Designing a Sustainable Shrimping Policy for Costa Rica

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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Abstract

Since Costa Rica's bottom trawling ban, there has been an urgent need to establish and encourage a sustainable and economically viable shrimping method. Our team determined and analyzed potential alternatives, and how these might best be implemented in the local context. By working with MarViva, an oceanic conservation organization, we conducted social, economic, and environmental analyses. The result of these analyses lay the groundwork for MarViva's campaign to influence authorities and legislators to help answer questions and set policy, not only on shrimping, but also concerning consumers' roles in the promotion of more sustainable shrimp production

Acknowledgments

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Executive Summary

One of Costa Rica's most important marine commodities is shrimp, which has traditionally been harvested through the process of bottom trawling. However, this practice is wasteful and detrimental to marine ecosystems. The negative effects of bottom trawling caused Costa Rica to implement the Fisheries and Aquaculture Law in 2013, under which the Costa Rican constitutional court deemed bottom trawl shrimping unconstitutional. The goal of our project was to determine and analyze potential alternatives to bottom trawl shrimping in Costa Rica, and how these alternatives might best be implemented in the local context. For this to be properly addressed and executed, we acquired the necessary information through research, organized by the following measurable objectives:

- Performing an analysis on the Costa Rican shrimp market (Economic Impact)
- Determining business and consumer opinions on bottom trawled shrimp and its alternatives (Public Opinion and Preference)
- Analyzing the environmental impact of both bottom trawling and shrimp farming, as well as any additional alternatives (Environmental Impact)
- Providing recommendations to MarViva for future technical and authoritative action

Findings

In our efforts to execute the measurable objectives listed above, we conducted many interviews and independent research utilizing various sources in an effort to address the three key components that influence the shrimping industry: the economy, public opinion and preference, and the environment. Using different techniques, the following listed below are what we determined to be the key findings and takeaways from our research.

- Restaurants and other businesses prefer shrimp caught from the ocean rather than farmed fish.
- Restaurants do not buy cultivated shrimp due to the poorer quality of cultivated shrimp; they are given cheap, chemical-laden feed. Some restaurants buy from higher end farms that instead use live bait and employ a natural, humane way of

removing them from the farms, making the fish physically identical to those collected from the ocean.

- Shrimp origins are often known by retailers, but not always. This is due to the fact that there is no official labeling system in Costa Rica that declares what needs to be on the label for consumer purchase. Fishermen and consumers agree that consumers deserve to be informed about these origins.
- Shrimp caught through gillnets or bottom trawling is generally more expensive than shrimp that is farmed. Shrimp that is imported tends to be more expensive than shrimp obtained nationally from Costa Rica.
- Grocery stores and restaurants are typically willing to pay more for sustainably acquired shrimp.
- Shrimp fishermen typically use gillnetting and are aware of the environmental damage it does to the ecosystem. They are open to improving their fishing methods in the future, but economic barriers prevent the fishermen from taking action. Fishermen potentially could begin to use more sustainable methods if customers are willing to pay more for shrimp.
- Bycatch (products in addition to shrimp that are unintentionally caught in the process of shrimp fishing), which is a major issue with current shrimping methods, can usually have commercial uses when caught with gillnets and therefore does not have to be wasted.
- The top 3 countries that export shrimp into Costa Rica cultivate 94% of their deliverable shrimp. In the last two years, more than 99% of the shrimp exported to the top 3 countries that Costa Rica exports shrimp to is cultivated.

Recommendations

Through our analysis of the economic, public, and environmental impacts, we have gained a significant understanding of the current issues surrounding the shrimping industry in Costa Rica.

We first recommend contacting authorities such as policy makers and legislators, as well as various organizations and relevant contacts to prompt stricter regulations on shrimp products. This could include, for example, more explicit labeling identifying where and how the products

were obtained. Regular checkups by authorities would additionally hold vendors accountable and ensure truthful labeling. We additionally recommend a ban on imported bottom trawled shrimp should also be implemented to avoid double standards. This would allow more focus to be directed towards improving shrimp farms as well as inspiring innovation to facilitate sustainable shrimp fishing.

Ideally, shrimp farms should focus on attempting to imitate the natural environment in which shrimp live in the ocean. This will incentivize businesses to purchase farmed rather than caught shrimp due to the fact that it will be cheaper without a difference in quality or taste. Growth of the shrimp farming industry will also solve many of the environmental issues currently facing the shrimping industry as a whole and will create more jobs on farms to supplement those lost on fishing vessels.

We also recommend additional educational programs for workers, businesses, and the public to raise awareness about the effects of shrimp farming versus bottom trawling. This may be supported with a study to identify any nutritional and taste differences between cultivated and fished shrimp, ideally using this information to make shrimp farms more attractive to consumers.

All of these recommendations made are supported by scientific evidence and economic and environmental indicators. Working with these groups and the data we collected, we hope to influence the implementation of technical regulations that addresses both the economic and environmental issues, and that satisfy all involved parties regarding the shrimp industry.

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Chapter 1: Introduction

The conservation and preservation of marine ecosystems are issues that have been at the forefront of global environmental concerns for decades. In particular, with increasing awareness of the ramifications of climate change, measures to improve oceanic health are being promoted worldwide. Human populations residing in coastal communities are most directly affected by changes in marine environments, and by extension, any measures of marine environmental protection directly benefit such populations as well. Coastal populations and communities rely heavily on their proximity to the oceans for industries of recreation, tourism, and perhaps most importantly, fishing.

Costa Rica is a coastal nation rich in diversity and marine resources. Its combined Caribbean and Pacific coastlines make up 1228 km (631 miles). Fishing is not only one of the country's many tourist attractions, but also a way of life and a source of income for much of its population. One of Costa Rica's most important marine commodities is shrimp, which has been harvested through the process of bottom trawling since the 1800s. Bottom trawling allows for the collection of about 19 million tons of fish and invertebrates annually, or about one quarter of wild marine landings. However, this practice is wasteful and detrimental to marine ecosystems. By non-selectively harvesting everything in their path, bottom trawling nets indiscriminately capture and destroy large amounts of marine life, further contributing to the overfishing of the world's oceans. Additionally, large, heavy bottom trawling nets often permanently disrupt ecosystems near and on the seafloor. The negative effects of bottom trawling caused Costa Rica to implement the Fisheries and Aquaculture Law in 2013, under which the Costa Rican constitutional court deemed bottom trawl shrimping unconstitutional. While this is a major step forward from an environmental conservation standpoint, the ban on bottom trawling has left the shrimp industry lacking sufficient options to keep up with consumer demand. Many Costa Ricans who were dependent on the shrimping industry have felt a negative impact from the decision, resulting in a need to find and promote more economically viable, but still environmentally sustainable, options.

The primary alternative to bottom trawled shrimp is sustainably farmed shrimp. The implications of shrimp farming, however, require further investigation and development, a responsibility taken on by the organization MarViva. MarViva is an international, non-governmental, and non-profit organization that works to protect oceanic and coastal areas in both

Latin America and the Caribbean through providing scientific and legal expertise to organizations, enforcing existing laws, and aiding in establishing new marine sanctuaries. The ultimate goal of MarViva is to create effective change to facilitate the conservation and more sustainable use of coastal and marine resources.

This project aimed to promote policy changes to encourage and support sustainable development in the shrimping industry, potentially through the outlawing of other practices. By working with MarViva and gathering information through research, we hoped to influence authorities on the decision-making process in order to help answer questions not only about shrimping alternatives, but also about consumers' roles in the promotion of more sustainable shrimp production.

Chapter 2: Background

2.1 The MarViva Foundation

MarViva is a non-governmental organization started by philanthropists dedicated to environmental conservation (particularly marine conservation) and socioeconomic development in Central America. The organization's work model is based on political advocacy, participatory processes, multi-sectoral partnerships, and use of communication tools to promote policies and standards, raise awareness, and foster changes of attitude toward marine issues. These marine issues involve consumer awareness and improvements to industry practices. MarViva is looking to find a sustainable alternative to bottom trawl shrimping. To determine an alternative requires research of other types of shrimp fishing as well as an analysis of how and if these methods could be successful in Costa Rica.

MarViva has already been involved in this issue, from increasing public awareness to generating policy changes. One notable achievement is the development of the Standard of Environmental Responsibility for the Marketing of Sea Fish (referred to as the Standard). This standard is a reference framework for the certification of seafood distributors seeking to promote sustainable marketing and consumption practices. This can act as a way for establishments, both wholesale and retail, to certify that the fish sold there is of sustainable origin.

This is only one example of MarViva's many achievements in their greater mission of promoting marine conservation. In addition to developing the Standard, MarViva has worked with numerous coastal communities to promote sustainable practices. This includes raising awareness and generating a variety of socioeconomic development opportunities within the community, as well as fostering communication between local buyers, private business sectors, and community groups. Much of MarViva's success in addressing marine conservation issues can be attributed to this holistic approach of focusing both on the environmental and socioeconomic aspects on the local level.

2.2 Bottom Trawling and its Impact

Bottom trawling is an industrial fishing method used to capture plentiful amounts of fish at once with minimal effort and expense. A bottom trawl is typically made up of a singular large

tapered net with a wide mouth and an enclosed end. There are also two weighted doors on the mouth of a trawl net, so the net is able to stay on the ocean floor. At the bottom of these nets is a thick metal cable which is studded with metal balls. These are typically hauled by one or two boats. Figure 2.2.1 depicts a typical bottom trawl. There are many variations of the bottom trawl. Bottom pair trawls are two mini trawls connected by two vessels, while bottom otter trawls are opened by two otter boards, which are connected by wires called bridles. Figure 2.2.2 (Fonteyne 2001) presents some of these iterations. These boats and nets are responsible for catching 7 different species of shrimp: white shrimp, marmoset shrimp, brown shrimp, pink shrimp, fidel shrimp, camel shrimp, and real shrimp (Universidad Nacional de Costa Rica 2016).

Bottom trawling, also known as "dragging," is known to be one of the most destructive methods of fishing worldwide, destroying ocean habitats and ecosystems worldwide. There are many examples of the destruction of ocean ecosystems caused by bottom trawling. For example, in Alaska, there were hard corals that had aged over hundreds of thousands of years. Despite the age of these massive monuments of the ecosystem, bottom trawls cut through the corals easily, effectively destroying the entire habitat.

