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UNDERSTANDING THE PUBLIC PERCEPTION OF
SELECTIVE BREEDING PRACTICES IN RHODE
ISLAND OYSTER AQUACULTURE

BY

NATHAN M. BROWN

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS
IN
MARINE AFFAIRS

UNIVERSITY OF RHODE ISLAND

2021

MASTER OF ARTS THESIS

OF

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2021

ABSTRACT

Selective breeding is a common practice within oyster aquaculture and is used to improve growth rates as well as reduce the negative impacts of water temperature rise, ocean acidification and disease among oysters. What is lesser understood is the public perception of the use of selective breeding in oyster aquaculture. A total of 81 Rhode Island residents responded online concerning how they perceived selective breeding in Rhode Island as well as what types of oysters they preferred. Multiple 5-point Likert scale questions and discrete choice experiments were used to better understand these perceptions. A majority of those who responded view selective breeding as positive for Aquaculture, Coastal Waters, Public Health and the Economy in Rhode Island. When given a choice of a selectively bred oyster product and a wild strain seed oyster product, respondents choose the less expensive option most of the time. However, when prices were the same, a majority of residents choose the local wild strain oyster product. These findings (coupled with relationships between perception and preference) suggest that price is the dominating factor in consumers decision making. Increasing outreach programs to educate the public on the benefits of selective breeding as well as making sure all product is priced competitively can ensure success for the industry.

ACKNOWLEDGMENTS

I would like to take the time to acknowledge and thank my major professor, Dr. Richard Burroughs, my wonderful committee members Dr. Simona Trandafir and Dr. Michael Rice, and my defense chair, Dr. Marta Gomez-Chiarri. It is with everyone's wisdom and guidance that I have been able to come as far as I have, and I offer my sincerest gratitude.

I would also like to thank Dr Tracey Dalton, Dr. David Bidwell, Dr. Rob Thompson, Prince Allotey, and all of my classmates for all of their help and encouragement along the way.

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CHAPTER 1

INTRODUCTION

Aquaculture can be defined as the “process of breeding, raising and harvesting fish, shellfish and aquatic plants¹” and is one of the fastest growing and most important food production practices of our time. Seafood is one of the most highly traded foods internationally². Fifty percent of the world’s seafood comes from aquaculture facilities, and global aquaculture grows about 4-5% each year³. This type of operation will be crucial to feed an ever-growing world population. The United Nations projects the global population to increase from 7.7 billion in 2019, to 8.5 billion in 2030⁴. This growth statistic can be contrasted with the decline of wild catch fisheries stocks around the globe. According to the United Nations Food and Agricultural organization (FAO), over half of the global fisheries stock are operating at or close to optimal yield, with no room for further expansion.

Seafood is a component of Rhode Island cultural identity. With increased concern for wild catch fisheries ability to provide a sustainable source of seafood to the industry, Rhode Island’s aquaculture industry has risen to meet

¹ NOAA Office of Ocean Exploration and Research, *What is Aquaculture?* Last accessed April 2020

² Reid, G.K., Helen J. Gurney-Smith, Flaherty, M., Garber, A.F., Forster, I., Brewer-Dalton, K, Knowler, D., Marcogliese, D.J., Chopin, T., Moccia, R.D., Smith, C.T., De Silva, S., Climate Change and Aquaculture: Considering adaptation Potential, *Aquaculture Environment Interactions*, 2019, Pg. 604

³ Food and Agriculture Organization of the UN, *The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals*, 2018, Pg. 19

⁴ United Nations, Department of Economic and Social Affairs, Population Division, *World Population Prospects: Highlights*, 2019, Pg.7

the challenge. Narraganset Bay alone, which produces approximately half of the state's aquaculture biomass has increased from a \$300,000 industry to one valued over \$1,500,000 in a 6-year period (2001-2007)⁵. These are incredible numbers and shows that aquaculture is growing very quickly. However, aquaculture is by no means a recent development for the state of Rhode Island. In fact, aquaculture can be traced back to Rhode Island's colonial roots.

1.A. HISTORY

It was during the 17th century that Rhode Island was harvesting very large quantities of oysters from the bay. However, at the turn of the 18th century, while many people did eat oyster meat for sustenance as well as taste, a large majority of oyster takings were for the lime in their shells. Some operations harvested oysters exclusively for their lime⁶. "The seemingly endless oyster beds of the 17th century were being depleted at an alarming rate ... and were harvested with wagons and oxcarts like vegetables⁷." The oyster shells were "burned to produce lime" and the act caused lawmakers to question the practice⁸. In 1734, the Rhode Island Colonial assembly outlawed the practice of harvesting oysters solely for lime on the grounds of it being an unacceptable waste of oyster meat⁹ and the growing fear of a total stock collapse¹⁰. By the

⁵ Byron C. Link J., Costa-Pierce, B., Bengtson, D., Calculating ecological carrying capacity of shellfish aquaculture using mass-balance modeling: Narragansett Bay, Rhode Island, *Ecological Modelling*, May 2011, Pg. 1743

⁶ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 24

⁷ Christopher L. Pastore, *Between Land and Sea*, 2012, Pg. 133

⁸ Christopher L. Pastore, *Between Land and Sea*, 2012, Pg. 133

⁹ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 24

¹⁰ Christopher L. Pastore, *Between Land and Sea*, 2012, Pg. 151

1730s, “lime production had become an important industry in Rhode Island¹¹.”

It was integral in the production of mortar, plaster, used to tan leather, refine sugar, produce iron and more¹². Despite the pushback, a ban on harvesting oysters for lime was put in place and not soon after in 1798, a law was enacted that mandated a seasonal closure of the oyster beds, along with the first lease¹³. The grantees did not pay for this lease, and the exclusion of public fishing from this area was a point of concern¹⁴ for other local fisherfolk. While this could be seen as the first “aquaculture” lease in the state’s history, the industry would not begin to take shape for another 50 years.

With amendments in 1864 came a new era of aquaculture in Rhode Island. “The number of submerged lands leased for aquaculture peaked in 1911 at around 21,000 acres; roughly 20 percent of the Narraganset Bay¹⁵. The industry was now considered to be worth multiple millions of dollars. Some of the larger leases were valued at over \$100,000. During this peak production period, over 1 million bushels of oysters were landed and over 1 million gallons of oyster meat was sold¹⁶. At this point, aquaculture was providing the state with a good amount of capital via selling leases, and the owners of said leases were making good money as well. This furthered the development of the state and its residents.

¹¹ Christopher L. Pastore, *Between Land and Sea*, 2012, Pg. 159

¹² Christopher L. Pastore, *Between Land and Sea*, 2012, Pg. 159

¹³ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 24

¹⁴ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 25

¹⁵ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 27

¹⁶ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 27

In the 1920s, the effects of pollution in Narragansett bay became impossible to overlook. These pollutants included tar from the gas companies, heavy metals from factories and sewage from the recently completed providence city sewer system¹⁷. Metals and tar can settle on the bottom of the bay where the oyster beds lie and smother the organisms. Thus, leading to extremely poor yields. Pollution was not the only concern, however. With increasing interstate shellfish trading occurring at around this time, disease and illness associated with raw shellfish was of growing concern¹⁸. In addition, sewage would nutrient load the bay and lead to algae blooms. This in turn can lead to low oxygen levels near the bottom of the bay and choke out any organisms that live there, including oysters. A similar problem came from the deforestation of upland areas intended to be farmed¹⁹. The great depression which began in 1929 and the hurricane of 1938 also played a part in the decline of aquaculture in Rhode Island, when widespread destruction took out much of the industries infrastructure. An already declining industry was accelerated to a crash.

After the last oyster farm closed in 1954, the aquaculture industry in Rhode Island was somewhat forgotten. It was not until almost two decades later that things began to change. In 1971, the Coastal Resources Management Council (CRMC) was established by the Rhode Island General Assembly²⁰. CRMC's job is to "preserve, protect, develop and restore coastal

¹⁷ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 30

¹⁸ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 30

¹⁹ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 32

²⁰ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 33

resources for Rhode Islanders²¹.” Among these duties, they also receive and process aquaculture leases. Five years later, Luther Blount, a local businessman, revived his family oyster business by leasing two oyster ponds off Prudence Island²². The main focus of this aquaculture operation however was not for financial gain. It was instead to teach the public about the potential for restoring shellfish aquaculture to Rhode Island²³. This strategy worked and new interest in aquaculture had begun. However, there were some issues pertaining to the leasing system. Many quahoggers voiced concern that these leases of public land were done without formal public hearings²⁴. It would be some time before the awkward system got a revamp. In 1996, legislation passed that “streamlined the permitting process and established CRMC as the coordinating agency²⁵.” After this, the industry boomed once more. As of today, the “farm gate value of aquaculture products for consumption is \$5,744,506²⁶.” Rhode Island’s aquaculture has had periods of major upheaval in the past, and today we are yet again facing new challenges to the industry.

1.B. CHALLENGES

Climate change poses a host of issues to all sorts of industries all over the globe and could be especially damaging to aquaculture. One of the major driving effects of climate change is water temperature rise. Our oceans have absorbed over 90% of the increase in energy in the climate system as a result

²¹ *RI Coastal Resources Management Council Home Page, About the CRMC* Accessed 2020, Pg. 1

²² Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 34

²³ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 34

²⁴ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 34

²⁵ Rice, M.A., *A Brief History of Oyster Aquaculture in Rhode Island*, 2006, Pg. 35

²⁶ *CRMC 2019 Annual Aquaculture Report*, Accessed 2020, Pg. 3

of climate change²⁷, causing water temperatures to rise across the globe. This affects aquaculture because it changes the ranges of water that an organism can live and be cultured in. Waters that have been suitable for a specific species can warm to a point where it is no longer possible, shutting down open water aquaculture in that area and damaging the sustainability of the practice.

As a result of increasing CO₂ levels in the atmosphere, hydrogen ions in the oceans are rising and are up 26% compared to pre-industrial levels²⁸. This decreases the pH in the oceans, making the water more acidic. Some organisms grown in aquaculture, mainly bivalves, can be greatly harmed by this²⁹. The increase in acidity attacks their shell making capabilities increasing mortality rates.

