the eggs and larvae (Frey & Berkes, 2014). Fish and invertebrates exposed to the toxin often suffer from organ damage as the cyanide inhibits cellular respiration (Thornhill, 2012). For those that do not suffer immediate death, long-term physiological effects are observed, most notably damage to the reproductive and digestive systems (Rubec et al., 2000; Thornhill, 2012). Corals are not immune either; cyanide can block the enzyme responsible for calcification and inhibit photosynthesis in the symbiotic zooxanthellae, leading to localized bleaching events and coral death (Rubec et al., 2000). An estimated 50% of animals collected survive if moved to clean water immediately (Rubec et al., 2000); however, those that remain on the reef and unable to escape the cyanide plume may suffer up to 100% rate of mortality (Thornhill, 2012).

In summary, harvest for the aquarium fishery can be a destructive activity. Removal of species and important functional groups coupled with the damage caused by cyanide fishing has led to a loss of biodiversity and therefore compromises the reef's resilience to other anthropogenic threats. The long-term effects of the aquarium trade could lead to a collapse in the fishery and loss of reef-derived ecosystem services, leaving the reef-adjacent communities and fishers who rely on the aquarium trade for livelihoods in a state of vulnerability.

Post-harvest behaviors also pose threats to the industry, as reviewed by Thornhill (2012). Following collection, fish are brought aboard the boat and “deflated” by decompression of the swim bladder using a needle. While this procedure prevents barotrauma (rupture of the swim bladder due to rapid pressure change, or emboli in the blood or organs), it poses a high risk for injury or death due to accidental trauma to the

body cavity or the introduction of bacteria from unsanitary needles. Further, fish possess sharp spines, barbs, or fins that fishers often clip to prevent injury to their bodies or puncture of the plastic transportation bag, causing a great amount of stress and pain to the animal (Thornhill, 2012).

Animals are packed in plastic bags where they remain until they reach the export facility. Aboard the collection vessel, mortality is high from punctured bags or bags being left in direct sunlight, causing fish to overheat (Thornhill, 2012). Once the fishers return to their community, fish are left in the plastic bags on the ground for up to five days until they can be sold to the middleman (Rubec et al., 2000). During this time, the animals are typically starved so that they do not excrete in their transport bags during the shipping process as excretion contains high levels of ammonia that can be fatal when concentrated (McCollum, 2007, Thornhill, 2012). To prevent the accumulation of ammonia in the bags, water changes are completed once daily (or twice for more valuable specimen; Rubec et al., 2000). These water change cause rapid temperature and salinity changes (Rubec et al., 2000) which stresses the animal (Thornhill, 2012). Stressed animals produce excess amounts of carbon dioxide, increasing the acidity in the bag (Thornhill, 2012). Stress is the second-leading cause of post-harvest mortality, with the first being residual effects from cyanide exposure.

Thornhill (2012) reports that 5-25% of captured fish will die almost immediately from a lethal dose of cyanide; another 20-40% will perish within hours to days from residual effects of the cyanide (most commonly digestive atrophy where the cyanide deteriorates the mucus lining of the digestive tract and the fish essentially dies of starvation). When coupled with stress and improper husbandry and handling techniques

as described above, it is predicted that more than 90% of animals that enter the aquarium trade are lost before reaching the consumer.

This high rate of mortality is not just an ethical concern, but an environmental one. For every specimen lost in the supply chain, another organism must be harvested to replace it (Thornhill, 2012). This often leads to fishers collecting as many animals as possible in a single fishing trip as they know lost product is lost profit. However, an often-overlooked outcome of this fisher behavior is the mis-alignment with market demand. Assuming lower than expected mortality is achieved, buyers will discard the less-desirable organisms as they can only sell to their buyer what is demanded (Glaser et al., 2015; Ferse et al., 2012b). Further, animals that show signs of injury from improper handling will be rejected (McCollum, 2007). Therefore, the animal serves no purpose on the reef or as a source of revenue for the dependent fisher.

High mortality is caused by a combination of factors including poor capture, handling, husbandry, and transport methods. The techniques used for these practices, the skill of the fisher, and the quality of equipment available influence the amount of product lost and market waste created in the fishery. Inferior practices lead to a depletion of stock, yet scarcity causes these practices to intensify, further exacerbating environmental and socio-economic costs of the industry.

The freshwater aquarium industry has less acute impacts as at least 90% of traded specimen are supplied through aquaculture (Wabnitz et al., 2003; Teletchea, 2016), therefore diminishing the environmental and social costs. It should be noted that some traded species are wild caught and risk overexploitation and habitat destruction where fishing occurs (Maceda-Viega et al., 2016, Raghavan et al., 2013). Regardless of how the

animal is sourced, freshwater organisms are exposed to many of the same welfare issues as the saltwater supply chain and the freshwater sector can benefit from similar trade reforms (Monticini, 2010).

1.3 Consumer purchasing power as a tool for trade reform

Improving the quality of the organisms in the trade can reduce the quantity demanded (Dee et al., 2014). By eliminating the use of cyanide and promoting safe, welfare-oriented harvest, handling, and transportation practices, the mortality risk of captured organisms can be largely reduced. Further, creating a management plan that will regulate the selection and overexploitation of a species or sex and age groups within the species could help to maintain biodiversity and functionality of the reef, which can potentially contribute to the well-being and livelihoods of the communities who depend on the trade and healthy reef ecosystems.

Given the consumer power of the trade (e.g. Wood, 2001; Wabnitz et al., 2003) arguably an effective way to improve trade practices would be to direct consumer purchase behavior toward sustainable options. If consumers opt for organisms that are known to have been harvested with environmental sustainability in mind (that is, without destructive methods and without harm to the population) as well as organisms that were offered high standards of husbandry and welfare through the supply chain, this can create an economic incentive for fishers and middlemen to improve practices while simultaneously improving livelihoods from increased revenue (Wabnitz et al., 2003; Shuman et al., 2004; Dykman, 2012).

The phenomenon of “green consumerism” (Shuman et al., 2004) has led to numerous market-based incentives to promote environmental sustainability at the consumer end of the supply chain for natural resource products. Most notable is the “eco-label” or certification scheme that serves to inform consumers about the environmental impact of their product while empowering them to reform the industry through their market power by purchasing behavior (Militz et al., 2017). Certification schemes have the potential to reward suppliers by encouraging consumers to invest in those who exhibit environmentally responsible practices (Jacquet et al., 2009) and offering a “competitive edge” to retailers who make the commitment to sustainability (Dykman, 2012). Successful examples of such certification schemes include those made for seafood, organic produce, and palm oil.

A certification scheme in the marine aquarium trade provides an opportunity for positive reform by providing consumers with the information necessary to make sustainable purchasing decisions. A well-placed certification scheme could have positive consequences for the environment, the social well-being of those employed by the trade, the quality and welfare of the organism, and, ultimately, the consumer who is investing in the practice. The criteria for a certified sustainable organism could be one that was harvested, handled, and transported using the high standards for environmental impact and animal welfare. Potential criteria for certification would be that a certified organism could not be captured using cyanide or other destructive method, would need to be harvested with attention to potential population disrupters (i.e. age, sex, and trophic imbalances), could not overcome the regeneration rate of the species (over-exploitative),

and would need to be given excellent care through its time without being subjected to injury, disease, or unnecessary stress.

Certified organisms would likely be offered with price premiums, indicating their superior value to non-certified organisms. This can have secondary incentives as fishers are likely to view certification-quality organisms as more valuable (and therefore less disposable) and would likely improve their techniques in order to garner higher financial rewards granted by the certification scheme. The most imperative aspect of the price premium is the increase in pay rate for fishers which would not only improve livelihoods and potentially reduce poverty (Dykman, 2012), but also incentivize sustainable practices to meet the certification standards (Shuman et al., 2004).

Previous studies (i.e. Alencastro et al., 2005, Murray and Watson, 2014, Militz et al., 2017, and Spruill and Dropkin, 2001 as cited in Dykman, 2012) have each demonstrated overwhelming support by hobbyists for the implementation of a certification scheme with price premiums associated with the certified organism. However, at present no certification system exists for sustainable organisms in the trade. This is largely due to the failure of the labeling system created by the Marine Aquarium Council (MAC) which was established in 2001 but disbanded only 3.5 years later due to a lack of effectiveness and consumer support (Mathews Amos and Clausson, 2009 as cited in Thornhill, 2012).

1.4 Significance of study and research questions

The global aquarium trade has great implications for the sustainability of coral reefs, equity for members in the supply chain, and welfare of the organisms traded. The industry is highly demand-driven and consumer purchasing behavior can influence how

these three issue areas are addressed in the trade. This study aims to assess consumer preferences for aquarium organisms with attributes that reflect the sustainability, equity, and welfare of the aquarium trade and how their purchasing behaviors may be used for potential management strategies. While this study does not explore specific certification schemes, it explores the potential for consumers to use their market power to support implicit qualities that could comprise a certification scheme.

In order to expand on current knowledge on the aquarium trade and help inform management by better understanding consumers' preferences and purchasing behavior for aquarium organisms, this research aims to explore three major research questions:

1. How knowledgeable are home aquarium owners about the issues of sustainability, equity, and welfare in the aquarium trade?
2. What are the preferences for different attributes related to sustainability, equity, and welfare, and what price premiums are consumers willing to offer to obtain organisms with these attributes?
3. How do individual aquarists' characteristics (i.e. values and involvement in the hobby) affect their level of knowledge and purchasing behavior?

CHAPTER 2

METHODOLOGY

2.1 Sampling considerations

The target population for this study is aquarium owners. While this research focuses on the marine aquarium trade, saltwater and freshwater aquarists were included in the sample. Although the freshwater aquarium trade seems to have less severe impacts, it is important to understand how these hobbyists perceive the environmental and social implications of the trade. Further, it is suspected that freshwater hobbyists have the highest potential of entering the saltwater market, so understanding their position in the trade can be a valuable and unique perspective for management of the marine aquarium trade.

2.2 Survey design

In order to explore the research questions defined above, an online survey (Appendix A) was implemented. The questionnaire used a variety of structured questions including multiple choice, open-ended response, Likert scales, and stated preference. The survey was organized into five sections: 1) hobbyist characteristics; 2) aquarium characteristics; 3) hobby engagement; 4) purchasing behavior; and 5) demographics.

2.2.1 Hobbyist characteristics

First, respondents were asked a series of questions to gauge their participation in the aquarium hobby. Included in this section were multiple choice and open-ended

questions asking in which country the respondent resides, if aquarium keeping is their primary hobby, how many hours a week they spend engaging in the hobby, why they choose to keep an aquarium, and if their aquarium(s) are saltwater or freshwater.

2.2.2 Aquarium characteristics

The questions presented in the second section gather more information about the characteristics of the aquarium(s). The respondent was presented with multiple choice and open-ended questions specifically related to saltwater aquariums, freshwater aquariums, or both, depending on which type of aquarium they own as indicated in the first section. For each respective aquarium type, respondents were asked the amount of time they have kept aquariums, the total volume of their tank(s), their plans to change capacity in the next year, what types of organisms they own, where they purchase these organisms, and how much they typically spend on organisms each month (in the currency of the country provided in section one). Those who own saltwater aquariums were asked if they began aquarium keeping with a freshwater tank. Freshwater owners were asked if they have owned a saltwater tank in the past but no longer keep one; if so, they were prompted to give reasoning for no longer keeping one. Respondents that owned only one type of aquarium were also asked if they have plans to purchase the other type.

2.2.3 Hobby engagement

This section presented three 5-point Likert scales totaling 28 items to gauge respondent attitudes related to activities, knowledge, and selection of organisms. The statements and scales provided to respondents are presented in Table 1.

Table 1. Likert scale items used to measure respondent attitudes toward activities, knowledge, and selection of organisms related to the aquarium trade.

