Galápagos Lobster

Exploring innovative management for the red spiny lobster fishery in the Galápagos Islands

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The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

_____
Steven Gaines, Ph.D.

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Notes:

- Photos without credits were taken by members of our team while in the Galápagos Islands in the summer of 2013
- Figures cited with a *letter* followed by a number can be found in the Appendix named by the same letter

Acronyms

AMET	Spatial and Temporary Management Areas (Initials in Spanish)
CDF	Charles Darwin Foundation
CEDENMA	Ecuadorian Committee for the Defense of Nature and the Environment
CI	Conservation International
COPROPAG	Santa Cruz cooperative
CPUE	Catch Per Unit Effort
DPA	Data-Poor Assessment
FMO	Fishery Management Organizations
GNP	Galápagos National Park
GMR	Galápagos Marine Reserve
IMA	Inter-Institutional Management Authority
ITQ	Individual Transferable Quota
LBAR	Mean Length Model
LBSPR	Length Based Spawning Potential Ratio
LOREG	Special law for the Galápagos
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
PMB	Participatory Management Board
PZS	Provisional Zonation Scheme
RBFM	Rights Based Fishery Management
SFG	Sustainable Fisheries Group
SPR	Spawning Potential Ratio
TAC	Total Allowable Catch
TURF	Territorial Use Rights Fishery
WWF	World Wildlife Fund

Abstract

The red spiny lobster (*Panulirus penicillatus*) is a keystone species in the marine ecosystem of the Galápagos Island archipelago. Currently, it is the most valuable commercially harvested species in the islands and provides the foundation for many fishermen's livelihoods. Despite management efforts, landings have continued to decline over the past decade, which has led to uncertainty regarding the health of the stock and the future of the fishery. Through the application of data-poor assessments we identified overfishing as a contributing factor to the decline in landings. Therefore, a reduction in catch is necessary to ensure the sustainability of the fishery. To address this necessary reduction, we explored two management strategies that could support a decrease in fishing pressure while maintaining stable economic rents within the fishery. The first approach assesses the feasibility of establishing a territorial use rights fishery (TURF). Our analysis demonstrates that, though there are some barriers to implementation, a TURF is a feasible strategy for reducing fishing pressure and may also create immediate benefits for fishermen. The second approach addresses the projected loss in income fishermen would experience with a mandated reduction in catch. We found that this loss could be offset by increasing the amount of lobster sold within the local market through marketing campaigns that increase demand. The ecological, cultural, and economic importance of lobster in Galápagos highlights the need for effective management. Through the development of innovative strategies the fishery could become sustainable, provide increased economic benefit to fishermen, and contribute to the conservation of this iconic archipelago.


LFS
DUTCH
HARBOR

Executive Summary

The Galápagos Islands, made famous by Darwin's early journey there, are known for their unparalleled marine and terrestrial biodiversity. Home to thousands of endemic species, the islands are so treasured that UNESCO declared them a World Heritage Site in 2001. The islands were uninhabited by humans for most of its history, until the 1950s when Ecuadorians began to migrate to the Islands following the collapse of lobster and sea cucumber fisheries on the mainland coast. Fueled by increased opportunities to harvest these valuable resources, the population of the islands continued to boom, and today they are home to over 25,000 citizens.

As the population of the Galápagos expanded, so did the number of tourists visiting the islands, contributing to heightened interactions between people and the ecosystem of the Islands. With the preservation of this iconic archipelago in mind, a management body was formed, the Galápagos National Park (GNP), in 1959. The GNP developed and implemented fisheries management plans for the sea cucumber and lobster to protect these resources and the stability of the local economy. Despite management efforts, the highly profitable sea cucumber fishery crashed in 2006 and has not been profitable since. With the closure of this fishery, many fishermen turned to the tourism industry and other jobs to supplement their lost income.

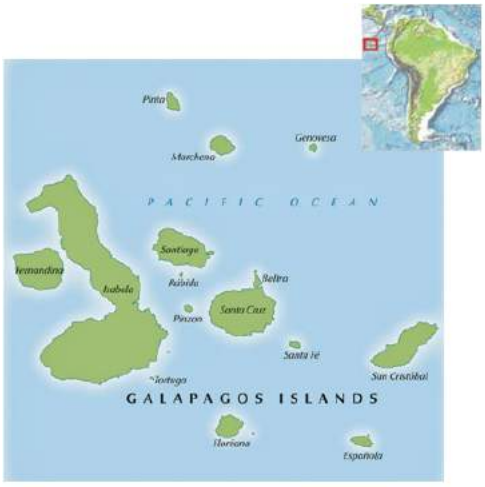

Figure 1. Map of the Galápagos Islands

Today, the red spiny lobster fishery is the most economically important fishery in the islands, but landings have been steadily declining over the past decade. The reason for this decline is unclear, as the population of the fishery has never been formally assessed. There is further uncertainty around the status of the stock due to a slight increase in lobster landings in the past three years. It is unclear whether this increase is indicative of a rebound in the stock or a surge in fishing pressure. The ambiguity surrounding the health of this resource has reached a critical point – the collapse of the lobster fishery would have drastic economic and ecological implications for the archipelago.

PROJECT OBJECTIVES

To ensure the future sustainability of the red spiny lobster population and maintain financial stability for the fishermen whose livelihoods depend on it, we set out to answer several key questions:

- Is overfishing occurring in the red spiny lobster fishery?
- If overfishing is occurring, what are ways to address this issue while maintaining the economic rents of the fishery?

Current management efforts for the fishery include a limited season and a total allowable catch (TAC) for each season. However, the TAC is established each year based on the prior year's landings and is not scientifically founded. Further troubling is that the TAC is often increased mid-season due to pressure from fishermen who demand access to more lobster. Given this understanding, we hypothesized that overfishing of the Galápagos lobster was occurring. Along with our client, Conservation International (CI), we thought that exploration of a spatial rights system and an increase in lobster sold within the local market could be viable ways to help the sustainability of the fishery without reducing the income of fishermen.

APPLICATION OF DATA-POOR ASSESSMENTS

The GNP had expressed the need for a tool to assess the status of the lobster stock on an annual basis to aid in the decision-making process for the fishery. We began our search for the right tool based on criteria that would enable the GNP to make annual assessments of the stock and inform fishery management decisions into the future. Though traditional stock assessments can be effective in determining the status of fisheries, they require a great deal of time and money to complete. Given the current time, resource, and technical expertise limitations of the GNP, we narrowed our search to models that could be easily run with minimal resources. Though the Galápagos lobster fishery is not considered a data-poor fishery in the traditional sense (an extensive database exists), data-poor assessments (DPAs) are a suitable tool for the GNP since they require fewer inputs than a traditional stock assessment, can be operated with little technical expertise, and can be run annually. The outputs from DPAs are indicators such as fishing mortality and spawning potential ratio that provide insight into the level of fishing pressure and can be effective tools in informing sound management decisions.

Photo 1. Gathering lobster data

To find the most appropriate DPA to meet the need of both the fishery and the GNP, we began by researching 12 existing DPAs that have already been developed and applied to fisheries around the world. The criteria used to evaluate these DPAs considered the biological application as well as feasibility of the model to be run by the GNP. Based on these criteria, the 12 DPAs were eventually narrowed to three. These three models were then run with data from the GNP's extensive lobster landings database dating back to 1995. After analyzing the various outputs, we determined that the Catch Curve model ultimately performed the best for all the criteria and was also the best suited DPA for continued use by the GNP.

Additionally, our analysis of outputs from the final three DPAs revealed that there is a high likelihood of overfishing occurring in the fishery. The outputs from each of the models showed a high ratio of fishing mortality to natural mortality, indicating higher than sustainable fishing levels. Lobster stocks around the world are known to be fairly resilient and as such can sustain higher fishing pressure than

most species. However, given the susceptibility of this animal to variations in the highly dynamic Galápagos ecosystem, the model outputs raise some concern for the health of the fishery.

In order to sustain the population and the fishery, fishing pressure will need to be reduced. However, by outright decreasing catch, fishermen will likely experience a significant decrease in their income and will not agree to such a solution. We analyzed two innovative management strategies to see if they might be able to compensate for the deficit that fishermen might experience.

DETERMINING TURF FEASIBILITY

TURFs are management systems in which exclusive spatial rights are granted to a small group of fishermen for a specific resource. These areas are usually accompanied by unique management rules that facilitate sustainable harvest. Studies have shown that allocating fishermen ownership of a resource in a well-defined area can result in improved stewardship of the resource. Additionally, TURF systems around the world have shown to decrease costs of fishing and increase revenues in both the short- and long-term.

We were interested in determining the feasibility of implementing a TURF for the lobster fishery as one method of relieving fishing pressure while maintaining the income of fishermen. To conduct our analysis of TURF feasibility, we developed a framework by examining four relevant case studies, theory on rights-based management, and empirical studies. From these sources we drew out commonalities that were important in the establishment of TURFs, including: biological, legal, economic, social, management, and geographic factors. We then applied these factors to the current structure of the Galápagos lobster fishery.

Photo 2. Fishing boats at the docks

We found that among the biological, legal, and economic factors, there is support for the creation of a TURF in the Galápagos. However, barriers exist within the social, management, and geographic factors. Some of the main obstacles to the establishment of a TURF system are a lack of social cohesion, tendencies towards a top-down management structure, and the complex geographic layout of the islands. Though these barriers exist, we have determined that there may be enough support for a small-scale TURF pilot project. If implemented and proven successful both economically and ecologically, a pilot could pave the way for a larger TURF system in the Galápagos.

We also explored the possibility for the market to offset financial losses that fishermen would experience if faced with a catch reduction.

SAN CRISTOBAL MARKET

Currently, much of the lobster landed in Galápagos is exported as frozen tails to the US market. Despite the large percentage of total landings that is sold to the export market, Galápagos lobster comprises a very small portion of the global lobster market. As a result, the Galápagos fishermen are price-takers in the export market and receive relatively small compensation for their catch. While a small percentage of landings are sold within the local market, when fishermen sell locally they make more money per lobster because the supply chain is substantially shorter. Even under these conditions, fishermen tend to sell most of their catch to the export market because the transaction costs of selling locally tend to be high.

Photo 3. Restaurant owners

To assess the capacity of the local market to absorb more lobster, we began by analyzing the current local demand on the island of San Cristóbal. We looked at the demand for lobster via restaurants and tourism operators, who make up the primary demand of the local market. We also analyzed the secondary demand from tourists, as they consume lobster from the restaurants and tourism operators. Using these two pieces, we constructed a total current local demand for the island.

Our calculations of current local demand revealed a discrepancy in the recorded number of lobster landed. Summing the quantities of lobster sold through both the export and the local markets, we found that these totals exceeded the total landings recorded by the GNP. This suggests that more lobsters are actually being caught and sold than are being recorded, and that there is even more overfishing occurring than indicated by our own data-poor assessments.

Sale of more lobster into the local market would bring increased revenue to the fishermen and could supplement the lost income they would experience if subject to a decreased TAC. We analyzed the survey data from tourists to determine their motivations for choosing to consume lobster or not while in the Galápagos. We determined that while an increase in local demand from tourists could not absorb the entire seasonal catch, it could absorb enough to offset a potential reduction in catch. To reach that point, demand can be increased through the use of social and educational marketing campaigns.

Photo 4. Fishing cooperative on San Cristóbal

CONCLUSION

The red spiny lobster provides stability for the marine ecosystem of this unique archipelago and the foundation for the livelihoods of hundreds of fishermen. The current degree of uncertainty regarding the health of this fishery is unacceptable when considering the economic and ecological implications of a collapse. Our analysis of the outputs from data-poor assessments show that overfishing is occurring. Our market study highlights a discrepancy between the recorded and actual landed catch, implying that there is even more uncertainty than initially observed. As such, reductions in catch may necessary to decrease fishing pressure on this species, should this fishery continue to provide support for this community. Given the implications of a catch reduction on the income of fishermen, a reduction in catch would likely be met with strong opposition. We found that a TURF and active increases in local demand could offset the losses associated with a reduction in catch. These proposed solutions take the fishing community's welfare into consideration and can help to garner support should a reduction in TAC be mandated.

To achieve stability in the fishery and ensure its future sustainability, we recommend the following:

- Establish a strict TAC for the upcoming season based on the indicators from the model
- Use the DPA in conjunction with a control rule to monitor fishing effort and make informed adjustments to the TAC each year
- Initiate a pilot TURF for Santa Cruz Island
- Increase the demand for lobster purchased on the Islands

These efforts will advance management of the red spiny lobster fishery towards a sustainable and profitable fishery for years to come while contributing to the overall conservation of this unique place.

Photo 5. Coastline of Santa Cruz Island

PROBLEM STATEMENT

Spiny lobster, *Panularis penicillatus,* is the most economically important species harvested in the Galápagos Islands. The majority of fishermen rely on this fishery as a primary source of income. In addition to its significance in the local economy, lobster play and integral role in the health of the marine ecosystem. Spiny lobster is a keystone species in the Galápagos and has been shown to maintain healthy balance of the biologic communities (Graham J. Edgar et al., 2010). Despite the importance of this fishery, there is still a great deal of uncertainty about the biological health of the stock. The Galápagos National Park, Charles Darwin Foundation (CDF), Conservation International, World Wildlife Fund (WWF), and local fishermen currently work together to provide support for the management of the fishery. Unfortunately, the amount of lobster commercially caught has declined over the last decade. Although there has been a slight increase in landings over the last three years, it is unclear whether this is the result of a rebound in the stock or an increase in fishing effort. Managing bodies and supporting organizations, particularly Conservation International, are seeking to incorporate innovative tools that can provide scientific support for management decisions in the future. If historical insights on fishing levels and population status can be provided, management goals can be set to achieve future sustainability within the lobster fishery.

OBJECTIVES

For this study, we aimed to address the following:

1) Eliminate uncertainty with regards to status of the lobster population and provide scientific backing to support future management decisions and monitoring protocols
2) Address any current and historic overfishing of the lobster stock with innovative management strategies that both reduce fishing pressure and maintain economic rents within the fishery to assure stakeholder support

BACKGROUND

THE GALAPAGOS ARCHIPELAGO

The Galápagos Islands are located 1000 kilometers west of the mainland coast of Ecuador. The archipelago consists of more than 130 large and small islands, which were formed by volcanic activity at the Galápagos hotspot. The archipelago is located at the confluence of three major oceanic currents, the Panama current, the upwelling sub-equatorial current (also known as the Crowmwell current), and the Humboldt current. The interaction of warm and cold water from these converging currents and the persistent upwelling conditions have created a highly dynamic and productive marine environment, consisting of distinct biogeographic regions in a relatively small area. These distinct

habitats, together with the isolated nature of the islands, has led to the formation of highly biodiverse marine communities and high levels of endemic species, such as the iconic marine iguanas and flightless cormorants (Bustamante, Okey, & Banks, 2008). The Galápagos archipelago is a unique place where cold water species such as fur seals and penguins mix with warm water species such as hammerhead sharks and corals (Danulat & Edgar, 2002).

The Galápagos Islands also served as the living, breathing laboratory that inspired the theory of evolution by natural selection after Darwin's famous visit in 1835. During his trip to the archipelago, Darwin wrote, "The natural history of this archipelago is very remarkable: it seems to be a little world within itself; the greater number of its inhabitants, both vegetable and animal, being found nowhere else" (Darwin, 1839). With the goal of protecting the archipelago's marine biodiversity, the Galápagos Marine Reserve (GMR) was created in 1998 (Jones, 2013). The unique flora and fauna of the islands also prompted the designation of the archipelagos as a UNESCO Natural World Heritage Site in 2001 (Hearn, 2008).

Photo 6. Red spiny lobsters

LOBSTER LIFE HISTORY

The red spiny lobster, *P. penicillatus*, is the most ubiquitous spiny lobster species and is found throughout the Indo-Pacific, mainly around archipelagos, but also in the coastal waters of mainland Mexico and Ecuador (Hearn & Toral-Granda, 2007). Spiny lobsters carry a brood of eggs during a breeding season that can last a few months for some and can occur multiple times a year for others. In Galápagos, studies have found gravid females during every month of the year with the highest rates of ovigerous females occurring in the warmer months. The red spiny lobster achieves sexual maturity between 21-22 cm according to Reck (1983) and 25 cm according to Danulat & Edgar (2002). Larval stages of lobster have evolved to spend a great deal of time in the open ocean, allowing them a large dispersal range. It is not until after months (as many as 8) of development offshore that lobster return to develop in coastal waters (Booth & Phillips, 1994).

Adult spiny lobsters are gregarious and known to prefer rocky substrates where they live in caves with groups of many individuals. They inhabit depths of 1 to 4 meters (Chan, 1998), and forage at night to feed on small benthic invertebrates such as crabs, gastropods, and sea urchins (Barr, 1968; George, 1972). The species is demanding in terms of oxygen concentration, while preferring low light and little freshwater influence. Spiny lobsters are generally found throughout the archipelago but have a preference for warm-water habitats. This may explain lack of populations in the western islands of Galápagos, which are affected by the cool upwelling of the Cromwell Current (G.J. Edgar et al., 2004).

Lobster is a keystone species in the marine ecosystem, exerting top-down control primarily on urchins (Graham J. Edgar et al., 2010). The study by Edgar el al. (2010) suggests that declines in the population of lobster likely magnified the impacts of the 1982/1983 El Niño through indirect effects by population expansions of grazing sea urchins. These expansions caused accelerated bioerosion, which destroyed coral reef habitat that was weakened by bleaching. Sufficient abundances have prevented the re-establishment of coral and macroalgal habitat, which has altered local benthic habitats (Graham J. Edgar et al., 2010). Increases in urchin densities also have decreased non-coralline algae, which is food for a range of species such as marine iguanas (Sonnenholzner, Ladah, & Lafferty, 2009). These examples illustrate that declines in lobster populations can create cascading effects and that the protection of lobster is important for the overall Galápagos marine ecosystem.