Marta Gomez-Chiarri, a URI Animal Science professor stated in an interview in 2019 that “Wild and Farmed oysters are facing major threats from water quality and disease.³⁰” “*Perkinsus marinus*”, or more commonly known as Dermo, is one such disease. While the current number of cases are low, “disease prevalence and intensity have increased significantly in a few oyster leases since 1998, indicating that dermo disease could potentially have a

²⁷ Reid, G.K., Helen J. Gurney-Smith, Flaherty. M., Garber, A.F., Forster, I., Brewer-Dalton, K, Knowler, D., Marcogliese, D.J., Chopin, T., Moccia, R.D., Smith, C.T., De Silva, S., Climate Change and Aquaculture: Considering adaptation Potential, *Aquaculture Environment Interactions*, 2019, Pg. 604

²⁸ Reid, G.K., Helen J. Gurney-Smith, Flaherty. M., Garber, A.F., Forster, I., Brewer-Dalton, K, Knowler, D., Marcogliese, D.J., Chopin, T., Moccia, R.D., Smith, C.T., De Silva, S., Climate Change and Aquaculture: Considering adaptation Potential, *Aquaculture Environment Interactions*, 2019, Pg. 606

²⁹ Fitzer, S.C., Rona A.R., McGill, Sergio Torres Gabarda, Hughes, B., Dove, M., O'Connor, W., Byrne, M., Selectively bred oysters can alter their biomineralization pathways, promoting resilience to environmental acidification, *Global Change Biology*, 2019, Pg. 4106

³⁰ Lavalley, D., URI researchers awarded multiple grants to study oyster genetics, breeding, diseases in support of aquaculture industry, *URI Today*, September 2019, Pg. 1

serious impact in Rhode Island oyster farms in the future.³¹ “The disease MSX, caused by the protozoan parasite *Haplosporidium nelsoni*, routinely causes heavy mortality in areas in the Northeast.³²”

With so many threats to the future sustainability of aquaculture, various methods to mitigate these issues have been explored. One of the most promising ways to address most of these issues is the idea of selective breeding.

1.C. SELECTIVE BREEDING and PUBLIC PARTICIPATION

The oyster species grown in Rhode Island is *Crassostrea virginica*, or the eastern oyster. This is the oyster that aquaculture farms all across Rhode Island grow and sell. Based on the area grown and methods of growth, these oysters can boast unique tastes. These oyster stocks are obtained from either an onsite hatchery or purchased from such a facility along the east coast to be grown into adult oysters and can vary based on the parent oyster stocks. This process can be altered through selective breeding.

Selectively breeding organisms for aquaculture is exactly as it sounds. Taking two parent organisms with desired traits or phenotypes and reproducing offspring with these traits. “One of the first documented selection experiments for fish started as early as in 1919” and now, large scale “family

³¹ Gomez-Chiarri, M., Improving Oyster Aquaculture in Rhode Island: Development and Testing of the “Rhodoyster”, *Sustainable Agriculture Research and Education*, 2010, Pg. 3

³² Gomez-Chiarri, M., Improving Oyster Aquaculture in Rhode Island: Development and Testing of the “Rhodoyster”, *Sustainable Agriculture Research and Education*, 2010, Pg. 3

breeding programs are now established as the industry standard for genetic improvement³³”.

What is less understood about this process is how the public views selective breeding in the aquaculture industry. Public perception is a key aspect of any project that takes place in the public eye or has any impact on a population³⁴. Understanding public perception of the topic will likely be key when implementing any sort of selective breeding operation or project in Rhode Island. Currently, there is a lack of understanding surrounding public perception of selective breeding in the aquaculture Industry.

Research into public perception is “required in order to anticipate and address future issues in a timely manner³⁵. This research aims to answer the primary question of; what are Rhode Islanders’ perceptions of selective breeding in local aquaculture operations? Aquaculture is an important industry in Rhode Island, so it is possible that a majority of people have a favorable view of the practice. In addition, we also want to see if It is possible that Individuals with more expertise on aquaculture practices have a more positive view of aquaculture³⁶. Do individuals with higher education also have a more positive perception? It is also possible that people who do not consume shellfish hold a more negative view of selective breeding or aquaculture. In

³³ Gjedrem T., Robinson N., & Rye M. The importance of selective breeding in aquaculture to meet future demands for animal protein: A review. *Aquaculture*, June 2012, Pg. 123

³⁴ Richards, D.J., Frosch R.A., *The Industrial Green Game: Overview and Perspectives*, 1997, Pg 28-29

³⁵ Schlag, K, A., Aquaculture: An Emerging Issue for Public Concern, *Journal of Risk Research*, 2010, Pg. 841

³⁶ Savadori, L., Savio, S., Nicotra, E., Rumiati, R., Finucane, M., Slovic, P., Expert and Public Perception of Risk from Biotechnology, *Risk Analysis*, October 2014, Pg. 1289

general, they miss out on some of the benefits that selective breeding provides. In addition to these perception questions, we are also interested in consumer preferences regarding selective breeding. Some studies show the public generally prefers wild products over farmed products.³⁷ We would like to extend this sentiment to this study and find out if Rhode Islanders prefer wild seed farmed oysters over selectively bred farmed oysters and why this may or may not have connections to an individual's perception of selective breeding. This is important because despite how consumers perceive selective breeding, if their perception is not reflected in purchasing behavior, future selectively bred stocks may not financially succeed.

The purpose for answering these questions is to better perceive the success of future large scale selective breeding programs in Rhode Island. While selective breeding already exists in Rhode Island, a majority is done at the local or farm level and large scale regional selective breeding programs are still for test and scientific purposes, rather than producing large quantities of oysters for sales. The information could also explain consumer behavior when encountering some of these products at a restaurant or at a market. This can inform farm owners, policy makers, marketers and scientists on what purchasing behaviors state residents could make when comparing future oyster types.

³⁷ Roheim, C.A., Omana Sudhakaran, P., Durham, C.A., Certification of Shrimp and Salmon for Best Aquaculture Practices: Assessing Consumer Preferences In Rhode Island, *Aquaculture Economics and Management*, July 2012, Pg. 283

The following section will take a closer look at selective breeding and go over studies that have looked into its effectiveness. It will also highlight studies that have dealt with consumer preferences and biotechnology. Following, the methodology section will outline the process of creating and administering the surveys. The Results chapter will outline key findings and the discussion chapter will connect these findings to our research questions.

CHAPTER 2

REVIEW OF LITERATURE

Selective breeding is the process of artificially selecting two “parents” with beneficial or desirable phenotype traits to reproduce and yield offspring with the desired traits³⁸ such as growth speed, size and disease resistance. In order for selective breeding to be effective, a few factors must be present. First, there must be genetic variation present in the population³⁹. Second, “a way of identifying individuals for selection that are likely to transmit the desired properties to the descendants, and third, sufficient spare reproductive capacity so that the population can be bred from only the chosen individuals⁴⁰.” In general, for many aquaculture species, the captive and structured style of aquaculture facilities along with the “high fecundity and short generation intervals⁴¹” make it feasible to preform selective breeding at scales that can address sustainability issues in the industry. These factors along with a relatively high heritability’s rate can lead to high trait transferals among the population in many aquaculture breeding programs, up to 12.5% genetic gain per generation average⁴². It is also important to understand that this is a long-term solution that takes time. While many aquaculture stocks have relatively

³⁸ “Selective breeding.” *Merriam-Webster.com Dictionary*, Merriam-Webster, Last accessed Feb. 2021

³⁹ Maloy, Stanley, Hughes, Miller, *Brenner’s Encyclopedia of Genetics*, 2013, Pg. 371-373

⁴⁰ Maloy, Stanley, Hughes, Miller, *Brenner’s Encyclopedia of Genetics*, 2013, Pg. 371-373

⁴¹ Gjedrem T., Robinson N., & Rye M. The importance of selective breeding in aquaculture to meet future demands for animal protein: A review. *Aquaculture*, June 2012, Pg. 123

⁴² Gjedrem T., Robinson N., & Rye M. The importance of selective breeding in aquaculture to meet future demands for animal protein: A review. *Aquaculture*, June 2012, Pg. 117

short generational intervals, these can still be as long as three to five years depending on the species. It will also likely take a few generational intervals to see the desired trait spread across a population.

In the case of this study, we are looking at selective breeding as it pertains to oyster aquaculture. There are various examples of potential beneficial effects and reasons for selective breeding oysters for aquaculture. Selective breeding efforts in eastern oysters in the US have been focused on fast growth and survival. Other potential traits that could be selected include preventing diseases (*Perkinsus marinus*) and harmful bacteria (*Vibrio Vulnificus*) commonly found in shellfish^{43, 44, 45}. These can cause harm to both the organism and the individual consuming the organism, depending on the disease or bacteria.

Another is using selective breeding as a method to cultivate oysters that are resilient to the adverse effects of ocean acidification⁴⁶ and warming waters. Such technology would be valuable to Rhode Island's aquaculture industry, but little is understood when it comes to public perception of the matter.

⁴³ Calvo R, Calvo L.M, Gustavo W., Burreson, Eugene M., Dual disease resistance in a selectively bred eastern oyster, *Crassostrea virginica*, strain tested in Chesapeake Bay, *Aquaculture*, April 2003, Pg. 69

⁴⁴ Moss, Shaun M ; Moss, Dustin R ; Arce, Steve M ; Lightner, Donald V ; Lotz, Jeffrey M, The role of selective breeding and biosecurity in the prevention of disease in penaeid shrimp aquaculture, *Journal of Invertebrate Pathology*, 2012, Pg. 247

⁴⁵ Gomez-Chiarri, M., Improving Oyster Aquaculture in Rhode Island: Development and Testing of the "Rhodoyster", *Sustainable Agriculture Research and Education*, 2010, Pg. 1

⁴⁶ Fitzer, S.C., Rona A.R., McGill, Sergio Torres Gabarda, Hughes, B., Dove, M., O'Connor, W., Byrne, M., Selectively bred oysters can alter their biomineralization pathways, promoting resilience to environmental acidification, *Global Change Biology*, 2019, Pg. 4112

It is important to understand public perception. Understanding can increase the success of current and future projects, risk communication and public awareness⁴⁷. If public perception is ignored however, it “may result in the failure of technically good innovations⁴⁸.” This is especially true when it comes to selective breeding and other biotechnologies or genetic engineering.