Not only does this type of fishing destroy the habitats, it also ends up killing all of the inhabitants. Because the catching method is unselective, any species that inhabit the area are unintentionally targeted and caught. This is referred to as bycatch; all different types of underwater life end up getting captured by the trawl. These organisms are typically discarded, and most do not survive the process. The remaining marine life then has to adapt to a lack of diversity and diminished population in their environment. Bycatch in bottom trawled nets have been known to increase over the years of their use. Between the years of 2003 and 2013, the amount of bycatch has increased from 31.37% to 44.51% (May 2010). This is especially detrimental in biodiverse areas such as Costa Rica, where many endangered species are affected as a result and where it has a direct impact on artisanal fishing. With bottom trawling shrimp only making up for about 15.1% of total shrimp production between the years of 2003 and 2013, it raises the question as to whether this destructive technique should be regulated or outlawed (Universidad Nacional de Costa Rica 2016).

Besides the destruction bottom trawling brings to individual ecosystems, it is necessary to understand the impacts of this process on a global scale. As described above, bottom trawling results in severely disrupting or even destroying the seabed ecosystem. This process is in many

ways similar to deforestation, both due to the aspect of habitat destruction and as it relates to carbon emissions. Sea beds are known to retain greenhouse gases and disrupting them can release these gases. This directly goes against Costa Rica's initiative to completely eliminate carbon emissions, one of the driving reasons for this practice being outlawed and a justification for ruling it as unconstitutional.

Due to its nonselective nature, bottom trawling is also a major contributing factor to the global problem of overfishing. Before this practice was banned in Costa Rica, an estimated 871,000 tons of bony fishes, sharks, and rays were caught in these nets as bycatch from 1950 to 2008. Of this, 50% were discarded. Additionally, in the Gulf of Mexico, scientists estimated that for every pound of shrimp caught, four to ten pounds of other marine resources were inadvertently caught and then discarded (Thurstan 2013).

Bottom trawling has been a destructive force for not only the Earth's sea beds, but also communities reliant on the fish for income and their livelihood. Since bottom trawling is indiscriminate, other species along with shrimp are depleted, negatively impacting the livelihood and economic well-being of fishermen. For example, in the 1860s, fishermen from the British Isles observed a 66% decrease in available fish as a result of bottom trawling (Thurstan 2013). Fishermen were forced to adapt to this change by going longer distances and using different equipment. While these small changes temporarily helped the local fishermen contend with the bottom trawls, the impact of bottom trawling still looms, evident from the fact that fishermen today still struggle to compete. This impact extends to communities dependent on fish for food and exports and, as a result, on markets dependent on the fishermen to sell their catch (Stockbridge 2010).

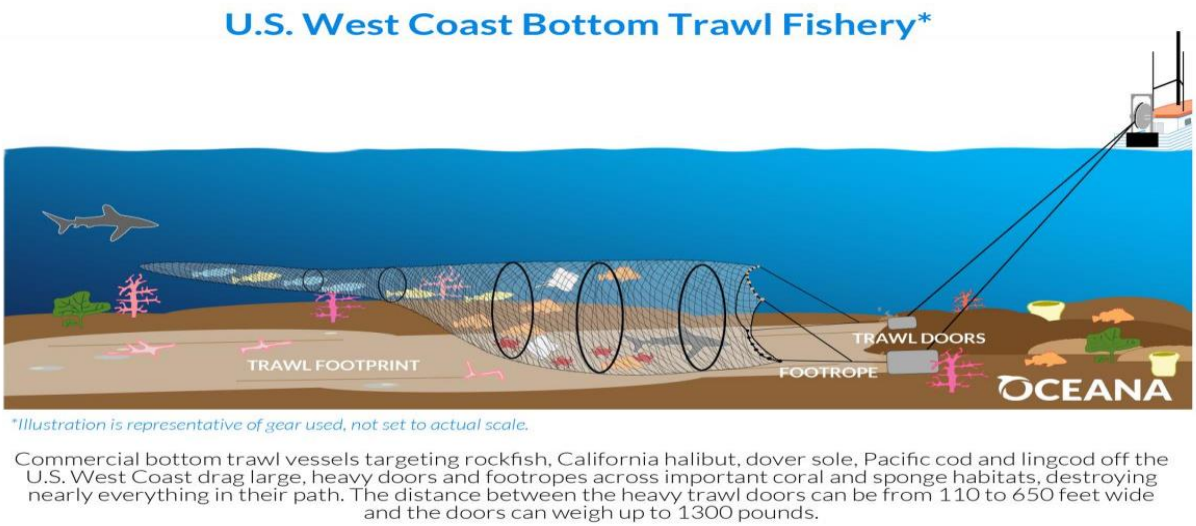

Figure 2.2.1 Bottom Trawl (Stockbridge 2010)

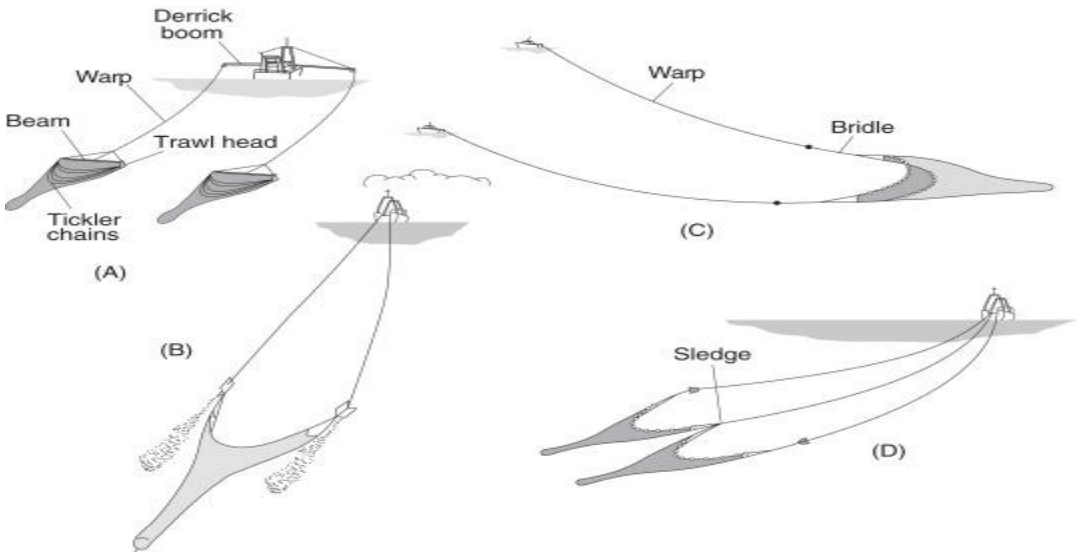

Figure 2.2.2 Different Iterations of Bottom Trawls

(A) Double rig beam trawl; (B) bottom otter trawl; (C) bottom pair trawl; (D) otter twin trawl (Fonteyne 2010)

2.3 Gill Netting

One other notable method of catching shrimp is gillnetting. This method has been used worldwide for generations, dating back over 3000 years with native North American and Japanese fishermen (History of Gill Netting, 2020). Often used by smaller-scale fisheries, gillnetting continues to be an effective and profitable method of shrimping today and is known to have lower environmental impacts than other methods.

Gillnetting consists of a net that is laid in the water perpendicular to the seafloor, similar in setup to a fence or wall (see Fig. 2.3.1). These nets are typically made of monofilament or multifilament nylon (NAOO 2019). Depending on the submersion depth of the net, either weights or buoys can be used to keep it in place. Gillnets are classified based on the sizing of the mesh, which determines the size and species of fish caught. This sizing is designed so that fish species are able to stick just their head through the netting. When a fish becomes caught in the net, it then tries to swim through, causing it to become further entangled. Typically, shrimp are targeted using drift gillnets, which acquire their name due to their ability to drift with the current (FAO 2020).

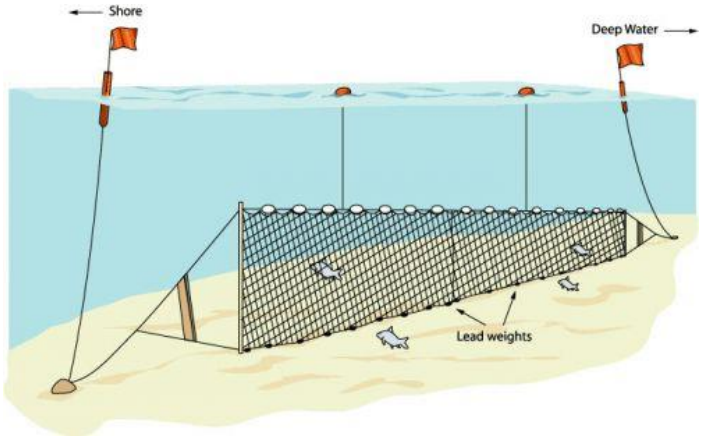

Figure 2.3.1 Gillnet Example (Sonia 2013)

Gillnetting is much less harmful than bottom trawling due to its limited interaction with the seabed; however, this method does come with some of its own drawbacks. Although the levels of bycatch are drastically lower than that of bottom trawling, this is still an issue with gillnetting as other species can become trapped in the net. Fortunately, this can be reduced by including breakaway panels and changing net factors such as slack, mesh size, and set depth (NAOO 2019). These factors work to target certain species more directly and allow other fish to avoid becoming entangled in the net. Gillnets can also cause further problems if they are used in rockier areas or

those inhabited by coral reefs, as this can cause the net to rip or become detached, contributing to ocean pollution. In some cases, these nets continue to trap and kill marine wildlife as they float in the ocean; these are referred to as “ghost nets” (Cornwall Good Seafood Guide). Despite its drawbacks, gillnetting has room for improvement and more potential to remain an effective shrimping method if fishermen are willing to take necessary measures to ensure sustainability.

2.4 Shrimp Farming

Coastal communities are not only home to about 40% of the world’s population, but also support a large portion of the world’s food production. The procurement of various types of fish and other ocean-dwelling creatures has for centuries provided people not only with opportunities for recreation, but also with economic livelihood and means of survival. Both fishing and aquaculture (fish farming) are very important in the marine and general economy, providing more than 38 million fishermen and fish farmers with fruitful and productive occupations. In 2003, the worldwide production for these industries was 132.5 million metric tons. However, fishermen have been recently experiencing trouble finding schools of shrimp large enough to be successful in shrimp production. Though the actual amount of wild shrimp is unknown, the decrease in their population has caused the fishable supply to dip substantially below demand. Additionally, with the increasing vigilance towards the conservation and preservation of our oceans in recent years, fishing via bottom trawling has been recognized as an environmentally detrimental process. Both recognitions illustrate the need for alternative methods of sustainable harvesting of marine organisms. Fortunately, farming is a viable solution to produce enough additional shrimp to meet market demand.