	Likert Item
ACTIVITIES 1 = extremely unlikely 5 = extremely likely	Belong to aquarium hobby group
	Belong to a conservation group
	Belong to an animal rights group
	Buy organic produce
	Buy certified seafood
	Donate to domestic poverty-alleviating program
	Donate to international poverty-alleviating program
	Visit a coral reef
	Visit a rainforest
KNOWLEDGE 1 = strongly disagree 5 = strongly agree	Aquarium care
	How organism was supplied (wild caught or captive bred)
	How organism was captured (chemicals or nets)
	Where organism originates (domestic or imported)
	Research organisms before purchasing
	Purchasing decisions impact environment
	Purchasing decisions impact livelihoods
	Purchasing decisions impact animal welfare
	Purchasing decisions impact aquarium industry
SELECTION 1 = not at all important 5 = extremely important	Price
	Function or fit in aquarium
	Aesthetics
	Rarity
	How organism was supplied (wild caught or captive bred)
	How organism was captured (wild caught or captive bred)
	Welfare along the supply chain
	Where organism originates (domestic or imported)
	Purchase supports livelihoods of indigenous people
	Organism comes with informative label

2.2.4 Purchasing behavior

A stated preference approach was used to determine hobbyist preferences for aquarium organisms with different attributes. There were seven sets of characteristics with two attributes defined for each: rarity of organism (rare or common), how the organism was supplied (wild caught or captive bred), how the organism was captured if wild caught (nets or chemicals), welfare standards (high or unknown), sale of the organism supports livelihoods of indigenous people in source countries (supports or does not support), and the organism has an informative label (available or unavailable).

First, the respondent was asked to give the amount they would typically spend on an aquarium organism in the currency of the country provided in section one, providing a base value used for the remainder of this section. Next, the respondent was prompted with the statement “You will be provided with a choice of two organisms with different features. Please select which one you are more likely to purchase assuming a) the information was made available to you, and b) all other factors are equal.” For each of the seven characteristics, respondents were presented with the two attributes as choices, while also having the option to choose “no preference” or “neither.” If an attribute was selected, a text box appeared with the prompt: “If you would typically spend [base value] on an organism, how much more are you willing to pay **extra** if the organism has this feature?” If “neither” was selected, respondents were asked to give their reasoning for not purchasing either organism.

2.2.5 Demographics and comments

The demographics section asked respondents standard questions to collect information on the age, education, gender, and average household income of the respondent. This page also asked respondents to list any other (non-aquarium) pets they have or are considering purchasing. The survey concluded with an open-ended question which offered respondents a chance to provide any additional information related to their purchasing preferences of aquarium organisms.

2.3 Data collection

The questionnaire was designed using Qualtrics software and was implemented online. The survey circulated from July 12, 2018 to September 28, 2018. A link to the survey with a cover letter explaining the study was posted in eighteen online fora and discussion groups (Appendix B) dedicated to aquarium and general pet owners. Fora were chosen based on the criteria of forum topic, number of members, level of daily activity, and the survey meeting the terms and conditions set forth by the website. Due to low response rates from the initial posting on five sites, fora were added through the survey period and circulation time on each discussion board varies. To increase response rates, respondents were periodically encouraged to take the survey.

Using an online survey as an instrument for data collection allowed access to the target population (aquarium owners) which is not highly represented in the general public. Using online fora and discussion groups allowed respondents to independently circulate the survey link and/or “tag” other hobbyists in the discussion thread, which allowed for a form of snowball sampling. Often, respondents would comment on the thread to announce their completion of the survey; this activity not only “bumped” the survey to make it more visible (and therefore better circulate) on the webpage, but also likely encouraged other users to participate. All fora used (with the exception of Facebook groups) were accessible to non-members, creating a larger pool of potential participants. Other advantages of using the internet to disseminate surveys over other methods (i.e. in-person, postal, or phone) are the low costs and high anonymity of this platform (Robson, 2011). Also, since this survey was targeting aquarium owners across

the globe, the internet was the best method to overcome geographic barriers presented by other survey forms.

The primary challenge of this method was the high number of respondents (19.1%) who began but did not fully complete the survey. The two suspected reasons for failed completion are respondent fatigue and confusion. The average respondent spent 16.3 minutes completing the survey; the higher-than expected completion time and possible loss of interest may have contributed to the early termination by respondents. A common challenge faced by online research is that the absence of the researcher disallows for clarification of questions. Several respondents used the comment tool on the online fora to express their confusion of questions (particularly those related to the price premiums) and admitted that their confusion prevented them from completing the survey.

2.4 Data analysis

Responses were considered valid if at least the first section of the questionnaire (hobbyist characteristics) was completed and responses for this or any following section of the survey were not considered to be “troll responses” (i.e. non-response to most or all questions, entering zero or unreasonably high numbers where unrealistic, etc.). Since further legitimacy could not be confirmed, 304 of the original 327 surveys were considered valid and used for analysis. Many respondents passed criteria for analysis but did not complete every question. For this reason, the number of valid responses (*n*) varies and is provided for each analysis.

To explore respondent characteristics and engagement with the aquarium hobby, data analyses were performed using SPSS (v. 25). Descriptive statistics (mean, median,

standard deviation, minimum, and maximum) were calculated for numerical variables. Following Shapiro-Wilk tests for normality, it was determined that the numerical data were not normally distributed and could not be normalized using standard transformations so nonparametric tests (Kruskal-Wallis H Test, Mann-Whitney U Test, and Spearman rank correlation) were used. Significant Kruskal-Wallis values were followed by Dunn's Multiple Comparison post-hoc tests with Bonferroni correction to determine direction and interaction effects between variables. Qualitative data provided as open-ended responses were recoded to categorical variables where themes were apparent.

A principle component analysis with varimax rotation was used to reduce data on activities, knowledge, and selection of organisms to a set of factors that are independently related but account for variation in the data and are thematically related to hobby engagement (Jolliffe, 2011). Factors were comprised of Likert items with Eigenvalues greater than 1.0 and factor loadings of 0.40 or above. Reliability of the factor scores were tested using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO, values greater than 0.700), Bartlett's Test of Sphericity ($p \leq 0.05$), and Chronbach's alpha ($\alpha \geq 0.60$). A composite score for each factor was created by averaging the respective Likert items for each respondent.

For the stated preference section, price premiums for attributes were calculated as a percentage of the value respondents would pay "extra" over the base value they typically spend on an aquarium organism to account for variations in base values among aquarium owners. Currencies for this and other sections of the survey were converted to USD based on the value of the foreign currency on the date the response was recorded.

CHAPTER 3

RESULTS

The contents of this chapter are organized according to the respondents' demographics and hobby characteristics, hobby engagement, and stated preferences for selection of aquarium organisms. Of the 327 submissions, 304 surveys met the criteria for analysis while only 243 (79.9%) respondents completed the full survey. Some variables will be mentioned throughout the chapter. For clarity, Table 2 provides variable names with definitions.

Table 2. Definitions of key variables.

Variable	Definition
<i>TYPE</i>	Type of aquarium (freshwater or saltwater)
<i>PRIMARY</i>	Primary hobby
<i>SUPPLY</i>	How organism was supplied (wild caught or captive bred)
<i>CAPTURE</i>	How wild caught organism was captured (nets or chemicals)
<i>WELFARE</i>	How animal was treated through the supply chain
<i>ORIGIN</i>	Place of origin (domestic or import)
<i>LIVELIHOODS</i>	Livelihoods of indigenous people involved in the trade in source countries
<i>LABEL</i>	Label that communicates information related to the environmental and social impacts of the product origin

3.1 Overview

A total of 304 surveys were conducted across 22 countries (Table 3), with the majority (66.8%, $n = 203$) of participants being from the United States. This sample includes 51 saltwater aquarium owners (16.8%), 201 freshwater aquarium owners (66.1%), and 46 respondents who own both types of aquariums (15.1%). Six respondents (2.0%) did not currently own an aquarium but were permitted to complete the survey for their potential to enter the market (Fig. 1). However, this group was removed from any analysis involving aquarium type due to small sample size.

Table 3. Distribution of surveys by country.

Region	Country	Number of respondents
Africa	South Africa	9
Asia	China	1
	Japan	2
	Malaysia	1
	Singapore	4
	South Korea	1
Australasia	Australia	11
	New Zealand	1
Europe	United Kingdom	13
	Belgium	2
	Germany	6
	Greece	1
	Ireland	1
	Luxembourg	1
	Malta	1
	Netherlands	1
	Poland	1
	Portugal	1
Middle East	United Arab Emirates	1
North America	United States of America	203
	Canada	41
South and Central America	Belize	1
TOTAL		304

Figure 1. Distribution of types of aquariums owned by respondents (n = 304).

3.2 Respondent and hobby characteristics

This section will describe the sample by providing basic demographic information and some characteristics of the respondents as hobbyists of their respective aquarium type. It should be noted that ownership of a saltwater versus freshwater aquarium is not exclusive, so some respondents are included in the hobby characteristics portion twice based on information they provided for each type of aquarium.

3.2.1 Descriptive statistics of respondent demographic information

According to the 243 respondents who completed the demographics section of the survey, the average respondent was male with a 2-year college degree and median household income of \$56,000 (IQR = \$53,996; Fig. 2). The majority (65.0%) of the sample was male; 73.3% of saltwater aquarium owners and 61.2% of freshwater aquarium owners were male.

Figure 2. Percentage of respondents for demographic variables: (a) gender identity (n = 243); (b) age (n = 242); (c) highest level of education completed (n = 241); and (d) household income (n = 224).

3.2.2 Hobby Characteristics

Table 4 provides an overview of hobbyist characteristics with distinctions by aquarium type, including the size of each group, perception of aquarium keeping being their primary hobby, time dedicated to hobby, aquarium parameters, and expenditures on organisms. Based on median values, saltwater and freshwater aquarists appear to be a relatively homogenous group although freshwater owners tend to keep more aquarium fish while saltwater owners spend more on organisms.

Table 4. Summary of hobbyist characteristics by aquarium type (values presented as median $\pm$ IQR).

Characteristic	Saltwater	Freshwater
Owned by respondents	31.9%	81.3%
Primary hobby	67.0%	55.9%
Hours spent per week spent engaging in aquarium-related activities	8 ($\pm$ 7.3)	7 ($\pm$ 8)
Time owned aquarium (years)	3 ($\pm$ 7)	3 ($\pm$ 9)
Volume of aquarium (gallons)	47.6 ($\pm$ 77.0)	45.5 ($\pm$ 70.0)
Number of fish	5 ($\pm$ 6)	15 ($\pm$ 24)
Number of reef-building invertebrates (corals, anemones, sea fans, sponges, etc.)	19.5 ($\pm$ 25)	-
Number of other invertebrates (crabs, shrimp, clams, snails, starfish, etc.)	10 ($\pm$ 16)	4 ($\pm$ 20)
Number of aquatic plants	-	10 ($\pm$ 15)
Amount spent per month on aquarium organisms (USD)	\$50.00 ($\pm$ 75.00)	\$20.00 ($\pm$ 28.15)
Amount spent on an individual organism (USD)	\$55.00 ($\pm$ 111.62)	\$20.00 ($\pm$ 28.56)

The number of respondents reporting aquarium keeping as their primary hobby (*PRIMARY*) did not differ by aquarium type (*TYPE*), $\chi^2(6, N = 304) = 11.83, p = 0.07$. However, for respondents who currently keep an aquarium, hours spent per week devoted to the hobby were significantly affected by type of aquarium, $H(2, 295) = 7.16, p = 0.03$, but the only significant interaction was between *freshwater* and *both saltwater and freshwater*, $H(2, 295) = -36.83, p = 0.03$. The number of hours a hobbyist devotes per week to the hobby is strongly affected by *PRIMARY*, $H(2, 300) = 47.40, p < 0.001$, with an interaction between *not primary hobby* and *primary hobby*, $H(2, 300) = -75.48, p < 0.001$, as well as *not primary hobby* and *unsure*, $H(2, 300) = -55.78, p = 0.004$. As expected, those who dedicate the greatest time to their aquariums are those who consider aquarium keeping their primary hobby (*Med.* = 10.0, *IQR* = 10.3), followed by those who are unsure (*Med.* = 8.0, *IQR* = 9.5) and do not consider aquarium keeping their primary hobby (*Med.* = 5.0, *IQR* = 5.0).

Volume of tanks are similar between saltwater and freshwater with nearly one-quarter of respondents owning more than 100 gallons of their respective aquarium type

(Fig. 3). Volume is not significantly affected by *PRIMARY* for saltwater aquarists, $H(2, 82) = 1.09$, $p = 0.58$, but is for freshwater, $H(2, 223) = 12.76$, $p = 0.002$ with interactions between *primary hobby* and *unsure*, $H(2, 223) = 34.74$, $p = 0.03$, and *primary hobby* and *not primary hobby*, $F(2, 223) = -29.35$, $p = 0.01$. Median volume for both tank types can be found in Table 4; saltwater owners who report aquarium keeping as a primary hobby, those who do not, and those who are unsure hold median tank capacities of 47.6 ($IQR = 93.5$), 50.0 ($IQR = 42.0$), and 45.0 ($IQR = 60.0$), respectively. Freshwater aquarists reported median volumes of 56.0 ($IQR = 75.9$), 36.5 ($IQR = 58.8$), and 29.0 ($IQR = 52.1$), for the respective values. Most saltwater aquarium owners have no plan to change their tank capacity within the next year (73.8%, $n = 62$); while 26.2% ($n = 22$) hope to increase their tank capacity and none expect to decrease. Only 3.1% ($n = 7$) of freshwater owners have plans to reduce tank capacity, with 44.2% ($n = 100$) planning to increase and 39.1% ($n = 119$) maintaining their tank capacity.