ECONOMIC AND SOCIAL FISHING HISTORY

Mainland Ecuador is one of the most economically depressed regions in South America. In the 1950's the country began to realize the value of untapped resources on the Galápagos Islands, and many Ecuadorians migrated from the mainland to pursue a better way of life. Migration intensified after many of the fishing stocks off the mainland coast became depleted. The Islands' population continued to expand over time and experienced waves of immigration as more economic opportunities became available. Today, there are over 25,000 inhabitants spread across four of the islands: Santa Cruz, San Cristóbal, Floreana, and Isabela. As relatively recent immigrants from the mainland, people living in the Galápagos Islands have minimal historic ties to the land and its natural state. They have approached the Islands' natural resources with a frontier mentality, focusing on short-term gains rather than long-term stewardship of the Islands (Hearn, 2008).

Photo 7. Fishermen with their catch

In the late 1990's and early 2000's the Galápagos sea cucumber fishery saw a surge in the price as global demand for sea cucumber soared. As the fishery became more valuable, the number of

registered fishermen on the Islands increased dramatically from 500 members in early 1990's to 1003 in 2005 (Hearn, 2008). This quickly led to an increase in fishing pressure on local sea cucumber stocks. The stocks continued to dwindle with the added effort, causing a spike from US$0.33 per individual in 2002 to US$1.21 in 2005 – increasing their value as populations plummeted. The sea cucumber fishery eventually collapsed and closed in 2006 (Hearn, 2008), dealing a huge blow to the economic stability of the local fishing sector. Following the collapse of sea cucumber, many fishermen transitioned to employment within the tourist industry. A fear of repeating the sea cucumber story exists within the lobster fishery – if the lobster fishery crashed there would be a lack of economic stability for the fishermen and businesses that rely on the lobster fishery for income.

FISHING SECTOR

When attempting to understand the economy of Galápagos and motivations of its citizens, it is important to recognize that the fishing sector is comprised of a heterogeneous group of fishermen. While the growth of fishing during the sea cucumber boom resulted in a doubling of the number of licensed fishermen on the Islands, the rapid expansion of the fishing sector has had other drivers as well. One key driver was the potential for fishing to provide a pathway into the tourism industry, which offers greater income relative to fishing (Hearn, 2008). As an incentive to minimize fishing effort, the GNP offered tourism permits to current fishermen looking for alternative income generating activities. Others hold on to permits while they wait for more profitable fisheries to emerge. The sector can be divided into "active" fishermen, who rely solely on fishing for income and "inactive" fishermen, who participate in the fishery to various degrees. This group of inactive fishermen comprises what is known as the latent fishing effort: individuals that are not currently fishing but could enter back into the fishery at any time (Bucaram, White, Sanchirico, & Wilen, 2013). A further example of the diversity of fishermen is that not all fishermen belong to the same socioeconomic bracket, as some are known to be boat owners (*armadores*) and others just fishermen (*pescadores*). Within these subgroups, some are known to fish only for lobster, only for 'white fish' (all fin fish), or for both, which provides varying degrees of income amongst fishermen. All groups of fishermen need to be taken into consideration when studying the lobster market because all permitted fishermen can legally participate in all fisheries. An unintended consequence in creating economic incentives for active fishermen may be to draw inactive fishermen back into the fishery. This may be detrimental to the fishery and will need to be tempered by regulation of effort.

Photo 8. Boats moored off of San Cristóbal Island

Fishing Methods

Historically, lobster fishermen have harvested lobsters by freediving and by hand. In the early 1970s, hookah dive gear was introduced into the fishery (Ramírez, Castrejón, & Toral-Granda, 2012), and divers could increase time spent underwater. Some fishermen also use Hawaiian slings to spear lobster. However, this method can be problematic as the lobster is speared before confirmation can be made that the lobster meets legal size limits and is not an ovigerous female, two regulations established to protect lobster abundance. Initially lobster fishing was a daytime practice, but in the late 1980s fishermen transitioned to night diving, as it was easier to capture lobsters when they come out at night to forage. Fishing trips are predominately made on fiberglass boats (*fibras*) or wooden boats (*pangas*). Occasionally larger boats (*botes*) are used for multi-day trips to distant islands such as Darwin and Wolf (Bucaram et al., 2013).

Photo 9. Hawaiian sling used to spear lobster

Management of the Lobster Fishery

The GMR and the current marine zoning scheme were developed following a period of conflict between stakeholders competing for resources. Increased pressure on natural resources in the Galápagos in the 1990s led to confrontations about access and use of resources (Baine, Howard, Kerr, Edgar, & Toral, 2007). The GMR was developed to tackle some of these access and consumption issues with the goal of the "protection of the archipelago's marine biodiversity, both in terms of its intrinsic (preservation) and utilitarian (fishing and tourism) values" (Jones, 2013). The GMR extends 40 nautical miles from the coastal baseline surrounding each island, covers 138,000 km^2, and is characterized by a zoning scheme regulating the activities conducted in the various zones. The GMR is managed by the GMR Management Plan, which includes the Provisional Zonation Scheme (PZS), agreed upon in 2000 through the consensus of local artisanal fishers; tourism operators; science, conservation, and education experts; and management authorities (G.J. Edgar et al., 2004). The PZS divides the GMR into three zones: coastal, open water, and port areas. Fishing is permitted in 78% of the coastal zones and the remaining 22% of coastal waters are no-take areas and tourist visitor sites. The PZS is currently being reassessed, making the consideration of TURFs especially timely, as they could potentially be incorporated into the zoning scheme.

The stakeholder process that established the GMR also established the Special Law for the Conservation and Sustainable Use of the Province of Galápagos. In March of 1998, the Ecuadorian Constitution included the Law of the Special Regime for the Conservation and Sustainable Development of the Province of Galápagos. This law gave way to a system of co-management, where management responsibility is shared between stakeholders and government agencies, and

management decision can be made at the regional level. A process of reform for the Galápagos Special Law began in 2009 (Ramírez et al., 2012), and these reforms are ongoing.

The co-management structure established by the Galápagos Special Law is a two-tier system that involves the major stakeholders. The Participatory Management Board (PMB) is the local decision-making body and is comprised of the tourism sector, naturalist guides, artisanal fishers, and the conservation and science sectors, which are represented by the Charles Darwin Foundation (CDF) and the GNP as administrators of the GMR. Decision-making is based on consensus at the PMB level, and then management proposals are elevated to the Inter-Institutional Management Authority (IMA) for ratification. The IMA is the second and highest tier of management in the GMR. The IMA is made up of Ministers of the Environment, Defense, Tourism, and Fisheries together with the Galápagos Chamber of Tourism, the Artisanal Fishing Sector, and the Ecuadorian Committee for the Defense of Nature and the Environment (CEDENMA). Typically, decisions that are reached by consensus at by the PMB are then ratified by the IMA. However, when the PMB cannot reach consensus, the IMA can decide by majority vote (Jones, 2013).

When industrial fishing was banned in Galápagos in 1998, fishing rights were granted solely to the local artisanal fishing sector (Hearn, 2008). The GMR Management Plan is the main policy document to manage human activities in the GMR. The Fishing Chapter of the GMR was established in 2009 and includes regulations currently in place such as the yearly total allowable catch (TAC), requirements for fishing licenses and boat permits, no-take zones, defined fishing season, minimum size requirement, ban of take of ovigerous females, and gear restrictions. One of the most important of these regulations is the use of a TAC system, which sets the maximum amount of catch allowed in a season. The TAC for the lobster fishery is set each year not with science-based knowledge, but based on the previous year's landings and political influences of various stakeholders. According to GNP statistics, the administration of the TAC has been inconsistent over time (Ramírez et al. 2012). The TAC was exceeded in 1999, 2000, 2007, and 2008. One of the main contributing factors to historical exceedances is a lack of enforcement once the quota had been reached (Baine et al., 2007). Since 2009, the TAC has yet to be exceeded according to GNP data. However, in 2011 the TAC was increased after the total quota was reached, only after two months into the season (Ramírez et al. 2012). The exceedance of the TAC in years prior to 2009 and the tendency for the TAC to be extended are important factors to consider when looking at total supply for the market.

Photo 10. Fishing boats off San Cristóbal Island

Table 1: The TAC of Spiny Lobster in Metric Tons (MT) of Tail and Total Landings

Year	TAC in MT (blank = no quota)	Total Landings in MT	Percentage TAC was Exceeded
1998		32	
1999	35	54	54%
2000	50	86	72%
2001		67	
2002		52	
2003		46	
2004		26	
2005		34	
2006		30	
2007	26	32	23%
2008	26	27	4%
2009	30	21	
2010	30	26	
2011	42	42	
2012	48	43.5	

Sources: Galápagos National Park; Ramírez et al. 2012

TOURISM SECTOR

The tourism industry in the Galápagos Islands comprises about 85% of the economy (Jones 2013) and serves as the largest employer for the local population (Baine et al. 2007). By comparison, the fishing sector makes up less than 5% of the total economy. Since the 1950's the tourism sector has continued to expand and bring in money from affluent travelers and remains the main driver of the Galápagos economy (Epler, 2007). Between the 1990's and 2011, the number of tourists entering the Galápagos has grown from 40,000 to over 185,000 (Directorate of the Galápagos National Park 2013). A number of restaurants have opened in order to meet this growing demand. During their stay in the Islands, tourists either stay in hotels, take all-inclusive cruises, or both. Each accommodation represents a distinct segment of the lobster market.

Photo 11. Tourists in the Galápagos

Chapter 1:
Data-Poor Assessment

Photo 1.1. Landed lobsters waiting to be weighed

OBJECTIVES

The primary objectives of this part of the study were to:

1) Select a data-poor assessment for use in management of the Galápagos lobster fishery
2) Assess the current status of the stock and historical fishing pressure

This study seeks to support the Park in their search for an effective tool for management of the lobster fishery and to eliminate the uncertainty with regard to the biological health of the stock.

SIGNIFICANCE

The Galápagos red spiny lobster (*Panulirus penicillatus*) fishery is among the thousands of artisanal fisheries worldwide that lack evaluation by a formal stock assessment. As a result, there is a great deal of uncertainty with regard to the biological status of the stock and sustainability of current fishing levels. The Galápagos lobster fishery is one of the most profitable fisheries in the islands (Bucaram, White, Sanchirico, & Wilen, 2013) and is a key component for maintaining the economic stability of the local fishing community. Red spiny lobster is also a keystone species, playing a crucial role in preserving the health of the marine ecosystem of this iconic archipelago (Graham J. Edgar et al., 2010). Overfishing of spiny lobster in other regions has been linked to a reduction in ecosystem resilience, specifically through the reduction of predatory control on urchins (Graham J. Edgar et al., 2010). This

has already been found to be true in Galápagos where declines in spiny lobster have been linked to an increased presence of sea urchins in the sub-tidal zone (Schiller, Alava, Grove, Reck, & Pauly, 2013).

The lobster fishery is managed in part by an annual TAC that has typically been established based on the prior year's landings; this was the case for all years preceding 2013. An outdated model poorly suited to the lobster fishery guided the TAC for the 2013 fishing season. In order to provide a more scientific basis for management, the annual TAC should be established at the beginning of every season based on analysis from a reliable stock assessment that incorporates data from the fishery.

The current uncertainty surrounding the health of the stock and sustainability of fishing practices contributes to an unacceptable degree of risk for the future of this fishery, particularly considering the economic and ecological importance of this species in Galápagos. The financial, time, and human resource limitations of the Galápagos National Park prohibit the application of a full stock assessment. For this reason, we explored the application of data-poor assessments (DPA) to the Galápagos lobster fishery as a tool for guiding annual management decisions.

Photo 1.2. Renato of GNP checking for eggs on a lobster

BACKGROUND

Data-Poor Fisheries Management and Modeling

Despite efforts on the part of many countries to manage their fisheries to sustainable levels of harvest, the majority of fish stocks around the world remain unassessed. It is estimated that sixty-four percent of global fisheries lacking formal stock assessments, a group that makes up eighty percent of the global fish catch, are overfished (Costello et al., 2012). This is largely due to a shortage of fiscal resources, insufficient amounts of data, and a lack of technical expertise required to run traditional stock assessments. Although informative and useful for management, traditional stock assessments require extensive amounts of data, are labor intensive, and costly to create. The completion of a full stock assessment can take years, during which time the status of the fishery remains unknown and standard management practices continue. There is a need for faster, cheaper, and simpler stock assessments that require less data and less expertise in order to evaluate the status of the unassessed stocks around the world (Honey et al., 2012).

"the majority of fish stocks around the world remain unassessed."

Data-poor stock assessments can provide a general picture

of a fishery's status by providing, for example, estimates of relative biomass, spawning potential, or fishing mortality. These DPA outputs can serve as a guide for policy and decision-making. These models require relatively limited inputs and analysis, but can play an important role in solving pressing fisheries problems in a reasonable amount of time, making them well-suited for application in the Galápagos lobster fishery (Honey et al., 2012).

Data-poor assessments can be effective tools for evaluating resource- and data-limited fisheries. These models require a relatively small amount of fisheries dependent or independent data (500 data points are generally considered a rough minimum) and can be run with minimal resource expenditure. These assessments are typically used in fisheries that have limited amounts of data for a myriad of reasons, including the lack of financial resources and low value of the species. The inputs necessary to run data-poor stock assessments rely on approximate catch and basic life history data that can be obtained from a number of sources. The resulting outputs and the validity of model assumptions are affected by variance in the inputs and so provide a very general overview as to the status of the stock. Their data-rich counterparts, traditional stock assessments, use inputs from a great depth of data and can, in theory, achieve accurate outputs as to status quantities for a given point in time and management reference points, indicators of stock status, and fishery performance (MacCall, 2010).

Different data-poor assessments are better suited to certain fisheries than others. Determining the most appropriate assessment for a particular fishery begins with identifying the biological characteristics of the species, the amount of available data, the current regulatory framework of the fishery, and the suitability of the DPA's assumptions to that fishery. When selecting or designing a DPA for a particular fishery, the quality and quantity of available data should be considered and imprecision must be incorporated into the model (MacCall, 2010). A suite of data-poor assessments has already been developed and tested in fisheries worldwide. Ovando et al. (2013) propose that the question is no longer whether or not DPAs can be a useful tool for evaluating fisheries but rather how to choose the best model to apply to a given fishery. When selecting an appropriate stock assessment the decision must be weighted between the efficacy of the model to the biology and ecosystem function of a particular species and the practicality of application of the model for fisheries management.


Photo 1.3. Weighing lobsters

In a study by Ovando et al. (2013) data-poor assessments were shown to present a low risk to fish populations even when they were not highly accurate. Use of these models for guiding decision-making often contributed to increases in populations and a reduction in the probability of collapse (Ovando et al., 2013). Obtaining all information that pertains to the fishery is especially important for data-poor assessments for achieving the most reliable outputs. Inputs such as life history parameters can be taken from literature and prior studies.

Photo 1.4. An intern with a measuring ruler waiting to gather lobster data at the docks

Application of Galápagos Lobster Fishery to DPA

An extensive record of landings and biological data collected by the Galápagos National Park and the Charles Darwin Foundation dates back to the early 1990s. Given the significant amount of data available for Galápagos spiny lobster, this is not a data-poor fishery in the traditional sense. However, the current financial, personnel, and time constraints characterizing the managing body for the Galápagos lobster fishery support the application of a data-poor stocks assessment as an effective tool for annual analysis of the stock. They are simpler to analyze and can more easily be replicated by local staff within the current resources bounds of the GNP.

According to Honey et al. (2012), application of data-poor stock assessments to a fishery should consider three questions:

1.) Does this model allow managers to set a TAC on an annual basis?
2.) How well do models compare to each other when the same inputs are entered and similar assumptions are made?
3.) How well does this model's outputs compare to those of the traditional stock assessments?

While the first two questions can be answered for the Galápagos spiny lobster fishery, the third will likely be left unanswered. Data-poor assessments can provide fisheries indicators that will allow managers with the GNP to adjust the annual TAC according to outputs indicating the level of fishing mortality. By comparing the outputs from several data-poor assessments we can determine how they

operate in relation to each other and how they predict common trends within the fishery. In this way we can also determine where models differ, analyzing the limitations and biases of the models and their predictions when running the same data sets. This approach can be useful both for the application of DPAs to determine trends in the fishery as well as implications for life history parameters and sampling methodologies specific to the Galápagos lobster fishery.

The Sustainable Fisheries Group (SFG), as per the request of the GNP, has attempted to conduct a formal stock assessment for the lobster fishery. However, due to uncertainties in the data, lack of Galápagos specific parameters, and time and resource constraints, this assessment has not been completed. Although a full stock assessment would provide an opportunity for comparison, DPAs can still provide insights into the dynamics of the lobster fishery. The potential for the widespread application of DPAs in data-poor fisheries around the world makes the use of these models in a fishery such as Galápagos with abundant data available, an effective tool in parsing out the nuances of and developing confidence in the models. Due to the low percentage of fisheries possessing traditional stock assessments (approximately 1%) (Costello et al., 2012), it is important to be able to confidently apply these models without a full assessment for comparison. The application of DPA for management of Galápagos red spiny lobster can serve as a case study for confident management through these methods.

"DPAs can still provide insights into the dynamics of the lobster fishery"

Control Rules and Management Objectives

In addition to the use of data-poor assessments in providing reference points and guiding the establishment of the annual TAC, a control rule that dictates corrective action when multiple targets or thresholds are exceeded must be developed for the Galápagos lobster fishery. A control rule will be most effective with the establishment of multiple target reference points as the interpretation of single reference points can be misleading (Kay, 2013). These reference points should be selected through close collaboration between managers and fisheries scientists on the basis of the ability to accurately estimate these values from available fishery data. Further targets to be explored include catch per unit effort (CPUE) and catch data (Kay, 2013). Once an appropriate target is established, the TAC and other fisheries regulations can be adjusted according to the control rule that specifies corrective action when managers determine that the target has been exceeded indicating a decline in the health of the fishery.