It should be noted when talking about biotechnology that genetically modified organisms (GMOs) and selective breeding are different. The USDA defines selective breeding as “Making deliberate crosses or mating of organisms so the offspring will have particular desired characteristics derived from one or both of the parents⁴⁹”, and GMOs as “an organism produced through genetic modification.⁵⁰” Selective breeding can modify organisms, but not in the same way that GMOs can. Selective breeding does not change any of the genetic makeup of the organism, but rather highlights traits that are already found in nature. In addition, the domestication distance from a selectively bred oyster and a “wild” eastern oyster is quite small. This means that wild eastern oysters and selectively bred eastern oysters are extremely similar to one another. While biotechnology can play a role in selective breeding, it can be done without it as well.

Current literature shows that a majority of the public view biotechnology as risky⁵¹. In addition, the majority of the public “lacks knowledge of the

⁴⁷ Richards, D.J., Frosch R.A., *The Industrial Green Game: Overview and Perspectives*, 1997, Pg. 28-29

⁴⁸ Richards, D.J., Frosch R.A., *The Industrial Green Game: Overview and Perspectives*, 1997, Pg. 28-29

⁴⁹ U.S. Department of Agriculture, *Agriculture Biotechnology Glossary*, Last accessed April 2021

⁵⁰ U.S. Department of Agriculture, *Agriculture Biotechnology Glossary*, Last accessed April 2021

⁵¹ Savadori, L., Savio, S., Nicotra, E., Rumiati, R., Finucane, M., Slovic, P., Expert and Public Perception of Risk from Biotechnology, *Risk Analysis*, October 2014, Pg. 1289/1297

aquaculture production processes and in spite of that lack of knowledge, those respondents hold a rather negative view of aquaculture⁵².” Past research has shown that the public can separate wild vs farmed fish when the information is provided and choose accordingly. More often than not, they choose wild fish⁵³. In addition, past studies have conducted similar research involving public perception of GMOs⁵⁴, and ecolabeling farmed seafood⁵⁵, but not the more popular selective breeding.

⁵² Roheim, C.A., Omana Sudhakaran, P., Durham, C.A., Certification of Shrimp and Salmon for Best Aquaculture Practices: Assessing Consumer Preferences In Rhode Island, *Aquaculture Economics and Management*, July 2012, Pg. 283

⁵³ Roheim, C.A., Omana Sudhakaran, P., Durham, C.A., Certification of Shrimp and Salmon for Best Aquaculture Practices: Assessing Consumer Preferences In Rhode Island, *Aquaculture Economics and Management*, July 2012, Pg. 283

⁵⁴ Amin L, Azad MAK, Gausmian MH, Zulkifli, Determinants of Public Attitudes to Genetically Modified Salmon. *PLOS ONE* Jan 2014, Pg. 1

⁵⁵ Bronnmann J, Asche F,. Sustainable Seafood From Aquaculture and Wild Fisheries: Insights From a Discrete Choice Experiment in Germany, *Ecological Economics*, December 2017, Pg. 113

CHAPTER 3

MATERIALS and METHODS

3.A. DATA COLLECTION METHODS

In order to accurately assess the perceptions of Rhode Island residents, it was decided that a questionnaire survey administered and circulated online would be the best option. Surveys are a “widely used social research method that collects data about people⁵⁶” and fits within the needs of this research. Some of the benefits of using this type of model include a straightforward approach to the study, flexibility and adaptability, and high amounts of data standardization⁵⁷. This research was conducted in accordance with URI IRB processes and requirements. The entire survey is available in the appendix.

3.B. SURVEY BUILDING and CONTENTS

Because selective breeding practices in aquaculture are a specific topic and many individuals might not have heard of the practice, there is a short description included in the survey before any questions about selective breeding appear. This description is as follows and is focused on selective breeding in Rhode Island aquaculture; “Selectively breeding oysters is a process where experts can breed oysters with useful but rare traits, so that they become more common across the population. Selectively bred oysters are found to have increased resistance to environmental pressures such as disease (Calvo et al. 2003). Selectively breeding oysters does not impact the

⁵⁶ Robson, C., *Real World Research*, 2011, Pg. 235

⁵⁷ Robson, C., *Real World Research*, 2011, Pg. 241

taste of the oyster. The majority of farmed oysters in Rhode Island are selectively bred.” This description was designed to offer a short explanation of selective breeding in Rhode Island aquaculture so that respondents with little or no knowledge of the practice could answer the following questions, while remaining as unbiased as possible. This description was drafted via personal communication with Dr. Michael Rice and can be found in the appendix along with the entire survey tool.

The survey was designed to properly reflect the respondent’s perceptions of selective breeding in Rhode Island oyster aquaculture. Multiple 5-point Likert scale questions asking respondents if they view selective breeding as beneficial or detrimental on four major areas: aquaculture, coastal waters, public health and overall economy. Additional research has been done using scales similar to this in studies involving public perception of sustainability labels^{58, 59}, and GMOs⁶⁰.

Beyond this, a discrete choice experiment method was used to assess respondents’ preferences of selectively bred and wild oyster products. A choice experiment is a type of contingent valuation stated preference technique, but with advantages over some willingness to pay techniques⁶¹. Other direct stated preference methods such as customer surveys simply ask

⁵⁸ Roheim, C.A., Omana Sudhakaran, P., Durham, C.A., Certification of Shrimp and Salmon for Best Aquaculture Practices: Assessing Consumer Preferences In Rhode Island, *Aquaculture Economics and Management*, July 2012, Pg. 266

⁵⁹ Bronnmann J, Asche F,. Sustainable Seafood From Aquaculture and Wild Fisheries: Insights From a Discrete Choice Experiment in Germany, *Ecological Economics*, December 2017, Pg. 113

⁶⁰ Amin L, Azad MAK, Gausmian MH, Zulkifli, Determinants of Public Attitudes to Genetically Modified Salmon. *PLOS ONE* Jan 2014, Pg. 1

⁶¹ Snowball J.D., *Measuring the Value of Culture*, 2008, Pg. 177

respondents what price they would be willing to pay for a product. This can cause customers to be unnaturally focused on price and provide misleading data⁶². In addition, respondents stated willingness to pay doesn't always translate into actual purchasing behaviors⁶³. By asking respondents to choose between two products with varying attributes including price, we mitigate some of these biases.

We created three sets of oyster products with differing attributes. These attributes were price and wild / selectively bred seed. The respondents were then asked to choose one of the two options (Figure 1).

Figure 1: Choice Experiment Images

In the first choice, the selectively bred oyster is the same price as the local wild strain counterpart, in the second, the selectively bred oyster is more expensive than its counterpart, and in the third and final choice, the wild strain

⁶² Breidert C, Hahsler M, Reutterer T., A Review of methods for measuring Willingness-To-Pay, *Innovative Marketing*, 2006, Pg. 8

⁶³ Breidert C, Hahsler M, Reutterer T., A Review of methods for measuring Willingness-To-Pay, *Innovative Marketing*, 2006, Pg. 8

oyster is most expensive. The order of the choices is randomized for each respondent to cut down on biases. It is disclosed that both types of oysters are found at the same restaurant and farmed at the same facilities. This is to show that factors such as water quality and farming practices are the same, and that the only difference between the products are the two aforementioned attributes. A consumer would not be able to tell the difference between a selectively bred oyster and a local wild strain oyster by taste or sight, and it is unlikely this distinction would be made on a menu. It is still important to understand consumer preference as it directly relates to consumer perception and the success of any future widespread selective breeding programs in the state.

The main statistical analysis performed was crosstabulations along with Freeman-Halton's extension of Fishers exact probability test to determine statistically significant relationships between variables found in the data. These tests determine how many different combinations of frequencies within the variable can be achieved, and then determine the probability that the cell configurations can be obtained by chance⁶⁴. Fisher's test was also used due to its increased accuracy with small sample sizes⁶⁵. The Freeman-Halton's extension was utilized because many of the variables used had more than two categories, resulting in three-by-three tables. We then compare column proportions so that we can find out what variables are in relation to others in each individual crosstabulation. We use the Bonferroni method along with this

⁶⁴ Zaiontz C, Fisher's Exact Test, *Real Statistics Using Excel*, 2021: Last accessed April 2021

⁶⁵ Zaiontz C, Fisher's Exact Test, *Real Statistics Using Excel*, 2021: Last accessed April 2021

to adjust p values because of the increased risk of type one errors when making multiple statistic tests⁶⁶. This is done by multiplying raw p values by the number of tests done⁶⁷. These cross tabulations were used for Likert scale perception questions, key demographics, choice experiments and finally New Environmental Paradigm scale questions.

In addition to demographic questions and questions that ask the respondents some basic questions about their shellfish eating habits, the survey also has a set of NEP scale questions. This is a test that asks a set of questions that will offer insight on how environmentally conscious an individual is or not. There are many different forms of NEP scales. For this study, we used the 15-item set NEP that was self-reported via the questionnaire. The answers were measured using a 5-point Likert scale with an additional 6th slot reading “I don’t know” for those who felt unable to answer. This format (besides the 6th Likert scale option) is optimal for data analysis⁶⁸. This along with other demographic information is useful to test against the choice experiments and perception questions to get a picture of selective breeding perceptions in Rhode Island.

After the initial survey was drafted, one round of focus groups was conducted. Information of the time, date, and content for the focus group was circulated in university media as well as outside the university. Four participants took place. Despite the low turnout, the focus group offered some

⁶⁶ Weisstein, Eric W., Bonferroni Correction, *MathWorld* 2021, Last accessed April 2021

⁶⁷ Hayes, A., Bonferroni test, *Investopedia*, 2020, Last accessed April 2021

⁶⁸ Howcroft L.J., Milfont T.L., The Use (and abuse) of the New Environmental Paradigm Scale Over the Last 30 Years, A Meta-Analysis, *Journal of Environmental Psychology*, June 2010, Pg. 151

helpful information. We ended up reworking some questions to make them clearer to the reader, as well as re formatting some of the questions to make the survey easier to follow.

3.C. SAMPLE SIZE and RESPONSE RATES

We used the online survey software Qualtrics⁶⁹ to create and distribute the survey. Surveys done online allow extra anonymity⁷⁰ that allows the respondents to answer with less bias. Because this study focuses on Rhode Islanders perceptions, it was required that only Rhode Island residents take the survey. Because we are only looking at Rhode Island residents, it is important to get a wide range of residents from all across the state. To do this, we used the social media platform, Facebook, to locate community pages from across the State. These are all pages that are tied to different towns throughout Rhode Island and by posting the survey there with permission by the page's administrators, we can look at where in the state our responses are coming from. We received responses from residents of Scituate, Tiverton, Richmond, Narragansett, Burrillville and Block Island (Figure 2). In total, we received 135 responses from our survey. After excluding non-residents as well as surveys that were incomplete and not usable we were left with 81 surveys with workable data.