Figure 3. Total volume (in gallons) of aquariums owned by saltwater ($n = 83$) and freshwater ($n = 224$) hobbyists.

The typical aquarist owns 37.5 (*IQR* = 44.8) saltwater organisms and/or 34.0 (*IQR* = 59.5) freshwater organisms and spends \$50.00 (*IQR* = 75.00) and/or \$20.00 (*IQR* = 28.15) respectively each month (Fig. 4a). Respondents typically spend \$30.00 (*IQR* = 35.49) on a single aquarium organism, with this value being significantly impacted by *TYPE*, $H(2, 253) = 63.29$, $p < 0.001$, where saltwater owners spend \$55.00 (*IQR* = 111.62) on a single organism and a freshwater organism will cost \$20.00 (*IQR* = 28.56; Fig. 4b). Organisms of both types are most often bought at local pet stores with 83.3% saltwater and 81.4% freshwater owners selecting this retailer (Figs. 5 & 6). Amount spent each month did not differ by *PRIMARY* for saltwater owners, $H(2, 82) = 3.06$, $p = 0.22$, but did for freshwater owners, $H(2, 219) = 13.15$, $p = 0.001$, with significant interactions between *primary hobby* and *unsure*, $H(2, 219) = 37.41$, $p = 0.02$, and *primary hobby* and *not primary hobby*, $H(2, 219) = -28.03$, $p = 0.01$ where those who report *primary hobby* spend more on organisms monthly (Fig. 7).

Figure 4. Percentage of respondents by aquarium type (saltwater, n = 78, freshwater, n = 216) illustrating (a) amount spent monthly (USD) on aquarium organisms and (b) amount (USD) a hobbyist will typically spend on an individual organism.

Figure 5. Percentage of respondents purchasing organisms from common retailers by aquarium type (saltwater, n = 84, freshwater, n = 226).

Figure 6. Median (± IQR) amount spent each month (USD) on aquarium organism by retailer with distinction by aquarium type (saltwater, n = 84, freshwater, n = 226).

*Third quartile exceeds graph area; values are \$678.99 and \$125.27 for saltwater and freshwater, respectively.

Figure 7. Median (± IQR) amount spent on aquarium organisms per month (USD) by involvement in hobby (n = 219).

PRIMARY was not related to the length of time the aquarium owner engaged in the saltwater or freshwater aquarium keeping hobby, $H(2, 81) = 5.58$, $p = 0.06$, and $H(2, 225) = 1.02$, $p = 0.60$, respectively. However, there is a weak yet significant positive correlation between volume and the length of time engaged in the hobby for both saltwater ($r_s(79) = 0.26$, $p = 0.02$) and freshwater ($r_s(222) = 0.38$, $p < 0.001$). Means for length of time respondents have engaged in the hobby can be found in Table 4 and distribution by respondents are illustrated in Fig. 8.

Figure 8. Percentage of aquarists (saltwater, n = 82, freshwater, n = 226) by amount of time (years) engaged in aquarium keeping.

When asked to identify the reason(s) they owned an aquarium, the majority of respondents indicated *connectedness to nature* (80.9%, n = 246), *aesthetics/décor* (78.3%, n = 238), and *appeal to exotic pets* (56.3%, n = 171) as their primary motivations (Fig. 9). These reasons did not differ by *TYPE* except for *conservation*, which was selected by 69.1% of saltwater aquarists, but only 18.2% of freshwater owners, $\chi^2(3, N = 304) = 9.93, p = 0.02$. Notably 10.5% (n = 32) respondents wrote in a response related to relaxation or stress/anxiety relief under the *other* prompt. This reason was cited by 8.3% of the sample as being their first or second most important reason. Other reasons captured in the *other* category were qualitatively grouped and provided in Table 5.

Figure 9. Answers selected for reasons to own an aquarium with distinction of reasons perceived as important (n = 304).

Table 5. Categorized qualitative responses for “other” when participants were asked why they keep an aquarium.

Reason	Number of respondents
Relax or stress/anxiety relief	32
Challenging/technical/using science	12
Enjoyment/entertainment/pleasure	10
High interest/passion/curiosity	8
Like fish/animals	7
To study/research	5
Not specified	4
Joy of nurturing/caring for something	3
Animal/fish rescue; give “better” life than pet store	3
Companionship/to have a pet	3
Sentimental attachment	1
Educate others	1

Respondents were asked a series of questions related to their history and prospects of owning each type of aquarium. Ninety-four percent (n = 79) of saltwater aquarists owned a freshwater aquarium before their saltwater tanks. Only 9.5% (n = 8) of

respondents who currently own saltwater aquariums (but not freshwater) plan on purchasing a freshwater aquarium in the future while another 9.5% (n = 8) are unsure. For freshwater owners (who do not currently own saltwater tanks), 24.9% (n = 45) plan to purchase a saltwater tank in the future and 33.7% are unsure. Freshwater aquarists who owned saltwater tanks in the past (11.7%, n = 23) cited several reasons for their decision to no longer keep this aquarium type (Table 6). Freshwater-only owners were also asked why they do not keep a saltwater aquarium at this time, with the primary reason being “too expensive” (Fig. 10).

Table 6. Stated reasons why freshwater owners who previously owned a saltwater aquarium no longer do.

Reason	Number of respondents
Not specified	7
Too much time/energy for upkeep	5
It was a long time ago/owned as child	5
It was too expensive	4
Environmental or ethical concerns	3
It was too stressful	2
Tragedy or loss of tank	2
Moved or change in living situation	2
High mortality of organisms	2
It was too difficult	1
Not enough space	1
Difficult to access supplies in my area	1

Figure 10. Answers selected for reasons freshwater aquarium owners choose not to keep a saltwater tank with distinction of reasons perceived as important (n = 184).

3.3 Hobby Engagement

3.3.1 Likert-scales and descriptive statistics of hobby engagement

Of the activities presented (Fig. 11), most respondents indicated they are likely to participate in the following activities: *visit a coral reef*, *belong to an aquarium hobbyist group*, *visit a rainforest*, *buy certified seafood*, and *belong to an environmental or conservation group*. While participation in no activity was considered unlikely by the majority of respondents, the least favorable activity was *belong to an animal rights group* followed by *donate to poverty-alleviating programs both internationally and domestically*, and *buy organic produce*.

Figure 11. Respondent likelihood to participate in various activities based on a 5-point Likert scale (n = 270).

Respondents had high stated knowledge regarding their aquariums and the supply chain that produces them (Fig. 12). Nearly every (96.7%, n = 257) respondent claimed they research the organisms they plan to purchase before adding to their aquarium. When asked how knowledgeable respondents consider themselves, more than half agreed (strongly or slightly) to each statement, with most (93.6%, n = 248) seeing themselves as highly knowledgeable about aquarium care. Respondents were less likely to claim their purchasing decisions impact the supply chain, although most respondents expressed some level of agreement with each statement apart from “my purchasing decisions of aquarium organisms impact livelihoods of indigenous people in source countries.”

Figure 12. Respondent stated knowledge and purchasing power based on a 5-point Likert scale (n = 266).

According to the respondents' designation of important attributes when selecting an organism (Fig. 13), *fit or function in aquarium* is the leading factor to consider while purchasing. Most respondents felt the following attributes were *very* or *extremely* important: *welfare standards* ("the organism was well cared for through the supply chain"), *capture* ("if wild caught, how the organism was captured"), and *aesthetics* ("how it looks"). Unexpectedly, respondents ascribed little importance to *rarity of species or color morph*. Notably, this scale also had the most frequent use of the neutral choice than any other Likert items presented in the questionnaire.

Figure 13. Respondent perception of important selection criteria based on a 5-point Likert scale (n = 259).

3.3.2 Factors of hobby engagement

A principle component analysis with varimax rotation revealed nine factors (eigenvalues greater than 1.0 and factor loadings over 0.40) related to hobby engagement, accounting for 68.0% of the total variance (Table 7; see Appendix C for expanded definition of variables). Each of the 28 Likert items loaded onto one of the nine factors with no variables loading on more than one. Following a Chronbach's alpha reliability analysis, Factor 6 and Factor 9 will not be used for further analysis due to poor reliability ($\alpha < 0.60$). Two factors (5 and 8) have only an "acceptable" level of reliability (see Hair et al., 2006) with values between 0.60 and 0.70, but will be used in analysis as these low scores are likely due to the small number of variables loaded on the factor. A composite score for each factor was created by averaging the respective Likert items for each respondent (Fig. 14); these values are the variables that will be used hereafter when referencing **factors of hobby engagement**. Values approaching 5.00 signify stronger engagement by hobbyists for the corresponding factor.

Table 7. Results of principle components analysis with nine resulting factors related to hobbyist engagement.

Factor and Included Variables	Factor Loadings	Description	Explained Variance (%)	Eigenvalue	Cronbach's α
Factor 1: Selection for Supply Chain Attribute			20.96%	5.870	0.845
Selection – Supply	0.662	Designation of important attributes based on the organism's history through the supply chain.			
Selection – Capture	0.702				
Selection – Welfare	0.658				
Selection – Origin	0.715				
Selection – Livelihoods	0.735				
Selection – Informative Label	0.758				
Factor 2: Knowledge of Supply Chain			9.65	2.702	0.794
Knowledge – Aquarium Care	0.701	Perceived knowledge of the aquarium supply chain.			
Knowledge – Supply	0.824				
Knowledge – Capture	0.816				
Knowledge – Origin	0.695				
Factor 3: Perceived Purchasing Power			8.11	2.272	0.817
Purchase – Environmental	0.789	Belief of how their purchasing behavior impacts the supply chain.			
Purchase – Livelihoods	0.811				
Purchase – Welfare	0.779				
Purchase – Industry	0.686				
Factor 4: Donate to Poverty-Alleviating Organizations			7.51	2.104	0.882
Activity – Donate Domestically	0.895	Likelihood of donating to poverty-alleviating organizations.			
Activity – Donate Internationally	0.871				
Factor 5: Belonging to Interest Group			6.16	1.725	0.692
Activity – Aquarium Hobby Group	0.784	Likelihood of belonging to an interest group based on beliefs or activities.			
Activity – Conservation Group	0.713				
Activity – Animal Rights Group	0.438				
Factor 6: Selection for Organism Attribute			4.21	1.177	0.542
Select – Price	0.679	Designation of important attributes based on characteristics of the individual organism.			
Select – Aesthetics	0.747				
Select – Rarity	0.625				
Factor 7: Visit Tropical Destinations			4.04	1.130	0.819
Activity – Visit a Coral Reef	0.875	Likelihood to visit tropical location.			
Activity – Visit a Rainforest	0.881				
Factor 8: Buy Eco-Certified Products			3.75	1.051	0.608
Activity – Buy Organic Produce	0.853	Likelihood to participate in eco-certification schemes.			
Activity – Buy Certified Seafood	0.701				
Factor 9: Selection for Fit			3.59	1.005	0.323
Knowledge – Research	0.769	Ensuring selection of appropriate organisms for aquarium.			
Selection – Function	0.639

Figure 14. Median ($\pm$ IQR) scores for factors of hobby engagement.

3.3.3 Hobbyist characteristics and engagement with the hobby

To analyze the relationship between *TYPE* and the factors of hobby engagement, a Kruskal-Wallis *H* test was used to examine the factor scores based on the aquarium types of saltwater, freshwater, or both (Fig. 15c). Additionally, Mann-Whitney *U* tests were used to explore all saltwater owners (saltwater and both Fig. 15b) and all freshwater owners (freshwater and both; Fig. 15c). The Kruskal-Wallis *H* test revealed interactions between saltwater and freshwater, $H(2, 256) = 12.82, p = 0.03$, as well as freshwater and both, $H(2, 256) = -47.38, p = 0.001$, with saltwater and both having the highest levels of stated knowledge regarding the supply chain of aquarium organisms.