Photo 1.5. Landed lobsters suspected of having their eggs scraped

There are limitations with all biological reference points, just as there are limitations with the models. The use of multiple reference points helps to minimize the ambiguity of individual reference points in application to management. A well-established control rule would outline a methodology for appropriate management response to changes in one or more reference

points. Until a control rule can be developed for Galápagos, the output from the data-poor assessment can serve as the reference point for guiding management decisions. Because the Galápagos Participatory Management Board was founded with participation, precaution, and adaptive management in mind, we suggest that the initial target F/M be established conservatively to guide the TAC for the spiny lobster fishery. F/M is the ratio of fishing mortality (F) to natural mortality (M) of the species and is often used as an indicator of fishing pressure in fisheries management.

SELECTION OF DPAs

Criteria Analysis

To determine the most suitable assessment for this fishery, twelve of the existing DPAs were evaluated based on a criteria applied to the models that included reliability, biases, cost of monitoring and management, output, and social plausibility. Reliability of the model was determined by previous application to fisheries where it had been successfully implemented as well as the models' sensitivity to input parameters. The number, type, and implications of these biases were evaluated. The differences in cost for both management and monitoring were evaluated based on the relative costs to the existing protocol. The cost of training, acquisition of expertise, software requisites, and adjustments to data collection methodologies were also considered. Outputs were evaluated on their application and translation for management, particularly how they translate into a total allowable catch adjustment. When considering the suitability of these models to the meet the specific needs of the Park, the tool had to be readily translatable into Excel and able to run on an annual basis without a great deal of technical or fisheries modeling expertise. Table 1.1 demonstrates the overall analysis.

Table 1.1. Criteria Analysis for DPA in Galápagos Lobster Fishery

Model	Can be run in Excel	Data Requirements: Length Based	Cost to Run (for GNP)	Reliability (success in other fisheries)	Output
LBAR	✔	✔	Low	✔	F/M
LBSPR		✔	Low	✔	SPR, F/M
Catch Curve	✔	✔	Low	✔	F/M
DR	✔		Low	✔	B/B_0
DTree		✔	-	✔	SPR
DCAC			-	✔	OFL, MSY
LBRP		✔	-	✔	% Spawning Biomass
SSS			-	✔	Sustainable catch estimate
BIOMAS		✔	High	✔	B/B_0, and other indicators
DB-SRA			-	✔	OFL, MSY, B_0
In-Season Depletion Estimator			-	✔	B/B_0
PSA			-	✔	Productivity and susceptibility of stock

Using this criteria, the initial twelve models were narrowed down to the three, found to be best suited to the specific needs of the Park. These three models were the Mean Length (LBAR) (Ault, Smith, & Bohnsack, 2005), Length Based Spawning Potential Ratio (LBSPR) (Hordyk, Ono, Sainsbury, Loneragan, & Prince, 2014), and Catch Curve (Sparre & Vanema, 1998) models. Each of these models has been successfully implemented in fisheries management around the world and contains their own sensitivities, biases, assumptions, and data requirements.

How the Models Work

LBAR

LBAR translates length-based data into a length frequency histogram as demonstrated in Figure 1.1.

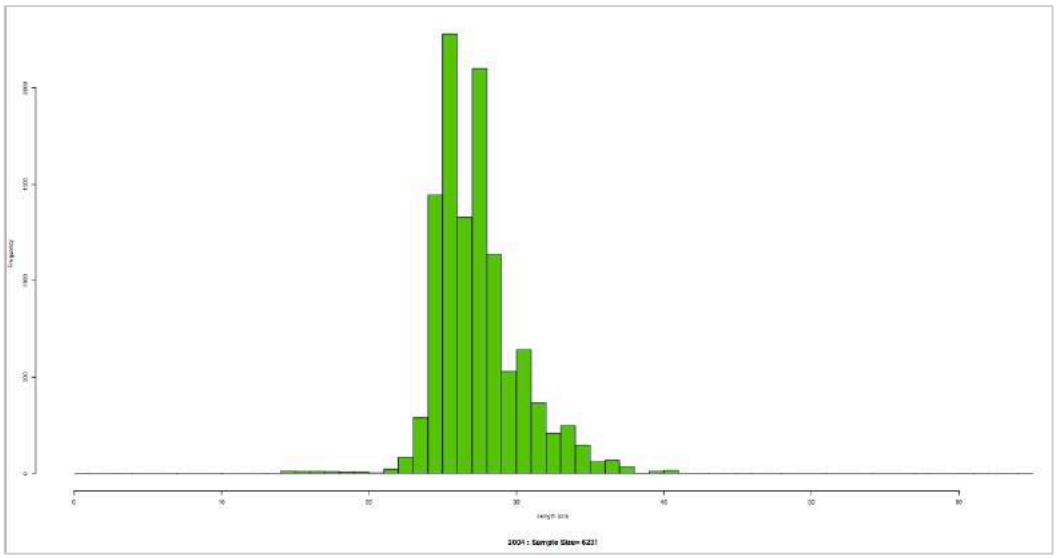

Figure 1.1. LBAR 2004 Length Frequency Data for Spiny Lobster

LBAR translates length-based data into a length frequency histogram by applying a number of species and location specific parameters.

The model uses the frequency at the mode and at L_{inf} (length at asymptote) or maximum captured length to determine an average between the two values. A total mortality value (Z) is found that best satisfies the mode (length at full commercial exploitation) maximum captured length and average length between those parameters. From this Z value the known natural mortality is subtracted to yield fishing mortality (F) (Ault et al., 2005; Ovando et al., 2013).

Catch Curve

Catch Curve converts length-based data into age classes using Von-Bertalanffy growth parameters. If available, data can be separated into Marine Protected Area (MPA) based data (areas where fishing

doesn't occur) and non-MPA based data (areas where fishing is allowed and occurs). A linear model is fitted to the age-based data from the mode to L_{inf} for each data set (Figure 1.2).

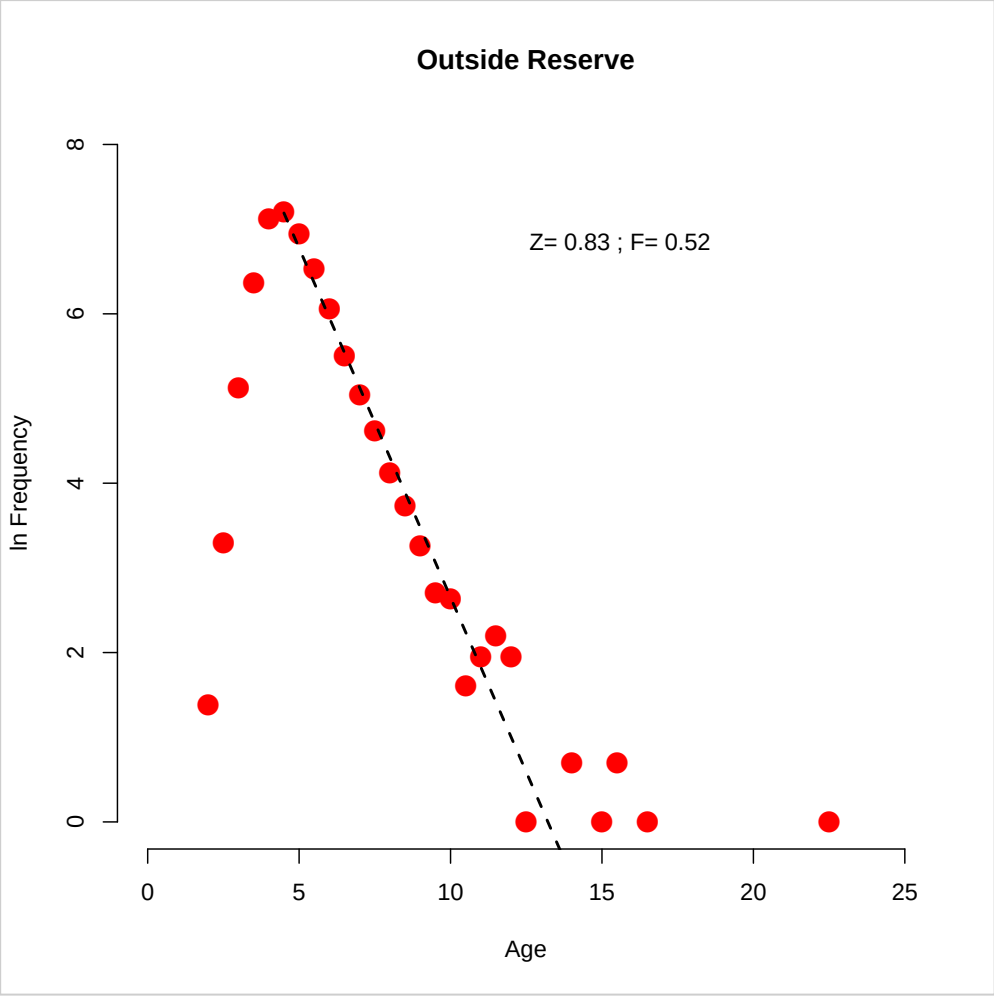

Figure 1.2. 2004 Catch Curve Analysis for Lobster Lengths

Catch Curve converts length-based data into age classes using Von-Bertalanffy growth parameters. It fits a line of regression, which is reflective of the rate of survivorship from one age class to the next.

For non-MPA data, the total mortality (Z, where total mortality is equal to fishing mortality (F) plus natural mortality) is determined by the slope of the line that is fit to the regression. F can be calculated from Z either by subtracting a literature estimate of M, or by M values obtained from MPA Catch Curve analysis (Kay & Wilson, 2012; Wilson, Prince, & Lenihan, 2010). If MPA data is available it can be used to determine M, represented by the slope of the model (which represents the death rate between age classes). The ratio of F/M can be compared against a desired reference level to obtain a target fishing level from which the yearly quota can be adjusted.

LBSPR

LBSPR builds upon the Catch Curve model. LBSPR is based on the comparison of a ratio of natural mortality (M) and individual growth rate (k) and the unfished equilibrium size structure. The model estimates fishing mortality by using size composition data from the fishery to predict unfished equilibrium size structure (Ovando et al., 2013). With length frequency data, it uses fecundity and weight at maturity parameters to calculate the number of eggs produced by the 'fished' or current population in relation to the number of eggs that would be produced in an 'unfished' population. The output is the spawning potential ratio (SPR), the average fecundity of a recruit over its lifetime. The estimated SPR can be compared to a target SPR and the TAC can be adjusted accordingly.

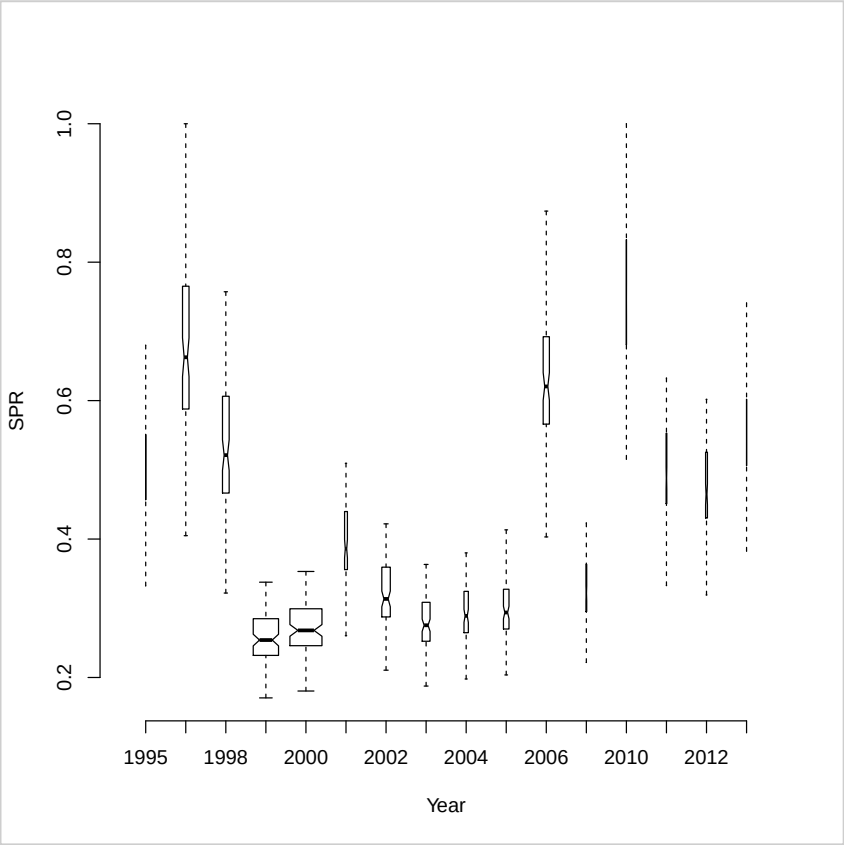

Figure 1.3. LBSPR Spawning Potential Ratio for Spiny Lobster 1995-2012

The spawning potential ratio (SPR) from the LBSPR model shows that while low, the SPR for the fishery is not at dangerous levels (Figure 1.3). Data from the most recent years shows decreased confidence.

Sensitivities, Limitations, and Assumptions

LBAR

LBAR is highly sensitive to the estimate of natural mortality and L_{inf}. It uses fishery dependent length frequency data to estimate fishing pressure and as such is sensitive to the accuracy of measurements collected from the fishery. Using LBAR, an estimate of fishing mortality is calculated from minimum, maximum, and average length from fishery dependent catch data, as well as the Von Bertalanffy growth parameter *k* and natural mortality. LBAR provides an output of F/M and commonly assumes that F_{msy} is equal to the natural mortality (M). From this output the ratio of F/F_{msy} can be calculated and the fishing effort can be adjusted.

Catch Curve

Because Catch Curve converts length data into age classifications, it is sensitive to the accuracy of the Von Bertalanffy growth parameter. For marine invertebrates that experience stepwise growth, this may incorporate some inaccuracies as the parameter assumes continuous growth. Additionally, Catch Curve assumes that MPA data reflects natural mortality while any differences in non-MPA data reflects only fishing mortality. Differences between sites or environmental factors are not accounted for. When using only non-MPA based data, the model is sensitive to the accuracy of natural mortality estimates. While MPA data can be used to estimate natural mortality, it is not necessary to run the model if there is a reliable estimate of M from previous studies, a parameter that for literature on the Galápagos lobster fishery is much higher than most spiny lobster fisheries. Catch Curve can also incorporate the assumption that F_{msy} is equal to natural mortality. Lastly, the model assumes that recruitment is relatively constant and that mortality experienced by each age class has been static through time. This is usually not the case in most fisheries due to environmental fluctuations, recruitment pulses, varying susceptibility to predation, and other elements of irregularity within the marine ecosystem.

LBSPR

Spawning potential ratio provides direct information about the biological condition of the stock. The current SPR of a fishery is directly related to and calculated from estimates of fishing mortality rates (F). LBSPR is sensitive to life history parameters such as age, sex, and maximum length. This method estimates the SPR of a population at static equilibrium and can be sensitive to variations in recruitment and environmental factors, as well as changes in natural mortality as lobsters age. This is a key sensitivity when considering application in Galápagos because of the highly dynamic nature of the islands' ecosystem.

APPLICATION OF THE MODELS

Data Sources

The data used to run the assessments was retrieved from an extensive database of biological and catch data for the lobster fishery. This data has been collected through efforts of the GNP and the CDF.

Mauricio Castrejón, a researcher at Dalhousie University who has done extensive work in the Galápagos lobster fishery, compiled the final version of the database for 1995-2011. The models were run on iterations of the data from the GNP's database for the years 1995-2012. The data was divided into three segments: male only, female only, and both sexes combined. Sampling methodology further separated these based upon whether measurements were of tail lengths, total lengths, and a combined "all lengths" data set (Table 1.2).

Table 1.2. Datasets for Spiny Lobster used in DPA Analysis

Sex	Sample Size (Total Lengths)	Sample Size (All Lengths)
Males	24,184	96,889
Females	8,864	38,499
Both	38,376	160,879

Our analysis focused primarily on the outputs for male only data sets, as there is a higher selectivity for males in Galápagos due to the illegal take of gravid females. A considerable amount of catch data for earlier years was recorded as tail lengths only; however, parameters for tail only measurements were not available in the literature. To utilize this data, we derived a tail to total length conversion rate by plotting the points for landings that had both tail and total lengths and applied a regression equation to those points with only tail lengths (Figure 1.4).

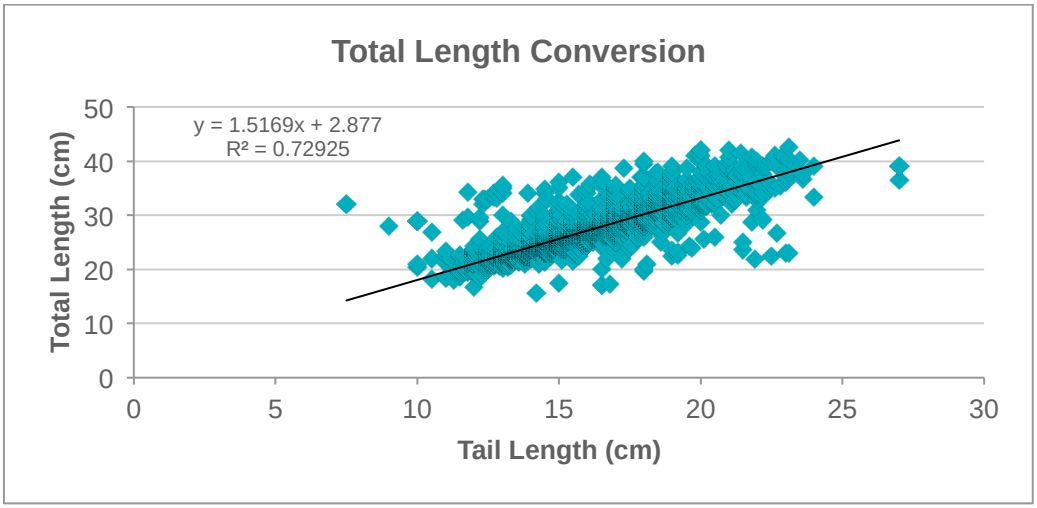

Figure 1.4. Tail length to Total Length Conversion

We applied this conversion factor to adjust the parameters for total lengths that had been taken from the literature in order to arrive at a set of tail only parameters. The data from "no-take zones" in Galápagos was not readily available or consistent, and so the models were run using only fisheries dependent data.