The process of shrimp farming can be involved and quite technical. It is divided into three different methods, each categorized by the level of technology employed in the process. The three methods also depend on the stocking density and the yield. Stocking density is defined as the amount of shrimp or larvae stocked into the manmade ponds or traps, while the yield is defined as how many shrimp are produced from said ponds or traps. Though the terminology varies over different regions, the methods are identified as extensive, semi-intensive, and intensive.

The first method is known as extensive shrimp farming. This process traditionally relies on the natural obtainment of shrimp post-larvae, gathered from wild sources. This process also

depends on the natural productivity of the ecosystem; it consists of built-in intertidal areas that experience water exchange through tidal action. The pond size is usually >10 ha, the density of the trap (and hold of wild shrimp) is about 1-3/㎡, and the yield of this shrimp farming process is generally less than 200 kg/ha/year.

The second method of shrimp farming is identified as semi-intensive. Semi-intensive shrimp farming new

The last method is classified as intensive shrimp farming. This process illustrates the shrimp aquaculture progression towards more advanced systems. It relies on a heavy feeding rate of many shrimp (high density), artificially stocked in small ponds. Additionally, this method employs mechanical aeration and sometimes utilizes water recirculation and treatment. This process of shrimp farming is usually stationed above high-tide level, which allows for the drainage and drying of the bottom of the pond between shrimp crops. Intensive farming produces the most shrimp and has the capability to yield over 7500 kg/ha/year through multiple crops (but typically yielding 5000 kg/ha/year) (Hoanh et al., 2019). These three methods illustrate how involved the aquaculture process can be, but it provides an appealing return on investment, which has resulted in many countries worldwide becoming involved in the industry.

Globally, aquaculture has a significant impact and provides many benefits as a growing industry. By 2003, its rapid expansion already made it responsible for about 30% of global fish supplies (Kadilak, Bryand, and Pani, 2006). Shrimp farming has also proven itself to be a quite lucrative investment and career, for it is one of the major sources of foreign earnings where it is practiced, and the estimated total employment provided by shrimp farming is around 2 million people worldwide (Hoanh et al., 2019). However, its current success depends heavily on the location and resources of its placement. Countries where marine farming is more established in their economy have the ability to support the market. The current main contributors, China, India, and Japan make up for 80% of aquaculture production. (Kadilak et al., 2006). On the other hand, Costa Rica is new to the global aquaculture industry. Although it has not yet reached a major producer status, the seafood market is still an important part of the country's economy. Its exports are currently comprised of species such as tilapia, salmon, trout, and some crustaceans. This includes shrimp as its second most exported aquaculture commodity. Despite currently operating on a smaller scale, Costa Rica aims to further increase its exports supported by an expansion in shrimp farming. Unfortunately, many Costa Rican shrimp farm managers lack the necessary

resources to substantially increase their production, but this does not deter them from developing shrimp aquaculture to achieve both environmental and economic benefits.

The limited number of shrimp farms that are operating in Costa Rica have proven to be successful. Between the years of 2003 and 2013, it was observed that the production of shrimp on these farms was 5.32 times more than the shrimp captured using bottom trawled nets, accounting for about 82.35% of total shrimp production. However, these shrimp farms have had their own hardships. In 2008, cultivated shrimp saw a decrease in production of 32.7% due to attacks of pests and diseases (Universidad Nacional de Costa Rica 2016).

Shrimp is considered a luxury and has some of the highest market prices, which further encourages the expansion and development of shrimp farming. The quick-profit potential draws in not only local farmers, but also outside entrepreneurs. However, as shrimp farming expands and dominates land use in the coastal zones, confrontation and debate arises. Its sustainability and the risks involved are still not completely understood, contributing to the polarization between those who advocate for the economic benefits of shrimp farming and those who reject it on the basis of its potential negative impacts (Hoanh et al., 2019).

Even though it may aid in addressing some shortcomings of the marine market, shrimp farming does come with its own set of drawbacks. Some of these issues include disease, hyper-nutrification of estuarine ecosystems by shrimp pond effluent, chemical leakage, "biological pollution" of native shrimp stocks through aquaculture stock escapement, and wetland destruction. With enough research, regulation (at both the state and federal levels), and new technology, these drawbacks may be remedied. Overall, aquaculture is still relatively new, and the issues and solutions have not been completely addressed yet. To improve shrimp farming will allow not only for the wild shrimp population to increase, but also for these farms to meet consumer demand (Hopkins et al., 1995).

2.5 Shrimp in the Costa Rican Economy

With 287 aquaculture producers in Costa Rica generating over 2,500 jobs, fishing and aquaculture impact the economy of not only Costa Rica, but also the countries to which it exports. Since the beginning of marine aquaculture in 1970 with the cultivation of shrimp, Costa Rica prides

itself on its fishing techniques. However, they have experienced some difficulties when it comes to shrimping both within the country and abroad. The Costa Rican Institute of Fisheries and Aquaculture reports that marine shrimp controls 13% of national aquaculture production (Navarro and Guzman, 2019). Throughout the last 50 years, shrimp production has seen a notable increase. In 2003, 4,582 metric tons of shrimp were produced in Costa Rica, compared to 272 metric tons produced in 1980. Almost all of these shrimp catches are consumed locally with the exception of large shrimp, which is primarily exported to Europe. In 2001, Costa Rica exported 46.82% of all its exportable shrimp to the US, 43.18% to Spain, and 9.75% to France (Quirós, 2002). The shrimp exported to Europe is all cultivated and accounts for more than 50% of total Costa Rican shrimp exports. Behind tilapia, shrimp is the second most exported aquaculture commodity, currently responsible for 14% of the nation's overall aquaculture production (Kadilak, Bryand, and Pani, 2006). According to Instituto Costarricense de Pesca y Acuicultura, or INCOPESCA (Costa Rican Institute of Fish and Aquaculture), bottom trawled shrimp is significantly more expensive than artisanally caught shrimp. For example, in 2013, the reported price of white shrimp caught using bottom trawling in Costa Rica was ₡14,700 ($29.3 USD) per kilogram while those caught artisanally had a cost of about ₡6,600 ($13.17 USD) per kilogram (Universidad Nacional de Costa Rica 2016).

According to a socioeconomic study conducted in Costa Rica, there are about 780 people currently employed by the shrimp fishing industry (Jiménez, 2006). The number of workers in this industry is continuing to drop due to diminutive sales of Costa Rican shrimp both abroad and in the country. Although Costa Rica exports fish and shrimp, the country also imports processed fish under free trade agreements. Countries such as the United States, Spain, and Belgium provide imports of processed fish to Costa Rica as well, including shrimp which can be sold for less than local shrimp businesses (Jiménez, 2018). Fish makes up for 0.5% of all imports to Costa Rica and has an import value of $47.7 million (Simoes, Landy, and Hidalgo, 2017). Rising costs of fuel have also been identified as one of the greatest threats to the shrimp industry. Diesel fuel is primarily used on shrimp boats and accounts for about 50.6% of the initial costs before shrimping. These fuel costs along with increased competition make it difficult for fishermen to make a profit, discouraging people to enter the shrimping industry and increasing the likelihood for others to leave it (Williams, 2010). For the total investment made by shrimp fishermen per vessel, see Figure 2.5.1, illustrating INCOPESCA recorded data in 2013 (Universidad Nacional de Costa Rica 2016).

Figure 2.5.1: Total Costs of Shrimp Fishing via Bottom Trawling (2013)(Universidad Nacional de Costa Rica 2016)			
	Item	Cost	%
1	Gas	₡72.966.992	56.60%
2	Salaries	₡26.402.479	20.48%
3	Maintenance and Reparations	₡7.950.000	6.17%
4	Depreciation	₡4.830.902	3.75%
5	Food	₡4.500.000	3.49%
6	Electrician	₡3.600.000	2.79%
7	Other Supplies	₡3.175.000	2.46%
8	Paint and Welding	₡3.000.000	2.33%
9	Surveillance	₡2.500.000	1.94%
	Total	₡128.925.373	100%

In the past, bottom trawling and other environmentally unfriendly shrimping methods were used in Costa Rica. In 2009, the United States became aware of these methods and placed a ban on the importation of Costa Rican shrimp. The U.S. State Department's Bureau of Oceans, Environment, and Science found that many Costa Rican shrimp nets lacked Turtle Excluder Devices (TEDs), which can endanger turtles and other large marine species that often become trapped in shrimp nets. Due to this ban, shrimp exports fell about $1,000,000, a 57% percent decrease in earnings from prior years. Although this did not have a huge impact on Costa Rican

exports, which were worth 4 billion dollars in 2010, it was still a major concern for one of the country's most traditional trades. In 2012, United States inspectors found that Costa Rican officials had taken appropriate action in protecting and sustaining marine resources while shrimping was still in practice, and the ban was lifted. Despite this achievement, there was still a 50% reduction in shrimp catching during the three-year span the ban was in effect (Williams, 2010).

According to studies of bottom trawling conducted in 2013, each shrimping vessel yields about 62.5 tons of shrimp and 15 tons of other commercial marine species per year. This means that 80% of total vessel production consists of shrimp specifically. However, an analysis of the impact of shrimp selling price illustrates that it is responsible for about 90% of the gross national income. The average price of imported shrimp is about ₡2,350 ($4.69 USD) per kilogram, generating ₡146,875,000 ($293,163.67 USD) for every vessel. Between the years of 2012 and 2014, Costa Rica exported 293.65 more kilograms of shrimp than it imported. This is because shrimp that is imported into Costa Rica is re-exported, and wild shrimp imports from Panama and Nicaragua as well as shrimp captured via bottom trawling outside of authorized docks are not implemented into official records (Universidad Nacional de Costa Rica 2016).

2.6 Regulations on Fish Product Labels

There is no universal labeling system that businesses in Costa Rica must follow when labeling their fish products for consumer purchase. That being said, customers do value the information that is provided on the traceability of their fish. Grocery stores, restaurants, and other businesses have worked with MarViva to ensure their products are obtained in a sustainable manner and provide their customers with additional, but not obligatory, data on their traceability of their products. In most stores, customers can see the official name of the fish, the price per kilogram or half kilogram, whether it is sold fresh or frozen, and the country of origin. The majority of businesses are aware of this information before their fish is put on sale for consumers, however, they are not required by law to display the information. Almost all businesses will regulate the origin of the fish products they receive, and how they are produced for sanitary and risk reasons, ensuring their customers are purchasing safe products.