⁶⁹ URI Informational Technology Services, University of Rhode Island, Last accessed April 2020

⁷⁰ Robson, C., *Real World Research*, 2011, Pg. 248

Figure 2: Map of Areas Surveyed (Base map provided by RI Food Policy Council)

CHAPTER 4

RESULTS of SURVEY and STATISTICAL ANALYSIS

4.A. DEMOGRAPHIC and DESCRIPTOR DATA

Our demographic data can be viewed in the following tables 1 and 2. All Rhode Island demographic data that is used to compare with our sample comes from the US Census. Our ethnicity breakdown is similar to the overall Rhode Island population. As of 2019, white (non-Hispanic) people made up 83.6% of the state's population. Our survey has this percentage slightly higher at 85%. Our sample population is also wealthier than the states average. As of 2018, the state's median household income was \$65,340. Our data had this number almost \$20,000 greater at around \$85,000. Our responses were 66% female and 29% male (about 5% for responses other than male or female). This is very different from the almost 51% female, 48% male breakdown of Rhode Island citizens as of 2018. The political affiliation breakdown of our responses is particularly interesting and very different from the percentages in Rhode Island. Over 40% of our responses identified themselves as Independent, 38.3% Democrat and 6.2% Republican. This could be due to the tumultuous political state that the US has been at the time of this study, but this is merely speculation and there is no data present that proves this. The sample population also boasts a higher education then the average in Rhode Island. The census shows 34.2% of the population holding a bachelor's degree or higher, while our data shows 76.5% of the sample population as

holding either a bachelors, masters / professional, or a doctorate degree. The median age of the sample population is close to the median age of the state; 45 vs 40.

Table 1: Demographic Frequency Table

		Count	Column Valid N %
Ethnicity	African American	0	0.0%
	White	69	85.2%
	Hispanic_or_Latino	2	2.5%
	Prefer_Not_Say	5	6.2%
	Other	5	6.2%
Gender	Other	1	1.2%
	Male	23	28.4%
	Female	54	66.7%
	Prefer_Not_Say	3	3.7%
Number of People in the Home	1_Person	8	9.9%
	2_People	35	43.2%
	3_People	20	24.7%
	4_People	15	18.5%
	5_or_More	3	3.7%
Children In Household	Yes	57	70.4%
	No	22	27.2%
	Prefer_Not_Say	2	2.5%
Highest Form of Education	High_school_or_GED	4	4.9%
	Some_College_or_associates_degree	15	18.5%
	Bachelors_degree	32	39.5%
	Graduate_or_professional_degree	23	28.4%
	Doctorate	7	8.6%
	Prefer_Not_Say	0	0.0%
	Other	0	0.0%
Annual Household Income of Last Year Before Taxes (2019).	0	5	6.2%
	10-14_Thousand	1	1.2%
	15-24_Thousand	0	0.0%
	25-34_Thousand	3	3.7%
	35-49_Thousand	3	3.7%
	50-74_Thousand	10	12.3%
	75-99_Thousand	17	21.0%
	100-149_Thousand	22	27.2%
	150_Thousand_and_Up	20	24.7%
Political Views	Democrat	31	38.3%
	Republican	5	6.2%
	Independent	34	42.0%
	Prefer_Not_Say	4	4.9%
	Other	7	8.6%

Table 2: Age Statistics

	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Error	Std. Deviation Statistic	Variance Statistic
Age	81	55	18	73	50.31	1.492	13.427	180.291

The survey also includes descriptor data that takes place before the perception and choice experiment questions. These are used later in the analysis to test for relationships between these descriptors and perception. Three major descriptor questions are as follows in table 3. The respondent's familiarity rankings in table three are a result of their own recorded familiarity, and not a test we administered to determine their familiarity.

Table 3: Descriptor Data Frequency Table

		Count	Column Valid N %
Familiar with selective breeding in oyster aquaculture	Yes	19	23.5%
	Somewhat	31	38.3%
	No	31	38.3%
Times per month eating shellfish	Less than once	18	22.2%
	1 to 2 times	40	49.4%
	3 to 4 times	13	16.0%
	More that 5 times	10	12.3%
Shellfish Consumption	Yes	73	90.1%
	No	8	9.9%

Based on table 3, there is a good variety of perceived familiarity with regard to selective breeding, and no one category greatly overshadows the other. On the contrary, the vast majority of responses show that they consume shellfish. This is in line with our idea that while this sample is small and not

entirely representative of the Rhode Island population, it does show the respondents care about the subject and are invested. In addition to the descriptor question, the New Environmental Paradigm scale was included to also test for relationships between said scale and perception. The results are shown in tables 4 and 5. The mean NEP score is 3.7. When broken down into High or Low scores, (High being anything above 3 which is neutral, and low being anything at 3 or below) we can see that 90% of the sample population falls in the high category.

Table 4: NEP Scale Statistics

	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Sum Statistic	Mean Statistic	Std. Error	Std. Deviation Statistic	Variance Statistic
NEP	81	2.67	2.26	4.93	302.83	3.7386	.06452	.58072	.337
Valid N (listwise)	81								

Table 5: NEP Scale Frequencies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High (Above3)	73	90.1	90.1	90.1
	Low (3 or Below)	8	9.9	9.9	100.0
	Total	81	100.0	100.0	

4.B. LIKERT SCALE PERCEPTION DATA

One of the major sections of this survey are the questions that ask the respondents how they view selective breeding impacts on four major areas: Rhode Island's oyster aquaculture, coastal waters, public health and economy. These are answered via a 5-point Likert scale (with the addition of an unsure option) to gauge respondents' perceptions as extremely beneficial, beneficial,

no effect, detrimental or extremely detrimental. The results are shown in Table 6 and figure 3.

The data shows that in every question, a majority (over 50%) of the sample population views selective breeding as having a positive (either beneficial or extremely beneficial) effect on each of the four areas in question. The highest of these being selective breeding's impact on Rhode Island's economy at 85.2% positive. The highest negative impact (responses noted as either detrimental or extremely detrimental) area we saw was in regard to selective breeding's impact on Rhode Island's coastal waters. That being said, this was only 6.2% of the sample population. The highest area that responders believed that selective breeding had no effect on was Rhode Island's public health at 23.5% of the sample population.

Table 6: Likert Scale Perception Frequency Table

	Extremely Beneficial		Beneficial		No Effect		Detrimental		Extremely Detrimental		I Dont Know	
	Count	Row Valid N %	Count	Row Valid N %	Count	Row Valid N %	Count	Row Valid N %	Count	Row Valid N %	Count	Row Valid N %
Selective breeding's impact on Rhode Island's Oyster Aquaculture	24	29.6%	41	50.6%	4	4.9%	1	1.2%	0	0.0%	11	13.6%
Selective breeding's impact on Rhode Island's Coastal Waters	15	18.5%	41	50.6%	9	11.1%	5	6.2%	0	0.0%	11	13.6%
Selective breeding's impact on Rhode Island's Public Health	12	14.8%	33	40.7%	19	23.5%	1	1.2%	0	0.0%	16	19.8%
Selective breeding's impact on Rhode Island's Economy	29	35.8%	40	49.4%	4	4.9%	1	1.2%	0	0.0%	7	8.6%

Figure 3: Likert Scale Perception Bar Chart

Freeman-Halton's extension of Fishers exact probability test was used to determine statistically significant associations between variables in the data. This is done by determining how many different combinations of frequencies can be achieved, and then determine the probability that the cell configurations can be obtained by chance⁷¹. In order to use this test, the data must be either categorical or nominal (numerical data doesn't fit the confines of this model) and consist of two independent groups. All of the following tests fit these assumptions. All of the relevant relationships must show a P-value of less than .05 to be statistically significant. The subscripts in the following tables denote the categories that do not differ significantly in value from one another (a-a, b-b). Conversely, if the subscripts are different, there is a statistical difference between the categories (a-b). For example, while two numbers in the same column or row may be different, if the subscripts along

⁷¹ Zaiontz C, Fisher's Exact Test, *Real Statistics Using Excel*, 2021, Last accessed April 2021

with these two numbers are both a, there is no statistical difference in these numbers. A Multinomial Logistic Regression tool was attempted to assess additional relationships within the data. Due to the nature of the sample, the multicollinearity assumption as well as the linear relationship assumption needed for an accurate model were not present, thus the model could not be executed.

Tables 7 and 8 show relationships between perception the demographic or descriptor data. This tells us what types of variables impact public perception so that researchers and aquaculture specialists can better understand why people perceive selective breeding the way that they do.

Table 7: Political Party Affiliation and Views on Selective Breeding

Count		Political Views			Total
		Democrat	Republican	Independent and other	
SBI on RI Oyster Aquaculture	Positive	29 _a	4 _a	33 _a	66
	Negative	1 _a	0 _a	1 _a	2
	Unsure or No Effect	1 _a	2 _b	10 _{a, b}	13
Total		31	6	44	81

Each subscript letter denotes a subset of Political Views categories whose column proportions do not differ significantly from each other at the .05 level.

There is a statistically significant difference ($p=.043$) between respondents who were either unsure or thought Selective Breeding had no effect on RI Oyster Aquaculture, and if they were either democrat or republican (Table 7). Statistically more unsure respondents were republican than were democrat.

Table 8: Familiarity with Selective Breeding and Views on its impacts on the Economy

Count

		Familiar with selective breeding in oyster aquaculture			Total
		Yes	Somewhat	No	
SBI on Rhode Island's Economy	Positive	18 _{a, b}	29 _b	21 _a	68
	Negative	0 _a	1 _a	1 _a	2
	Unsure or No Effect	1 _{a, b}	1 _b	9 _a	11
Total		19	31	31	81

Each subscript letter denotes a subset of Familiar with selective breeding in oyster aquaculture categories whose column proportions do not differ significantly from each other at the .05 level.

In addition, there is a statistically significant difference ($p=.013$) between residents who answered with positive or negative perceptions, vs. if they were somewhat familiar with selective breeding or not familiar (Table 8). More respondents who were somewhat familiar viewed selective breeding's impact on Rhode Island's economy as positive, over respondents who were not familiar.