Parameters

The parameters used to run each of the models were taken from an extensive amount of extant literature and studies of Galápagos lobster. Parameters are male and female specific, and these values were averaged to run data sets including both sexes.

Another source of valuable information in the case of low migratory benthic species such as lobster are "no-take" zones or MPAs. These areas can serve as proxies for fished sites and comparisons can be made between the two in order to develop baseline data. Differences in animal densities between fished and no-take areas have already been observed in Galápagos and so may provide baseline data for valuable species (G.J. Edgar et al., 2004). While data from these areas is not yet reliable enough for input into the models, should data be collected from "no-take" areas it could be used to derive parameters in the future.

Table 1.3. Galápagos Spiny Lobster Life History Parameters

Life history Trait	Abbreviation	Source	Value
Natural Mortality	M	Hearn and Murillo (2008)	0.342 (female) 0.378 (male)
Length at Asymptote	L_{inf}	Hearn (2004)	40.14 cm (female) 41.9 cm (male)
Length at 50% Maturity	L_{50}	Toral and Hearn (2007)	22.6 cm (female) 25.5 cm (male)
Length at 95% Maturity	L_{95}	Toral and Hearn (2007)	26 cm (female)
Growth Rate	k	Hearn (2004)	0.2237 (female) 0.2088 (male)
Length at Asymptote (Tails)	L_{inf}	Converted from total length	24.57 (female) 24.15 (average)
Length at 50% Maturity (Tails)	L_{50}	Converted from total length	13.0 cm (female) 14.9 cm (male)
Length at 95% Maturity (Tails)	L_{95}	Converted from total length	15.24 cm (female)

RESULTS

Many fisheries around the world are managed to obtain a target F/M value reflective of specific management goals. An F/M value of 1 implies that fishing mortality is equal to natural mortality, which is indicative of fishing at B_{msy}. Lobster is typically considered a fairly resilient animal and as such is managed at higher a target F/M than most fisheries. Some lobster fisheries can be managed at target F/M values as high as 2. Given the susceptibility of Galápagos lobster to environmental fluxes such as

El Niño events in a highly dynamic ecosystem (Graham J. Edgar et al., 2010) for our analysis we set a target F/M ratio of 1.25 to evaluate acceptable fishing levels. This target was based on the known targets of spiny lobster fisheries around the world and the knowledge of the particularities of the marine ecosystem of Galápagos. Although this target exceeds F_{msy}, the resiliency of lobster and the ability of this genus to tolerate F greater than F_{msy} support the application of this reference point.

DPA Models

LBAR

LBAR showed average F/M values that exceeded the established target value of 1.25 for all years when run on all datasets (Figures A1-A6). Although we anticipated that the years for which sample sizes were considerably smaller (2006 and on) would experience greater ranges of confidence interval for F/M calculations, ranges for these years were comparable to those years with larger sample sizes. This trend occurred throughout all datasets (Figures A7-A10). Outputs from LBAR also show a decline in the average size of lobster over the history of the fishery, a further indication of overfishing (Figure A1.5).

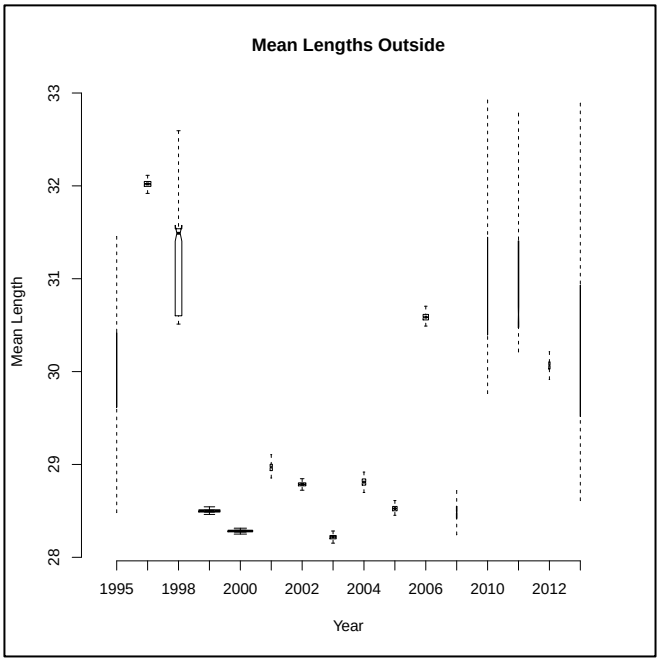

Figure 1.5. Mean Lengths for Spiny Lobster 1995-2012

The average size of lobster declines throughout the years. In the data from most recent years it appears that this trend has reversed. Sample size is represented by the width of the boxes. Years with little data are expressed by narrow boxes with large error bars.

For mean lengths, the confidence in data from years following 2006 is significantly lower than previous years due to a shift in sample size and methodology following the transfer of collection duties from CDF to the GNP. Increased error bars around the outputs from these years exemplify the

decrease in confidence. This result is different from the confidence intervals for F/M values and may be attributed to the amount of uncertainty accounted for in the calculation.

We hypothesized that F/M values may correspond to years with higher landings due to increased effort within the fishery. While high landings are not always indicative of high effort (a fishery with large biomass can have low effort), if the fishery has been depleted there would likely be catch that exceeded MSY, which would correspond to a catch rate above F_{msy}. However, landings for each year did not correlate with the respective F/M values. This was true for all datasets tested (Figures A11-A13), demonstrating that other factors influence mortality. Some potential factors may include illegal fishing that is not recorded with official landings or environmental factors.

Catch Curve

The model outputs from Catch Curve show average levels of F/M for all male datasets exceeding the precautionary target of 1.25 (Figures A1-A6). Female and both sexes data sets exhibit lower F/M values indicating that the increased selectivity pressure for males is diluted in the iterations run on data containing both sexes (Figures A1-A, A5-A6). F/M values for male-only data were consistently higher than females only and both sexes data, underscoring the presence of higher selectivity for males (Figures A3-A4). The majority of historical data exceeded our F/M target of 1.25. Although we believed variations in sample size would influence confidence interval ranges for F/M calculations, ranges of confidence intervals were consistent with a higher number of samples. This trend occurred throughout all datasets tested (Figures A7-A10). Again, we tested whether fishing mortality increased as recorded landings (and possibly effort) increased. As with LBAR, increased landings for the season did not correlate with increased F/M values for each data set tested (Figures A14-A16). Therefore, other factors must be influencing fishing or natural mortality between years, such as illegal fishing not included in landings data or environmental factors.

LBSPR

LBSPR was run only for datasets of male total lengths and male all lengths. Plots of F/M demonstrate similar results to those of LBAR and Catch Curve. F/M values for males total lengths were higher than 1.25 during half of the past years, while males all lengths were higher more than half of the time (Figures A31-A32). Data from the most recent years demonstrates an F/M value around 1 for both datasets. However, years with larger sample sizes predicted higher average F/M values, leading us to suppose that sample size may play a factor in accuracy of F/M calculations. When compared with outputs from LBAR and Catch Curve, LBSPR predicts lower F/M values, however a significant number of F/M values are above the target 1.25.

SPR trends were linearly correlated between the two datasets, demonstrating accuracy in the tail to total length conversions. SPR was between 0.2 and 0.4 for the years 1999-2009 with the exception of 2006 (Figures A34-A36). All other years had a SPR between 0.4 and 0.8. Many commercially harvested species are held to a SPR of around 0.4. However, since lobster is generally a hearty species they may be managed at a target SPR of between 0.2 and 0.4. Because none of the years fell below a SPR of 0.2,

the amount of eggs produced by the population does not appear to have been affected drastically by higher than desired F/M values predicted by the other models. The expected correlation between a decrease in SPR as landings increase was not observed in the model outputs.

LBSPR also provides information on age and cohort structure. Age residuals demonstrate that there is more variability and outliers in ages 4-7 (Figures A35-A36). This may be caused by greater variability in the length to age calculation using the Von Bertalanffy growth parameter for these years or irregularity in the growth rate of young lobsters. Cohort residuals show high levels of variability and outliers in 2005, 2007, 2008, and 2009 (Figures A37-A38). This may be attributed by low sample sizes for these years.

Comparison Between Models

Each of the models showed consistently high F and F/M values. Each model we ran exhibited F/M values consistently higher than the established target, indicating overfishing through time (Figure A1-A6, A31-A32). LBAR reported higher F/M and F values than Catch Curve for every year 92% of the time. Because LBAR predicts higher values for the same datasets, we identify this as the more conservative model for estimating fishery pressure. LBSPR outputs for F/M were highly consistent with those of Catch Curve (Figure A3-A4, A31-A32).

Comparison Between Datasets

Comparisons between datasets of different lengths can provide insight into the limitations of the assessments. It can also highlight the importance of purposeful and consistent sampling methodology. This is particularly true if results are variable between databases comprised of different lengths, indicating that conversion between lengths is not entirely accurate. F/M outputs from LBAR when using the all lengths data set were higher for male only and both sexes data when compared with total lengths (Figures A17-A18). When the same datasets were run in Catch Curve, results were more variable. F/M values were higher for the all lengths data until F/M values reached 1. Once F/M reached a value greater than 1, total length F/M values were consistently higher than all length values (Figures A19-A20). For female-only datasets, F/M values were consistently higher for total lengths for both models (Figures A21-A22). For LBSPR, F/M values were fairly consistent between total lengths and all lengths for male only datasets. However, 2003-2005 (which have large sample sizes) demonstrated higher F/M values for total lengths (Figures A31-A32).

Comparisons between males only, female only, and both sexes can provide us with insight into differences in fishing mortality between females and males. We expect to see a difference in selection between sexes because the take of egg-bearing females is illegal in this fishery. When comparing between male, female, and both sexes datasets, both LBAR and Catch Curve predicted slightly higher F/M values for males only when compared to both sexes for measurements of all lengths and total lengths (Figure A23-A26). The trends in female only data showed greater variability between datasets. Comparison between total lengths only demonstrated that lower F/M values were seen for females while F/M increased for both sexes data. This was consistent for LBAR and Catch Curve (Figures A27-

A28). When analyzing all lengths, female only, and both sexes data sets, F/M values were linearly correlated and accurately predicted each other for both models (Figures A29-A30).

All methods and data sets indicate some degree of overfishing. The degree to which overfishing is occurring depends on the assessment and the established threshold. As expected, the models report a higher pressure on male datasets than female.

Selection of Catch Curve

Through the analysis of model outputs and the application of our criteria, we determined that Catch Curve is the best model for continued application and management in the Galápagos lobster fishery. This model uses the most fisheries dependent data and as such places less weight on the ability of parameters to generate estimates of fishing mortality. Catch Curve uses a larger portion of the collected data to construct the age frequency curve. The greater amount actual fisheries dependent data makes this model a more reliable source of fishing mortality estimates. Ultimately, of all the models we evaluated, Catch Curve best fits the criteria we developed to assess the suitability of models to the particular needs of the GNP particularly considered cost, input requirements, technical expertise, and ability to be translated into Microsoft Excel.

Additionally, this model can incorporate MPA data that can determine the amount of variation in M with relation to environmental fluctuations and uneven exposure to fishing pressure. This model would allow the GNP to make use of their established no-take zones to incorporate fisheries independent data collected from these zones to produce a more accurate output.

Photo 1.6. Checking for eggs on a lobster

Photo 1.7. GNP staff weighing lobsters at the docks

DISCUSSION

Differences Between Model Outputs – Implications for Fishing Pressure and Management

- Does sample size greatly affect the model outputs?

The GNP is striving to achieve a standardized sampling methodology for the lobster fishery. Currently the Park employs dockside monitors that collect biological data during the lobster season. This data is presently collected by opportunistic sampling without a clear purpose for the eventual use of the data. With the implementation of data-poor assessments, the GNP will be able to direct their monitoring efforts towards taking only those measurements necessary for use as inputs into the assessment (total lengths and weights of lobsters landed). Through our analysis we have determined that increasing sample size of lobster lengths has influenced the outputs of the DPAs. While the ideal sample size for this fishery has yet to be determined, there is a positive correlation between increased confidence and larger sample size. Determining the sample size that provides the most reliable output will enable the Park to streamline their data collection efforts, saving valuable time and personnel resources.

- What other factors could be influencing any large differences between outputs?

Differences in the outputs of the models can be attributed the particular parameters used, the amount of available data, and the biases of each model. LBAR is known to be particularly sensitive to the estimate of natural mortality (Ovando et al., 2013). The M value we used to run the models was taken from a Galápagos specific study (Hearn & Murillo 2008); however, this value is significantly higher than many spiny lobster species and may contribute to differences in the outputs of the models. LBSPR is sensitive to the measuring and ageing fish, and estimates of max length. Given the variability in data collection of Galápagos, it is possible that errors in sampling data had an impact on outputs from both Catch Curve and LBSPR.

- What does this uncertainty say about management for the lobster?

Photo 1.8. Fishermen waiting as staff and volunteers of the GNP gather data of landed lobsters

Although all three of the models predict similar trends within the lobster fishery, some outputs are more conservative than others and may lead to different conclusions about the status of the fishery. For example, in the same year LBAR and Catch Curve may predict F/M values that are 0.5 units apart. This difference may determine whether the fishery is efficient or overfished. Additionally, we must consider the inherent differences in the models. Catch Curve and LBSPR use a larger potion of the biological data than LBAR, which can potentially safeguard against any irregularities in the data and ensure that relationships are accurate. Because the Galápagos Islands are characterized by high levels of ecosystem variability, we suggest that a model including more data would be desirable for the fishery. The uncertainty within the models highlights the importance for the use of multiple reference points within a control rule.

DPAs in decision making processes at GNP

The annual use of the Catch Curve is critical in guiding decision-making with regard to the seasonal lobster TAC. The ability of the Galápagos National Park to comfortably and confidently run the assessment was a major consideration in selecting a model to ultimately recommend. In order to maximize the potential for application of this model by the GNP, it needed to be translated from R to an easy to use Excel-based format.

Photo 1.9. Weighing lobsters with a hand scale

In comparison with most finfish, crustacean fisheries, lobster in particular, are much more resilient and can withstand higher fishing mortality. Fishing to within a pressure determined solely by the biological resilience of the fishery does not consider the detriment to the economy or the potential for

recruitment overfishing (Kay, 2013). The use of Monte Carlo simulations to determine the probability of stock collapse at a number of targets will help to establish the most responsible limit for F/M values. Working closely with GNP officials, appropriate goals within the framework of the Special Law of the Galápagos must be established prior to setting target reference points. This will help to build an appropriate control rule based on reference points in addition to those achieved by the model and create management decisions that align with the Special Law of the Galápagos.

Adjustments to fishing pressure

Fishing pressure in Galápagos can be adjusted (reduced or increased) in a number of ways. Given the political clout of the local fishermen and the potential for strong resistance to restrictions, it is important that reductions in effort be approached with a strong scientific backing and justification. The following means of restricting effort each have associated costs and benefits, both from the biological, enforcement, and stakeholder 'buy-in' perspective:

- Season length (increase or decrease)
- Legal size increases: ensures that each animal reproduces at least once before capture
- Legal size decrease: animals less valuable on the market, larger animals are more effective in top-down ecosystem control, protects large reproductive females
    - Our research supports a strong preference for "medium" sized lobsters within the local market
- Effort adjustments through a strictly enforced TAC
- Sex based regulations (male only fishery or maximum size for females)

These adjustments to fishing regulation can be used in conjunction with a control rule, based upon a number of selected reference points, in order to reduce the impact to the stock. Depending on how many or which of the reference points are exceeded managers can impart these alterations to management to redress the problem.

Making well-informed decisions

With the application of DPAs, a greater importance is placed on sampling technique, as the amount of data used to manage the fishery is typically limited and the reliability of the models is dependent on the accuracy of inputs. It is imperative that a uniform data collection and sampling methodology is used throughout all sampled areas. In Galápagos, this means that all GNP staff must follow the same sampling protocol using the standardized tools and data entry sheets on every island and point of landing during the lobster season. Our first-hand observations of fisheries dependent data collection indicate highly variable methodology and record keeping. We are developing a data collection worksheet and sampling methodology to streamline the data collection efforts across the islands. In addition, we are determining a target range for sampling that will provide managers with sufficient data to achieve a reliable model output for the following year. Increased efficiencies between sampling efforts and methodology will allow the GNP to focus efforts on collecting the specified amount of data and redirect excess resources towards other management improvements within the fishery.

Photo 1.10. Fishermen carrying lobsters to sell after they are measured and weighed

CONCLUSION

Through our analysis, we have identified that F/M values are higher than desired when managing the fishery to a suggested target of 1.25. If the GNP decides to move forward with this target reference point, a reduction in fishing mortality will be necessary in the immediate future. Our predictions that mortality would be highest for males was validated by the models and can be used to indicate accurate fishing mortality levels for future management of the fishery. Through our in-depth analysis of three data-poor assessments, we believe that Catch Curve is best suited to the needs of the GNP for management. This model can be used in conjunction with a control rule to support the decision-making process of fisheries managers, and influence the establishment of a strict yearly TAC. The use of a DPA in this data-rich fishery presents a unique opportunity to evaluate the efficacy of these assessments and develop confidence in the methodology. Effective data collection will increase the reliability of the model as well as provide purpose to sampling for the GNP.