Imported products, however, are subject to different regulation. When importing fish into Costa Rica, more rules have to be followed in order for the products to be cleared so that they may

enter the country. In 2012, additional regulations were added as the Central American countries reached agreements on several new laws for importations. These included the labeling of packaged foods, nutritional labeling of all food products, and the identification of any additives these products may have when entering any of the Central American countries. All imported food must additionally have their labels in Spanish, and must also include the following information:

- Product name;
- Net content and drained weight in international system units;
- Artificial color and flavors (if any);
- Ministry of Health registration number;
- Ingredients listed in decreasing order, by weight;
- Importer's name and address;
- Lot number and expiration date;
- Country of origin;
- Preservation and use instructions;
- Nutrients such as saturated fat, protein, sodium, etc.

The information stated above is regulated by the ministry of economy labeling department through audits (Gonzalez 2013).

Similar to Costa Rica, the United States also does not have a universal labeling system that businesses must follow when selling food directly to consumers. However, some areas such as the United Kingdom require additional information. These include, but are not limited to, the name of the fish product, list of ingredients, a use-by or best before date, storage conditions, the name and address of the manufacturer or packer, nutrition, country of origin, and health claims. The traceability information that keeps track of all the stages of production, processing, and distribution of the fish product is also required. Although this information does not have to be on the label itself, a health mark must be visible on the label that certifies that this information can be traced through Hygiene for Products of Animal Origin. The traceability currently requires the commercial designation, scientific name, catch area and production method for all supply chain stages of the product being put on sale. This information ensures that consumers may easily identify exactly where their fish comes from and all the processes that have been used from when the fish is collected to when it is put on sale (Seafish 2020).

Chapter 3: Methodology

The goal of this project is to determine and analyze potential alternatives to bottom trawl shrimping in Costa Rica, and how these alternatives might best be implemented in the local context. For this to be properly addressed and executed, we acquired the necessary information through research, organized by the following measurable objectives:

- Performing an analysis on the Costa Rican shrimp market (Economic Impact)
- Determining business and consumer opinions on bottom trawled shrimp and its alternatives (Public Opinion and Preference)
- Analyzing the environmental impact of both bottom trawling and shrimp farming, as well as any additional alternatives (Environmental Impact)
- Providing recommendations to MarViva for future technical and authoritative action

The following sections outline and describe the means of achieving these objectives.

3.1 Economic Impact

In order to be able to influence any policy changes regarding current methods of obtaining shrimp, we conducted an in-depth analysis of the impact of shrimping on the Costa Rican economy. A primary goal of our project was to find an environmentally friendly solution that minimizes bycatch and habitat destruction. However, before suggesting any changes in policy, the potential economic implications for the fishing industry had to be taken into consideration.

In order to better understand the impact of shrimping on the Costa Rican economy, we spoke with representatives from various restaurants, grocery stores, and other businesses that sell shrimp. In these interviews, we gathered information regarding how much shrimp they buy and the price points at which the shrimp are sold. We also gathered information from members of coastal communities dependent on the fishing industry to determine the scope of and the costs associated with shrimping in these communities, and the potential economic implications of new policies. An online consumer survey was sent out to determine public opinion (see section 3.2), from which we were able to gauge how changing the price of shrimp for consumers will affect the

margins of business profits. All relevant interview questions and data can be found in Appendix A.

In addition, we analyzed data from online sources including the Ministerio de Economia, Industria y Comercio (MEIC) (Ministry of the Economy, Industry, and Commerce), PROCOMER (La Promotora del Comercio Exterior de Costa Rica), and INCOPESCA (Instituto Costarricense de Pesca y Acuicultura). These sources are responsible for providing data and results from similar studies they have conducted in the past, and from their online databases, we gathered data on shrimp imports and exports to Costa Rica, including the prices involved based on year and country (see Appendix A). We also spoke with the Science and Responsible Markets department at MarViva to gather any additional information.

3.2 Public Opinion and Preference

To determine the feasibility of implementing sustainable shrimping methods in Costa Rica, we sought to gauge public opinion on the matter. We accomplished this by going to local businesses and conducting interviews of business owners and speaking with members of coastal communities directly affected by the bottom trawling ban. Additionally, we sent out an online survey to shrimp consumers. The purpose of these methods was to establish an understanding of the opinions of shrimp buyers and sellers before recommending any new policies.

We first wanted to determine how local restaurants, markets, and other shrimp vendors felt about sustainable shrimping. To do this, we conducted individual interviews with various representatives of these businesses. In particular, we asked questions targeted at determining whether these businesses are willing to differentiate between bottom trawled and farmed shrimp, and whether they are willing to push for traceability where it is not noted. We visited a variety of restaurants and supermarkets including La Divina Comida, Porto 8, Bacchus, AutoMercado, Masxmenos, Pricesmart, Maxi Pali, Walmart, and Mercado Central.

We also sought to collect data on shrimp consumers. This included anyone who buys shrimp, whether it be from a grocery store or from a restaurant. We constructed an online survey aiming to determine if buyers are interested in knowing the origins of their shrimp and if they are willing to pay more for sustainable products, both imported and local. Our sponsor then sent out this survey to a consumer base. There were limitations to this method, including potential bias

from the population the survey was sent to, and the fact that this was a voluntary online survey. However, due to MarViva's scope as an organization, we determined that this was the best way to reach the widest audience possible in the amount of time we had. These potential biases were accounted for in our analysis and recommendations. Through our survey of the public, we also hoped to determine if educational campaigns about this issue would be necessary or useful in our approach.

Additionally, we sought the opinions of members of coastal communities by interviewing fishermen along the Pacific coast in the Gulf of Nicoya. With these interviews, we wanted to determine whether the fishermen were willing to change their fishing methods to be more sustainable, and how they believed their customers would feel about these types of changes. Due to the fact that the shrimping industry is so vital to these communities, there has been much controversy surrounding the bottom trawling ban and newer policies. Fortunately, MarViva has over time been able to establish communication and trusting relationships with members of these communities. To avoid any issues and to obtain as much information as possible, rather than having us conduct these interviews, MarViva sent a representative from the company who was already familiar with these shrimp fishers to conduct interviews with the questions we drafted.

3.3 Environmental Impact

The main alternative method of shrimping we sought to further investigate was shrimp farming. With the help of MarViva, we determined suitable locations to visit to learn more about this industry in Costa Rica, including a variety of places along the coasts such as Puntarenas, Gulf of Nicoya, and Costa de Pajaros. However, we were faced with the same issue regarding political tensions as described in section 3.2. For this reason, we opted to gather our information from various local sources stationed around San Jose, made up of mostly shrimping businesses, consumers, and distributors. Our questions aimed to gather information regarding shrimp origins, types of shrimping methods used, and any related environmental impacts. In addition, we gathered information about the environmental impacts of shrimp fishing from the fishermen along the Pacific coast mentioned in section 3.2.

3.4 Summary

The methods described above were used to complete the objectives listed and the overall project goal of identifying potential alternatives to bottom trawling in Costa Rica, and any related social, economic, and environmental implications. Analyzing the Costa Rican shrimp market allowed us to gain the necessary information to fully understand the economic impact that any changes to the current shrimping industry may bring. Determining business owners' and customers' opinions and preferences in relation to shrimp obtained via fishing methods versus cultivation allowed us to properly address the issues at hand. Analyzing the environmental impacts of bottom trawling, farming, and any other shrimping alternatives also allowed us to make recommendations in harmony with environmental sustainability. We applied our research to providing technical recommendations to MarViva for potential authoritative actions to reach an agreement amongst all parties. It was also important to educate MarViva and the general public about the benefits and drawbacks of our recommended alternatives. The responses we acquired in our data collection were identity-blind and unbiased, and therefore sensitive to the privacy of the informants. This work done in Costa Rica allowed us to recommend an economically and environmentally sustainable shrimping alternative using the many methods described.

Chapter 4: Results and Analysis

In our efforts to execute the measurable objectives listed in Chapter 3, we conducted many interviews and independent research utilizing various sources. The following section is organized in accordance with our methodology subsections, addressing the three key components that influence the shrimping industry: the economy, public opinion and preference, and the environment. Throughout these sections, we highlighted the most important aspects that influenced each of these components in order to analyze which alternatives can be best implemented in Costa Rica.

4.1 Economic Impact

The economic impact was analyzed in order to further understand the various parts of the shrimping industry through interviews and independent research. This included the analysis of the overall difference between the cost of cultivated versus caught shrimp. These cost values, however, depend greatly on the source, namely shrimp fishermen. The fishermen were contacted via a local communications representative from MarViva prepared with our specific interview questions. This allowed us to obtain information about shrimp production and revenue, the cost of fishing as an occupation, and whether fishermen would be willing to pay more in order to be environmentally sustainable. The shrimp are then transported to various restaurants, grocery stores, distributors, and independent fish shops that all vary in not only the amount of shrimp they buy, but also the price they purchase and sell their shrimp for. Lastly, we completed our data acquisition by evaluating the online importation and exportation values of various shrimp species through the economic organization PROCOMER.

Differences between wild-caught and cultivated shrimp were identified through numerous interviews and analyses. The information gathered asserted that shrimp caught from the ocean has a much greater value than the shrimp that is farmed. The main differences and therefore price influencers between the two are the taste, size, and overall quality of the shrimp. The price therefore varies depending on the comparative desirability of wild-caught versus farmed shrimp. The fishermen stated that on average, cultivated shrimp is valued between 4,000 and 5,000 colones while shrimp caught in the ocean is valued between 12,000 and 15,000 colones, illustrating how

fished shrimp is generally the more expensive of the two. Many establishments overlook this difference in price in favor of satisfying the consumers, who prefer wild-caught shrimp due to a difference in taste.

To obtain information directly from the wild-caught shrimping source, interviews were conducted by a communications representative from Marviva to seventeen local fishermen, as stated above. According to these fishermen, each shrimping trip using gillnets costs about 16,000 colones. The amount spent is between about 11,000 colones and 21,000 colones. However, there are many variable costs when it comes to shrimping. Gas, ice and workers' salaries make up for the majority of the costs; in some cases, the gas alone for the boats are responsible for more than 50% of the total expenses. Depending on the length of the trips, tides, and overall fishing conditions, the amount of shrimp captured varies from 5 kilograms to 60 kilograms per month with an average of about 19 kilograms per month. The majority of these fishermen sell their shrimp to the Center of Acopio and are paid an average of 9,909 colones per kilogram. Others bring their shrimp directly to their own clients, restaurants, and other businesses in which the selling price varies. Some are paid more, and some are paid less than the average selling price in the Center of Acopio depending on the type and quality of the shrimp.