4.C. CHOICE EXPERIMENT RESPONSE DATA (Conjoint Analysis)

Table 9: Choice Experiment Frequency Table

Choice Experiment Questions	Selectively Bred Oyster		Local Wild Strain Oyster		Neither	
	Count	%	Count	%	Count	%
Which of the two oyster products would you most likely purchase? (Oyster prices at the same amount: \$2.50)	27	33.3%	36	44.4%	18	22.2%
Which of the two oyster products would you most likely purchase? (Selectively bred price: \$3.00, Local wild strain: \$2.00)	10	12.3%	55	67.9%	16	19.8%
Which of the two oyster products would you most likely purchase? (Selectively bred price: \$2.00, Local wild strain: \$3.00)	45	55.6%	21	25.9%	15	18.5%

Figure 4: Choice Experiment Bar Chart

Table 9 and figure 4 shows the results of the choice experiment section of the survey. As stated above, the respondents were asked to choose between two oyster products 3 separate times. The only difference in attributes between the two options were price and if the oyster was selectively bred or a wild strain. In one of the choices the prices are the same.

In the two choice experiments where the prices are different, a majority of the respondents chose the cheaper oyster product regardless of whether it was a selectively bred seed or a local wild seed. When the two prices were the same, more people chose to purchase the local wild strain oyster product. This example also had the lowest margin between the two oyster products at 11.1%. This data shows that price is an important factor in determining people's choice of oyster products. That being said, there are also other factors that help determine people's preferences to the products. The following

significant relationships were found using the same Freeman-Halton's extension of Fishers exact probability test as described above.

Table 10: Consumer Preference and Familiarity when Selectively Bred Oyster is More expensive

Count		Familiarity with SB			Total
		Yes	Somewhat	No	
Choice Experiment 2	Selectively_Bred	2 _{a, b}	8 _b	0 _a	10
	Local_Wild	13 _a	18 _a	24 _a	55
	Neither	4 _a	5 _a	7 _a	16
Total		19	31	31	81

Each subscript letter denotes a subset of Familiar with selective breeding in oyster aquaculture categories whose column proportions do not differ significantly from each other at the .05 level.

Tables 10 shows a statistically significant relationship ($p=.034$) between choice experiment 2 (whereas the selectively bred oyster option was more expensive) and respondents' familiarity with selective breeding (table 10). More respondents who chose the selectively bred oyster option in choice experiment 2 were somewhat familiar with selective breeding (8_b) over those who were not familiar (0_a). Subscripts are the same in all other cells, implying that this is the only statistical difference.

The following tables 11 through 14 help us to understand if respondents' choices on what type of oyster products they prefer have any relationships with their perception of selective breeding. In other words, do their perceptions of selective breeding impact their purchasing behaviors, and when.

Table 11: Consumer Preferences in Relation to Selective Breeding's Impacts on Rhode Island Oyster Aquaculture When Prices are the Same

Count		Choice Experiment 1			Total
		Selectively Bred	Local Wild	Neither	
SBI on RI's Oyster Aquaculture	Positive	25 _a	26 _a	15 _a	66
	Negative	1 _a	0 _a	1 _a	2
	Unsure or No Effect	1 _a	10 _b	2 _{a, b}	13
Total		27	36	18	81

Each subscript letter denotes a subset of Which of the two products above would you most likely purchase? - same price categories whose column proportions do not differ significantly from each other at the .05 level.

There is a significant relationship ($p=.032$) found between the first-choice experiment (both oyster products prices were the same) and how respondents perceive selective breeding's impact on Rhode Island's oyster aquaculture (table 11). All p values that show significance can be found in the appendix. There is a statistical difference in the number of respondents who chose selectively bred oyster products or local wild strain oyster products when they also were unsure about selective breeding's effect on Rhode Island oyster aquaculture. If they were unsure, they more often chose the local wild seed product.

Table 12: Consumer Preferences in Relation to Selective Breeding's Impacts on Rhode Island's Coastal Waters When Prices are the Same

Count		Choice Experiment 1			Total
		Selectively Bred	Local Wild	Neither	
SBI on Rhode Island's Coastal Waters	Positive	24 _a	20 _b	12 _{a, b}	56
	Negative	1 _a	3 _a	1 _a	5
	Unsure or No Effect	2 _a	13 _b	5 _{a, b}	20
Total		27	36	18	81

Each subscript letter denotes a subset of Which of the two products above would you most likely purchase? - same price categories whose column proportions do not differ significantly from each other at the .05 level.

In addition, there is a statistically significant difference ($p=.046$) in the number of respondents who chose the selectively bred oyster option vs. the local wild strain option, based on if they noted a positive or unsure perception of selective breeding on RI's local waters (Table 12). More respondents who noted positive impacts were more likely to purchase the selectively bred product, and more respondents who noted unsure chose the local wild product.

Table 13: Consumer Preferences in Relation to Selective Breeding's Impacts on Rhode Island's Economy When Prices are the Same

Count

		Choice Experiment 1			Total
		Selectively_Bred	Local_Wild	Neither	
SBI on Rhode Island's Economy	Positive	26 _a	28 _a	14 _a	68
	Negative	1 _a	1 _a	0 _a	2
	Unsure or No Effect	0 _a	7 _b	4 _b	11
Total		27	36	18	81

Each subscript letter denotes a subset of Which of the two products above would you most likely purchase? - same price categories whose column proportions do not differ significantly from each other at the .05 level.

Another statistical difference ($p=.039$) can be found in the number of respondents who chose the local wild strain option vs. neither, when they noted an unsure or no effect for selective breeding's impact on Rhode Island's economy (Table 13). More respondents who were unsure about the effect chose the local wild option over the selectively bred option.

Table 14: Consumer Preferences in Relation to Selective Breeding's Impacts on Rhode Island's Public Health When the Selectively Bred Option was More Expensive

Count

		Choice Experiment 2			Total
		Selectively_Bred	Local_Wild	Neither	
SBI on Rhode Island's Public Health	Positive	9 _a	27 _a	9 _a	45
	Negative	1 _a	2 _a	0 _a	3
	Unsure or No Effect	0 _a	26 _b	7 _b	33
Total		10	55	16	81

Each subscript letter denotes a subset of Which of the two products shown above would you most likely purchase? - selective breed more expensive categories whose column proportions do not differ significantly from each other at the .05 level.

There were also statistically significant relationships ($p=.024$) found between the second-choice experiment and selective breeding impact on Rhode Island's public health (table 14). The number of respondents who noted unsure or no effect in regard to selective breeding's impact on Rhode Island's public health was different based on their choice in the second-choice

experiment. If the respondents chose the local wild option or neither option more often if they were unsure of the effect.

This section briefly touches on the relationships between how respondents answered questions and their NEP score areas. These scores were again, based off of scale from 1-5, where 5 indicates a strong environmental attitude and 1 indicates a low environmental attitude. These scores were valued from table 5 to be either high (above neutral: 3) or low (at or below neutral: 3). These scores were also broken up as High (4.00 or above) Medium (3.00-3.99) and Low (2.99 and lower). The results are the same. There were only 2 Likert scale questions that showed a low degree of relationship with NEP scores areas and no significance found between the NEP score areas and the choice experiments. Based on the low number of significant relationships and the level of significance, there is little evidence to support that an individual's NEP score had any impact on their answers.

CHAPTER 5

DISCUSSION

If any future selective breeding programs are to be successful, it is important to understand how the public views the practice. Public perception is something that if understood, can increase the success of projects as well as risk communication and public awareness⁷². The data above shows that a majority of the sample population views selective breeding as positive for Aquaculture, Coastal Waters, Public Health and the Economy in Rhode Island (Table 6, Figure 3). Positive can be categorized by selective breeding being either beneficial or highly beneficial to these aspects. This shows that a majority perceive selective breeding in Rhode Island aquaculture as a good thing. We also looked at relationships between perception and other demographic and descriptive variables to see if there was some sort of profile that would help inform aquaculture professionals on subsets of the population that view selective breeding a certain way. The only relationships found were among political party affiliation and familiarity with selective breeding in oyster aquaculture. More respondents who were somewhat familiar with selective breeding viewed it as positive, over respondents who were not familiar (Table 8). In addition, a statistically significant difference was found in the number of democrats who were unsure about selective breeding's impacts in Rhode Island's oyster aquaculture and republicans who were also unsure (Table 7).

⁷² Richards, D.J., Frosch R.A., *The Industrial Green Game: Overview and Perspectives*, 1997, Pg. 28-89

This difference while statistically significant, was minor. These are the only two statistically significant relationships between the four perception questions and the ten demographic/descriptive variables. Having such a low number of relationships here suggests that demographic and descriptor data do not largely affect perception. We also hypothesized that because aquaculture is such an important industry in Rhode Island, that our sample of Rhode Island residents would have a positive view of selective breeding in the oyster aquaculture. Again, this was found to be true. Additional hypothesis such as education levels or shellfish consumption levels impacting selective breeding perceptions was found to not be apparent, as there were no statistically significant relationships found between education levels and neither the choice experiments nor the Likert scale perception questions.

The choice experiments in this study do not directly measure perception, but rather preference. That is not to say that they are not related. Perceptions are a result of a person's acquired information, and preference is how an individual prioritizes things. There are studies that successfully use preferences as a tool to derive perception⁷³. It is also important to understand preference on its own because despite how consumers perceive selective breeding, if this positive sentiment is not reflected in purchasing behaviors, future selectively bred stocks may not succeed financially. Despite the positive view of selective breeding, when prices are the same, more people will choose

⁷³ Kaplan R., The analysis of perception via preference: A strategy for studying how the environment is experienced, *Landscape Planning*, August 1985, Pg. 161

a local wild strain oyster over a selectively bred one (Table 9, Figure 4). When prices are not equal, people will choose the cheaper option at a greater difference than when the prices are equal (Table 9). This information supports some of our hypothesis. We hypothesized that the general public would prefer wild products over farmed products. Our study speaks to this a bit differently because both products in our choice experiment have been farmed, but the sentiment of a “wilder” product over a cultivated one is shown through the first-choice experiment (Table 9).