Figure 15. Median ($\pm$ IQR) scores for factors of hobby engagement by aquarium type: (a) saltwater only, freshwater only, and both; (b) all saltwater (saltwater only and both) and freshwater only; and (c) all freshwater (freshwater only and both) and saltwater only.

** denotes significance at 0.01 probability level; * denotes significance at 0.05 probability level

PRIMARY was related to factor scores for four of the seven remaining components (Figure 16). **Selection for Supply Chain Attribute** had a significant interaction between *primary hobby* and *not primary hobby*, $H(2, 256) = -25.59$, $p = 0.04$ with those who report *primary hobby* indicating a higher level of importance for supply chain attributes when selecting an organism. There were two significant interactions within the **Knowledge of Supply Chain** factor: *primary hobby* and *not primary hobby*, $H(2, 262) = -41.98$, $p < 0.001$, and *primary hobby* and *unsure*, $H(2, 262) = 67.37$, $p < 0.001$. The same interactions were present for **Perceived Purchasing Behavior**, $H(2, 260) = -27.82$, $p = 0.02$ and $H(2, 260) = 41.26$, $p = 0.02$, respectively. Those who reported *primary hobby* had the higher levels of stated knowledge for both factors. *Primary hobby* and *not primary hobby* also resulted in a significant interaction for **Belonging to Interest Group**, $H(2, 265) = -29.03$, $p = 0.01$, where once again *primary hobby* revealed the higher likelihood of participating in this activity.

Figure 16. Median ($\pm$ IQR) scores for factors of hobby engagement by involvement in aquarium hobby.

** denotes significance at 0.01 probability level; * denotes significance at 0.05 probability level

The lengths of time both saltwater and freshwater aquarists have participated in the hobby have positive correlations with the **Knowledge of Supply Chain** factor, $r_s(76) = 0.47, p < 0.001$ and $r_s(214) = 0.27, p < 0.001$, respectively. Saltwater aquarists' perception of knowledge is not correlated with volume, but freshwater owners have a weak, yet significant, correlation, $r_s(212) = 0.15, p = 0.02$. Further, the amount spent per month on aquarium organisms is unrelated to this factor score, but the average amount a respondent typically spends on an individual organism is highly significant, $r_s(254) = 0.25, p < 0.001$.

When comparing factor scores with reasons respondents choose to participate in the hobby, a notable relationship is that between *conservation* as a selected reason and the factors of **Selection for Supply Chain Attribute**, $U(257) = 22.17, p < 0.001$, and **Knowledge of Supply Chain**, $U(263) = 8.07, p = 0.005$ where respondents scored higher for both factors if they own an aquarium for conservation purposes. For freshwater owners who choose not to own a saltwater aquarium for environmental concerns, six of the seven factors are significant with **Visit a Tropical Destination** being the only unrelated factor (Figure 17). For each factor, the group of respondents who indicated *environmental concerns* as a reason scored higher than the group that did not cite this reason.

Figure 17. Relationship between hobby engagement factor scores and selected response of environmental concerns for freshwater owners who choose not to own saltwater aquariums.

3.4 Stated preferences

This section will describe respondents' preferences for attributes related to organism and supply chain attributes as well as provide average price premiums hobbyists are willing to offer for an organism with their selected attributes. This portion of the questionnaire was completed by 243 participants. After presenting a summary of hobbyists' preferences and price premiums, this section will conclude with an examination of the potential drivers of consumer preferences based on hobbyist characteristics and hobby engagement factors.

3.4.1 Hobbyist preferences for organism attributes

Table 8 provides a summary of which attributes respondents preferred versus those that had *no preference* or would not be purchased with either given attribute. More respondents preferred *high welfare standards* than any other organism attribute (86.4%, n = 210). *Captive bred* was the next most popular attribute (75.7%, n = 151), with *captured*

with nets being the third most selected attribute (62.4%, n = 151). Respondents rarely chose *neither*, but many (19.8%, n = 48) selected this choice for *CAPTURE*. When this choice was selected, a text box appeared which prompted respondents to provide reasoning for this selection; here, respondents expressed their choice being *neither* because they exclusively purchase captive-bred organisms, so these attributes do not pertain to their purchasing decisions. The variables *RARITY*, *LIVELIHOODS*, and *INFORMATIVE LABEL* had nearly equal distributions between a preference for an attribute and *no preference*, although the attributes of *rare*, *supports livelihoods*, and *information available* were selected more than any other choice for their respective variables. *ORIGIN* is the only variable which the respondents' selection for *no preference* exceeded all other choices (62.1%, n = 151).

Table 8. Hobbyist preferences for organism attributes.

Variable	Attribute	n	% Respondents
Rarity	Rare	118	48.8
	Common	16	6.6
	No Preference	107	44.2
	Purchase Neither	1	0.4
Supply	Captive Bred	184	75.7
	Wild Caught	8	3.3
	No Preference	49	20.2
	Purchase Neither	2	0.8
Capture	Chemicals	1	0.4
	Nets	151	62.4
	No Preferences	42	17.4
	Purchase Neither	48	19.8
Welfare	High Standards	210	86.4
	Unknown	2	0.8
	No Preference	31	12.8
	Purchase Neither	0	0.0
Origin	Domestic	81	33.3
	Import	10	4.1
	No Preference	151	62.1
	Purchase Neither	1	0.4
Livelihoods	Supports	121	49.8
	No Support	4	1.6
	No Preference	111	45.7
	Purchase Neither	7	2.9
Informative Label	Available	130	53.7
	Unavailable	2	0.8
	No Preference	107	44.2
	Purchase Neither	3	1.2

3.4.2 Economic valuation of selected attributes

If a respondent indicated a preference for an attribute, they were asked how much they would spend *extra* for that attribute. This was converted to a percent increase from the price they provided when asked “how much would you be typically willing to spend on an aquarium organism?” (Table 9). Hobbyists would spend most for an organism that is considered rare, despite citing it as the least important to consider when selecting an organism (Fig. 13). While the vast majority of respondents prefer captive bred over wild caught organisms, those who prefer either attribute are willing to pay a similar price premium at 43.9% and 38.7%, respectively. Similarly, while most hobbyists did not express a preference for origin of their organism, those who did provided similar price premiums (43.9% for domestic and 52.8% for imported). The price premium for the most favored attribute, *high welfare standards*, was 52.9%, where *captured with nets* elicited a price increase of 38.1%. Although these attributes were considered less popular than others presented, for the attribute *supports livelihoods*, consumers would spend an additional 47.4%; hobbyists will also pay a 30.7% price premium for an *informative label*. It is important to note that each attribute had a minimum price premium of 0.0%, indicating that some hobbyists have preferences for that attribute, but are unwilling to offer more for an organism that has it over one that does not. Also notable are the high price premiums some respondents provided where they would offer several times the typical price of the organism in order to realize this preference. These minimum and maximum values indicate hobbyists differ in their perceived importance and valuations of the attributes.

Table 9. Marginal price premiums (represented as percentages) hobbyists are willing to offer for each attribute over base value of a typical aquarium organism.

Variable	Attribute	n	Median	IQR	Min.	Max.
Rarity	Rare	114	50.0	66.7	0.0	416.7
	Common	14	20.0	35.0	0.0	66.7
Supply	Captive Bred	178	33.3	33.3	0.0	240.0
	Wild Caught	8	17.1	43.8	0.0	200.0
Capture	Chemicals	1	0.0*			
	Nets	145	28.6	43.3	0.0	240.0
Welfare	High Standards	203	40.0	40.0	0.0	300.0
	Unknown	1	40.0*			
Origin	Domestic	77	30.0	33.3	0.0	200.0
	Import	10	18.3	75.0	0.0	300.0
Livelihoods	Supports	117	33.3	33.8	0.0	200.0
	No Support	3	0.0	n/a	0.0	30.0
Informative Label	Available	126	20.0	34.3	0.0	400.0
	Unavailable	2	0.0	0.0	0.0	0.0

*Only one respondent selected this attribute.

3.4.3 Drivers of stated preferences and valuation

For this section the variables *RARITY* and *ORIGIN* were removed from analysis because their social and environmental impacts are more complex and depend on several factors including location of capture, location of respondent, and species of organism. The other variables (i.e. *SUPPLY*, *CAPTURE*, *WELFARE*, *LIVELIHOODS*, and *INFORMATIVE LABEL*) have arguably more direct implications on the supply chain and will be used in this section to measure respondents' preference for an attribute and price premiums they would offer for an organism with the selected attribute. For simplicity, this section is also limited to only the “optimal” attribute (hereafter referred to as *positive attribute*) which will most positively impact the social and environmental factors of the supply chain (e.g. *net captured*). To analyze these data, a new binary variable was created which designated if a respondent had a preference (for the *positive attribute*: *captive bred*, *net caught*, *high welfare standards*, *supports livelihoods*, and *information available*) or *no preference*. The price premiums used for analysis were only those associated with the aforementioned *positive attributes*.

The base value consumers typically spend on an aquarium organism was unaffected by all demographic control variables except income, $H(7, 223) = 14.81, p = 0.04$ (with no significant interactions between income categories), although income did not have a significant relationship with any of the marginal price premiums for any variable (Table 10). The only demographic control variable that was found to significantly relate to price premiums was gender identity for *welfare* with males opting to spend more. Gender also impacted a respondent's selection for *supports livelihoods* and *information available* where females were more likely than males to have a preference, $X^2(3, N = 151) = 13.79, p = 0.003$ and $X^2(3, N = 153) = 19.26, p < 0.001$. No other demographic variables (income, age, education, or region), *PRIMARY*, nor *TYPE* were related to any stated preference for an attribute or the price premium a respondent is willing to offer.

Table 10. Relationships between marginal price premiums respondents will offer for *positive attribute* and demographic variables.

Variable	Test Result	Captive Bred	Net Caught	High Welfare Standards	Supports Livelihood	Information Available
Income Category	n	165	135	189	110	117
	<i>H</i>	8.18	11.48	9.25	5.56	8.06
	df	7	7	7	7	6
	<i>p</i> -value	0.317	0.119	0.235	0.592	0.234
Age Category	n	177	144	201	117	125
	<i>H</i>	7.40	3.76	10.89	7.34	1.29
	df	7	6	7	7	6
	<i>p</i> -value	0.388	0.710	0.144	0.394	0.973
Highest Level of Education	n	175	142	200	116	125
	<i>H</i>	10.34	6.05	4.69	7.19	7.49
	df	7	7	7	7	7
	<i>p</i> -value	0.168	0.534	0.698	0.410	0.379
Gender Identity	n	177	144	202	117	125
	<i>H</i>	5.10	1.26	8.71	0.605	4.00
	df	3	3	3	3	3
	<i>p</i> -value	0.165	0.739	0.033	0.895	0.261
Region	n	178	145	203	117	126
	<i>H</i>	1.79	4.68	2.76	1.97	7.76
	df	4	6	6	5	6
	<i>p</i> -value	0.775	0.586	0.839	0.853	0.256

*Bold typeface indicates significance at .05 probability level.

To explore if a respondent's hobby engagement was related to having a preference for the *positive attribute*, a Mann-Whitney *U* Test was performed using the factor scores presented in Table 7 and the binary preference variables (i.e. *preference* or *no preference* for the *positive attribute*, Table 11). There were significant relationships between most factors and preference for attributes with the factors **Selection for Supply Chain Attribute**, **Belonging to Interest Group**, and **Buy Eco-Certified Products** being significantly related to all attributes. **Visit Tropical Destinations** was not significantly related to preference for any attribute. For all factors of hobby engagement that are significantly related to preference for an attribute, the mean rank for *preference* was higher than *no preference*, indicating that those who are more engaged with the hobby (i.e. scoring higher on each factor) are more likely to have preferences for organism attributes when making purchasing decisions.

Table 11. Relationships between average factor scores and respondent indication of preference or no preference for the *positive attribute*.