"a reduction in fishing mortality will be necessary in the immediate future"

This analysis can be built upon in the future to incorporate additional fisheries indicators for management purposes. A future evaluation of stock biomass in relation to B_{msy} (biomass at maximum sustainable yield) would provide us with important information on whether the status of lobster populations in relation to MSY. This would allow GNP managers to have increased confidence when determining the degree to which fishing effort should be adjusted. Further collaboration with the GNP will be necessary in setting appropriate targets based on their particular goals for the fishery. Additional analyses, such as Monte Carlo simulations, can be run to determine the probability of fisheries collapse at these objective targets. Knowledge of the local stakeholders suggests that a proposed reduction in TAC would likely be met with hostility from the fishing community. Because support from the fishing sector will be necessary to enforce these reductions, exploration of innovative solutions to gain stakeholder support and incentivize catch reductions is a key component of effective management.

Chapter 2:
TURF Feasibility

Photo 2.1. Puerto Ayora, Santa Cruz Island

TURFs for the Galápagos Lobster Fishery

OBJECTIVE

The objective of this study is to determine the feasibility of implementing a TURF system for the lobster fishery in the Galápagos Islands. To develop a feasibility evaluation framework, we examined factors that contribute to the success of other already existing TURFs. However, our objective was not to determine whether or not a TURF would ultimately be successful, but rather if a TURF could feasibly be implemented. This distinction is important because many aspects that would contribute to its success (i.e. size, management structure, participants, location, etc.) would depend on the specific objectives of the TURF, which would need to be established by the GNP, CI, fishermen, and other stakeholders.

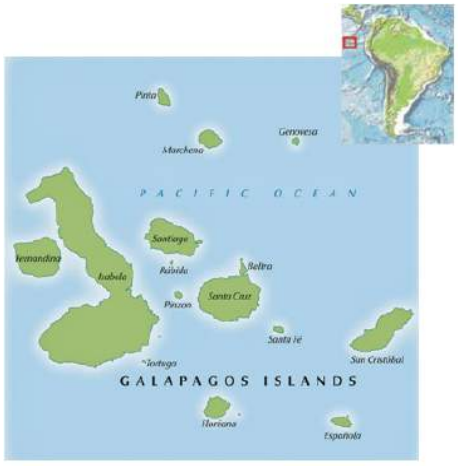

Figure 2.1. Map of the Galápagos Islands

To guide our research we established some minimal design elements of a potential TURF to better analyze the feasibility of its implementation. The TURF would be located in the waters surrounding Santa Cruz Island, with some part of its border adjacent to the coastline of the island. The only fishermen that would have the option to participate in the TURF would be Santa Cruz Island fishermen. The current fishery regulations would apply to the TURF as well, along with an additional rule that all lobsters would have to be caught live. When fishermen harvest lobster with spears it can result in the unintended take of undersized or ovigerous individuals because it is difficult to identify small or gravid lobsters prior to capture. The loss of these important individuals could be detrimental

to the populations. By mandating live capture of lobster, fishermen could collect an undersized or egg-bearing individual and release it alive.

PROJECT SIGNIFICANCE

Photo 2.2. Checking for eggs

For more than two decades, the management of the lobster fishery in the Galápagos Islands has relied on top-down input and output policy controls. Historically the GNP has implemented the following policy controls to manage the fishery: gear restrictions, licensing for boats and fishermen, size limits, ban on the take of ovigerous females, seasonal closures, and the use of a TAC. However, these regulations do not address the fundamental lack of secure harvesting rights, which incentivizes the race-to-fish scenario often leading to overfishing. The race-to-fish prevents fishermen from planning operations based on market demand, resulting in economic inefficiency (M. Castrejón, 2012). As such, the decline in lobster landings over the past decade is not surprising (Ramírez, Castrejón, & Toral-Granda, 2012). With a TURF system, incentives are focused on long-term stewardship and increased coordination to work towards a more sustainable strategy, which could improve both the biological and economic performance of the fishery.

"Implementation of catch shares halts, and even reverses, the global trend toward widespread fisheries collapse" *(Costello et al., 2008)*

BACKGROUND

Catch Shares

Because most fisheries operate under open access conditions, fishermen are incentivized to race-to-fish, or catch as many fish (or other species) as possible before others do. When all fishermen are operating with this same logic, this leads to competition and overexploitation of the resource, classically known as the "tragedy of the commons" (Hardin, Garrett, 1968). Worldwide, as many

fisheries have collapsed, or are on a trajectory towards collapse (Pauly,D., Christensen, V., Dalsgaard, J., 1998), due to open access conditions, some fishing communities have turned to rights based fisheries management (RBFM) (Wilen, Cancino, & Uchida, 2012). Often termed 'catch shares,' this management approach seeks to change the incentives by providing secure rights to the resource in order to eliminate the race-to-fish. Management through catch shares involves the allocation of a secure area or portion of total catch to a specified group or individual. Catch shares can be quota-based, allocating a part of the TAC of a fishery to an individual or a group, as in the case of individual transferable quota (ITQs). Catch shares can also be area-based, allowing for individuals or groups to harvest within a specific area such as in territorial use rights fisheries (TURFs).

Photo 2.3. Fishing boat

The use of catch shares has increased since the 1970s, and today some form of catch shares is used in 18% of countries around the world (Bonzon, McIlwain, Strauss, & Van Leuvan, 2010). By providing secure rights to a common pool resource, a catch share intends to shift incentives for fishermen from race-to-fish conditions towards collective behavior that fosters long-term stewardship of resources. This change in incentives can result in an increase in revenue, decrease in capture of non-target species (bycatch), increase in the TAC, and compliance with rules (Environmental Defense Fund website). Catch shares have proven successful in many cases around the world. A comprehensive study of more than 11,000 fisheries worldwide found that the implementation of catch shares "halts, and even reverses, the global trend toward widespread [fisheries] collapse" (C. Costello, Gaines, & Lynham, 2008). This illustrates the success of the catch share approach in many fisheries around the world, showing that catch shares represent one strategy for reforming failing fisheries.

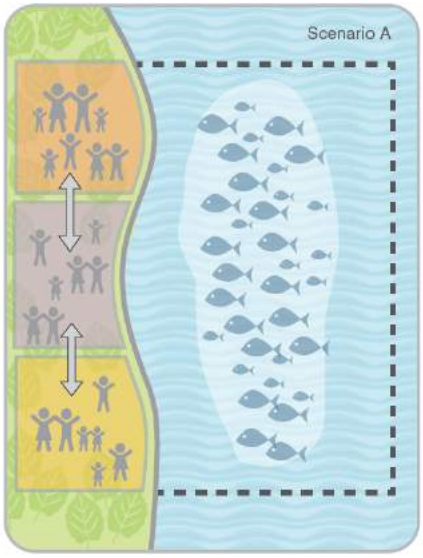

Figure 2.2. An example of a TURF system. TURF systems are found around the world and can take many forms. Figure: Poon and Bonzon, 2013.

Territorial Use Rights Fisheries (TURFs)

The area-based versions of a catch share management, TURFs, grant exclusive access to specific individuals or groups so that only they may fish for a resource (or multiple resources) in a specific area (Wilen et al., 2012). This management system alleviates the inefficiencies of open access resource use by providing secure access rights to groups or individuals, as well as the right to exclude others from fishing in the designated area. TURFs typically also have a unique set of rules by which the fishermen must abide; usually they are rules that increase the sustainability of the fishery. In this system, some of the spatial

externalities not addressed by other forms of catch shares are internalized such as the overexploitation of productive fishing areas, the use of gear that is destructive for habitat, and issues in coordinating harvest over time and space (Wilen et al., 2012). This form of management can increase coordination between fishermen and catalyze the formation of cooperative practices. TURFs have been implemented in a number of fisheries around the world and can differ dramatically in design, enforcement, number and classification of species included, level of involvement from the government, and decision-making processes.

Benefits and Implementation Around the World

TURFs have been used for hundreds of years by coastal communities around the world in many different applications to manage a variety of species. Anthropologists have documented the traditional use of TURFs in the islands of the South Pacific for centuries (Johannes, 1978). Japan has also used TURFs for centuries, but they were not legally recognized as such until the Japanese Fishery Law was enacted in 1901 (Cancino, Uchida, & Wilen, 2007). Since then, TURFs have been incorporated into fisheries around the world, and today hundreds of local fishing cooperatives participate in managing TURFs (Poon & Bonzon, 2013). In every case worldwide, TURFs have been adapted to the bounds of local realities and have met various challenges and successes.

Economic Benefits

Catch shares in general can have economic benefits when designed and implemented to suit the objectives of a particular fishery, and these benefits can occur even in the early years following catch share implementation (Poon, 2013). One common economic benefit is the reduction in cost for fishermen. "By ensuring exclusive access to a certain quantity of fish, fishermen can reduce costs by focusing on harvest efficiency rather than racing to harvest as much as possible from an allocation that is open to all fishermen" (Christopher Costello, Lynham, Lester, & Gaines, 2010). While this refers to quota-based systems, it can also hold true for area-based systems such as TURFs. In the Baja California benthic FEDECOOP TURF system, which works in conjunction with a quota system, fishing cooperatives coordinate and share information on harvests within the TURF system, thereby reducing repetitive fishing of the same grounds and reducing search costs (C. J. Costello & Deacon, 2007). TURF systems can also improve economic efficiency by reducing the overall fishing capacity (Poon & Bonzon, 2013). In some systems, fishermen work in teams with the most proficient fishermen doing the actual harvesting while other fishermen take on jobs like processing or sales. This unique allocation of work reduces the number of trips taken to fish, thus reducing costs. By realigning the

Photo 2.4. Fishermen fueling up at Puerto Ayora, Santa Cruz Island

incentives of a fishery, fishermen can work more efficiently and reduce the costs associated with fishing.

In addition to reductions in cost, catch share management can increase profits through market coordination (Christopher Costello et al., 2010). For example, in Japan's multi-species TURF systems, most cooperatives have an offloading and handling facility that allows them to control the flooding of markets by coordinating and anticipating peak harvest plans for high volume times of the season, and ultimately enhancing revenues for participants (Cancino et al., 2007). Additionally, TURF systems can catalyze improvements in centralized and coordinated marketing for products. In Chile's benthic TURF system fishermen have been able to dramatically improve the structure, predictability, and planning of shellfish marketing practices, as well as the ability to negotiate and meet the needs of buyers. These practices have resulted in higher prices for loco, the main shellfish product of Chilean TURFs (Cancino et al., 2007). In addition to benefits that can occur in the short-term, long-term benefits such as increased returns from the rebuilding of biological productivity of stocks that would otherwise be subject to overexploitation in an open access system can also be attributed to TURFs (Wilen et al., 2012). By eliminating the race-to-fish, fishermen can work strategically and collaboratively to increase returns, all while the stock is growing or maintaining a sustainable level.

Ecological Benefits

The ecological benefits from TURF systems can be derived either from the direct management of the targeted resource or from ancillary effects of TURF implementation. In the case of Chile's TURF system, benthic resource abundance has increased inside TURFs due to direct management efforts (Gelcich, Godoy, Prado, & Castilla, 2008). The spiny lobster fishery in Punta Allen (Mexico), managed by a TURF system, has seen increases in lobster landings since 2000 and is the most productive fishing cooperative in the Mexican Caribbean since 1982 (Sosa-Cordero, Liceaga-Correa, & Sejio, 2008). Additionally, several communities managing fisheries with TURFs have voluntarily implemented the use of no-take zones to increase productivity of target stocks as well as other species. A study by Gelcich et al. (2008) suggests that in addition to observed improvements for the targeted invertebrate species in the Chilean TURFs, reef-fish species were also significantly more abundant and diverse inside the TURF as compared to outside. Ecological enhancements can also come from conservation activities conducted by fishermen like those in Japan that participated in community no-take zones, sea grass bed restoration, beach cleanups, and water quality improvement projects (Yagi, Clark, Anderson, Arnason, & Metzner, 2012). These examples exemplify both the indirect and direct benefits of TURFs for ecosystems.

Photo 2.5. Coastal ecosystem. Photo by Sue Cullumber.

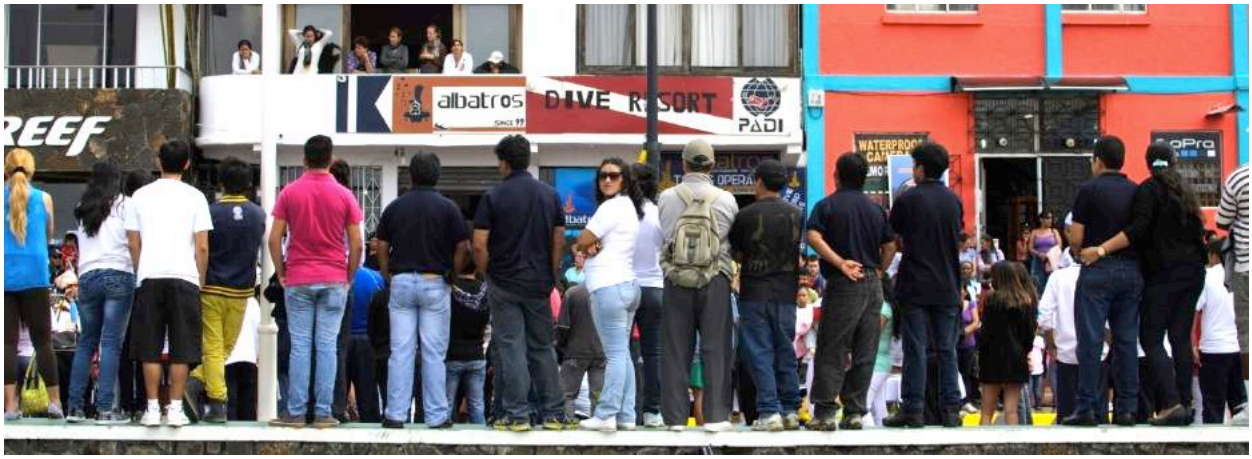

Photo 2.6. Community of Puerto Ayora, Santa Cruz Island

Social Benefits

TURFs can also provide social benefits to fishing communities. These social benefits include increased local employment, increased safety conditions for fishermen, and the empowerment of local communities to steward resources. In Punta Allen, TURFs have helped to increase lobster landings, which have fostered economic and social prosperity through the creation of jobs for both men and women working for the local fishing cooperative. Many members of the community are involved in the fishery, and the community fares better economically than other fishing communities because of the successful management (Poon & Bonzon, 2013). According to Grimm et al (2012), catch shares in general can also improve safety for fishermen by eliminating the incentive associated with open access conditions to "sacrifice safety for speed" (p. 650). This allows fishermen to plan trips when weather conditions are favorable. In the U.S and British Columbia, fishing safety nearly tripled on average in fisheries that switched to catch share management based on an index of safety data across fisheries (Grimm et al., 2012). Lastly, TURFs can also empower fishermen and promote stewardship by directly involving fishing communities in decision-making and the management of a resource. TURF management conducted in conjunction with local communities allow for management at a finer scale enabled by local science and decision-making (Prince, 2003), which in turn can build the capacity of community members to serve as stewards. This can also result in shifts in attitudes as seen in Chile. A survey conducted with three fishing syndicates of the Chilean Benthic TURF system showed that 94% of surveyed fishermen agreed or strongly agreed that "fishers have a duty to conserve marine resources for the next generation" (Castilla, Gelcich, & Defeo, 2007). These examples illustrate that TURFs can produce a variety of social benefits in addition to economic and ecological benefits.

A well-designed TURF system for a fishery suited to spatial management can be beneficial for the health of marine resources and fishing communities alike. However, while many potential benefits exist for TURF systems, transaction costs can be high in terms of coordination and conflict resolution. A TURF will only be successful when these transaction costs are outweighed by the benefits (Wilen et al., 2012). Factors that influence the effective management of open access resources can influence these transaction costs (Agrawal, 2003; E. Ostrom, 2009; Elinor Ostrom, 1990). An analysis of these factors within the context of the Galápagos Islands will help to determine the feasibility of a TURF system for the Galápagos spiny lobster fishery.

Photo 2.7. Fisherman repairing his boat

APPLICATION OF TURFS IN GALAPAGOS: METHODOLOGY

Framework

To soundly analyze the feasibility of a TURF for the Galápagos lobster fishery, we first needed to establish what factors make a TURF feasible. We set out to construct a logical and evidence-based framework by exploring literature on common pool resources and community structures, as well as previous studies that investigated important factors for the implementation of rights-based management systems. After extracting the common factors we found throughout these sources, we grouped the factors into major categories. We then entered information from the existing dynamics of the Galápagos lobster fishery into this framework to ultimately determine the feasibility of a TURF management system there.

Sources

The literature we reviewed consisted of works on common pool resource theory, empirical studies on co-management of resources, and four case studies of fisheries with similar social and cultural dynamics to Galápagos. We conducted an in-depth study of Ostrom's (1990) work involving governance of common pool resources and some of the factors required for collective action systems to be successful. Further work by Wade (1994) and Baland & Platteau (1996) contributed to a more complete understanding of common pool resources and their successful management. Empirical studies conducted on multiple cases of co-management structures (Gutiérrez, Hilborn, & Defeo, 2011) were essential in filling out some of the aspects of existing social and management structures necessary for the transfer of governance down to the community level. The four case studies we reviewed (Beitl, 2011; Cunningham, Apel, Ruiter, & Van Leuvan, 2013) were chosen because of their similarities to the Galápagos lobster fishery: they were primarily implemented to target valuable benthic species, have management systems existing in the context of Latin American legal systems

and cultural forces, and they have been largely successful at achieving economic benefit and sustainability of stocks.