We have already determined that price is a major factor in determining individuals' choices of what type of oyster product they chose in the choice experiment section (Table 9, Figure 4). In the first-choice experiment, there was no difference in price between the two oyster products. Because of this, we can look at relationships between the choices made and other variables to see what factors besides the price of a product dictate choice. Our data shows that familiarity with selective breeding did have a relationship with what choice the respondents chose in the second experiment where prices were different (Table 10). This suggests that changing someone's familiarity or educating them in regard to selective breeding can affect what types of products they buy to some means. There was also a relationship found between choice experiment 3 and shellfish consumption, but the findings were minor and do not pertain to any of our hypothesis or research questions. It can be found in the appendix.

So how does perception influence preference? Three of the four significant relationships between the Likert scale perception questions and the choice experiments are found within the first-choice experiment where prices were the same (Tables 11, 12, 13). In specific, these relationships are with selective breeding impact on Rhode Island's oyster aquaculture, coastal waters, and the economy. The only relationship that was not present was with Rhode Island's public health.

This coupled with the majority of respondents choosing the cheaper of the two oyster products in the second and third choice experiment (Table 9, 15 and 16), and the lack of significant relationships between these choice experiments and perception data further shows how prices are the major factor in choosing between the oyster products. These results also suggest that perception of selective breeding is most influential on purchasing behavior when prices are not a factor. The lack of these relationships between the second / third choice experiments and perception is likely because despite how respondents answer perception questions, the majority of respondents still chose the cheaper option. Respondents stated reasons to why they chose the cheaper oyster product further proves this.

Figure 5: Respondents Stated Reasons for Choice Experiment 2

Figure 6: Respondents Stated Reasons for Choice Experiment 3

The data shows that there are some areas where respondents environmental aptitude is related to their perception of selective breeding, but it is low. Only two significant relationships were found between respondents NEP scores and their responses to perception questions or their choices in the

choice experiments. This low number of significant relationships between respondents NEP scores and their perceptions / decisions alludes to the possibility that selective breeding is not thought of as an environmental issue to a majority of our sample, or rather how environmentally conscious they are doesn't play a role in their perception of selective breeding.

In reviewing relevant literature, we came across studies that concluded that in some cases, the public views GMOs as risky⁷⁴. In our study, we can conclude that a majority of our sample does not find selective breeding in Rhode Island risky, but rather beneficial (Table 6). This might suggest that our sample can distinguish selective breeding from GMOs or similar biotechnology. In addition, some studies concluded that the public lacks knowledge of the aquaculture process and in spite of that, those people hold a negative view of aquaculture⁷⁵. In this study, we found that over 50% of the sample population stated they believed they were familiar or somewhat familiar with selective breeding in regard to oyster aquaculture. It is difficult to say if all of these responses are accurate in this, but regardless, the data shows that our population views selective breeding in oyster aquaculture as positive.

5.A. LIMITATIONS

⁷⁴ Savadori, L., Savio, S., Nicotra, E., Rumiati, R., Finucane, M., Slovic, P., Expert and Public Perception of Risk from Biotechnology, *Risk Analysis*, October 2014, Pg. 1289

⁷⁵ Roheim, C.A., Omana Sudhakaran, P., Durham, C.A., Certification of Shrimp and Salmon for Best Aquaculture Practices: Assessing Consumer Preferences In Rhode Island, *Aquaculture Economics and Management*, July 2012, Pg. 283

It should be understood that for various reasons, definitive conclusions should not be made, and more data collection is necessary before such conclusions can be made. These reasons will be outlined in detail below.

Because the sample size is lower than the proper representative sample, there are a few options in how the data can be interpreted. One option is to treat this sample as a self-selective sample. This would mean that out of the thousands who had the availability to take this survey, our respondents felt strongly enough about the subject that they chose to participate. They are also likely the people who would end up impacting aquaculture policy or programs in the area. Self-selection samples often come with some level of self-selection bias and can lead to bias results. They can, however, offer an accurate look into how an invested portion of the effected population can act. Another option is to look at this data as a case study. Collecting data about multiple cases (our responders' perception of selective breeding in Rhode Island aquaculture) helps us better understand the overall phenomenon in question⁷⁶.

Rhode Island has a population of just over 1,000,000 people, so 81 responses is certainly not a representative sample. We were attempting to reach 300 responses. In addition, there were some issues with our sampling methods. For starters, the areas that we got responses from are by and large more suburban or rural areas of the state. We did not gather information from the more urbanized areas in Rhode Island such as Cranston, Pawtucket or

⁷⁶ Heale R, Twycross A. What is a case study? *Evidence-Based Nursing*, 2018, Pg. 7-8

Providence. This was not due to lack of trying. Community groups in these areas were contacted, but either did not want a survey such as this posted or did not respond at all. Another issue is with the medium that we used to circulate surveys. By primarily using Facebook community groups, we only received feedback from individuals who have access or an interest in these groups. This is backed up in our demographic data. Once again this is not without effort. Different listservs and community groups on other mediums were contacted for circulation, but nothing came from it.

Another limitation that should be addressed has to do with the respondents understanding of what is defined as a wild oyster, a selectively bred oyster, and what “local” means to them. These are all phrases that appeared throughout the choice experiments in the survey. There was a short definition of selective breeding, but no definitions of “wild” when referring to oysters nor “local” when referring to oysters. This could be an issue because different respondents may have different definitions of these terms and some have incorrect definitions of these terms. These internal definitions inform respondents answers and choices in the survey and by not having an established definition, the answers may not be conducive to what we would see in the real world. These limitations can be extended to some of the Likert scale questions as well. What one respondent identifies as Rhode Island public health may be different from another respondent’s definition. Attaching definitions to all of these terms can help mitigate these limitations. Biases should be kept in mind when creating limitations.

Another area that should be addressed is the respondent's familiarity with selective breeding. In the survey, before the short description of selective breeding, respondents were asked if they were familiar with selective breeding. They were to answer yes, somewhat or no. There were no controls for this section and all statements were self-reported. This sort of self-assessment can be dangerous as it invokes a Dunning-Kruger effect. This is essentially where a person with little knowledge of a subject believes they are very knowledgeable⁷⁷. This can make an impact on this study, as relationships within the data pertaining to familiarity may show respondents believed familiarity over their actual familiarity. Either would be useful as data, but without some sort of control, we cannot say for certain which we are looking at.

5.B. COVID-19 IMPACT STATEMENT

It is important to remember that this study was done during the height of the Covid-19 pandemic with no funding available. It is quite possible that our low number of responses was in part due to people being too preoccupied to respond to a survey such as this. It is also worth noting that oysters for many is considered a luxury good. With the global pandemic, many people have made cuts to their budgets and luxury good such as oysters are no longer prioritized. This would affect our choice experiment data. It is difficult to say

⁷⁷ Kruger, Dunning, Unskilled and Unaware of It: How Difficulties in Recognizing Ones Own Incompetence Lead to Inflated Self Assessments, *Journal of Personality and Social Psychology*, 1990 Pg. 1121–1134.

what effect and what extent this may have had, and more data would be required to confirm these effects.

5.C. RECOMMENDED FUTURE RESEARCH

First and foremost, all of the limitations described in the previous selection should be accounted for before continuing a similar study. This research offers valuable information, but with such a small sample size it can be difficult to make more impactful conclusions. If a similar study were to be done, getting a larger sample size over a wider area would be incredibly useful. As it stands, most of the respondents in this survey are shellfish eaters. It would be interesting to see a greater mix of shellfish eaters and non-shellfish eaters' perceptions.

This study could also be expanded to other aquaculture areas other than oyster aquaculture. Possibly doing a similar study focusing on the selective breeding of a product that is not already widely selectively bred would hold a greater amount of relevant information.

CHAPTER 6

CONCLUSION

Aquaculture is an important industry in Rhode Island. Our states history is rich with the practice, it holds a value of over \$6 million as of 2019⁷⁸, provides 219 local jobs across 81 farms⁷⁹ and helps supply food to the state. Despite all these benefits, environmental factors such as increases in disease rates, water temperature rise and ocean acidification threaten the industry as a whole by creating conditions that are not suitable for growth^{80, 81}. Selectively breeding oysters to be resistant to these factors have shown that it can help mitigate these issues^{82, 83}. But the stakes are getting higher. While some of these factors such as disease have been a low threat in Rhode Island, warming water temperatures in the state has increased the likelihood of some shellfish diseases becoming problematic. Areas of the country with warmer waters than us have seen what a disaster these diseases can cause firsthand. Diseases have causes hundreds of millions of dollars in losses in the Delaware regions since the 50s, and recently these diseases have spread as

⁷⁸ CRMC 2019 Annual Aquaculture Report, Accessed 2020, Pg. 3

⁷⁹ CRMC 2019 Annual Aquaculture Report, Accessed 2020, Pg. 3

⁸⁰ Lavallee, D., URI researchers awarded multiple grants to study oyster genetics, breeding, diseases in support of aquaculture industry, *URI Today*, September 2019, Pg. 1

⁸¹ Fitzer, S.C., Rona A.R., McGill, Sergio Torres Gabarda, Hughes, B., Dove, M., O'Connor, W., Byrne, M., Selectively bred oysters can alter their biomineralization pathways, promoting resilience to environmental acidification, *Global Change Biology*, 2019, Pg. 4106

⁸² Gomez-Chiarri, M., Improving Oyster Aquaculture in Rhode Island: Development and Testing of the "Rhodoyster", *Sustainable Agriculture Research and Education*, 2010, Pg. 1

⁸³ Calvo R, Calvo L.M, Gustavo W., Burreson, EugeneM., Dual disease resistance in a selectively bred eastern oyster, *Crassostrea virginica*, strain tested in Chesapeake Bay, *Aquaculture*, April 2003, Pg. 84

far as Massachusetts⁸⁴ with low numbers in Rhode Island. These compounding issues could be problematic for Rhode Island's aquaculture industry in the future. In order for the industry to thrive going forward with increasing environmental issues, it is possible that more selective breeding will have to take place. Despite this, much less is known what the general public thinks about selective breeding in oyster aquaculture. Because of this we need to know how people feel about it, and where we can improve local knowledge.

This research can offer insights into how residents may perceive a widescale selective breeding program in Rhode Island to counter environmental changes. Currently most selective breeding in Rhode Island is done at the farm level or purchased from a separate private hatchery. There are some larger regional programs⁸⁵, but these are done primarily for research purposes and not for the circulation of seed for product. This research also displays consumer behavior when it comes to selectively bred oysters vs "wild" seed oysters as they are encountered at a restaurant or market. This information could be extended into decisions about labeling selectively bred oyster product and what types of consumer behavior could come from that.