	Factors of Hobby Engagement	Preference		No Preference		N	U	p
		Median	IQR	Median	IQR			
Captive Bred	Selection for Supply Chain Attribute	3.33	1.17	2.67	1.58	231	6367.00	0.000
	Knowledge of Supply Chain	4.00	1.25	3.75	1.19	230	5654.00	0.003
	Perceived Purchasing Power	3.75	1.00	3.50	1.25	228	4931.50	0.130
	Donate to Poverty-Alleviating Programs	3.00	2.00	3.00	2.00	233	5086.00	0.163
	Belonging to Interest Group	3.33	1.33	3.00	1.00	230	5203.00	0.041
	Visit Tropical Destinations	4.00	2.00	4.00	2.00	230	4545.00	0.539
	Buy Eco-Certified Products	3.50	1.25	3.00	1.88	231	5273.00	0.047
Net Caught	Selection for Supply Chain Attribute	3.33	1.00	2.50	1.50	192	4694.00	0.000
	Knowledge of Supply Chain	4.00	1.25	3.50	1.25	191	3978.00	0.004
	Perceived Purchasing Power	3.75	1.00	3.25	1.25	188	4267.50	0.000
	Donate to Poverty-Alleviating Programs	3.00	2.00	3.00	1.50	193	3845.00	0.033
	Belonging to Interest Group	3.33	1.33	2.67	1.33	189	3703.00	0.047
	Visit Tropical Destinations	4.00	2.00	4.00	1.63	190	3444.00	0.202
	Buy Eco-Certified Products	3.50	1.00	3.00	2.00	191	3770.50	0.040
High Welfare Standards	Selection for Supply Chain Attribute	3.17	1.17	2.08	1.79	239	4828.00	0.000
	Knowledge of Supply Chain	4.00	1.44	3.75	1.50	238	3553.00	0.332
	Perceived Purchasing Power	3.75	1.00	3.25	0.94	236	4266.00	0.001
	Donate to Poverty-Alleviating Programs	3.00	2.00	2.50	2.25	241	4017.00	0.033
	Belonging to Interest Group	3.33	1.33	2.67	1.25	237	3807.50	0.044
	Visit Tropical Destinations	4.00	2.00	4.00	2.00	238	3165.50	0.895
	Buy Eco-Certified Products	3.50	1.00	3.00	2.00	239	4009.00	0.027
Supports Livelihoods	Selection for Supply Chain Attribute	3.50	1.17	2.75	1.04	230	9446.50	0.000
	Knowledge of Supply Chain	3.75	1.25	4.00	1.50	229	6355.50	0.703
	Perceived Purchasing Power	4.00	1.00	3.25	1.00	227	8563.50	0.000
	Donate to Poverty-Alleviating Programs	3.50	1.00	2.50	1.63	232	8858.00	0.000
	Belonging to Interest Group	3.33	1.67	2.00	1.33	228	8787.00	0.000
	Visit Tropical Destinations	4.00	2.00	4.00	2.00	229	6795.50	0.601
	Buy Eco-Certified Products	3.50	1.38	3.00	2.00	230	8344.50	0.000
Information Available	Selection for Supply Chain Attribute	3.50	1.17	2.67	1.08	235	10213.00	0.000
	Knowledge of Supply Chain	4.00	1.50	4.00	1.00	234	7016.00	0.650
	Perceived Purchasing Power	3.75	1.25	3.50	1.00	233	8369.00	0.001
	Donate to Poverty-Alleviating Programs	3.00	2.00	3.00	1.75	247	8851.00	0.000
	Belonging to Interest Group	3.33	1.33	3.00	1.00	234	8194.00	0.006
	Visit Tropical Destinations	4.00	2.00	4.00	2.00	234	6721.50	0.919
	Buy Eco-Certified Products	3.50	1.25	3.00	2.00	235	8997.50	0.000

*Bold typeface indicates significance at .05 probability level.

Spearman correlation revealed weak yet significant positive associations between the factor **Selection of Supply Chain Attribute** and price premiums for every *positive attribute*, indicating that hobbyists who ascribe higher importance in selection criteria will pay more for these preferences to be realized (Table 12). The only other significant correlations between factors and price premiums were those for *high welfare standards* and the factor score of **Perceived Purchasing Power**, $r_s(197) = 0.19$, $p = 0.01$, as well as *supports livelihoods* and the **Belonging to Interest Group** factor, $r_s(112) = 0.24$, $p = 0.01$, although these positive correlations are also weak.

Table 12. Spearman correlations of factor score for Selection of Supply Chain Attribute and price premiums for *positive attributes*.

Positive Attribute	r_s	df	p -value
Captive Bred	0.363	174	0.000
Net Caught	0.208	142	0.012
High Welfare Standards	0.322	200	0.000
Supports Livelihoods	0.400	113	0.000
Information Available	0.299	122	0.001

CHAPTER 4

DISCUSSION

4.1 Overview of consumer engagement and purchasing behavior

For market-based management strategies to be successful in improving the sustainability, equity, and welfare of the aquarium trade, consumers must be knowledgeable of supply chain issues and receptive to market incentives. This study explores how home aquarium owners engage in the aquarium keeping hobby by exploring three guiding research questions:

- 1) How knowledgeable are home aquarium owners about the issues of sustainability, equity, and welfare in the aquarium trade?
- 2) What are the preferences for different attributes related to sustainability, equity, and welfare, and what price premiums are consumers willing to offer to obtain organisms with these attributes?
- 3) How do individual aquarists' characteristics and level of engagement in the hobby affect purchasing behavior?

Participants of this study considered themselves to be considerably knowledgeable about the aquarium hobby. Preferences for attributes related to sustainability, equity and welfare varied among respondents. The most preferred attributes were *high welfare standards*, *captive bred*, and *net caught*, with *rare* being the least preferred attribute. All characteristics determined to be a *positive attribute* (i.e. presence of attribute most likely to positively impact the industry) had a median price premium of at least 20.0%. Findings also indicate that those respondents who are more

knowledgeable and demonstrate more refined selection behaviors while purchasing organisms participate in the hobby and associated markets differently than those with less knowledge and less selective behaviors.

High welfare standards was not only the most popular attribute, but the *positive attribute* with the highest associated price premium. The next highest price premiums were for captive bred and supports livelihoods, although fewer hobbyists will pay a price premium for the latter. Despite the strong opinions regarding chemical (i.e. cyanide) use in the supply chain that respondents presented through the questionnaire and in the additional comments section, a *net caught* organism had a lower price premium than that for other *positive attributes*. One respondent's comment may reveal the explanation for this low value:

“Because I *already* purchase fish that are captive bred, have low environmental impact, and support the livelihood of those in other countries, the "amount extra" I would be willing to pay is minimal because I already do typically pay extra for those fish” (edited for formatting).

Given the number of respondents who used qualitative response sections to emphasize that they only purchase fish with certain attributes (i.e. captive bred), the projected price premiums could be low to reflect this behavior already being practiced and included in the initial base value of the organism.

4.2 Implementation of a certification scheme

At present, there is no active certification scheme for the promotion of sustainability, equity, or welfare in the aquarium trade. This study does not evaluate the consumers' explicit attitudes toward a certification scheme, but instead uses respondents' stated values as implicit support for a market-based reform of the industry. This section

explores the potential for a certification scheme by identifying a target audience, consumer support, and barriers to implementation.

4.2.1 Target audience

‘Avid’ hobbyists (i.e. those who consider aquarium keeping their primary hobby with great time and financial contributions to their stock) are an interesting subset of the consumer population. While only about 7% of aquarists worldwide are members of this group, it is projected that they purchase up to 40% of all organisms in the trade (Townsend, 2011). These hobbyists are an ideal target for a certification scheme due to their significant purchasing power in the industry. Meanwhile, novice or intermediate aquarists should not be ignored as potential targets; novices are unlikely to be committed to a specific set of practices and may be more flexible in changing purchasing behaviors as they acclimate to the hobby.

Avid hobbyists in this study are those respondents who indicated that aquarium keeping is their primary hobby. Those who consider aquarium keeping their primary hobby spent more hours engaging in the hobby (aquarium care, research, engaging in online fora, etc.) than those who do not. These hobbyists also scored significantly higher in the engagement factors **Selection for Supply Chain Attribute**, **Knowledge of Supply Chain**, and **Perceived Purchasing Power**, providing evidence that those who are more involved in the hobby are more knowledgeable and have stronger preferences when purchasing aquarium organisms. An indication of *primary hobby* was not related to type of aquarium. However, freshwater aquarists tended to have larger volume tanks and spent more on organisms each month if aquarium keeping is their primary hobby while the

volume and monthly expenditures of saltwater owners were unrelated. One interesting note is that the number of years engaged in the hobby was not significantly related to whether a respondent indicated aquarium keeping as a primary hobby, indicating that even novice aquarists may consider themselves avid hobbyists.

4.2.2 Support for a certification scheme

The results of this study show substantial support for a reform in the trade as the represented consumers highly value sustainability, equity, and welfare of their aquarium organisms and the supply chain that produces them as indicated by their preferences and price premiums. Comments provided by respondents emphasized the lack of information available to consumers when making purchasing decisions. Information regarding the supply chain is largely unavailable and while consumers feel informed about the issues, the attributes of the organism are often unknown when making purchasing decisions. This is especially true for welfare where information on care is likely to be available to both consumers and retailers. This finding agrees with a study by Murray and Watson (2014) which revealed that 97% of consumers felt they lacked information about the origin and collection methods of their organisms. Several respondents highlighted their support for a market-based approach to improve information availability. As one respondent mentioned in the comments section of the survey, “I would love to see more regulation, better standards and communication in the industry. The cost will go up but that's a good thing for everyone in the supply chain. The fish is the cheapest part of owning an aquarium,” and another stated “I am willing to spend more on [an] organism based on my ethics if the information is available.”

The respondents of this study revealed other implicit values that may make them more receptive to a certification approach. For example, respondents were more likely than not to purchase sustainable seafood and organic produce, indicating most are responsive to eco-certification initiatives. Nearly 70% of respondents affirmed they are likely to visit a coral reef and 60% a rainforest, suggesting hobbyists have some form of connection with the environments facing degradation by the trade. Further, 69.1% of saltwater aquarists selected *conservation* as a reason for owning an aquarium, meaning they may be more likely to participate in an initiative that will benefit both the environment and future of their hobby. Aquarium hobbyists may be further primed for implementation of a market-based approach since price is relatively unimportant to the average consumer (Fig. 13; see also Murray and Watson, 2014). Consumers in the aquarium industry are typically of affluence with higher than average household income (Murray and Watson, 2014) as noted by aquarium organisms being considered luxury goods (Rhyne and Tlustý, 2012, Militz et al., 2017). Since aquarium organisms are luxury goods and product of a hobby, it is also speculated that price premiums will be higher for these organisms than normal goods.

Another possible indicator of support for the implementation of a certification scheme is respondents' perceived purchasing power. When prompted with the statement "My purchasing decisions of aquarium organisms impact the..." followed by environment, livelihoods of indigenous people in source countries, welfare of animals, and aquarium industry, less than 25% of respondents disagreed with each of the four statements. This perception of purchasing power could be leveraged for implementation of a consumer-driven certification scheme.

4.2.3 Barriers to implementation of a certification scheme

While consumer support for the features that would comprise a certification scheme is evident, the lack of credibility, traceability, and durability present substantial barriers to implementation. Due to a past failure of a certification scheme created by the Marine Aquarium Council (MAC), the potential for a revised labeling system lacks credibility with consumers. MAC established a certification scheme for aquarium fish in 2001, but it was disbanded only 3.5 years later due to a lack of effectiveness (Mathews Amos and Clausson, 2009 as cited in Thornhill, 2012). Several studies to date (see Alencastro et al., 2005, Thornhill, 2012, Jacquet et al., 2009, and Miltz et al., 2017) cite a myriad of impediments that culminated in the ultimate failure of the MAC certification scheme, including mislabeling and misidentification of animals and a lack of transparency lending credibility to claims of sustainable organisms. Traceability in the supply chain is limited and compounded by MAC's lack of proper documentation procedures, resulting in shipments that contained mixtures of certified and non-certified organisms, diminishing authority in the system (Mathews Amos and Clausson, 2009 as cited in Thornhill 2012). Most notably, Townsend (2011) attributed lack of consumer demand as the primary deterrent of the certification scheme and claims that a successful certification initiative must be inclusive to engaging all actors in the market, particularly consumers. Ultimately, without adequate consumer support, the MAC did not result in the price premiums, quality improvements, or mortality reductions necessary to drive a change in demand (Thornhill, 2012). A new certification scheme may face criticism due to the lack of credibility caused by the initial failure, creating a potential barrier for future implementation of a revised program.