We ultimately decided on the most important factors of TURF implementation by compiling our sources into three main variables: Case studies of similar fisheries, Theory on common-pool resources, and Empirical Studies. We then populated the table, indicating factors for each variable that were found to be important during implementation of the TURF. Factors that occurred in at least one variable were considered in our analysis. We analyzed these selected factors in context of the current situation in the Galápagos lobster fishery. Table 2.1 below shows the factors and variables we considered from these sources, which we grouped according to six main categories based on their similar nature.

Table 2.1. TURF Implementation Factors

Category	Factor	Case Studies	Theory	Empirical Studies
Economic	Species valuable enough to warrant protection	X		
	Ability to increase efficiency & revenue for participants	X		X
Legal	Existing legal structure to implement TURF/Ability to create legal structure to support	X	X	
Biological	Adult home range conducive to spatial management	X	X	
	Benthic species important for spatial management	X		X
	Migration patterns conducive to spatial management	X	X	X
	Larval dispersal conducive to spatial management		X	
Social	Fishing culture/method conducive to spatial management	X		
	Social cohesion among fishermen	X	X	X
Management	Co-management	X	X	X
	Organizational capacity and strength of co-op	X		X
	Leadership	X	X	X
	Institutional stability (secure rights)		X	
	Quality of knowledge and decision-making	X		X
Geographic	Distance between fishing ground and population center (Allocation)	X		X
	Distance between fishing ground and population center (Enforcement)	X	X	X
	Clearly defined boundaries	X	X	X

Hierarchy

Before thinking through the feasibility of a TURF system in the Galápagos specifically we realized that not all categories were necessarily equal in importance for implementing a TURF. Therefore, we identified some categories as necessary prerequisites for implementation prior to the consideration of other categories. The hierarchy is as follows, with the most fundamental category presented first:

Biological

Firstly, the target species itself must be conducive to spatial management. If the species were able to leave the boundaries of the TURF through regular movement or seasonal migrations there would be

no incentive for fishermen within the TURF to protect the resource, as it would be at the mercy of open-access pressures when it was outside the TURF boundary. The size of the TURF can be designed according to the movement of the target species (a larger sized TURF for mobile species, a smaller sized TURF for sedentary species). However, TURF management is considered infeasible for highly migratory species and species with high dispersal rates can pose problems for spatial management as well.

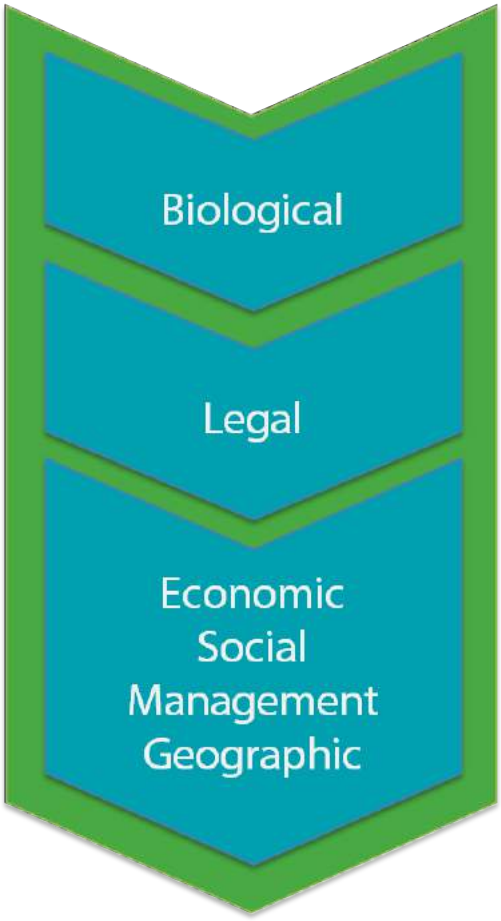

Figure 2.3. Hierarchy, analysis of factors

Legal

The legal framework where the TURF would be implemented must have the structure to explicitly allow the creation of a TURF or must contain a legal pathway to establish one. If neither of those options exists, precedence could be used to support the development of a TURF, as prior rights-based management would suggest a legal structure that may give leeway for a similar project.

Economic, Social, Management, Geographic

Within the hierarchy, we considered these four categories to be equally influential. Though they are less limiting than the biological and legal categories, they must be considered to determine the feasibility of implementation.

Economic: A TURF system should create enough added value that the benefits outweigh the costs, otherwise it would likely not be a worthwhile endeavor for many of the potential stakeholders.

Social*:* There must be adequate social cohesion and social will to lend support for implementation of a TURF. Since the success of a TURF is closely tied to the ability of members to cooperate with one another as well as with managers, a lack of social will to join such a management system can become a barrier to implementation. Specifically, strong fishing co-ops are an important factor that contributes to the successful implementation of many TURF systems.

Management*:* The existing management system, if not already structured as such, must be willing to transition to a co-managed system by devolving some authority to the co-ops. Since much of the decision-making power will be given to co-ops, organizational capacity must exist and there should be sufficient trust that leaders will make decisions in the interest of members.

Geographic*:* The location of the resource in relation to users is also an important consideration for TURF management. The proximity of the TURF to the homeports of fishermen will have implications for the allocation of resources among members of the TURF. Furthermore, the geographic aspects of the TURF will affect the cost associated with monitoring and enforcing the boundaries of the TURF.

Applying Categories to Galápagos

Once our general framework was established, we then found Galápagos specific information for each category to determine feasibility. We found an abundance of information available in scientific literature, including studies specific to the Galápagos so that we could construct a cohesive understanding of the Biological, Legal, Economic and Geographic aspects of the islands. We also utilized information obtained through personal interviews while in the Galápagos to understand factors related to the Management category. For the Social category, limited data regarding local perceptions of rights-based management systems specific to the Galápagos lobster fishery existed. In order to make a determination about the Social category of our framework, we conducted extensive primary research through surveys with fishermen and local stakeholders while in the Galápagos.

Social Factor Methodology

The surveys for fishermen were designed through a collaborative effort between our team, CI, CDF, and WWF. Throughout the survey design process we sought to limit the number of assumptions made to obtain the most representative results possible. Michael Henderson, Ph.D., Senior Director of West Coast Operations at Maritz Research, evaluated the efficacy of our survey. The survey was administered in Spanish by an interviewer who read it aloud and marked answers once the interviewee responded.

Photo 2.8. Surveying fishermen

The survey was implemented on Santa Cruz Island by members of our team as well as two local volunteers. Our initial goal was to obtain surveys for a census of all the fishermen on the island during our six-week research period from July to September 2013. We obtained a list of active fishermen from the GNP to systematically identify and record completed surveys with fishermen. Fishermen remained anonymous as their names were crossed off the roster after completing the survey but not indicated on the surveys themselves. We primarily used convenience sampling, and surveyed fishermen who were present at the two main fishing docks in Puerto Ayora. Upon realizing that surveying all fishermen at the docks was infeasible, we visited the homes of fishermen to appeal to them to take the survey. The two volunteers, as well as two community members of RARE, had connections with local fishermen and accompanied us when administering surveys at the docks and assisted us in setting up visitations to fishermen's houses. We ultimately collected 50 valid surveys out of a population of 113 active lobster fishermen that were members of the Santa Cruz fishing co-op.

Upon beginning a survey (Appendix D) with a fisherman, we administered two screening questions that would qualify or disqualify them from the remainder of the survey:

Photo 2.9. Surveying fishermen

- The first question asked fishermen which species they fish for. If they answered "lobster" or "lobster and white fish," they continued with the survey. If they answered "only white fish" or "none," they were ineligible.
- The second question asked whether they fished for lobster during the past season. If they answered "yes," they continued with the survey, and if they answered "no," they were not considered to be representative of the population of active lobster fishermen.

If they passed the screening questions, they were then asked about their activities as a lobster fisherman: methods of fishing, efficiency of fishing, and their lobster sales prices.

The next section of the survey consisted of questions specific to perceptions of a TURF in the Galápagos. We first asked whether they were aware of management regimes similar to a TURF. Next, we asked them about their willingness to participate in TURFs of three different sizes: 10km (Scenario 1), half-island (Scenario 2), or whole-island (Scenario 3), each extending 1km out from the coastline. For scale, the person administering the survey presented a map of Santa Cruz and used a piece of string to provide the fisherman with a proxy for what 10 km by 1km area looked like. The string was never placed on the map in order to remove the possibility of bias should a fisherman be partial to the specific location of a potential TURF. The survey administrator informed the fishermen of the TURF rules, which were the same for all three sizes: participating fishermen can only capture live lobster, cannot take ovigerous or undersized individuals, cannot capture lobster outside of the TURF, and all current rules of GNP apply including the quota.

To determine their willingness to join a TURF, we asked a series of questions.

- First, we asked if they would join the proposed TURF of the given size. If they said "yes," we asked how many fishermen they would be willing to share the TURF with. If they said "no," they were provided with the following list of incentives and asked to rank their influence on changing their minds so they would join the TURF (1 being most influential):
  - Higher price for lobster
  - Guaranteed sale of lobster at a set price through the cooperative
  - A longer lobster season
  - Limited number of other participants

Figure 2.4. Sample of map used in survey

- Exclusive access to whitefish within the TURF as well

We then asked the fisherman if he would now be willing to join the TURF if his top two incentives were provided. The fisherman could also state that he would never join a TURF of this size and move on to the next scenario.

Whether the fisherman answered "yes" or "no" to the original question, he was asked whether he would be willing to assist in other jobs such as processing and sale of the catch, monitoring, or enforcement. He was also asked whether he preferred regulation to be conducted by only the GNP, only the participating fishermen, or both. The same process was then followed for Scenarios 2 and 3, the only difference between all three scenarios being the size of the proposed TURF.

At the end of scenario 3, we asked fishermen if there were any other benefits that would incentivize them to join a TURF. We then asked them to report, in their opinion, what their ideal size of TURF (in kilometers) would be and with how many other fishermen the would be willing to share that space. At end the survey, we asked whether they belonged to COPROPAG, the local co-op on Santa Cruz Island.

Limitations and Assumptions

The survey was relatively complicated and took longer than 20 minutes to administer. Because of the level of complexity of the survey, some respondents may not have fully understood the exercise with the three scenarios we provided for them. Some studies have shown that people taking surveys with issues "far-removed from the daily experience" of their lives are "to an unknown extent 'making up' or 'inventing' their answers" to a hypothetical situation with which they are not familiar (Hausman, 2012). Some fishermen may not have answered truthfully, since they tend to be skeptical of surveys (heard from local contacts) and the accuracy of information they provide, which they could perceive to be potentially harmful their livelihood in the future. It is also important to consider that in any hypothetical "willingness to pay" situation, results tend to be upward-biased (Jamieson & Bass, 1989). For our purposes, we considered an opposite bias associated with the "willingness to join." However, we assume that most of these issues are statistically insignificant due to our relatively large sample size compared to the total population of fishermen on Santa Cruz Island.

RESULTS

Biological

Adult Home Range/Benthic Species

In studies of spatial rights and the biological dispersal of target species, it is understood that implementing a management area, such as a TURF, that is small relative to species home range and mobility will result in intensive overharvesting similar to open-access conditions (White & Costello, 2011). This overharvesting occurs, even despite the presence of spatial rights, because fishermen inside the TURF have do not have enough ownership of the stock. This promotes a race-to-fish against fishermen outside the TURF before the species leaves the boundaries of the TURF. The spiny lobster is known to be a low-mobility, benthic species, and studies find that it exhibits a high degree of site fidelity (Hearn & Murillo, 2008). This makes it a good candidate as a target species in a TURF, provided the TURF is sized appropriately to incorporate adult mobility.

Photo 2.11. Lobsters waiting for sale

Migration

Even if adult home range is constrained, certain species can sometimes migrate seasonally to areas long distances away from their home range. Other members of the *Panilurus* genus are known for such season migrations in other parts of the world (Herrnkind & Cummings, 1964). Galápagos spiny lobster, based on available knowledge, do not appear to be migratory. A previous tag and recapture field study of 474 spiny lobsters in the Galápagos has shown that they exhibit little movement over time, with ninety-nine percent of those recaptured found to be located either at the release site or less than 5 kilometers from the release site (Hearn & Murillo, 2008). These results are consistent with reports of other populations of the same species elsewhere (Plaut & Fishelson, 1991).

Photo 2.10. Boats moored in Puerto Ayora, Santa Cruz Island

If lobsters migrate seasonally and have a high chance of being caught outside of the TURF, then the benefits associated with exclusive access to resources within the TURF will not be visible to participating fishermen. In order for TURFs to be effective, members of the TURF must feel that their rights to the resource are exclusive and non-competitive with non-members. Since evidence points towards Galápagos spiny lobsters as a non-migratory species, it is believed that spiny lobsters will stay within the confines of their home range. A properly designed TURF should limit exchange of individuals between the inside and outside of the TURF.

Larval Dispersal

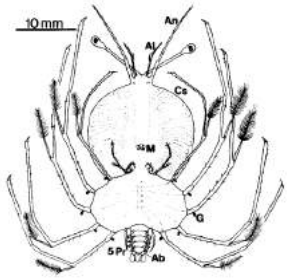

Figure 2.5. Stage X phyllosoma of *P. penicillatus* (Pitcher, 1993)

Even though in the adult stage spiny lobsters do not migrate, the dispersal of their planktonic larvae may add another layer of complexity to the biophysical aspects of this species. Many spiny lobster species appear to breed throughout the year, sometimes with a peak in the warmer months. During breeding, the female releases thousands of eggs, which are fertilized as they pass over a sperm packet deposited by a male. The fertilized eggs are carried by the female for about a month before they hatch into planktonic larvae (Pitcher, 1993). These larvae are known to drift for as long as a year in the open ocean and may be subject to dispersal through ocean currents (Booth & Phillips, 1994; Tolley & Volety, 2005). In the Eastern Pacific and Galápagos Islands, studies have suggested that lobster larvae spend between 7-8 months in the water column (Johnson, 1968) and can have larval dispersal of up to 1,800 and 2,000 nautical miles (Johnson, 1974).

It is known that a wide larval dispersal range relative to adult home range can lead to compromised ownership of stock (White & Costello, 2011) and over-exploitation behavior similar to open-access conditions (Janmaat, 2005). Unless a TURF in the Galápagos was to be extremely large, it is likely that not all the benefits of the TURF would remain within the boundaries of the TURF. Even if fishermen conserve the resources within the TURF, their benefits are likely to spill over to surrounding waters as larvae from TURF lobster travel outside and lessen the benefit between inside and outside. However, there is to date little information about larval dispersal specific to Galápagos lobster. It is unlikely that fishermen consider larval dispersal in their evaluation of the efficacy of TURFs or willingness to participate. There are many examples of TURFs around the world have been established with small management units compared to larval dispersal – and have been successful both ecologically and economically – such as in the four TURF case studies we examine in this paper. This suggests that the prevalence of larval dispersal on its own is not a limiting factor on implementation and success of a TURF, though it is a factor that needs to be considered during the design phase.

Legal

In order for a TURF to be feasible, the legal framework must be present or the ability to amend the current legal structure must be possible. The GMR Management Plan is an important policy instrument that supports the legal feasibility of a TURF. The Plan details many of the policies currently in place for the fishing sector, and the most recent version of the Plan includes a clause for "Special and Temporary Management Areas" (known as AMET in Spanish). This clause could potentially

provide the necessary legal support for a TURF pilot project. These AMET zones were designed for experimentation or recuperation of species and habitat. However, this recent version of the Plan has yet to be ratified by the central government and signed by the Minister of the Environment, so this designation has yet to be used for projects (J. Ramírez, personal communications, October 28, 2013).

Even under the AMET designation, the TURF pilot project would still have to receive approval by the Participatory Management Board (PMB) and be ratified by the Inter-institutional Management Authority (IMA). The PMB is made up of representatives from the tourism sector, naturalist guide groups, artisanal fishers, and the conservation and science sectors. The IMA is made up of Ministers of the Environment, Defense, Tourism, and Fisheries together with Galápagos Tourism, Fishing Sectors, the Ecuadorian Committee for the Defense of Nature and the Environment (CEDENMA), and the GNP. Because a decision must be made by consensus through the PMB (and later ratified by the IMA), any proposal must have support from all sectors to be implemented. TURFs could prove to be divisive for the fishermen since the system allows exclusive access to some individuals within the artisanal fishing fleet. While access to a pilot TURF would be voluntary, there may be resistance from those who do not wish to participate and are opposed to any loss of fishing grounds, even if this translates to a reduction in the density of fishermen elsewhere. A pilot project may be seen as less threatening if described as voluntary and small in scale, with limited impacts on those who don't participate.

Precedence for TURFs currently exists on the coast of the mainland Ecuador where shrimp farming has led to the depletion of coastal mangroves. To address this conservation issue and provide support for independent fishermen, TURFs have been established for the cockle fishery (Beitl, 2011). Groups of fishermen in local coastal villages have exclusive rights to harvest cockle in small coastal areas of mangrove habitat. These TURF permits span a ten-year period and at the end of this time fishermen may renew the permit after providing maps, the association agreement, a list of members, and their management plan.

Because long-term secure rights are often a factor contributing to the success of TURFs, it would be optimal to create specific legal infrastructure to support TURFs in the GMR. In the current co-management structure, this would require consensus from the PMB and the ratification from the IMA through a similar process detailed above. The potentially divisive nature of TURFs within the fishing sector could be conflated with the lack of training in negotiation and conflict resolution, which in the past has lead to a polarization in topics and verbal brawling. Any attempt to reach consensus would have to include strong sector support and high amounts of facilitation to find common ground and promote collaboration. This type of support in decision-making has historically been missing from the process (Hearn, 2008). However, a successful TURF pilot project may prove to help foster widespread support from the fishing sector to add specific language to the GMR Management Plan that enables the implementation of TURFs.