With a successful harvest, shrimp farms produce about 4,000 kilograms of shrimp every 90 days if 10 shrimp are farmed per square meter. The production of shrimp can either be doubled or cut in half depending on the various variables of shrimp farming. Once produced, the farmers will take the shrimp to fish shops where they will sell them to four or five distributors for about 2,000 to 2,500 colones per kilogram. A harvest of 90 days will cost a fish farm with four workers about 5.6 million colones. A successful harvest thus leaves about 4.4 million colones of profit every 90 days for the owner of the farm which translates to about 17.9 million colones per year. The former fish farmer also revealed that there are many struggles with selling the grown fish. Due to the economy of Costa Rica, he disclosed that cultivated shrimp is imported from Nicaragua and Guatemala which are sold for as little as half the price of that of the Costa Rican farms. The competition of imports therefore makes it very difficult for these farmers to make profits.

The quality of shrimp can be often linked to the method in which it is collected. Although most fishermen believe it is important to have a sustainable way of obtaining shrimp, they cannot afford to invest in these sustainable practices. With this, there is no guarantee that clients would pay more for sustainably caught shrimp, further incentivizing fishermen to continue their current,

more affordable methods. For more information on interviews conducted to fishermen in this industry, please refer to Appendix A.3.

Due to the wide variation in not only shrimp species, but also size and method of capture, it is impossible to determine a fair average to be analyzed without resulting in a hasty generalization. Additionally, prices vary greatly between different establishments that sell shrimp. This creates inconsistency between the obtained data, but for all prices received from grocery stores, restaurants, and fish shops, please refer to Appendices A.1, A.2, and A.5 respectively.

The following conclusions were drawn from all establishments. The analysis completed was through the investigation of not only fishing and fish farming, but also fishing and farming in relation to restaurants, grocery stores, fish distributors, and independent fish shops. It can be noted that in general, cultivated shrimp is sold for less than shrimp that is wild-caught within all establishments. This difference in price is accredited to the cost of fishing for shrimp as a full-time occupation; the use of both bottom trawls and gillnets both require many additional expenses. This is due to the costs of operating vessels, the price of gas and equipment, upkeep, and paying employees.

On the other hand, shrimp that is imported, usually from Nicaragua or Honduras, tends to be more expensive than locally obtained shrimp from Costa Rica. Comparing imported shrimp to bottom trawled shrimp reveals that they both are relatively equal in price, and if not, imported shrimp tend to be a bit more expensive. Imported shrimp that is acquired via farming, however, will in general be cheaper than imported bottom trawling shrimp, yet it will still be more expensive than nationally farmed shrimp.

Overall, fishing with nets, including both bottom trawls and gillnets, tends to be more expensive than fish farming, and importations as a whole tend to be more expensive than locally obtained shrimp. This information emphasizes that any combination of these four elements, whether farmed or fished, and imported or national, influences the procurement and economic value of each species of shrimp. In general, the least expensive method of shrimping is for nationally cultivated shrimp, and the most expensive being either imported or nationally fished shrimp via bottom trawls or gillnets.

To further analyze the difference in price between imported and nationally collected shrimp, the following data were retrieved from Procomer, the foreign trade promoter of Costa Rica. This data illustrates the various prices of imported and exported shrimp in Costa Rica.

Honduras, Nicaragua, and Ecuador are the countries that export the most shrimp into Costa Rica. 97.5% of the shrimp imported from Honduras, 95.7% of the shrimp imported from Nicaragua, and 94.3% of the shrimp imported from Ecuador are cultivated shrimp. Belgium, Spain, and the United States are countries that receive the most shrimp exported from Costa Rica. From 2017 to 2019, the amount of cultivated shrimp exported to the United States increased from 40% to 99.5%. During the same time period, 100% of the shrimp that was exported to Belgium and Spain was cultivated. In conclusion, these data show that almost all the shrimp that are imported and exported comes from shrimp farming. The Costa Rican importation and exportation values can be more clearly seen in figure 4.1.1 and 4.1.2, respectively (Procomer 2019).

Figure 4.1.1: Shrimp Importations to Costa Rica per Country/Region in Thousands of Dollars per year (Procomer 2019)

Country	2013	2014	2015	2016	2017	2018	2019*
Guatemala	$11.70					$0.27	$0.07
Honduras	$398.01	$117.67	$931.21	$5,009.90	$2,531.68	$5,967.26	$2,998.68
Nicaragua	$442.98	$664.74	$2,273.40	$3,865.50	$6,993.45	$6,581.44	$4,931.16
Panama	$49.92	$120.22	$295.92	$83.18			$99.91
Central America	$902.60	$902.63	$3,500.53	$8,958.58	$9,525.13	$12,548.97	$8,029.83
United States	$1.31			$5.76	$13.39		
Argentina	$0.18	$3,390.69	$2,200.44	$1,408.93	$150.76		$127.92
Ecuador	$390.89	$322.20	$1,045.48	$1,300.97	$1,586.45	$1,213.29	$1,267.39
Venezuela							$0.50
South America	$391.07	$3,712.89	$3,245.92	$2,709.90	$1,737.21	$1,213.29	$1,395.82
Indonesia	$0.54		$1.30	$8.04			
Vietnam		$2.50	$0.80	$10.12	$5.14		

Asia	$0.54	$2.50	$2.10	$18.16	$5.14		
Madagascar					$3.97		
ND		$71.16		$64.57			$147.69
Other		$71.16		$64.57	$3.97		$147.69
Grand Total	$1,295.52	$4,689.18	$6,748.56	$11,756.97	$11,284.84	$13,762.27	$9,573.34

Figure 4.1.2: Shrimp Exportations from Costa Rica to Country/Region per year in Thousands of Dollars (Procomer 2019)

Country	2014	2015	2016	2017	2018	2019*
Guatemala		$0.71		$54.84		
Honduras				$84.88		
Central America		$0.71		$139.72		
Canada				$0.46		
United States	$1,549.32	$1,124.12	$0.10	$162.71	$0.28	$221.48
Mexico	$177.76					
North America	$1,727.08	$1,124.12	$0.10	$163.17	$0.28	$221.48
South Korea	$169.75					
Japan	$57.27					
Vietnam	$349.35					
Asia	$576.37					
Dominican Republic	$134.97					
Germany				$1,980.61		

Belgium			$1,513.49	$8,769.68	$10,355.76	$6,286.59
Spain	$1,855.45	$333.30	$1,239.21	$1,835.47	$1,227.26	$1,543.58
France				$377.04	$180.96	$100.70
Netherlands						$1,657.80
Europe	$1,855.45	$333.30	$2,752.70	$12,962.80	$11,763.98	$9,589.70
Grand Total	$4,293.87	$1,458.13	$2,752.80	$13,265.70	$11,764.26	$9,811.17

Analyzing and understanding the various values between shrimp species, sizes, procurement methods, and their importation and exportation rates allowed us to have a better understanding of the Costa Rican shrimping economy. These values indicate which areas are important to Costa Rica when it comes to shrimp importations and exportations. The Costa Rican shrimp industry is a substantial source of revenue each year, and without these transactions, it would not be able to operate.

4.2 Public Opinion and Preference

When interviewing restaurants, we found that most were willing to take necessary measures to ensure that their shrimp were caught sustainably, regardless of any increase in price. This could be due to the fact that the restaurants we visited were all more expensive, higher-end establishments, and they were more concerned about quality and offering a better experience for their customers than they are about affordability. However, one restaurant did state that whether or not they would be willing to pay more would depend on the price increase.

All of the restaurants stated that they would rather serve shrimp that had been caught from the ocean than farmed. The reason cited for this was that the cultivated shrimp has a much different, less desirable flavor, an opinion they said their customers shared with them. In addition to the flavor, restaurant owners stated that if the cultivated shrimp is frozen, it feels less tender compared to caught shrimp after being defrosted. The only exception to this opposition to farmed seafood was in our interview with Bacchus. The chef told us that they had one farm they are willing to purchase fish from due to the superb conditions, resulting in the seafood being physically identical to that caught from the ocean. If similar farms can be established for shrimp, this may be a viable

option for restaurants concerned about the difference in flavor; however, more research would be necessary on this topic. An important consideration is the fact that these are more expensive restaurants, so these opinions do not necessarily reflect the opinions of the more general public or the practices of more casual dining establishments. The data was taken from these particular restaurants because of the staff's knowledge regarding their seafood practices. The findings from our grocery store interviews and consumer survey below provide a more accurate reflection of the opinions of middle-class citizens.

In our interviews with grocery stores and fish shops, we found that most had some general knowledge about the origins of their shrimp, as well as some interest in ensuring sustainable practices. When asked if they would be willing to pay more for sustainably obtained shrimp, store representatives most often said yes. Generally, it was always known whether the shrimp was cultivated or caught, and where the shrimp's geographic origin was. Both cultivated and caught shrimp were relatively common in these stores (see Appendix A for full listings). Most of the time, retailers knew the method of fishing used for caught shrimp, but sometimes this method was unknown or unlisted. These methods most often involved gill netting, but some stores said their shrimp was obtained via bottom trawling. This applied even for shrimp caught within Costa Rica, meaning this practice is still in place to some extent despite the 2013 ban. Additionally, it was found that some labels on shrimp being sold were inconsistent with the information given to us verbally through the interviews. This implies that further work may be necessary to ensure compliance with local and national standards to address this issue. To further explore how these issues would impact the method by which shrimp is caught, fishermen were contacted to share their views.

Many fishermen expressed interest in addressing issues within the shrimping industry and were in favor of fishing more sustainably. The main obstacle hindering them from achieving this is purely the financial investment. The amount of money it would take for fishermen to improve all of their equipment, gear, and processes is too large and risky making it difficult for the business to ensure they will still make a profit for their daily lives; many investments would have to be made to improve the methods of shrimp farming. All fishermen stated that if environmentally-friendly improvements to fishing methods were more available, they would be in favor. However, from the investment standpoint, consumers may be willing to pay more money to producers and fishermen who use more selective fishing gear and operate more responsibly. When asked about

this directly, the responses from the fishermen varied. Some stated that there exist many buyers who are willing to pay more for an environmentally responsible and sustainable product. Others argued that the price is the main issue due to the fact that some consumers do not wish to pay more for shrimp, no matter the process by which they are caught. Yet the general consensus among all fishermen was that more information should be provided to the customer beforehand, explicitly stating the shrimp fishing method and origin. This may or may not impact how much consumers would be willing to spend on shrimp.