Another issue presented with the previous attempt of a certification that will hinder future application is the lack of traceability in the supply chain. At each step of the supply chain it is common practice to pool organisms by species or taxa with no means to differentiate organisms by non-physical (i.e. supply chain) attributes (Cohen et al., 2013). Since the *positive attributes* for which respondents were willing to pay a price premium in this study would not be easily distinguished in the pooled organisms, supply chain members could attempt to sell organisms as “certified” in order to garner the price premiums. To prevent this from occurring, a reputable third party would likely need to enforce and monitor the trade and solutions will need to be created to maximize traceability of the organism origin.

For the certification scheme to be durable and continue delivering environmental and social benefits, the economic incentives for supply chain members must be ongoing. As seen with the previous attempt by MAC, a certification scheme can be short-lived without the proper support for credibility and traceability. If these qualities are lost, price premiums will diminish and as soon as it becomes more economically viable to produce organisms using unsustainable techniques, supply chain members will quickly revert to these practices (Thornhill, 2012).

4.3 Responsibility of supply chain

The supply chain for the aquarium is often long and complex with organisms being moved through several intermediaries (transporters, middlemen, exporters, importers, wholesalers, and retailers) between fisher and hobbyist (Wabnitz et al., 2003). Although consumers drive the trade (Rhyne and Tlustý, 2012), other parts of the supply

chain could also influence sustainability of the industry. Retailers are the medium through which consumers interact with the supply chain. While this study only briefly explored how consumers interact with various retailers, respondents used the comments sections to share evidence of the role of retailers when making purchasing decisions. Notably, respondents cited three major responsibilities for retailers: taking care of their organisms, sharing knowledge on the species and associated requirements, and stocking animals ethically.

Numerous respondents shared the importance of retailer impressions when making purchasing decisions. Since welfare is of high importance to hobbyists but the treatment of the animal through the supply chain is unknown, respondents reported using the condition of the animals at the time and location of purchase as a measure of welfare to guide purchasing decisions. Hobbyists also mentioned that they are unlikely to engage with retailers who demonstrate sub-standard care for their animals. Prioritizing welfare has implications beyond just ethical concerns; improving welfare standards will reduce supply chain mortality and, in turn, mitigate some of the exploitation pressure on the reef system (Thornhill, 2012). Further, welfare of the organism goes beyond only handling and care; many respondents argued that welfare considerations should include the trade of organisms that fail to thrive in captivity as well as retailers selling organisms without the appropriate information for care, therefore leading to inevitable mortality. For this reason, several respondents cited lack of knowledge on the species or aquarium care by retailer staff as their primary reason to not purchase an organism. Respondents also noted that it is for this reason that they are unlikely to shop at commercial pet stores and this is

further evidenced in Fig. 5 where consumers (particularly saltwater owners) visited this retailer less.

Since consumers have imperfect information, retailers could play an important role in how the stock is sourced in terms of environmental, social, and welfare concerns. While the Convention on International Trade of Endangered Species (CITES) regulates the trade of endangered species, the aquarium trade lacks species or taxa-specific regulations for non-endangered organisms (Rhyne et al., 2012). Rare species of organisms that may not be regulated by CITES are particularly vulnerable to the trade. In this study, rarity elicited the highest price premiums, suggesting that they are more valuable in the trade, at least to individual consumers, and by the law of demand will be sought more, further diminishing the wild stock. As a few respondents highlighted, information on species-specific care is limited for rare organisms, leading to higher mortality and exacerbation of environmental and welfare issues. Some species may not be considered rare in the wild, but their popularity in home aquaria can have negative impacts on the age, sex, and trophic structures of wild populations. Aesthetic appeal is a primary reason a hobbyist owns an aquarium, as noted by 78.3% of respondents. More than half of all respondents indicated aesthetics as an important selection criterion when purchasing an organism. This leads to a higher selection for male and juvenile specimen as they are often most desired alongside rare species or color morphs (Thornhill, 2012). The selection criterion considered most important to respondents was the functional role of the organism in home aquaria. Consumers used the qualitative response options to emphasize the importance of function as they want an organism to fill its natural role in the aquarium (i.e. algae eating). However, popularity of these organisms is causing

trophic imbalances as low-trophic organisms are being overexploited for the aquarium trade (Thornhill, 2012).

Finally, the collection and handling of organisms could be improved to reduce impacts of the aquarium trade. Cyanide fishing is of concern to aquarists and conservationists alike. Respondents of this study opted for net-caught, or more commonly, captive bred specimens for concerns of environmental impacts by cyanide use. Although cyanide bans are common, illegal fishing continues since enforcement is weak in the areas cyanide fishing persists (Ferse et al., 2012a). Supply chain losses due to handling issues (i.e. barotrauma, injury, ammonia accumulation, etc.) can be minimized with improved training and education programs of supply chain members. Shortening the supply chain to reduce the time organisms are in transport and subjected to stressful conditions could further reduce mortality rates. While market incentives may help, these problems are mostly institutional and beyond the role of the consumer.

4.4 Future perspectives

4.4.1 Implications for management

Few respondents in this study plan to reduce their tank capacity where several plan to increase it, indicating potential growth in the industry. To avoid collapse of the fisheries that produce organisms for the hobby, there are several possible management interventions. Proposed strategies include introducing mariculture to fishing-dependent communities, banning trade from highly-exploited areas, or implementing market-based incentives to improve the supply chain.

The respondents of this study showed considerable support for captive-bred aquarium organisms. Artificially rearing marine organisms using mariculture would be an ideal solution since it can create alternative livelihood opportunities and reduce the pressures created by harvesting wild organisms, therefore relieving some of the ecological and socio-economic contentions of the trade. Some species (i.e. many species of coral) require low technical support and little specialized knowledge, making them ideal candidates for mariculture (Glaser et al., 2015). However, exclusive mariculture of ornamental fish species is far from becoming a reality as only 50 of the 2,000-plus species in the trade have been reared in captivity even in the most technologically-advanced situations (Militz et al., 2017). Mariculture also requires a great amount of capital which would not be feasible for many fishers. Therefore, while mariculture may produce some additional livelihood opportunities and reduce harvest pressure, it may not be the most optimal alternative to the wild-caught fishery.

While the extensive ecological impacts make trade bans in highly-exploited areas seem like a plausible solution, bans will likely be more detrimental than positive by creating a black market that increases prices and incentivizes more illegal and destructive behaviors. For many communities, the aquarium fishery is one of the only sources of livelihood (Ferse et al., 2012b). Removing the industry where few alternatives exist will only create financial and food insecurities, making the community and ecosystem more vulnerable. Fishers often practice destructive and over-exploitative behaviors to meet the immediate needs of livelihood and food security for their families, even though most are aware of the likelihood of long-term devastation (Nurdin and Grydehøj, 2014). Thus, in order to promote more sustainable harvest practices in these communities, fishers would

need to be well-compensated, a factor that can only be present with market-based incentives.

This study provides evidence that consumers are willing to provide the necessary market incentives to obtain organisms that have preferred attributes in the interest of sustainability, equity, and welfare. Creating price premiums for attributes that will positively impact the industry can encourage more sustainable practices along the supply chain and provide environmental and social benefits. Using a certification scheme as a tool to inform consumers and direct purchasing behavior could be an effective strategy for reforming the trade.

For a certification scheme to be accepted by consumers, the barriers of credibility, traceability, and durability will need to be overcome. Successful implementation of a certification scheme would need to look beyond the price premiums offered by consumers and identify some of the responsibilities and obstacles faced by retailers and other supply chain members.

4.4.2 Consumer stewardship

It would be naïve to assert that the aquarium trade is the only or even most significant threat to global reef systems. Other anthropogenic stressors, on local (i.e. point-source pollution) or global scales (i.e. atmospheric carbon dioxide concentrations), are causing massive losses in coral reefs around the world and the marine aquarium trade can only be considered additive to these effects. In fact, ending destructive and over-exploitive fishing practices will only alleviate some pressure, but not be enough to fully restore the reefs.

Consumers have considerable stewardship abilities for global coral reef conservation that can be leveraged as a management approach for the marine aquarium trade. Results of this study support those in Rhyne et al. (2014) which found that aquarium hobbyists feel a sense of connection for the environments from where their animals are sourced and are more likely to support conservation initiatives. The large number of saltwater aquarium owners in this study who choose to keep an aquarium to promote conservation (69.1%) may be inclined to support certification initiatives in the interest of the environment and future of the hobby. Stewardship by the consumer can also extend beyond just market-based strategies. Both home and public aquaria provide educational opportunities for a great number of people and can foster stewardship at large scales, even for geographically-removed individuals (Tlusty et al., 2013; Rhyne et al., 2014) and can be used as a tool to promote coral reef conservation efforts.

A respondent provided an excellent statement that encapsulates the issues with the aquarium industry and a consumer's role in sustainability:

“I'm personally **avoiding animals from Philippines, Vietnam, and Indonesia because of the high use of cyanide** still used to capture fish even though it is illegal. I am stocking majority of my tank with **captive-bred** fish with some exceptions for my favorite fish (wrasses) but will avoid those from the previously mentioned countries and look to specimens from Australia. However, I'm also aware that these **local fishing communities rely on the trade for their economy**. I wish there were stronger and more concentrated efforts to help communities still using cyanide to move to net caught fish (**perhaps incentives would need to be in place to make net caught fish more profitable than using cyanide**). Of course, there's still the **issue of welfare** after being caught. Too many animals die in the transport as well as going through wholesalers and to the [local fish store] (many of which are atrocious). I have moral qualms with stocking wild caught fish, but am excited to see more and more captive bred becoming available on the market - I'm **willing to pay a premium** for captive bred fish” (bold typeface added to emphasize key points).

4.4.3 Limitations

This study offers a unique perspective on the marine aquarium trade by capturing views of both saltwater and freshwater aquarists. Saltwater and freshwater aquarists provided similar responses to most of the survey questions. Participation in the market and purchasing behaviors are consistent across these two groups, with the exception that saltwater aquarists tend to spend more on organisms although the size of proportional price premiums do not differ. The only significant difference between groups worth noting is that saltwater hobbyists scored higher on the **Knowledge of Supply Chain** factor. Since the freshwater trade faces less extensive environmental and social impacts than the marine trade, consumers may be unaware or feel these supply chain characteristics do not pertain to them. One limitation of combining freshwater and saltwater hobbyists is that some attributes are more readily realized in freshwater organisms than saltwater (i.e. captive bred) and since some issues are less extreme for the freshwater trade, they may place less importance on attributes during selection or assigning price premiums.

Despite potential limitations of including freshwater aquarists in the sample for this study, their place in the marine market as potential consumers should not be ignored. Nearly all saltwater aquarium owners indicated that they began aquarium keeping with a freshwater tank. One-quarter of freshwater owners plan to purchase a saltwater aquarium soon with another one-third considering the purchase, creating a total of 58.6% of the freshwater-only respondents being potential consumers. Their current knowledge and purchasing behaviors can serve as unique insight to the establishment of a market-based

certification scheme. To date, no studies on the sustainability of the marine aquarium trade have included preferences of freshwater aquarium owners.

Using an online survey promoted on hobby discussion fora as a method for convenience sampling presents limitations from potential bias. It is likely that those who engage in these online discussion groups are highly invested in the hobby and will express higher than average levels of knowledge and more pronounced selection and purchasing behaviors. However, as noted above, ‘avid’ hobbyists should be targeted for their significant purchasing power. Since there is no existing database of aquarium owners and hobbyists are dispersed globally, an online survey remains the best method for reaching the target population despite the potential bias.

Another limitation of this survey is the geographic scope of respondents. Twenty-two countries from five continents were represented in this study. While having representation of respondents across the globe provides valuable information about regional purchasing behaviors, some attributes are highly dependent on the location of the respondent (i.e. whether the organism was imported and distance from export country, availability and popularity of organisms in this area, etc.). Nevertheless, most respondents were from the United States, the largest importer of aquarium organisms, so the disproportional geography of respondents may fairly represent the imbalance in trade quantities.

4.4.4 Future studies

There have been several studies (i.e. Alencastro et al., 2005; Murray and Watson, 2014; Militz et al., 2017) that have evaluated consumer preferences for aquarium

organisms and receptibility to a certification scheme. This study provided some preliminary findings of consumer attitudes and engagement with retailers. Future studies could explore the relationships between consumers and intermediary supply chain members (i.e. retailers, wholesalers, and exporters) to better understand their receptiveness to a certification scheme given the price premiums consumers indicated in this survey. Studies could also explore the barriers and responsibilities of these supply chain members in producing sustainably and ethically sourced organisms. These studies could use lessons learned from successful “eco-labels” (i.e. seafood, organic produce, timber, palm oil, etc.) as well as the failed MAC certification to investigate approaches to implementing a successful certification scheme for the aquarium trade. Further, to leverage a certification scheme as a tool for management, future research could examine the direct connections between consumer preferences and impacts on sustainability, equity, and welfare in the aquarium trade.