Photo 2.12. Lobsters waiting for sale.

Economic

Before moving forward with the establishment of a TURF, it is important to determine the economic implications of implementation.

Value of the Species

Lobster holds cultural and economic value within the Galápagos community. The cultural importance of lobster stems from its role as one of the primary motivators for immigration to the islands from mainland Ecuador. Even six decades later there is still an air of excitement surrounding the lobster season because it only lasts for a few months and lobster cannot be sold or consumed once it is over. As such, restaurants direct marketing efforts towards special advertisements to announce the arrival of lobster on their menus. Also, lobster can be seen throughout the islands on murals and logos, demonstrating its status as an icon in the islands.

Economically, lobster is the most valuable single-species fishery in the islands. The combined worth of all other fished species on the islands, approximately 68 species (M. Castrejón, 2008), net about three million dollars annually. However, the lobster fishery alone nets about one million dollars annually (Baine, Howard, Kerr, Edgar, & Toral, 2007).

As our framework shows, a species' value is an important factor in determining whether it warrants the work associated with implementing a TURF. Because of the high value of the lobster, both culturally and economically, the species is well worth the effort associated with implementing protective measures for it.

Photo 2.13. Boats *moored* at low tide

Costs

Another important consideration for the economic feasibility of implementing a TURF is an analysis of the associated costs. Particularly, we compared the costs under the current system with costs under a potential TURF system. This assessment used available data from the GNP for the current system costs, but we had to logically deduce future costs for the TURF system. Without specific design elements of the TURF, it was difficult to be precise with amounts, so instead we looked at whether there would be increases or decreases.

Costs associated with the lobster fishery include boats, fuel, gear, maintenance, monitoring and enforcement (see Table 2.1):

***Fuel**:* Currently, many fishermen use small boats and travel to multiple islands throughout the archipelago to fish for lobster. Such travel requires associated fuel costs. Fishermen consistently report a cost per trip of $50USD. Under a TURF regime they would be fishing in a location somewhere around Santa Cruz Island, their home island, and not travelling as far. Therefore, associated fuel and costs would decrease for most participating fishermen.

Gear: Currently, most fishermen catch lobster by hand or with a Hawaiian sling (a type of spear). All fishermen in the TURF would be required to catch lobster live, which would mean they could catch by

hand or use a lasso to capture lobster. Since the many already catch by hand, they would experience no change in gear costs. Those that use slings could convert to catching by hand for no cost, but if they choose to switch to a lasso they would the cost of switching gear.

Maintenance: Boats and gear currently require a baseline level of maintenance. Because participating fishermen would be travelling less and using simpler gear, maintenance costs would probably decrease.

Monitoring: Landings data is already collected at the dock by the GNP, and would continue to be collected, unchanged, under a TURF system. However, offseason monitoring may change. During the offseason, lobster fishermen and GNP employees collect lobster data at different sites around the island. To transition with the TURF system, they could discontinue some current sampling site locations and replace them with sites inside the TURF for no change in costs. There could be additional costs from potential monitoring efforts unique to the TURF, including data collection for other species or habitat, which would help determine the broader impacts of the TURF system.

Enforcement: Currently, in-season monitors not only record landings data, but also enforce that no undersized individuals or ovigerous females are landed. Under a TURF system, in addition to this continued enforcement, TURF-specific enforcement efforts would be necessary to ensure that non-participating fishermen are excluded from the area. The GNP, the TURF fishermen, or a combination of both could pay for this. Alternatively, some of the TURF fishermen could forgo fishing and take on the task of enforcement provided there is a well-established profit sharing agreement.

TABLE 2.1. Costs Under Current Scenario vs. TURF scenario

	CURRENT	TURF
Fuel (fishermen)	$50 USD/trip	Decrease
Gear (fishermen)	Unknown	Small increase, no change, or less
Maintenance (fishermen)	Unknown	Decrease
Off-season Monitoring(GNP)	~$28,000 USD/season	No-change, or potential increase
Enforcement (fishermen, GNP, or both)	~$30,000/season	Increase

Benefits

As mentioned earlier, the benefits of TURFs have been studied for different fisheries throughout the world. While we cannot know the specific economic benefits that would occur in this system, TURFs have been shown to increase efficiency, thereby decreasing costs and increasing prices of landed product. We assume efficiencies in the Galápagos lobster TURF would increase the price received for lobster as well as decrease costs to the fishermen, thereby increasing their benefit.

Photo 2.14. Fishermen relaxing on land

Social

The results for the social factors that contribute to TURF feasibility are broken into four sections: fishing habits, perceptions of TURFs, characteristics increasing likelihood of joining a TURF, and overall social cohesion. We assessed the first three of these aspects through our fishermen survey, which yielded a 95% confidence level in our responses with a confidence interval of 10.39 around the mean response. We evaluated the final aspect by comparing important social cohesion characteristics in common-pool resource theory with analysis in the existing literature about social structure and cultural norms of fishermen in the Galápagos.

Fishing Habits

An overwhelming majority of fishermen (86%) targeted both lobster and whitefish (Figure 2.6). Almost all (96%) knew other fishermen within their common fishing grounds. Only about half were boat owners (44%), with the rest performing their fishing activities as crew on boats.

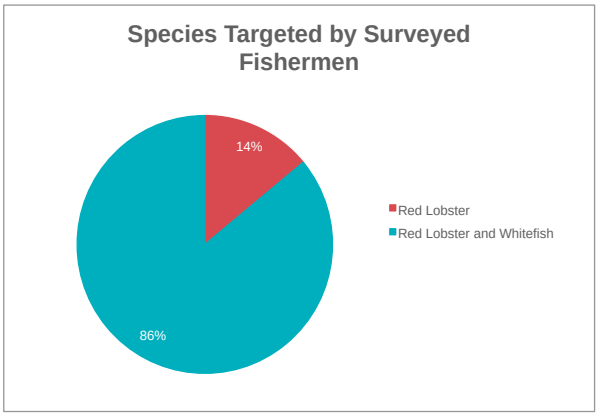

Figure 2.6. Types of species targeted by fishermen

For fishing gear, we found that the vast majority of surveyed fishermen (93%) catch lobster by hand as their primary fishing method (Figure B1). These results

countered the prior assumption that the primary method of capture was by Hawaiian sling, which kills lobsters instantly and damages the carapace so they are usually not sold as whole lobster. Previous work showed that most fishermen used a Hawaiian sling as the primary method, suggesting that the shift to catching lobster by hand is a recent trend. A number of fishermen reported only carrying the Hawaiian sling to use as defense against sharks while fishing. The fishermen who caught lobster by hand were almost evenly split between using hookah (48%) and freediving (45%). Fishermen reported catching more lobster on average with hookah than freediving (Figure B2). However, after conducting an ANOVA test, we found no statistically significant difference between the two different catch methods while using a hookah (p-value = 0.854) or freediving (p-value = 0.982). The amount of lobster caught, however, increased with the use of the hookah device versus freediving (see Table 2.2).

Table 2.2. Lobster Caught By Various Fishing Methods

	Min	Max	Average	St. Error
Hand (freediving)	3	100	34.66	± 3.23
Hand (hookah)	2	200	64.08	± 5.82
Hawaiian Sling (freediving)	2	100	37.37	± 3.05
Hawaiian Sling (hookah)	5	200	69.73	± 6.80

We also found that most fishermen sold lobster live (71%). Other forms sold were tail only (28%) and fresh (not live) (1%). This showed that not only do most fishermen catch lobster live, but also sell lobster live. Many fishermen provided information for the prices they received during the prior 2012 season for various sizes and forms of lobster. Whole lobster was sold at a higher price than tail, except for the minimum price for small lobster. For whole lobster, prices increased with the size of the lobster (see Table 2.3.).

Table 2.3. Prices in US Dollars Reported for the Various Forms of Lobster

	Min	Max	Average	St. Error
Tail	8.90	20	10.92	0.30
Small Live	5	22	12.74	0.77
Medium Live	10	27	17.41	0.74
Large Live	20	35	25.87	0.69

These results are notable for the feasibility of a TURF because they show that many fishermen would be amenable to the proposed rule of having to catch lobster live in order to have rights to fish for lobster in the TURF.

A majority of fishermen (80%) reported fishing for lobster off of islands other than Santa Cruz (80%), most commonly off the islands of Isabela, San Cristóbal, Floreana, Darwin, Wolf, and Santiago (Figure 2.7). For those who fish on Santa Cruz primarily, more than half (62%) reported also fishing off of other islands. A small portion of the fishermen who reported fishing on other islands (18%), reported that they did not fish off of Santa Cruz. On average, fishermen visit the coasts of 3.28 islands when fishing for lobster. These results show that most fishermen have a culture of fishing throughout the archipelago. Because a TURF system involves specific designated areas for fishermen, implementing this would require a shift from the current culture of traveling to multiple islands to fish for those who participate in the TURF system.

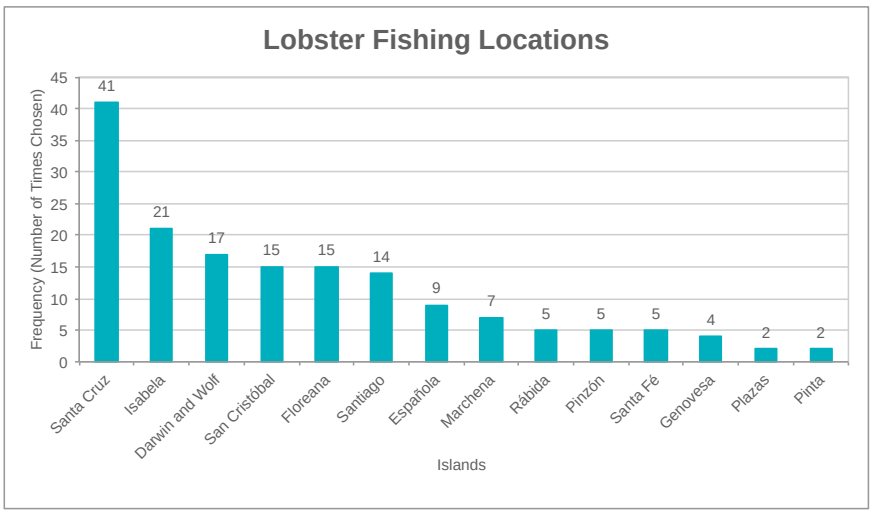

Figure 2.7. Lobster Fishing Locations

Perceptions of TURFs

A majority of fishermen (72%) reported that they were familiar with the concept of spatial rights-based management (Figure B3). Almost half of surveyed fishermen (46%) responded that they had heard of the concept but did not know the term for it, while 28% of respondents had never heard of the idea. Other respondents (22%) were familiar with "concesiones," a term used in places such as the FEDECOOP benthic TURFs of Baja California Sur, Mexico.

The results for initial willingness to join a TURF showed a positive correlation with larger TURF sizes. For a TURF of 10km, 36% of fishermen surveyed were willing to join, while 42% of fishermen were willing to join a quarter island TURF. This number continued to increase for a whole island TURF, with 48% of fishermen willing to join. However, even for the largest size TURF presented, only half of the respondents were willing to join when first asked (See Figure 2.8).

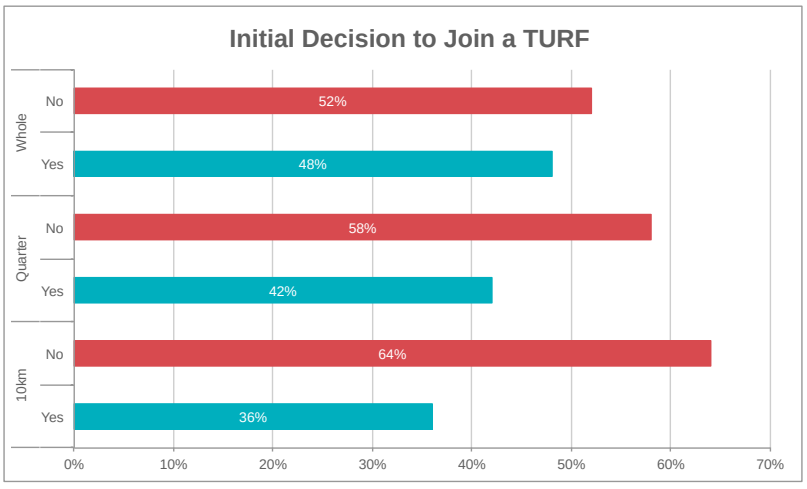

Figure 2.8. Fishermen interest in joining a TURF without incentives.

The total proportion of surveyed fishermen willing to join the various TURF sizes increased with the presentation of incentives. With the use of incentives to motivate participation in a TURF, 58% would join a 10km TURF,

63% would join a quarter island TURF, and 68% would join a whole island TURF (See Figure 2.9). Despite the positive correlation between the size of TURFs and the total number of willing participants, the number of fishermen who changed their decision to join after being offered their top two incentives was almost the same for the 10km, quarter, and whole island TURF: 11, 10, and 10 fishermen respectively. For each size, the top incentives were: "a better price per lobster," "a longer lobster season," and "a limited number of other fishermen participating in the TURF" (Figure B4). "A better price per lobster" was almost always a top three response, and the response "a limited number of other fishermen" was most frequently ranked as the top incentive (Figure B5). Fishermen desired the greatest price increase for a quarter island TURF (Figure B6).

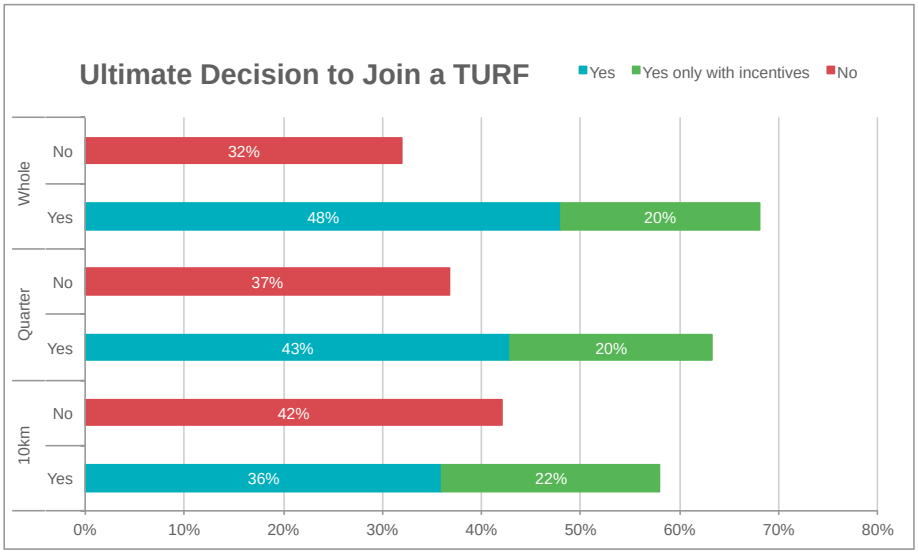

Figure 2.9. Fishermen's interest in joining a TURF. We had one less response for a quarter island TURF than from the initial responses.

While the reason for unwillingness to join a TURF was not a specific question on the survey, surveyors often recorded informal responses for fishermen who were not willing to join any size TURF, even with incentives. Seven respondents generally stated that they did not want to participate in any TURF because they did not want to give up the option to fish on other islands. Three respondents stated that even the whole island TURF was too small of an area to renounce fishing in other areas. These responses indicate that these fishermen perceive the ability to fish freely off of multiple islands as a more valuable than having an exclusive right to a specific fishing ground, regardless of how many other fishermen also fished in that area. In other words, this indicates that these fishermen did not perceive increased benefits from participating in a TURF as compared to the current fishing situation. Lastly, three fishermen indicated that they would not join a TURF because lobsters migrate, even though studies on the life history of Galápagos lobster suggest otherwise.

We also assessed the preferred density (number of fishermen per area) of each TURF size in. We asked the preferred number of others participating in the TURF to: 1) respondents willing to join initially; 2)

respondents who would join with incentives and included "limited number of other fishermen" as an influential incentive; and 3) for all respondents at the end of the survey. The combined average densities were: 20.85 fishermen in a 10km TURF, 15.96 fishermen in a quarter island TURF, and 32.78 fishermen in a whole island TURF. Generally the larger the TURF, the higher the reported preferred density, however the combined average reveals a higher density in a 10km TURF than a quarter island because of one unusually high response (see Table 2.4).

Table 2.4. TURF Density Preferred by Fishermen.

		Average Number of Fishermen	Average Density (fishermen/km)
Respondents who would join initially	Number of fishermen in 10km TURF	8.11	0.81
	Number of fishermen in a Quarter Island TURF (about 40 km)	16.38	2.44
	Number of fishermen in a Whole Island TURF (about 110 km)	29.33	3.75
Respondents who would join with top two incentives	Number of fishermen in 10km TURF	33.50	3.35
	Number of fishermen in a Quarter Island TURF (about 40 km)	15.54	2.57
	Number of fishermen in a Whole Island TURF (about 110 km)	36.22	3.03
Final preferred density	Preferred kilometers	31.55	0.84
	Preferred number of fishermen	10.92	

For all participants willing to join a TURF (with or without incentives), the preferred enforcement entity for the 10km TURF was divided between "participating fishermen" (59%) and "a joint effort between the GNP and participating fishermen" (41%). These numbers shifted as the TURF size increased. For a whole island TURF, 68% of respondents preferred a joint enforcement structure versus 29% favoring enforcement by participating fishermen, with 3% preferring the GNP as the enforcing entity. Generally, the larger the TURF, the more respondents preferred a joint enforcement structure.