Our results show that a sample of Rhode Islanders already view selective breeding in oyster aquaculture as beneficial which bodes well for future aquaculture practices. After asking about selective breeding's impact on Rhode Island's oyster aquaculture, coastal waters, public health, and

⁸⁴ Gomez-Chiarri, M., Improving Oyster Aquaculture in Rhode Island: Development and Testing of the "Rhodoyster", *Sustainable Agriculture Research and Education*, 2010, Pg. 2

⁸⁵ Gomez-Chiarri, M., Improving Oyster Aquaculture in Rhode Island: Development and Testing of the "Rhodoyster", *Sustainable Agriculture Research and Education*, 2010, Pg. 1-20

economy, over 50% of respondents felt it had a positive impact in all four categories with some as high as 85% positivity (Table 6). However, when given the choice between a selectively bred oyster product and a local wild strain oyster product (both farmed), when prices are the same a majority of individuals opted for the wild seed which can be more susceptible to diseases depending on the situation. Consumers showing preference to a product that is easily susceptible to disease over a product that is resistant could be problematic for the future Rhode Island aquaculture industry. The research points out that an individual's familiarity with selective breeding impacts their choice. In addition, relationships were found between perception questions and choosing between two oyster products of the same price (Tables 11, 12, and 13). This points to the conclusion that informing the public about the benefits of selectively bred oysters can impact the decisions of individuals. When prices are not the same however, the majority of individuals chose the cheaper option (Table 9). The study concludes price is the driving factor when the consumer is judging these two products when prices were different. Increasing public awareness of the benefits of selective breeding in Rhode Island oyster aquaculture as well as lowering prices of selectively bred stock can better prepare Rhode Island for future environmental issues. Understanding this information can better prepare Rhode Island's aquaculture industry for future challenges and successes and improve existing selective breeding programs by offering insight into public perception.

APPENDICES

1. Fishers T-Test Tables

Political Affiliation and SBI on RI Oyster Aquaculture

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)	Point Probability
Pearson Chi-Square	6.685 ^a	4	.153	.175		
Likelihood Ratio	7.975	4	.092	.075		
Fisher's Exact Test	8.065			.043		
Linear-by-Linear Association	4.516 ^b	1	.034	.037	.021	.011
N of Valid Cases	81					

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .15.

b. The standardized statistic is 2.125.

SBI on Rhode Island's Economy * Familiarity with selective breeding

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)	Point Probability
Pearson Chi-Square	11.052 ^a	4	.026	.016		
Likelihood Ratio	11.595	4	.021	.022		
Fisher's Exact Test	10.010			.013		
Linear-by-Linear Association	7.711 ^b	1	.005	.006	.002	.001
N of Valid Cases	81					

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .47.

b. The standardized statistic is 2.777.

Choice experiment 2 * Familiarity with Selective Breeding

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)	Point Probability
Pearson Chi-Square	9.632 ^a	4	.047	.044		
Likelihood Ratio	12.376	4	.015	.024		
Fisher's Exact Test	9.935			.034		
Linear-by-Linear Association	1.097 ^b	1	.295	.312	.180	.059
N of Valid Cases	81					

a. 4 cells (44.4%) have expected count less than 5. The minimum expected count is 2.35.

b. The standardized statistic is 1.047.

Choice experiment 3 * Shellfish Consumption

Choice Experiment 3 (Selectively bred oyster less expensive)
*** Shellfish Consumption Crosstabulation**

Count

		Shellfish Consumption		
		Yes	No	Total
Choice Experiment 3	Selectively_Bred	43 ^a	2 ^a	45
	Local_Wild	19 ^a	2 ^a	21
	Neither	11 ^a	4 ^b	15
Total		73	8	81

Each subscript letter denotes a subset of Shellfish Consumption categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.245 ^a	2	.044	.058		
Likelihood Ratio	5.253	2	.072	.126		
Fisher's Exact Test	5.458			.040		
Linear-by-Linear Association	5.590 ^b	1	.018	.027	.021	.014
N of Valid Cases	81					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.48.

b. The standardized statistic is 2.364.

SBI on Rhode Island oyster aquaculture* Choice Experiment 1

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.469 ^a	4	.076	.062		
Likelihood Ratio	9.794	4	.044	.047		
Fisher's Exact Test	8.528			.032		
Linear-by-Linear Association	1.072 ^b	1	.301	.315	.176	.047
N of Valid Cases	81					

a. 5 cells (55.6%) have expected count less than 5. The minimum expected count is .44.

b. The standardized statistic is 1.035.

SBI on Rhode Island Coastal Waters* Choice Experiment 1

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)	Point Probability
Pearson Chi-Square	8.288 ^a	4	.082	.073		
Likelihood Ratio	9.257	4	.055	.076		
Fisher's Exact Test	8.706			.046		
Linear-by-Linear Association	3.667 ^b	1	.056	.067	.034	.011
N of Valid Cases	81					

a. 4 cells (44.4%) have expected count less than 5. The minimum expected count is 1.11.

b. The standardized statistic is 1.915.

SBI on RI Economy * Choice Experiment 1

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)	Point Probability
Pearson Chi-Square	6.928 ^a	4	.140	.133		
Likelihood Ratio	10.731	4	.030	.036		
Fisher's Exact Test	8.221			.039		
Linear-by-Linear Association	4.369 ^b	1	.037	.039	.024	.010
N of Valid Cases	81					

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .44.

b. The standardized statistic is 2.090.

SBI on Rhode Island public health* Choice Experiment 2

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)	Point Probability
Pearson Chi-Square	8.900 ^a	4	.064	.072		
Likelihood Ratio	12.870	4	.012	.013		
Fisher's Exact Test	10.105			.024		
Linear-by-Linear Association	2.556 ^b	1	.110	.128	.067	.022
N of Valid Cases	81					

a. 4 cells (44.4%) have expected count less than 5. The minimum expected count is .37.

b. The standardized statistic is 1.599.

SBI on Rhode Island Coastal Waters * NEP Score

SBI on Rhode Island's Coastal Waters * NEP Score

Count

		NEP Score		Total
		High	Low	
SBI on Rhode Island's Coastal Waters	Positive	53 ^a	3 ^b	56
	Negative	3 ^a	2 ^b	5
	Unsure or No Effect	17 ^a	3 ^a	20
Total		73	8	81

Each subscript letter denotes a subset of NEP_Cat categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.972 ^a	2	.031	.048		
Likelihood Ratio	5.187	2	.075	.092		
Fisher's Exact Test	6.172			.024		
Linear-by-Linear Association	2.338 ^b	1	.126	.153	.109	.065
N of Valid Cases	81					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .49.

b. The standardized statistic is 1.529.

SBI on Rhode Island's Public Health * NEP Score

SBI on Rhode Island's Public Health * NEP Score

Count

		NEP Score		Total
		High	Low	
SBI on Rhode Island's Public Health	Positive	45 ^a	0 ^b	45
	Negative	2 ^a	1 ^a	3
	Unsure or No Effect	26 ^a	7 ^b	33
Total		73	8	81

Each subscript letter denotes a subset of NEP_Cat categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests						
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	11.550 ^a	2	.003	.011		
Likelihood Ratio	14.298	2	.001	.002		
Fisher's Exact Test	12.811			.001		
Linear-by-Linear Association	9.753 ^b	1	.002	.001	.001	.000
N of Valid Cases	81					

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .30.

b. The standardized statistic is 3.123.

2. Survey Tool:

Understanding Public Perceptions of Selective Breeding Practices in Rhode Island Oyster Aquaculture

Start of Block: Default Question Block

Q1 Are you 18 years of age or older?

☐ Yes (1)

☐ No (2)

Skip To: End of Survey If Are you 18 years of age or older? = No

End of Block: Default Question Block

Start of Block: Block 1

Q3 Are you a Rhode Island resident?

☐ Yes (1)

☐ No (2)

Skip To: End of Survey If Are you a Rhode Island resident? = No

End of Block: Block 1

Start of Block: Block 2

Q4 Do you own a home in Rhode Island?

☐ Yes (1)

☐ No (2)

Q5 How many months out of the year do you live in Rhode Island?

- ☐ Less than 1 month (1)
- ☐ 1 to 3 months (2)
- ☐ 4 to 8 months (3)
- ☐ 9 or more months (4)

End of Block: Block 2

Start of Block: Consent Form

Q9

Survey Participant,

Thank you for participating in the University of Rhode Island's survey about selective breeding in Rhode Island oyster aquaculture. The results of this survey will be used to help us better understand the public's views about selective breeding in Rhode Island oyster aquaculture. The survey should last about 10 minutes.

All of the information that you disclose in this survey will be kept completely anonymous and will only be used for this research. In addition, you may choose to not answer any question or withdraw from the survey at any time. You may also request your information to be destroyed at any time.

If you have any question or comments please feel free to contact:

Richard Burroughs: Principal Investigator, at 401-874-4045 or rburroughs@uri.edu

Nathan Brown: Secondary Investigator, at (401)-787-1130 or nathan_brown@uri.edu

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 below to be taken to the survey, you indicate that you have read and understood the above and volunteer to participate in this study.

Thank you for your participation!

- ☐ Continue (1)
- ☐ End Survey (2)

Skip To: End of Survey If Survey Participant, Thank you for participating in the University of Rhode Island's survey about... = End Survey

End of Block: Consent Form

Start of Block: Shellfish Preferences

Q27 Shellfish Eating Preferences: The following section will contain questions that will help us understand your thoughts and preferences of shellfish consumption.

Q10 Do you consume shellfish?

- ☐ Yes (1)
- ☐ No (2)

Skip To: Q11 If Do you consume shellfish? = No

Skip To: Q12 If Do you consume shellfish? = Yes

Page Break

Q11 If no, why not?

☐

Health / Allergies (1)

☐

Taste (2)

☐

Texture (3)

☐

Cost (4)

☐

Other (5) _____

Skip To: End of Block If If no, why not? = Health / Allergies

Skip To: End of Block If If no, why not? != Health / Allergies

Page Break

Q12 How often do you consume shellfish in a given month?