An additional demographic that we wanted to address was the shrimp consumers in the general public. MarViva aided our study by sending out a survey through their MailChamp Alias. The questions that were on the survey can be referred to in Appendix B. For the results, the age group that was reflected in the bulk of our collected data, about 59%, consisted of people around 25-40, all of them Costa Rican locals. 63% of the consumers reached are well informed on how their shrimp is caught. Many respondents did deem that it was important that consumers understand how the shrimp was caught, and consumers unanimously decided that they preferred to buy and consume shrimp that was captured in a responsible manner. This directly correlated to the final question of our survey, which asked if the consumer was willing to buy shrimp that was responsibly caught for an increase in price. 81% stated that they would be willing, with some respondents commenting that it could depend on the price. However, if the price was relatively affordable, they would purchase more sustainably obtained shrimp.

4.3 Environmental Impact

In the interviews with fishermen in the Gulf of Nicoya, we discussed the environmental impacts of various methods of shrimp fishing. The preferred method in this region is gillnetting, which is known to be somewhat more sustainable and less damaging to marine ecosystems than other methods (described in section 2.3). The fishermen that participated in these interviews used 3-inch gillnets, consisting of either 33 or 50 meshes across the nets in order to capture the fish. The majority of the fishermen acknowledged the environmental drawbacks to this method, but they asserted that these effects are insignificant especially compared to bottom trawling. Although bycatch is still prevalent with gillnetting, it is much less of a factor with this method, and the

fishermen stated that they use any bycatch for commercial purposes, ensuring nothing goes to waste.

The fishermen also stated that the shrimp caught using this technique is also larger and of better quality. However, this method does yield a lesser amount of shrimp due to the fact that the nets do not reach the ocean floor. While research is still being conducted on various fishing alternatives and many are still being studied in practice, the majority of the fishermen stated that they would be open to improving their methods even further. This attitude contributes greatly to the steps away from bottom trawling and those towards a more environmentally sustainable future for the marine industry.

In our own independent research throughout this project, we travelled through San Jose and Heredia which allowed us to reach a greater variety of shrimp distributors. One restaurant, though most of their purchased shrimp comes from the ocean, buys all of their tuna from Mercotico S.A., a tuna farm in Santa Ana, Costa Rica. This tuna farm was proven to be clean, sustainable, efficient, and overall as natural as possible. The fish are raised in large ponds where they are able to swim freely and are fed live bait. The tunas are also removed from the ponds in a humane and sustainable way. The nearly pristine conditions of this tuna farm contribute to the health of the fish, therefore creating a more desirable product without the adverse effects of improper treatment.

However, this is not usually the case with shrimp farms. After speaking with a former fish farm manager who specifically farmed King Prawns in the Nicoya Gulf, we learned a significant amount of information about the process and industry of cultivated shrimp. This shrimp farmer, along with four workers, aimed to harvest shrimp when they weigh between 17 to 18 grams which takes about 90 days depending on various variables. First, shrimp eggs are imported primarily from Ecuador and Guatemala. They are then sent to a laboratory where they undergo mutation under extreme cold temperatures in order for the eggs to become larvae. The larvae are then sent to the farms where they are put into a temperature regulated tank. Since the larvae are accustomed to cold temperatures, the farmers will slowly increase the temperature of the tank in order for the larvae to adapt to the waters of the lagoon. About 12 larvae are placed per square meter in the lagoon as they begin to grow into shrimp. This illustrates how many of these farms utilize ponds that are densely packed with shrimp. They are fed manufactured food that consists of mixed grains, flour, and fish. The feed that is used for the shrimp is designed with high protein so that they grow

more quickly. They employ this feed at heavy rates, for more organic and natural feed tends to be more expensive.

As the shrimp grow, there are a lot of variables that the farmers must monitor in order for the shrimp to grow successfully. First, the water in the lagoon needs to be regulated with fertilizer to retain freshness. Additionally, there are often issues with lack of oxygen in the lagoon, necessitating that the farmers must either pump out the water and replace it using a propeller, or use a machine that pumps oxygen into the lagoon.

In order to ensure the health and quality of the shrimp, shrimp farms usually hire a biologist to come once per week to check on the process of the shrimp. However, the representative disclosed that some farms instead rely on experience to regulate the shrimp which often leads to a bad harvest. These biologists primarily check the shrimp for parasites or diseases. The most common disease found in these farms is known as Mancha Blanca, a white spot virus that can kill the shrimp in 7 to 10 days if not treated properly. Antibiotics are administered to the shrimp to treat Mancha Blanca, which does affect the physique of the shrimp; however, this must be applied 4 weeks prior to harvest in order for the shrimp to remove it from their system before they are consumed. If parasites are found, the shrimp are fed garlic to eliminate them.

Knowing this, steps can be taken to address the discrepancies between various marine farms, especially working with shrimp farms, to raise the standard and assure that all rearing and treatment of cultivated marine organisms is sustainable and environmentally sound overall.

Chapter 5: Conclusions and Recommendations

With the research and analysis done over the fourteen weeks of this project, we have established there is still much to be done in order for Costa Rica to find improvements to shrimping that are beneficial to the people, environment, and economy. The following paragraphs outline the key findings of our study and the subsequent recommendations we have for MarViva and the government of Costa Rica on action to take regarding this topic.

Details regarding the origins of shrimp are typically available to retailers, but businesses and their consumers are not always aware of this information. There is no official labeling system in Costa Rica that states what specifically needs to be on the label for purchase. Shrimp fishermen around Costa Rica do believe that consumers should be informed about how their shrimp is caught. Additionally, many consumers believe they should be able to trace the origins of the shrimp they have purchased.

Restaurants and other businesses tend to prefer shrimp caught from the ocean over farmed shrimp. This has to do with a perceived difference in quality between the two; however, with appropriate changes and conditions, aquaculture farms can produce shrimp that is physically equivalent to caught shrimp.

Shrimp caught from the ocean, whether through bottom trawling or gillnetting, is generally more expensive than farmed shrimp. Additionally, imported shrimp tends to be more expensive than shrimp obtained nationally. Of the shrimp imported by Costa Rica, 94% of the shrimp that comes from the top three exporting countries is cultivated. For the top three countries to which Costa Rica exports shrimp, over 99% of these exports in the last two years have been cultivated.

In the Gulf of Nicoya, where the industry is most prevalent, shrimp fishermen typically acquire their shrimp through the method of gillnetting. They are aware of the environmental drawbacks associated with this method, and they take what actions they can to limit their harm to marine ecosystems. There are further improvements that can be made, but currently, economic factors and uncertainty over whether customers will be willing to pay more to support more environmentally friendly methods is preventing these fishermen from taking action.

Through our analysis of the economic, public, and environmental impacts, we have gained a significant understanding of the current issues surrounding the shrimping industry in Costa Rica.

With this information, we have developed the following recommendations for MarViva and other stakeholders involved parties to take necessary action to take on the issue.

We first recommend contacting high-level authorities such as policy makers and legislators, as well as the various organizations and contacts mentioned in the above objectives that can influence and regulate the shrimp industry in relation to shrimp fishing and farming. Beneficial policy changes would include stricter regulations on shrimp products, such as more explicit labelling identifying where and how they are obtained. This could mimic a policy already implemented by the United Kingdom, where all products must be certified and receive a stamp on labels for consumer purchase that identifies a source where one may find all of the traceability information of that product. Regular spot checks by authorities would additionally hold vendors accountable and ensure truthful labeling. We additionally suggest that because bottom trawling shrimp is already banned within the country, a ban on imported bottom trawled shrimp should also be implemented to maintain consistency and avoid double standards. This would allow more focus to be directed towards improving shrimp farms as well as inspiring innovation to facilitate sustainable shrimp fishing. We also recommend continued efforts to remove illegal bottom trawling practices from Costa Rica completely.

The most ideal solution would be to urge fish farms to replicate the natural marine environment in which shrimp live by using fewer chemicals and using live bait as feed. If these farms focus more on attempting to imitate the natural environment in which shrimp live in the ocean, businesses would be incentivized to purchase farmed rather than caught shrimp due to the fact that it will be less expensive without a difference in quality or taste. This would also solve many of the environmental issues currently facing the shrimp industry. For example, the improvement of farming would support increased growth of the wild shrimp population. Growth of the shrimp farming industry would also create more jobs on farms to supplement those lost on fishing vessels. We also recommend that MarViva continue to work with shrimp fishers who use gillnetting and encourage any moving towards more sustainable practices. Any financial concerns can be addressed with the data we found that shows that consumers are generally willing to pay more for sustainably caught shrimp.

Additional educational programs for workers, businesses, and the public are recommended in order to raise awareness about the effects of shrimp farming versus bottom trawling. This will include campaigns to educate the public about its detrimental effects and how shrimp can be

obtained more sustainably. Additionally, a push for increased regulation on shrimping practices and labeling requirements as mentioned above can aid this process. These practices may also be supported with a study to identify any nutritional and taste differences between cultivated and fished shrimp, ideally using this information to make shrimp farms more attractive to consumers.

All of these recommendations made are supported by scientific evidence and economic and environmental indicators. Working with these groups and the data we collected, we hope to influence the implementation of technical regulations that addresses both the economic and environmental issues, and that satisfy all involved parties regarding the shrimp industry.

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APPENDIX A: Interviews

The following interviews were completed to achieve the objectives stated in our paper. Our team traveled to various locations with previously established interview questions reviewed by MarViva. All interviews were conducted in Spanish to facilitate communication with the workers/owners. The interviewees are identified as a representative of the company in order to keep the informants anonymous.

A.1. Interviews with Grocery Stores and Restaurants

Interview questions:

1. Where and how do you purchase shrimp for your business?
2. About how much and how often do you buy shrimp?
3. Could you tell us how much you pay to buy shrimp?
4. What is the average price that you sell your shrimp to consumers?
5. Do you know how the shrimp you buy is caught? Is how they are caught important to you or your business?
6. If so, would you be willing to pay a little more money for your shrimp to ensure it is caught in an environmentally friendly way?