CHAPTER 5

CONCLUSION

The marine aquarium trade is embedded in many reef-adjacent communities as a unique social-ecological system. While the potential for benefits is great, current trends in the industry point toward a likely collapse of the fishery caused by destructive and over-exploitative harvesting practices. Through the supply chain, animals are often given sub-standard care. Poor welfare results in high mortality of organisms which creates market waste and exacerbates collection pressures to compensate for lost product. A threat to the industry is not only a threat to the livelihoods and food security of the hundreds of fishers and their families, but to thousands more who rely on healthy reef systems for subsistence or other livelihood strategies. As the popularity of home aquaria continues to expand, consumer demand will remain the driver of the quantity and quality of organisms in the trade. As demand continues to grow it only seems more likely that the supply chain will become more susceptible to poor sustainability, equity, and welfare.

It is possible for the fishery to be sustainably managed, but extensive reform is needed to promote sustainable collection and handling practices from the fisher to consumer. Strategies that address the complex linkages between the people, ecosystems, and markets are critical, while those that simultaneously empower and incentivize supply chain members may find the most success.

Implementing a certification scheme (or “eco-label”) for the aquarium industry may provide the incentives necessary to improve supply chain practices that meet standards for sustainable harvest of organisms, equitable compensation for fishers, and

ethical treatment of animals. Offering product certified under these criteria together with price premiums can amplify revenue for supply chain members since these organisms can garner higher prices in the market. Thus, the supply chain will be more incentivized to harvest and handle organisms to these standards. Ideally, the price premiums will be dispersed fairly through the supply chain and could potentially be used for poverty alleviation efforts in aquarium fishery-dependent communities.

Participants in this study were not asked for their explicit attitudes toward a certification scheme, but instead evaluated on their preferences for organism characteristics that could demonstrate implicit support for a market-based reform of the industry. Results of this study reveal that consumers have strong preferences for organisms with attributes that positively reflect sustainability, equity, and welfare in the aquarium trade. Hobbyists are considerably knowledgeable about the organisms they purchase as well as the industry that supplies them.

However, respondents note that it is rare for this information to be provided to them at the time of purchase. For this information to be available and the organism to feature attributes that will positively impact the supply chain, a hobbyist will offer at least 20% more than the commercial price of the organism. Findings also indicate that those respondents who are more knowledgeable and demonstrate more refined selection behaviors while purchasing organisms participate in the hobby and associated markets differently than those with less knowledge and less selective behaviors.

This study offers a unique perspective to the marine aquarium trade by including freshwater aquarists given that they have the highest potential of entering the saltwater aquaria market. While the supply chain for freshwater organisms has less acute

environmental and socio-economic impacts, animals are exposed to many of the same sub-standard welfare practices. Welfare of the organisms is of utmost importance to consumers and elicited the highest median price premium of 40% with respondents showing stronger preference for high welfare standards over any attribute reflecting sustainability or equity. Improving industry practices and promoting higher welfare standards can have positive implications for sustainability and equity. Improving welfare will reduce mortality; a reduction in mortality will relieve pressure on reef systems since fewer organisms will need to be harvested to compensate for supply chain losses. All members of the supply chain can benefit as lost product is forgone profit.

Despite the heaviness of the industry, the aquarium trade can also be a positive force in reef conservation. The trade is unique for its ability to promote stewardship in both consumer and producer spheres, which in turn can have respective global and local consequences for coral reef systems. The stewardship abilities of consumers can be valuable in leveraging market power to reduce the environmental and socio-economic impacts of the aquarium trade.

This study confirms that consumer support for trade reform is present and aquarium owners highly value organisms that positively reflect sustainability, equity, and welfare in the supply chain. Consumers are willing to pay price premiums to have these attributes realized, which should incentivize the production of higher quality organisms. However, the lack of cooperation by retailers and supply chain intermediaries combined with the deficit of information necessary for consumers to make informed purchasing decisions will impede progress for a sustainable aquarium fishery.

APPENDICES

APPENDIX A: ONLINE SURVEY INSTRUMENT

Consumer Preferences for Aquarium Organisms

Start of Block: Part I: Introduction and Consent

You are being asked to take part in a research study. The purpose of the research study is to better understand hobbyist preferences for organisms in the aquarium trade. Anyone who is 18 years or older and currently owns an aquarium (saltwater or freshwater) or is considering purchasing one is eligible to participate. Please read the following before agreeing to be in the study. If you agree to be in this study, it will take you approximately 15 minutes to complete this survey. Questions will be asked about your participation in the aquarium hobby and your purchasing behavior for aquarium organisms. There are no known risks, benefits or compensation.

Your responses will be strictly confidential. To help protect your confidentiality, the survey will not ask for any identifying information except for your IP address which is used to prevent respondents from taking the survey multiple times. The responses may be used for scholarly purpose and aggregate data may be shared or published.

The decision to participate in this study is entirely up to you. You may refuse to take part in the study at any time without affecting your relationship with the investigators of this study or the University of Rhode Island (URI). Your decision will not result in any loss of benefits to which you are otherwise entitled.

You have the right not to answer any single question, as well as to withdraw completely from the survey at any point during the process; additionally, you have the right to request that the researchers not use any of your responses. You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have questions about the study, at any time feel free to contact Tracey Dalton from the Department of Marine Affairs at the University of Rhode Island (URI), at dalton@uri.edu.

Additionally, you may contact the URI Institutional Review Board (IRB) if you have questions regarding your rights as a research participant. Also contact the IRB if you have questions, complaints or concerns which you do not feel you can discuss with the investigator. The University of Rhode Island IRB may be reached by phone at (401) 874-4328 or by e-mail at researchintegrity@etal.uri.edu. You may also contact the URI Vice President for Research and Economic Development by phone at (401) 874-4576.

If you would like to keep a copy of this document for your records, please print or save this page now. You may also contact the researcher to request a copy.

By clicking the “agree” button below, you are indicating that:

You have read and understand the above information
You voluntarily agree to participate
You are at least 18 years of age

If you do not wish to participate in this survey, please decline participation by clicking the “disagree” button.

☐ Agree (1)

☐ Disagree (0)

Skip To: End of Survey If Consent = Disagree

Page Break

End of Block: Part I: Introduction and Consent

Start of Block: Part IIa: Hobby Involvement

In which country do you currently live?

▼ Afghanistan (1) ... Zimbabwe (195)

Do you consider aquarium keeping your primary hobby?

☐ Yes (1)

☐ No (0)

☐ Unsure (2)

On average, how many hours a week do you dedicate to the aquarium hobby?

This may be maintaining your aquarium, researching aquarium-related topics, engaging in hobbyist-based websites or social media, or other activities related to aquarium keeping.

Why do you own an aquarium? Please select all that apply.

☐

Aesthetics/décor (1)

☐

Connectedness to nature (2)

☐

Appeal of exotic pets (3)

☐

Conservation (4)

☐

Breeding/propagation of organisms (5)

☐

For another household member (6)

☐

Other (please specify) (7) _____

Of the reasons you selected above, which is the most important to you?

▼ Aesthetics/décor (1) ... Other (7)

Of the reasons you selected above, which is the second most important to you?

▼ Aesthetics/décor (1) ... Other (7)

What type(s) of aquarium do you currently own?

- ☐ Saltwater (1)
- ☐ Freshwater (2)
- ☐ Both (3)
- ☐ Neither, but I am planning on purchasing one (4)
- ☐ Neither, but I am interested in the aquarium hobby (5)

Skip To: End of Survey If Type = Neither, but I am interested in the aquarium hobby

Page Break

End of Block: Part IIa: Hobby Involvement

Start of Block: Part IIb (1) Saltwater ONLY

Display This Block:

If Type = Saltwater

Or Type = Both

The following questions are to be answered regarding your SALTWATER tank(s). If you answered "both" on the previous page, you will be asked about your freshwater tank(s) in a separate set of questions to follow.

How long have you maintained a saltwater tank? Please specify a unit of time.

Time	Months (1)	Years (2)
	☐	☐

How many of each type of organism do you keep in your saltwater aquarium? If none, enter "0".

☐ Fish (1) _____

☐ Reef-building invertebrates (corals, anemones, sea fans, sponges, etc.) (2)

☐ Other invertebrates (crabs, shrimp, clams, snails, starfish, etc.) (3)

☐ Other (please specify in the box below) (4)

Optional: You may use the box below to tell us more about the types of organisms or species in your saltwater aquarium.

What is the total volume of your saltwater tank(s)? Please specify a unit of measurement.

Volume		
	Gallons (1)	Liters (2)

	☐	☐
--	-----------------------	-----------------------

Do you have plans to change your saltwater tank capacity within the next year?

- ☐ Yes, INCREASE tank capacity (1)
- ☐ Yes, DECREASE tank capacity (2)
- ☐ No planned change in tank capacity (3)

Where do you generally purchase your saltwater aquarium organisms? Check all that apply.

- ☐ Pet store - chain/commercial (1)
- ☐ Pet store - local (2)
- ☐ Online retailer (3)
- ☐ Trade shows (4)
- ☐ Other hobbyists (5)
- ☐ Other (please specify) (6) _____

On average, how much do you spend per month on saltwater aquarium organisms? Please use the currency of $\$ \{ 1 / \text{ChoiceGroup} / \text{SelectedChoices} \}$.

Before owning a saltwater aquarium, did you own a freshwater aquarium?

☐ Yes (1)

☐ No (0)

Do you have plans to purchase a freshwater tank in the future?

☐ Yes (1)

☐ No (0)

☐ Unsure (2)

☐ I already own a freshwater tank (3)

Page Break

End of Block: Part IIb (1) Saltwater ONLY

Start of Block: Part IIb: Freshwater ONLY

Display This Block:

If Type = Freshwater

Or Type = Both

The following questions are to be answered regarding your FRESHWATER tank(s).

How long have you maintained a freshwater tank? Please specify a unit of time.

Time	Months (1)	Years (2)

How many of each type of organism do you keep in your freshwater aquarium? If none, enter "0".

☐ Fish (1) _____

☐ Invertebrates (crabs, shrimp, clams, snails, etc.) (2)

☐ Aquatic plants (3) _____

☐ Other (please specify in the box below) (4)

Optional: You may use the box below to tell us more about the types of organisms or species in your freshwater aquarium.

What is the total volume of your freshwater tank(s)? Please specify a unit of measurement.

Volume	Gallons (1)	Liters (2)
	☐	☐

Do you have plans to change your freshwater tank capacity within the next year?

- ☐ Yes, INCREASE tank capacity (1)
- ☐ Yes, DECREASE tank capacity (2)
- ☐ No planned change in tank capacity (3)
-

Where do you generally purchase your freshwater aquarium organisms? Check all that apply.

- ☐ Pet store - chain/commercial (1)
- ☐ Pet store - local (2)
- ☐ Online retailer (3)
- ☐ Trade shows (4)
- ☐ Other hobbyists (5)
- ☐ Other (please specify) (6) _____

On average, how much do you spend per month on freshwater aquarium organisms? Please use the currency of $\$ \{1/\text{ChoiceGroup/SelectedChoices}\}$.

Why do you choose not to own a saltwater tank? If you do own a saltwater tank, you may skip this question.

- ☐ Too much time/energy for upkeep (1)
- ☐ Too difficult (2)
- ☐ Too expensive (3)
- ☐ Not enough space (4)
- ☐ Environmental concerns (5)
- ☐ No interest (6)
- ☐ Other (please specify) (7) _____

Of the reasons you selected above, which is the most important to you?

▼ Too much time/energy for upkeep (1) ... Other (7)

Of the reasons you selected above, which is the second most important to you?

▼ Too much time/energy for upkeep (1) ... Other (7)

Do you have plans to purchase a saltwater tank in the future?

☐ Yes (1)

☐ No (0)

☐ Unsure (2)

☐ I already own a saltwater tank (3)

Have you owned a saltwater tank in the past? If so, please tell us more about your experiences and why you no longer own one.

☐ No (0)

☐ Yes (please expand) (1) _____

Page Break

End of Block: Part IIb: Freshwater ONLY

Start of Block: Part IIc: Attitudes and Values

How likely are you to participate in the following activities?