☐

Less than once (1)

☐

1 to 2 times (2)

☐

3 to 4 times (3)

☐

More than 5 times (4)

☐

Other (5) _____

Page Break

Q13 What is your preferred shellfish? (check all that apply)

☐

Oysters (Raw) (1)

☐

Oysters (Cooked) (2)

☐

Mussels (3)

☐

Clams (Quahogs) (4)

☐

Scallop (5)

☐

Lobster (6)

☐

Crab (7)

☐

None (8)

☐

Other (9) _____

End of Block: Shellfish Preferences

Start of Block: Selective Breeding in Oyster Aquaculture

Q28 Selective Breeding in Oyster Aquaculture: The following section will provide information on selective breeding in aquaculture as well as ask questions about the subject.

Q14 Are you familiar with selective breeding in oyster aquaculture?

☐

Yes (1)

☐

Somewhat (2)

☐

No (3)

Page Break

Q16 Selectively breeding oysters is a process where experts can breed oysters with useful but rare traits, so that they become more common across the population. Selectively bred oysters are found to have increased resistance to environmental pressures such as disease (Calvo et al. 2003). Selectively breeding oysters does not impact the taste of the oyster. The majority of farmed oysters in Rhode Island are selectively bred.

Q17 In your opinion, what is selective breeding's impact on Rhode Island's:

	Extremely Benefi- cial (1)	Beneficial (2)	No Effect (3)	Detrimental (4)	Extremely Detri- mental (5)	I Do Not Know (6)
Oyster Aquacul- ture (1)	☐	☐	☐	☐	☐	☐
Coastal Waters (2)	☐	☐	☐	☐	☐	☐
Public Health (3)	☐	☐	☐	☐	☐	☐
Economy (4)	☐	☐	☐	☐	☐	☐

End of Block: Selective Breeding in Oyster Aquaculture

Start of Block: Oyster Choices

Q19 The Following question will show you different oyster products at various price points. Please select the option that you would be most likely to purchase if you were to encounter them at a restaurant. Each product is grown from the same aquaculture facility.

Q20

Q21 Which of the two products above would you most likely purchase?

- ☐ A (1)
- ☐ B (2)
- ☐ Neither (3)

Skip To: Q22 If Which of the two products above would you most likely purchase? = A

Skip To: Q44 If Which of the two products above would you most likely purchase? = B

Skip To: Q45 If Which of the two products above would you most likely purchase? = Neither

Page Break

Q22 Please explain your reasoning for choosing A

☐

Environmental reasons (1)

☐

Recommendations (2)

☐

The quality of A seems better (3)

☐

Other (please explain) (4) _____

Skip To: End of Block If Please explain your reasoning for choosing A , Environmental reasons Is Displayed

Page Break

Q44 Please explain your reasoning for choosing B

☐

The quality of B seems better (1)

☐

Recommendations (2)

☐

Environmental reasons (3)

☐

Other (please explain) (4) _____

Skip To: End of Block If Please explain your reasoning for choosing B , The quality of B seems better Is Displayed

Page Break

Q45 Please explain your reasoning for choosing neither

Skip To: End of Block If Condition: Please explain your reasoni... Is Displayed. Skip To: End of Block.

End of Block: Oyster Choices

Start of Block: Oyster Choices

Q29 The Following question will show you different oyster products at various price points. Please select the option that you would be most likely to purchase if you were to encounter them at a restaurant. Each product is grown from the same aquaculture facility.

Q30 Click to write the question text

Q31 Which of the two products shown above would you most likely purchase?

☐

A (1)

☐

B (2)

☐

Neither (3)

Skip To: Q32 If Which of the two products shown above would you most likely purchase? = A

Skip To: Q42 If Which of the two products shown above would you most likely purchase? = B

Skip To: Q43 If Which of the two products shown above would you most likely purchase? = Neither

Page Break

Q32 Please explain your reasoning for choosing A

☐

The price of A is more expensive (1)

☐

Environmental reasons (2)

☐

Recommendations (3)

☐

The quality of A seems better (4)

☐

Other (please explain) (5) _____

Skip To: End of Block If Please explain your reasoning for choosing A , The price of A is more expensive Is Displayed

Page Break

Q42 Please explain your reasoning for choosing B

☐

The price of B is less expensive (1)

☐

The quality of B seems better (2)

☐

Recommendations (3)

☐

Environmental reasons (4)

☐

Other (please explain) (5) _____

Skip To: End of Block If Please explain your reasoning for choosing B , The price of B is less expensive Is Displayed

Page Break

Q43 Please explain your reasoning for choosing neither

Skip To: End of Block If Condition: Please explain your reasoni... Is Displayed. Skip To: End of Block.

End of Block: Oyster Choices

Start of Block: Oyster Choices

Q23 The Following question will show you different oyster products at various price points. Please select the option that you would be most likely to purchase if you were to encounter them at a restaurant. Each product is grown from the same aquaculture facility.

Q25 Click to write the question text

Q26 Which of the two products shown above would you most likely purchase?

☐

A (1)

☐

B (2)

☐

Neither (3)

Skip To: Q27 If Which of the two products shown above would you most likely purchase? = A

Skip To: Q40 If Which of the two products shown above would you most likely purchase? = B

Skip To: Q41 If Which of the two products shown above would you most likely purchase? = Neither

Page Break

Q27 Please explain your reasoning for choosing A

☐

The price of A is cheaper (1)

☐

The quality of A seems better (2)

☐

Recommendations (3)

☐

Environmental reasons (4)

☐

Other (please explain) (5) _____

Skip To: End of Block If Please explain your reasoning for choosing A , The price of A is cheaper Is Displayed

Page Break

Q40 Please explain your reasoning for choosing B

☐

The price of B is more expensive (1)

☐

The quality of B seems better (2)

☐

Recommendations (3)

☐

Environmental reasons (4)

☐

Other (please explain) (5) _____

Skip To: End of Block If Please explain your reasoning for choosing B , The price of B is more expensive Is Displayed

Page Break

Q41 Please explain your reasoning for choosing neither

Skip To: End of Block If Condition: Please explain your reasoni... Is Displayed. Skip To: End of Block.

End of Block: Oyster Choices

Start of Block: Environmental Attitude

Q29 Environmental Attitude: This section will help us to understand your environmental attributes. Please remember that all answers in this survey are confidential.

Q39 Please choose whether you strongly agree, agree, are unsure, disagree, or strongly disagree with each of the following statements.

	Strongly Agree (1)	Agree (2)	Unsure (3)	Disagree (4)	Strongly Disagree (5)
We are approaching the limit of the number of people the Earth can support. (1)	☐	☐	☐	☐	☐
Humans have the right to modify the natural environment to suit their needs. (2)	☐	☐	☐	☐	☐
When humans interfere with nature it often produces disastrous consequences. (3)	☐	☐	☐	☐	☐
Human ingenuity will insure that we do not make Earth unlivable. (4)	☐	☐	☐	☐	☐
Humans are seriously abusing the environment. (5)	☐	☐	☐	☐	☐

Page Break

Q43 Please choose whether you strongly agree, agree, are unsure, disagree, or strongly disagree with each of the following statements.

	Strongly Agree (1)	Agree (2)	Unsure (3)	Disagree (4)	Strongly Disagree (5)
The Earth has plenty of natural resources if we just learn how to develop them. (1)	☐	☐	☐	☐	☐
Plants and animals have as much right as humans to exist. (2)	☐	☐	☐	☐	☐
The balance of nature is strong enough to cope with the impacts of modern industrial nations. (3)	☐	☐	☐	☐	☐
Despite our special abilities, humans are still subject to the laws of nature. (4)	☐	☐	☐	☐	☐
The so-called "ecological crisis" facing humankind has been greatly exaggerated. (5)	☐	☐	☐	☐	☐

Page Break

Q44 Please choose whether you strongly agree, agree, are unsure, disagree, or strongly disagree with each of the following statements.

	Strongly Agree (1)	Agree (2)	Unsure (3)	Disagree (4)	Strongly Disagree (5)
The Earth is like a spaceship with very limited room and resources. (1)	☐	☐	☐	☐	☐
Humans were meant to rule over the rest of nature. (2)	☐	☐	☐	☐	☐
The balance of nature is very delicate and easily upset. (3)	☐	☐	☐	☐	☐
Humans will eventually learn enough about how nature works to be able to control it. (4)	☐	☐	☐	☐	☐
If things continue on their present course, we will soon experience a major ecological catastrophe. (5)	☐	☐	☐	☐	☐

End of Block: Environmental Attitude

Start of Block: Demographics

Q31 Demographics: The following section asks demographic questions to ensure that all groups are fairly represented. Please remember that all answers in this survey are confidential.

Q32 Please specify your ethnicity.

- ☐ African American (1)
- ☐ Asian (2)
- ☐ Native Hawaiian or Pacific Islander (3)
- ☐ Hispanic or Latino (4)
- ☐ American or Alaskan Native (5)
- ☐ White (6)
- ☐ Prefer not to say (7)
- ☐ Other (8) _____

Page Break

Q33 Please select your gender.

- ☐ Male (1)
- ☐ Female (2)
- ☐ Nonbinary (3)
- ☐ Prefer not to say (4)
- ☐ Other (5) _____

Q34 What is your age?

Page Break

Q35 What is your household size?

- ☐ 1 person (1)
- ☐ 2 people (2)
- ☐ 3 people (3)
- ☐ 4 people (4)
- ☐ 5 or more people (5)
- ☐ Prefer not to say (6)
-

Q36 Do you have children?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Prefer not to say (3)
-

Page Break

Q37 What is your highest education achieved?

- ☐ Less than high school (1)
- ☐ High school or GED equivalent (2)
- ☐ Some college or an associate degree (3)
- ☐ Bachelor's degree (4)
- ☐ Graduate or professional degree (5)
- ☐ Doctorate (6)
- ☐ Prefer not to say (7)
- ☐ Other (8) _____
-

Page Break

Q38 Please select the category that closest represents your annual household income of last year before taxes (2019).

- ☐ Less than \$10,000 (1)
- ☐ \$10,000 - \$14,999 (2)
- ☐ \$15,000 - \$24,999 (3)
- ☐ \$25,000 - \$34,999 (4)
- ☐ \$35,000 - \$49,999 (5)
- ☐ \$50,000 - \$74,999 (6)
- ☐ \$75,000 - \$99,999 (7)
- ☐ \$100,000 - \$149,999 (8)
- ☐ \$150,000 or more (9)

Page Break

Q39 How would you describe your political views?

- ☐ Democrat (1)
- ☐ Republican (2)
- ☐ Independent (3)
- ☐ Prefer not to say (4)
- ☐ Other (5) _____

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