Walmart

The seafood section of Walmart sells four types of shrimp to the public. This includes Costa Rican pink shrimp, Costa Rican bald shrimp, red Argentine shrimp, and large Argentine shrimp. They are acquired every Wednesday from a company known as PesCarnicas. Each delivery consists of about 5 kilograms of shrimp, translating to roughly 260 kg of shrimp per year. Upon delivery, the shrimp is either fresh or frozen. Those that are fresh are ready for sale immediately, while the frozen are kept so to maintain freshness for later parts of the week. The local shrimp (obtained domestically) comes from Guanacaste and is produced via shrimp farming. However, the method for procuring Argentine shrimp is not known. Walmart was unwilling to disclose the cost of purchasing shrimp from PesCarnicas for business reasons. However, the informant believes that due to the size and popularity of the business as well as competition from other grocery stores, Walmart would be willing to spend more money to ensure their shrimp is caught in an environmentally friendly way. Figure A.1.1 illustrates the prices of various shrimp species sold to consumers at Walmart.

Figure A.1.1: Walmart Prices of Shrimp sold to Consumers		
Type of shrimp	**Price/kg (colones)**	**Price/kg (dollars)**
Pink shrimp	₡10,995	$19.34
Bald shrimp	₡12,000	$21.11
Red Argentine shrimp	₡12,995	$22.86
Large Argentine shrimp	₡9,950	$17.49

Automercado

After working closely with MarViva, Automercado is the only grocery store in Costa Rica to have obtained a certification that the business complies with sustainable fishing standards and adheres to all requirements for environmental sustainability. The complete traceability of their fish products means that the seafood is tracked from when it is fished or farmed to when it is available to customers for purchase. Automercado purchases their shrimp in the Acopio Center, where the shrimp is either farmed or caught in the Nicoya Gulf. They purchase 30 kg of shrimp two or three times a year, depending on the commercial size of the shrimp. The shrimp that is not ready for immediate sale is frozen using a method known as Individual Quick
Freezing (IQF). This freezes each shrimp individually so that they maintain freshness for consumers when they are eventually ready to be sold.

Automercado's shrimp selection is wide, including white bald shrimp, pink bald shrimp A.N., jumbo white shrimp U-15, jumbo white Shrimp U-10, jumbo white shrimp U-7, pink bald shrimp, white bald shrimp 41-50, conch pink, jumbo shrimp U-12, and jumbo white shrimp U-8. The notation U-# is used in labeling shrimp and describes how many shrimp of each particular species are in each pound (for example, U-15 designates that a pound will consist of 15 or fewer shrimp of that particular species). Automercado cannot disclose how much they pay for shrimp, but the informant claimed that the chain spends more money than other stores to ensure they meet the sustainability standards established by MarViva. Figure A.1.2 illustrates the prices of various shrimp species sold to consumers at Automercado.

Figure A.1.2: Automercado Prices of Shrimp sold to Consumers (Barrio Dent Location)		
Type of shrimp	**Price/kg (colones)**	**Price/kg (dollars)**
White bald shrimp 31/41	₡13,560	$23.84
Pink bald shrimp A.N	₡15,385	$27.05
Jumbo white shrimp U-15	₡20,990	$36.94
Jumbo white shrimp U-10	₡26,685	$47.04
Jumbo white shrimp U-7	₡32,205	$56.85
Pink bald shrimp	₡11,775	$20.79
White bald shrimp 41-50	₡12,715	$22.46
Conch pink shrimp	₡13,090	$23.12
Jumbo shrimp U-12	₡22,600	$39.92
Jumbo white shrimp U-8	₡30,625	$54.09

Figure A.1.3: Automercado location B (downtown)							
Type of Shrimp	**Size**	**With/without Shell**	**Fresh or Frozen**	**Origin**	**Method Captured**	**Price/Kg**	**price/kg**
Pinky	41-50	Without	Fresh	Domestic (Nicoya Gulf)	Unknown	₡13,090	$22.71
Pinky	41-50	With	Fresh	Domestic (Nicoya Gulf)	Unknown	₡15,385	$26.69
Fidel	Unlisted	Without	Fresh	Domestic (Nicoya Gulf)	Unknown	₡9,420	$16.34
Fidel	Unlisted	With	Fresh	Domestic	Unknown	₡11,775	$20.43

				(Nicoya Gulf)			
White	Jumbo U-15	Without	Fresh	Domestic (Nicoya Gulf)	Unknown	₡20,990	$36.41
White	Jumbo U-12	Without	Fresh	Domestic (Nicoya Gulf)	Unknown	₡22,600	$39.20
White	Jumbo U-10	Without	Fresh	Domestic (Nicoya Gulf)	Unknown	₡26,685	$46.29
White	51-40	With	Fresh	Nicaragua	Cultivated	₡12,245	$21.24
White	31-40	With	Fresh	Nicaragua	Cultivated	₡12,715	$22.06

Figure A.1.4: Masxmenos							
Type of Shrimp	**Size**	**With/without Shell**	**Fresh or Frozen**	**Origin**	**Method Captured**	**Price/Kg**	**price/kg**
Pinky	41-50	Without	Frozen	Domestic (Cagevy)	Unknown	₡12,775	$22.16
Pinky	41-50	With	Fresh	Domestic (Cagevy)	Unknown	₡12,000	$20.82
Fidel	unlisted	With	Frozen	Domestic (Cagevy)	Unknown	₡15,308	$26.55
White	41-40	With	Frozen	Honduras	Cultivated	₡8,800	$15.26

A.2. Interviews with Restaurants

Porto 8

Porto 8 is a premium seafood restaurant located in Escazu, San Jose. Two types of shrimp are used in the dishes at Porto 8. These include 41-50 pink shrimp and jumbo white shrimp. Porto 8 obtains shrimp via a company known as El Barco, which delivers about 15-20 kilograms of shrimp two days a week. The restaurant purchases the shrimp for ₡11,500 colones ($20.14) per kilogram. The pink shrimp is cultivated in farms while the jumbo white shrimp is caught. The cultivated shrimp cost less than the shrimp that is caught. Both varieties of shrimp come from Puntarenas, but more specifically, the jumbo white shrimp is fished directly from the Nicoya Gulf. The representative of Porto 8 stressed the importance to the restaurant of knowing how the shrimp is caught, however to know whether Porto 8 would pay more in order to ensure the shrimp is caught in an environmentally friendly way would depend on the price increase.

La Divina Comida

La Divina Comida is a Peruvian restaurant located in Escazu, San Jose. The restaurant uses shrimp in a variety of their meals including ceviche. The shrimp that the restaurant uses is fished from the Gulf of Nicoya and then transported from Guanacaste and Puntarenas. The representative of La Divina Comida declared that all of the shrimp used in their dishes is "caught responsibly" without a price increase. They have a variety of vendors that bring them their shrimp every day. The amount they purchase everyday depends on how much shrimp was consumed the prior day. It was also noted that in the past, the restaurant had sometimes bought cultivated shrimp, but consumers distinguished that the flavor was different than the shrimp caught directly from the ocean leading them to believe that the farmed shrimp was of poorer quality. La Divina Comida would pay more for their shrimp to be caught in a more sustainable way however they will not buy cultivated shrimp due to the change in flavor in their dishes.

Figure A.2.1: La Divina Comida							
Type of Shrimp	**Size**	**With/without Shell**	**Fresh or Frozen**	**Origin**	**Method Captured**	**Price/Kg**	**price/kg**
Pinky	41-50	With	Frozen	Domestic (Guajinique)	Gill netting 3”	₡6500	$11.28
Blanco	Jumbo U-12	With	Frozen	Domestic (Guajinique)	Gill netting 3”	₡16500	$28.62

Figure A.2.2: Bacchus							
Type of Shrimp	**Size**	**With/without Shell**	**Fresh or Frozen**	**Origin**	**Method Captured**	**Price/Kg**	**Price/kg**
Pinky	41-50	With	Frozen	Domestic (Nicoya Gulf)	Gill netting 3” and 3.5”	₡9,000	$15.61
White	U-10	Without	Fresh	Domestic (Nicoya Gulf)	Gill netting 3” and 3.5”	₡16,000 - ₡18,000	$27.75 - $31.22
Pinky	41-50	With	Frozen	Domestic (Puntarenas, Osa)	Cultivated	₡9,000	$15.61
White	71-90	With	Frozen	Domestic (Puntarenas, Osa)	Cultivated	₡17,000	$29.49

A.3. Interviews with Industry Workers

1. What is your method of obtaining shrimp?
2. What are the environmental impacts of this shrimping method? Is there any bycatch?
3. What are the benefits and drawbacks of this method of obtaining shrimp?
4. What are the economic costs of this method of obtaining shrimp?
5. About how much shrimp do you capture per month?
6. Who do you sell this shrimp to and for how much?
7. Do you believe that clients and businesses would be willing to pay more money to those producers who use more selective fishing gear or produce shrimp in a more responsible manner? Why or Why not?
8. What is the difference in price of cultivated shrimp and shrimp that is caught from the ocean? Why is there a difference?
9. Would you be willing to improve your capture mechanism or production process in order to differentiate yourself in the market as an option for responsible shrimp consumption even if this means investing more money? Why or Why not?

Shrimp Fisherman Interview Analysis

The majority of fishermen in Costa Rica seem to use 3-inch gill nets to catch their shrimp. Many of these fishermen use gillnets consisting of either 33 or 50 meshes across the nets that capture the fish. The majority of the fishermen agree that there are some effects to the environment using their method of shrimping, however it is not significant. Although in all their catches, there is some bycatch, almost all of their bycatch has commercial uses therefore none of it is wasted. There is a lot of variety in the answers to the benefits and drawbacks of using gill nets to shrimp. One of the main benefits is that the shrimp that is caught is bigger and of better quality. Although there is some environmental impact to this method, it is a lot more sustainable than bottom trawling due to the fact that the nets don't reach the bottom of the ocean floor. There is still some bycatch but there is less damage to habitats and ecosystems. Despite the quality of fish being better, the amount of shrimp that is captured is a lot less because the nets are extended more and don't reach the ocean floor. According to the seventeen interviews, the average spent on their shrimping trips is 15,941.18 colones. The minimum spent was 11,000 colones and the max is 21,000 colones. Many mentioned that gas was the major cost of the trips along with ice, food, and general spending. The majority of the fishermen catch shrimp monthly, but production really depends on how the tides are. The range of how much shrimp is captured varies from all the fishermen interviewed, as it ranges from 5 kilograms per month all the way to 60 kilograms per month with an average of

19.35 kilograms. The majority of these fishermen sell their shrimp to the center of Acopio and are paid an average of 9,909 colones per kilo. Others bring their shrimp directly to their own clients, restaurants, and other businesses in which the selling price varies. Some are paid more, and some are paid less than the average selling price in the center of Acopio. Some fishermen declared that consumers would be willing to pay more for shrimp that is caught sustainably. However, some disagreed by saying that the price was the main issue, as some consumers do not want to pay more for shrimp farming. Both agreed that more information should be provided to the customer beforehand. All fishermen agreed that shrimp caught from the ocean has a much greater value than the shrimp that is farmed. The main difference between the two options is the taste, size, and quality of the shrimp. On average these fishermen said that cultivated shrimp cost between 4,000 and 5,000 colones while shrimp caught in the ocean cost between 12,000 and 15,000 colones. The majority of the fishermen have stated that they would be open to improving their methods for the sake of the environment. The only problem is the money needed to invest to improve, which is too much for the fishermen, as some only make enough to support their daily lives.