	Extremely unlikely (1)	Somewhat unlikely (2)	Neither likely nor unlikely (3)	Somewhat likely (4)	Extremely likely (5)
Belong to an aquarium hobbyist group (1)	☐	☐	☐	☐	☐
Belong to an environmental or conservation group (2)	☐	☐	☐	☐	☐
Belong to an animal rights group (3)	☐	☐	☐	☐	☐
Buy organic produce (4)	☐	☐	☐	☐	☐
Buy certified seafood (5)	☐	☐	☐	☐	☐
Donate to poverty- alleviating programs domestically (6)	☐	☐	☐	☐	☐
Donate to poverty- alleviating programs internationally (7)	☐	☐	☐	☐	☐
Visit a coral reef (8)	☐	☐	☐	☐	☐
Visit a tropical rainforest (9)	☐	☐	☐	☐	☐

Page Break

End of Block: Part IIc: Attitudes and Values

Start of Block: Part III: Knowledge

Please indicate your level of agreement with the following statements.

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
I consider myself knowledgeable about aquarium care. (1)	☐	☐	☐	☐	☐
I consider myself knowledgeable about how aquarium organisms are supplied (wild caught, captive bred, etc.) (2)	☐	☐	☐	☐	☐
I consider myself knowledgeable about how wild caught aquarium organisms are captured (nets, cyanide, etc.) (3)	☐	☐	☐	☐	☐
I consider myself knowledgeable about which country my aquarium organisms originate. (4)	☐	☐	☐	☐	☐
I research the organisms I buy before adding them to my aquarium. (5)	☐	☐	☐	☐	☐
My purchasing decisions of aquarium organisms impact the environment. (6)	☐	☐	☐	☐	☐
My purchasing decisions of aquarium organisms impact livelihoods of indigenous people in source countries. (7)	☐	☐	☐	☐	☐

My purchasing decisions of aquarium organisms impact how animals are treated in the supply chain. (8)

☐☐☐☐☐

My purchasing decisions impact the aquarium industry. (9)

☐☐☐☐☐

Page Break

End of Block: Part III: Knowledge

Start of Block: Part IVa: Organism Selection

When selecting an aquarium organism, how important are the following qualities?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Price (1)	☐	☐	☐	☐	☐
Fit or function in aquarium (2)	☐	☐	☐	☐	☐
Aesthetics (how it looks) (3)	☐	☐	☐	☐	☐
Rarity of species or color morph (4)	☐	☐	☐	☐	☐
How the organism was supplied (wild caught, captive bred, etc.) (5)	☐	☐	☐	☐	☐
If wild caught, how the organism was captured (nets, cyanide, etc.) (6)	☐	☐	☐	☐	☐
The organism was well cared for through the supply chain (high welfare standards) (7)	☐	☐	☐	☐	☐
The country from which the organism originates (8)	☐	☐	☐	☐	☐
Extra revenue from sale of organism supports the livelihoods of indigenous people in source countries (9)	☐	☐	☐	☐	☐

Includes a label that communicates information related to the environmental and social impacts of the product origin (10)

☐ ☐ ☐ ☐ ☐

Page Break

End of Block: Part IVa: Organism Selection

Start of Block: Part IVb1: Base Value

How much would you be typically willing to spend on an aquarium organism? Please use the currency of $\${1/ChoiceGroup/SelectedChoices}$.

Page Break

End of Block: Part IVb1: Base Value

Start of Block: Part IVb2: Purchasing Behavior

The purpose of this section is for you to tell us how much different features of aquarium organisms are worth to you.

You will be provided with a choice of two organisms with different features. Please select which one you are more likely to purchase assuming a) the information was made available to you, and b) all other factors are equal.

On the previous page, you said you are typically willing to spend $\${32/ChoiceTextEntryValue}$ (in the currency of $\${1/ChoiceGroup/SelectedChoices}$) on an aquarium organism. Based on your preferences, you will be asked how much you are willing to pay **extra** for an organism with this feature.

An organism whose species or color morph is rare or one that is common

- ☐ Rare (1)
- ☐ Common (2)
- ☐ No preference (3)
- ☐ Neither (4)

Display This Question:

If Rarity = Rare

Or Rarity = Common

If you would typically spend $\$ \{32/\text{ChoiceTextEntryValue}\}$ on an organism, how much are you willing to pay **extra** if the organism has this feature? (Note: we are not asking for how much you are willing to spend for the organism in total)

Display This Question:

If Rarity = Neither

Please give your reasoning for not purchasing either organism.

An organism that was supplied by being captive bred or one that was wild caught

- ☐ Captive bred (1)
- ☐ Wild caught (2)
- ☐ No preference (3)
- ☐ Neither (4)

Display This Question:

If Supplied = Captive bred

Or Supplied = Wild caught

If you would typically spend $\${32/\text{ChoiceTextEntryValue}}$ on an organism, how much are you willing to pay **extra** if the organism has this feature? (Note: we are not asking for how much you are willing to spend for the organism in total)

Display This Question:

If Supplied = Neither

Please give your reasoning for not purchasing either organism.

A wild caught organism that was captured using chemicals (i.e. cyanide) or captured using nets

☐ Chemicals (i.e. cyanide) (1)

☐ Nets (2)

☐ No preference (3)

☐ Neither (4)

Display This Question:

If Capture = Chemicals (i.e. cyanide)

Or Capture = Nets

If you would typically spend $\${32/\text{ChoiceTextEntryValue}}$ on an organism, how much are you willing to pay **extra** if the organism has this feature? (Note: we are not asking for how much you are willing to spend for the organism in total)

Display This Question:

If Capture = Neither

Please give your reasoning for not purchasing either organism.

An organism that was known to be well cared for (high welfare standards) in the supply chain or one whose welfare history is unknown

- ☐ High welfare standards (1)
- ☐ Welfare unknown (2)
- ☐ No preference (3)
- ☐ Neither (4)

Display This Question:

If Welfare = High welfare standards

Or Welfare = Welfare unknown

If you would typically spend $\$ \{32/\text{ChoiceTextEntryValue}\}$ on an organism, how much are you willing to pay **extra** if the organism has this feature? (Note: we are not asking for how much you are willing to spend for the organism in total)

Display This Question:

If Welfare = Neither

Please give your reasoning for not purchasing either organism.

An organism that was supplied in your own country or one that was imported

- ☐ From own country (1)
- ☐ Imported (2)
- ☐ No preference (3)
- ☐ Neither (4)

Display This Question:

If Import = From own country

Or Import = Imported

If you would typically spend $\$ \{32/\text{ChoiceTextEntryValue}\}$ on an organism, how much are you willing to pay **extra** if the organism has this feature? (Note: we are not asking for how much you are willing to spend for the organism in total)

Display This Question:

If Import = Neither

Please give your reasoning for not purchasing either organism.

An organism whose extra revenue from its sale supports the livelihoods of indigenous people in source country or one that does not support livelihoods

- ☐ Supports indigenous people (1)
- ☐ Does not directly support indigenous people (2)
- ☐ No preference (3)
- ☐ Neither (4)

Display This Question:

If Livelihood = Supports indigenous people

Or Livelihood = Does not directly support indigenous people

If you would typically spend $\${32/\text{ChoiceTextEntryValue}}$ on an organism, how much are you willing to pay **extra** if the organism has this feature? (Note: we are not asking for how much you are willing to spend for the organism in total)

Display This Question:

If Livelihood = Neither

Please give your reasoning for not purchasing either organism.

An organism that has a label that communicates information related to the environmental and social impacts of the product origin or one that does not have a label

- ☐ Information available (1)
- ☐ Information unavailable (2)
- ☐ No preference (3)
- ☐ Neither (4)

Display This Question:

If Label = Information available

Or Label = Information unavailable

If you would typically spend $\${32/\text{ChoiceTextEntryValue}}$ on an organism, how much are you willing to pay **extra** if the organism has this feature? (Note: we are not asking for how much you are willing to spend for the organism in total)

Display This Question:

If Label = Neither

Please give your reasoning for not purchasing either organism.

Page Break

End of Block: Part IVb2: Purchasing Behavior

Start of Block: Part V: Demographics

The following questions ensure that all groups are fairly represented in the research study. All answers will be kept confidential.

What other (non-aquarium) pets do you currently own or are you considering purchasing?

How old are you?

▼ 18-19 (1) ... Prefer not to answer (9)

What is the highest level of education you completed?

▼ Less than high school (1) ... Prefer not to answer (8)

What is your gender?

- ☐ Male (1)
- ☐ Female (2)
- ☐ Other (3)
- ☐ Prefer not to answer (4)

What is your approximate annual household income? Please use the currency of
\${1/ChoiceGroup/SelectedChoices}.

Page Break

End of Block: Part V: Demographics

Start of Block: Part VI: Comments

Please provide any further information you would like to share on your preferences when purchasing
aquarium organisms.

End of Block: Part VI: Comments

APPENDIX B: LIST OF ONLINE FORA USED FOR SURVEY DISSEMINATION

Group Name	url	Date Posted
Animal Forum	http://www.animalforum.com/	7/12/2018
BC Aquaria	www.bcaquaria.com/forum	
Everything Aquatic	www.everythingaquatic.proboards.com	
Fishlore: Aquarium Fish Forum	https://www.fishlore.com/aquariumfishforum/	
Nano Reefs	https://www.nano-reef.com/forums/	
Aquarium Addicts! (Facebook)	https://www.facebook.com/groups/1684562768499664/	8/15/2018
Aquarium Hobbyist Freshwater Tropical Fishkeeping Tanks, Plants, Etc. (Facebook)	https://www.facebook.com/groups/aquariumsFresh/	
Aquarium Keepers (Facebook)	https://www.facebook.com/groups/1563788500589837/	
The Aquarium Spot (Facebook)	https://www.facebook.com/groups/THEAQUARIUMSPOT/	
Aquarium (Reddit)	https://www.reddit.com/r/aquarium/	
Aquariums (Reddit)	https://www.reddit.com/r/Aquariums/	
Reef Tank(Reddit)	https://www.reddit.com/r/ReefTank/	
Sample Size (Reddit)	https://www.reddit.com/r/SampleSize	
Captive Reefs	http://www.captivereefs.com/forum/basics/	9/14/2018
Marine Aquariums South Africa	https://www.marineaquariumsa.com/	
Reef Central	http://www.reefcentral.com/forums/forumdisplay.php?f=1	
Reefing the Australian Way	http://www.masa.asn.au/phpBB3/viewforum.php?f=45&sid=49b2be2e8de89680e98528a56ede3607	
Singapore Reef Club	http://www.sgreefclub.com/forum/	

APPENDIX C: EXPANDED DEFINITIONS OF LIKERT ITEMS USED IN
PRINCIPLE COMPONENT ANALYSIS

Likert Item	Expanded Definition
Activity – Aquarium Hobby Group	Belong to aquarium hobby group
Activity – Conservation Group	Belong to a conservation group
Activity – Animal Rights Group	Belong to an animal rights group
Activity – Buy Organic Produce	Buy organic produce
Activity – Buy Certified Seafood	Buy certified seafood
Activity – Donate Domestically	Donate to domestic poverty-alleviating program
Activity – Donate Internationally	Donate to international poverty-alleviating program
Activity – Visit a Coral Reef	Visit a coral reef
Activity – Visit a Rainforest	Visit a rainforest
Knowledge – Aquarium Care	Aquarium care
Knowledge – Supply	How organism was supplied (wild caught or captive bred)
Knowledge – Capture	How organism was captured (chemicals or nets)
Knowledge – Origin	Where organism originates (domestic or imported)
Knowledge – Research	Research organisms before purchasing
Purchase – Environmental	Purchasing decisions impact environment
Purchase – Livelihoods	Purchasing decisions impact livelihoods
Purchase – Welfare	Purchasing decisions impact animal welfare
Purchase – Industry	Purchasing decisions impact aquarium industry
Selection – Price	Price
Selection – Function	Function or fit in aquarium
Selection – Aesthetics	Aesthetics
Selection – Rarity	Rarity
Selection – Supply	How organism was supplied (wild caught or captive bred)
Selection – Capture	How organism was supplied (wild caught or captive bred)
Selection – Welfare	Welfare along the supply chain
Selection – Origin	Where organism originates (domestic or imported)
Selection – Livelihoods	Purchase supports livelihoods of indigenous people
Selection – Informative Label	Organism comes with informative label

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