Former Fish Farm Manager Interview

After speaking with a former fish farm manager who specifically farmed King Prawns in the Nicoya Gulf, we learned a significant amount of information about the process and industry of cultivated shrimp. This shrimp farmer, along with four workers, aimed to harvest shrimp when they weigh between 17 to18 grams which takes about 90 days depending on various variables. The total costs for the harvest for the fish farmers costs about 5,600,000 colones per harvest. First, shrimp eggs are first imported primarily from Ecuador and Guatemala. They are then sent to a laboratory where they undergo mutation under extreme cold temperatures in order for the eggs to become larvae. The larvae are then sent to the farms where they are put into a temperature regulated tank. Since the larvae are accustomed to cold temperatures, the farmers will slowly increase the temperature of the tank in order for the larvae to adapt to the waters of the lagoon. About 12 larvae are placed per square meter in the lagoon as they begin to grow into shrimp. They are fed manufactured food that consists of mixed grains, flour, and fish. The feed that is used for the shrimp is designed with high protein so that they grow at a faster rate.

As the shrimp grow, there are a lot of variables that the farmers must monitor in order for the shrimp to grow successfully. First, the water in the lagoon needs to be regulated with fertilizer

to retain freshness. Additionally, there are often issues with lack of oxygen in the lagoon, necessitating that the farmers must either pump out the water and replace it using a propeller, or use a machine that pumps oxygen into the lagoon.

In order to ensure the health and quality of the shrimp, shrimp farms usually hire a biologist to come once per week to check on the process of the shrimp. However, the representative disclosed that some farms instead rely on experience to regulate the shrimp which often leads to a bad harvest, for these biologists check the shrimp for parasites or diseases. The most common disease found in these farms is known as Mancha Blanca, a white spot virus that can kill the shrimp in 7 to 10 days if not treated properly. Antibiotics are administered to the shrimp to treat Mancha Blanca, which does affect the physique of the shrimp; however, this must be applied 4 weeks prior to harvest in order for the shrimp to remove it from their system before they are consumed. If parasites are found, the shrimp are fed garlic to eliminate them. If the process of raising the crustacean is successful, a harvest will contain about 4,000 cultivated shrimp. Depending on the quality of the equipment and the variables mentioned above, this number can double or be cut in half. The shrimp is then taken to a fish shop in Puntarenas where 4 to 5 distributors will buy the cultivated shrimp for 2,000 to 2,500 colones. The distributors will place the shrimp in large trucks that are filled with ice and deliver them to other clients. The former fish farmer also revealed that there are many struggles with selling the grown fish. Due to the economy of Costa Rica, he disclosed that cultivated shrimp is imported from Nicaragua and Guatemala which are sold for as little as half the price of that of the Costa Rican farms. The competition of imports therefore makes it very difficult for these farmers to make profits.

A.4. Interviews with Seafood Distributors

Within **Cenada**: Distribuidora de Mariscos: Gulfo de Papagayo, Pulpomar, Distribuidora de Frutas del Mar, Riquizas Marinas

Figure A.4.1: Cenada					
Establishment	**Type of Shrimp/Size**	**Fresh or Frozen**	**Imported or National**	**Method Captured**	**Price/kg**
Belca	White Jumbo/U-10	Not specified	Imported (Nicaragua, Honduras)	Cultivated	₡19,146 ($33.64)
Belca	White Juvenile/U-14	Not specified	National	Cultivated	₡13,390 ($23.53)
Belca	Cultivated/41-50	Not specified	National	Cultivated	₡6,373.6 ($11.20)
Belca	Cultivated/51-60	Not specified	National	Cultivated	₡6,178 ($10.86)
Belca	White Cultivated/51-60	Not specified	National	Cultivated	₡6,866.7 ($12.07)
Belca	White/26-30	Not specified	Imported (Nicaragua, Honduras)	Cultivated	₡8,761.2 ($15.40)
Belca	Without head, with shell/36-40	Not specified	Imported (Nicaragua, Honduras)	Cultivated	₡10,146 ($17.80)
Belca	White Cultivated/71-90	Not specified	National	Cultivated	₡6,048 ($10.62)
Belca	With tail/26-30	Not specified	National	Cultivated	₡8,435.6 ($14.81)
Distribuidora de Frutas del Mar	Pinky/41-50	Fresh	National (Puntarenas)	Unknown	₡7,000 ($12.29)

Distribuidora de Frutas del Mar	White Jumbo/41-50	Fresh	National (Cañas, Guanacaste)	Cultivated	₡6,500 ($11.42)
Distribuidora de Mariscos	Pinky/N/A	Fresh	Unknown	Unknown	₡6,800 ($11.95)
Distribuidora de Mariscos	White Jumbo/N/A	Fresh	Unknown	Unknown	₡12,000 ($21.09)
Distribuidora de Mariscos	With shell/N/A	Fresh	Unknown	Unknown	₡7,000 ($12.30)
Pulpomar	Pinky without shell/N/A	Fresh	National (Puntarenas)	Bottom trawled	₡7,000 ($12.30)
Pulpomar	Pinky with shell/N/A	Fresh	National (Puntarenas)	Bottom trawled	₡7,000 ($12.30)
Riquizas Marinas	Pinky/41-50	Fresh	Unknown	Bottom trawled	₡5,500-7000 ($9.67-12.30)
Riquizas Marinas	White Jumbo/U-15 - U/12	Fresh	Nicoya Gulf	Unknown	₡15,000 ($26.37)
Riquizas Marinas	White Jumbo/U-10 - U-8	Fresh	Nicoya Gulf	Unknown	₡13,000 ($22.86)
Riquizas Marinas	White/41-50	Frozen	Imported (Nicaragua, Honduras)	Cultivated	₡5,000-6,500 ($8.79-11.43)

A.5. Interviews with Fish Shops (Pescaderias)

Figure A.5.1: Fish Shops					
Establishment	**Type of Shrimp/Size**	**Fresh or Frozen**	**Imported or National**	**Method Captured**	**Price/Kg**
Pescaderia Costa Rica	Pinky/41-50 with Shell	Fresh	National (Pacific)	Unknown	₡8,600 ($15.12)
Pescaderia Costa Rica	Pinky/N/A without Shell	Fresh	National (Pacific)	Unknown	₡8,600 ($15.12)
Pescaderia Costa Rica	White Jumbo/U-10 with Shell	Fresh	National (Pacific)	Unknown	₡22,000 ($38.68)
Pescaderia Costa Rica	White/N/A with Shell	Fresh	National (Punta Morales)	Cultivated	₡8,000 ($14.06)
Pescaderia Costa Rica	White/71-90 with Shell	Fresh	National (Punta Morales)	Cultivated	₡9,000 ($15.83)
Pescaderia El Rey	Pinky/41-50 without Shell	Fresh	National (Nicoya Gulf)	Bottom trawled	₡9,000 ($15.83)
Pescaderia El Rey	Pinky/ Mediano with Shell	Fresh	Imported (Nicaragua)	Bottom trawled	₡9,000 ($15.83)
Pescaderia El Rey	White/71-90 with Shell	Fresh	National (Costa de Pajaros)	Cultivated	₡8,000 ($14.06)
Marlin Durado	Pinky/41-50 with Shell	Fresh	National (Pacific)	Trasmallo 3/3.5 inches	₡8,500 ($14.95)
Marlin Durado	White Jumbo/U-15 without Shell	Fresh	National (Pacific)	Trasmallo 3/3.5 inches	₡18,000 ($31.65)
Marlin Durado	White/U-17 with Shell	Fresh	National (Guanacaste)	Cultivated	₡8,000 ($14.06)

APPENDIX B: Consumer Survey

1. Are you aware of the various methods of obtaining shrimp?
2. Are you aware/ do you care about the traceability of the shrimp you eat?
3. Would you rather buy shrimp that is obtained sustainably?
4. Would you be willing to pay more for Shrimp that is caught in an environmentally friendly way?

Figure B.0.1: Consumer Survey

Age	Are you aware of the various methods of obtaining shrimp?	Are you aware/do you care about the traceability of the shrimp you eat?	Would you rather buy shrimp that is obtained sustainably?	Would you be willing to pay more for shrimp that is caught in an environmentally friendly way?	Where are you from?
25-40	No	Yes	Yes	Yes	Costa Rica
25-40	No	No	Yes	No	Costa Rica
55+	Yes	Yes	Yes	Yes	Costa Rica
55+	Yes	Yes	Yes	Yes	Costa Rica
25-40	Yes	Yes	Yes	No	Costa Rica
18-25	Yes	No	Yes	Yes	Costa Rica
25-40	Yes	In reality, it is important to me but I don't think about it in the moment	Yes	Yes	Costa Rica
40-55	Yes	Yes but it is difficult to find the information	Yes	Yes	Costa Rica
18-25	No	Yes	Yes	Yes	Costa Rica
25-40	No	No	Yes	No	Costa Rica
25-40	Yes	Yes	Yes	Depends on how high the price changes	Costa Rica
18-25	Yes	Yes	Yes	Yes	Costa Rica
40-55	Yes	No	Yes	No	Costa Rica
25-40	Partially	Yes	Yes	Yes	Costa Rica
25-40	Yes	Yes	Yes	Yes	Costa Rica

25-40	Yes	Yes	Yes	Yes	Costa Rica
25-40	Yes	No	Yes	Yes	Colombia
40-55	No	Yes	Yes	Yes	Costa Rica
25-40	No	Yes	Yes	Yes	Costa Rica
40-55	Yes	Yes	Yes	Yes	Costa Rica
25-40	No	Yes	Yes	Yes	Costa Rica
25-40	Yes	Yes	Yes	Yes	Costa Rica