In all of the TURF scenarios, respondents were overwhelmingly willing to assist with tasks other than fishing such as processing, selling, and monitoring. This was true even in several cases for fishermen who were not willing to join the TURF under any circumstances. The percentage willing to play a non-fishing role in the function of the TURF ranged from 92% to 95%, the largest percentage being for the whole island TURF. However, some respondents who did not want to participate in any TURF were not asked this question due to inconsistent survey instructions.

Characteristics Making Participants More Likely to Join a TURF

Through a logistic regression analysis, we found several characteristics that predicted willingness to join a TURF. These characteristics included: fishing ability (as determined by the reported number of lobsters caught), ownership of a boat, and targeted fish species. Results were only statistically significant for models assessing variables to predict the likelihood of joining a whole island TURF, and not for any other TURF size. It is important to consider that all of these models considered each variable individually, holding all other variables constant (see Table 2.5).

Table 2.5. Statistically significant Variables Influencing the Joining of a TURF

Variable	Intercept	Coefficient	St. Error	Z-value	p-value
Number of lobster caught by hand while freediving	1.726	-0.056	0.024	2.216	0.017
Number of lobster caught by Hawaiian sling with hookah	-0.020	-0.020	0.010	-2.107	0.035
Boat ownership	-0.693	1.455	0.613	2.373	0.018
Fish species	1.792	-2.120	1.123	-1.887	0.060

The number of lobster caught influenced the decision to join a TURF for two fishing methods: catching lobster by hand while freediving and catching lobster by Hawaiian sling with hookah. For both of these methods, catching fewer lobster increased the likelihood that a fisherman would decide to join a whole island TURF. We assessed the difference between a highly proficient fisherman and an inefficient fisherman by using the minimum and maximum number of lobster caught by both methods.

Number of Lobsters Caught by Hand while Freediving: Using equations from our logistic regressions in the table above (see Table 2.5), we found that for catching lobster by hand while freediving, the odds ratio of a fisherman who catches 3 lobsters joining a whole island TURF versus a fisherman who catches 100 lobsters by hand while freediving is 4.75/0.02 = 237.5. This means that a fisherman using this method who catches 3 lobsters is 237.5 times more likely to join a whole island TURF than a fisherman who catches 100 lobster. Out of all the results, this variable had the largest influence on predicting the decision to join a TURF.

Number of Lobsters Caught by with Hawaiian Sling with Hookah: Though the results for catching lobster by Hawaiian sling with hookah followed a similar pattern, the influence of the variable was not as strong. Using the minimum and maximum number of lobster caught with this method we found that the odds ratio of a fisherman who catches 5 lobsters versus a fisherman who catches 200 lobsters is 3.46/0.07 = 49.4. This means that a fisherman using this method who catches 5 lobsters is 49.4 times more likely to join a whole island TURF than a fisherman who catches 200 lobster. The complete distribution of lobsters caught by fishermen by hand and by hookah can be found in Appendix B.2.

Boat Ownership and Species Fished: Two other variables had statistically significant results: boat ownership and species fished. For boat ownership, we found that a fisherman who owns a boat is 4.28

times more likely to join whole island TURF than a fisherman who does not own a boat. For species fished (whitefish and lobster versus only lobster), a fisherman who fishes for only lobster is 8.33 times more likely to join a whole island TURF than a fisherman who fishes for both lobster and whitefish.

Photo 2.15. Fishermen and buyers at docks

Overall Social Cohesion

In addition to a collective interest in a TURF system, the level of homogeneity among users of interests and identities and the presence of shared norms for the sustainable use of a resource are important for reaching and maintaining sustainable agreements in the governance of common property resources (McCay et al., 2014; E. Ostrom, 2009). Without shared norms and a common vision, reaching agreements may be challenging and may result in high transaction costs. Several scholars describe the Galápagos culture as a "frontier culture," with relatively recent settlement fueling an increase in population and shortsighted overexploitation of resources (Hearn, 2008; Jones, 2013). Without a long history of occupation, shared norms about ethics and behavior are not strong in the archipelago's fishing sector. Hearn (2008) also describes a lack of a shared vision for the sustainable use of resources. Furthermore, fishermen cite the lack of unity as the principal problem with the cooperative COPROPAG (Ramírez et al., 2012). Additionally, the fishing sector is heterogeneous when considering characteristics such as ownership of a vessel and the level of dependence on the resource. This heterogeneity translates to varied interests and a lack of a common identity. Because fishermen would be coming to negotiations from different standpoints, this may increase the length of discussions and the support necessary to reach an agreement, thus increasing transaction costs. Lastly, Hearn (2008) also describes a widespread feeling of mistrust among members of the co-op. This social mistrust may lead to increased enforcement costs to ensure compliance with established agreements.

Management

Co-management

Co-management was found to be the most effective system for TURF management throughout the case studies we reviewed. The Law of the Special Regime for the Conservation and Sustainable

Development of the Province of Galápagos (LOREG) facilitate this type of management and allow decisions to be made at the regional level (Mauricio Castrejón, 2011). However, reforms to the law are currently being considered. The proposal for reform removes the PMB's voting role and transforms the agency to be nothing more than an advisory board. These reforms are expected to pass in spring 2014 and would convert the current co-management system into a top down regime. This would mean that the GMR and the GNP would make decisions regarding the fishery, with guidance from the Ministry of the Environment, the Ministry of the Maritime and Transportation, and the President (G. Banda-Cruz, personal communications, February 7, 2014). Decisions about fisheries management would have to conform to the national agenda, which would likely slow the decision-making process.

Photo 2.16. Staff at Galápagos National Park

Organizational Capacity

A strong fishing co-op would also facilitate the ease of establishing a TURF, but the current co-op structure does not indicate much strength or cohesion(Ramírez et al., 2012). The co-op was initially established to aid in the processing of lobsters to frozen tails for export. Currently, co-op assistance does not seem to span father than that infrastructure despite the potential to improve the condition of the fishery.

Leadership

Leadership within the fishery stems from the co-op presidents as well as the GNP. However, many fishermen we interviewed did not feel strongly tied to the co-op or the co-op leaders, who seem to have high rates of turnover. As for Park leadership, there are many employees of the GNP and several strong leadership positions. How fishermen view those leaders is not as well known.

Institutional Stability

Institutional stability of the GNP has historically been insecure. The GNP has frequent turnover of staff, exemplified by one instance when there were eight different directors of the GNP within a single year. During our time in the archipelago, the Head of Fisheries resigned and two park administrators, with whom we worked closely, were fired. While leadership within the GNP itself is unstable, there is a degree of consistency within conservation organizations and academics working in the islands to improve the depth of research and management of the resource, which can help inform the decision-making process.

Quality of Knowledge

Because the Galápagos archipelago is a treasured place and World Heritage Site, there are many organizations and stakeholders interested in its well-being. As such, there is a great amount of historical and ongoing data collection. This data is collected not only through the efforts of the GNP, but also through non-profit organizations and local and foreign academics that work collaboratively in the field and share data. While the data collected by the GNP is vast, collection methods could be improved for quality.

Photo 2.17. View from Fernandina Island to Isabela Island. Photo by Sue Cullumber

Geographic

Distance Between Fishing Ground and Population Center

There is substantial evidence that common pool resources are better managed when those who benefit from them the most are in close proximity to the resource (Elinor Ostrom, 1990). For the Galápagos Islands, residents are confined to 3% of the total land area of the archipelago, resulting in concentrated communities. Eighty six percent of this population lives within three main towns on San Cristóbal Island, Santa Cruz Island, and Isabela Island (Baine et al., 2007). For Santa Cruz Island, this means that the majority of people live in the town and fishing port of Puerto Ayora, located at the southern end of the island. Fishermen, however, fish in the coastal waters around the circumference of Santa Cruz Island (Bucaram, White, Sanchirico, & Wilen, 2013), which means that the user group not necessarily in close proximity to the resource. Our study results show that 80% of Santa Cruz

fishermen surveyed also report fishing off of other islands in the archipelago, further describing a fishing culture where fishing grounds are a relatively long distance away from population centers. Bucaram et al. (2013) also describes fishing behavior in the Galápagos as fluctuating and reliant on economic conditions rather than based on spatial behaviors. For such a system, allocation of fixed spatial rights in a TURF to fishermen may conflict with fishermen's tendencies to fish in different spots around the archipelago

The spatial layout of population centers and fishing grounds also indicates some complexity when considering the enforcement of a TURF in the Galápagos. Enforcement is critical in a rights-based management system because it fortifies the exclusivity for users (Elinor Ostrom, 1990; Wade, 1994). For the Galápagos, the enforcement aspect will likely be taken into consideration during the design phase of the TURF; however, it is more costly to monitor and enforce boundaries especially as the size of a TURF increases.

Clearly Defined Boundaries

Contributing to the problem with enforcement is the issue of a TURF in the Galápagos having clearly defined boundaries. Clearly defined boundaries are essential for TURFs, since the allocation of spatial rights hinges upon the ability to exclude non-users (Poon & Bonzon, 2013). Well-defined boundaries were an important factor to the success of the TURF system in Chile, where TURFs were easily defined as existing within a geographical cove, or a "caleta" (Bonzon et al., 2010). Since fishing grounds in the Galápagos span the entire circumference of the islands and lack convenient geographical features like large bays or coves, the boundaries of a TURF would be difficult to define and identify during enforcement efforts. The lack of easily identifiable landmarks and geologically enclosed areas to visually distinguish a TURF from an open-access part of the coastline poses problems for securing the TURF's borders.

Photo 2.18. Coastline of Isabela Island

DISCUSSION

After in-depth analysis of each factor the larger implications can be summarized (see Table 2.6):

Biological: Biologically, lobster is apt for spatial management due to it being a benthic species with a small home range and low mobility.

Legal: Though an outright law for the establishment of TURFs does not currently exist, the newly proposed GMR Management Plan could facilitate the development of such a system. Even in the case that the new Plan is not passed there is precedence for TURFs in Ecuador and a pathway to establish one.

Economic: Economically, only few fishermen and potentially the GNP could incur increased costs with a switch to a TURF system. However, the potential for both immediate and long-term increases in revenues from efficiency gains and a more strategic market approach outweigh the potential costs.

Social: While there is some cohesion amongst fishermen, the frontier mind-set and desire to maintain access to fishing grounds throughout the islands does not support the idea and collaborative demand of a TURF.

Management: Though some co-management currently exists, the potential LOREG reforms away from co-management would threaten the successful implementation of a TURF. Though there is ample access to helpful resources, the strength of the co-op, leadership, and institutional stability are not currently at levels that could facilitate a TURF.

Geographic: Due to the geographic layout of the islands and population centers, there are no immediately observable ideal places for a TURF to be located.

Overcoming Barriers

When we observe all the feasibility factors collectively, there are some barriers to implementing a TURF in the Galápagos. However, there are actions that can be taken to work towards overcoming these barriers:

Social: Social will and cohesion are not as strong as other regions that have seen successful TURF implementation. However, there is enough support to launch a pilot TURF on a small scale. This could serve to generate interest in the TURF system as fishermen witness the benefits that participating fishermen will likely experience.

Management: The current management structure is not ideal for implementing a TURF system. TURFs typically require both co-management efforts and stability in management. This barrier could be addressed by increasing the role of fishermen in the co-management effort. This would require an agreement between fishermen and the GNP that could not be easily broken.

Geographic: Geographically, the islands are not conducive to a TURF system because there are no real enclosed areas and because the population is located in one centralized location on the island. This can be challenging for enforcement and allocation purposes. However, the geographic element could be addressed through an in-depth analysis of design metrics that could yield a best-possible site for the TURF.

Table 2.6. Summary of TURF Feasibility Factors in Galápagos

Category	Factor	Present in Galápagos lobster fishery?
Biological	Adult home range conducive to spatial management	Yes
	Benthic species important for spatial management	Yes
	Migration patterns conducive to spatial management	Yes
	Larval dispersal conducive to spatial management	No
Legal	Existing legal structure to implement TURF/Ability to create legal structure to support	Yes
Economic	Species valuable enough to warrant protection	Yes
	Ability to increase efficiency & revenue for participants	Yes
Social	Fishing culture/method conducive to spatial management	No
	Social cohesion among fishermen	Some
Management	Co-management	Some
	Organizational capacity and strength of co-op	Some
	Leadership	Some
	Institutional stability (secure rights)	Some
	Quality of knowledge and decision-making	Some
Geographic	Distance between fishing ground and population center (Allocation)	No
	Distance between fishing ground and population center (Enforcement)	No
	Clearly defined boundaries	No

Photo 2.19. Children on a field trip to the fish market

CONCLUSION

To assess the feasibility of a TURF for the lobster fishery in the Galápagos Islands, we first created an evaluative framework. This framework was created by gathering common factors found in TURF case studies, empirical evidence, and literature on common pool resources. We assembled these factors into six main categories that are important to consider when establishing a TURF. The framework was organized into a logical hierarchy and Galápagos specific information relating to each category was laid into the framework.

After applying Galápagos specific information to the framework, we have found that a TURF system for the lobster fishery is feasible, but its implementation will require the hurdling of several barriers. Support for the biological, legal, and economic pathways is present. Social and management factors pose some challenges, but could be circumvented by starting with a smaller scale project to prove the benefits of TURFs to initially unwilling stakeholders. The geographic location of a TURF might be complex to determine, but through analysis of fishing grounds, landings, and habitat, a suitable site could be found.

Recommendations

Though more research would have to be conducted prior to implementing a large-scale permanent TURF, we recommend a pilot TURF for the lobster fishery.

"a TURF system for the lobster fishery is feasible"

Our recommendations specifically include:

- Implement a TURF pilot project off a portion of the coast of Santa Cruz Island for only live capture of spiny lobster.
- Restrict TURF access to active fishermen.
- Establish the pilot as an opt-in system, meaning that all active fishermen that want to participate can, and the rest do not have to – those that participate can only fish for lobster inside the TURF and nowhere else, and those that do not participate can fish for lobster anywhere except inside the TURF.
- Use the TURF pilot to increase the capacity of and collaboration within the co-op, which can foster increased efficiency for the fishing community including value added marketing and re-distribution of jobs.
- Advocate for LOREG reforms to support a co-management structure rather than a top-down system as the proposition currently stands.
- Collaborate with stakeholders and technical experts to specify the details of design for a large TURF system (i.e. size, location, number of participants, etc.).

Photo 2.20. Lobster season

Chapter 3:
Lobster Market

Photo 3.3. Selling lobster at the docks

A Study of the Local Lobster Market on San Cristóbal Island, Galápagos

OBJECTIVE

The primary objectives of this study were to:

1) Determine current local demand on San Cristóbal for lobster from restaurants, tourism operators, and tourists
2) Evaluate the potential increase in local demand given various future scenarios and the resulting ability to maintain the fisheries revenue given a catch reduction

This study began with the hypothesis that stakeholder support would be difficult to gain for a catch reduction in the lobster fishery unless economic incentives could be provided to fishermen. We measured the amount of lobster that restaurants and tourism operators will be able to absorb and determined how this had the potential to provide

Photo 3.4. Lobsters for sale

supplemental revenue that would offset income losses associated with catch reductions.

PROJECT SIGNIFICANCE

The Lobster Market On San Cristóbal

While the Galápagos archipelago has only four populated islands, each of these islands maintains its own unique characteristics. Differing landscapes, jobs, and populations have created individual identities for the islands. Specifically for the lobster fishery, the three main islands have individual cooperatives that are managed independently. As such, studying the entire Galápagos lobster market could be done, but more salient and informative data is obtained by analyzing each island separately.

The work of Castrejón (2012) & Velasco (2012) provides a comprehensive review for the Santa Cruz Island lobster market, but the market on San Cristóbal Island remains unstudied. San Cristóbal Island is home to the capital city of the Galápagos archipelago, Puerto Baquerizo Moreno, is the second most populated island, and is the second most visited island by tourists after Santa Cruz.

"potential to increase socioeconomic condition of fishermen… without increasing harvest levels"

By studying the San Cristóbal market we can create a baseline of information, and project the current and potential growth of local demand for lobster for this island. The impacts of the amount of lobster that remain in San Cristóbal versus the amount that is exported extends to local fishermen, local business owners, exporters, and other members of the value chain. Increasing the amount of lobster sold locally signifies an increase in the benefits of the local fishery that would remain within the island's economy. This study will provide direction for local decision-making for stakeholders of the market.

Increasing the amount of lobsters sold within the Galápagos economy has the potential to increase the socioeconomic condition of fishermen and other local stakeholders without increasing harvest levels of lobster (Ramírez, Castrejón, & Toral-Granda, 2012). However, this concept is contingent upon having a reliable and enforceable quota. Otherwise, increases in demand and price may have undesired increases in fishing pressure, which may lead to the overexploitation of the Galápagos lobster fishery.

Photo 3.5. Lobster sold as tails

BACKGROUND

The Global Lobster Market

The global lobster market is comprised of two main products:

Spiny lobster and American lobster, commonly referred to as Maine lobster. American lobster, *Homarus americanus*, is harvested mainly in the US and Canada. The term 'Spiny lobster' encompasses a number of species from the family *Panularidae* and is harvested throughout the world. Although both species represent a large potion of the global lobster market, the trends in supply, demand, and price for each are drastically different. For example, in 2013 the American lobster season experienced record low ex-vessel prices of $3.20 per pound and a trend of decreasing demand. In contrast, spiny lobster prices and demand continued to increase to $18 per pound in the same year. In 2008, American lobster represented 55% of the total global lobster production, while Spiny lobster represented 36% (Sackton, 2010); the remaining 9% of the market is comprised of various other species. American lobsters are mainly sold live to Europe and North America while the majority of Spiny lobsters are sold in the form of frozen tails to Asia (Sackton, 2010; Tselikis & McCarron, n.d.).

In the global market, lobsters are sold in a variety of forms including tail only, meat only, frozen whole, frozen halved, and live (Tselikis & McCarron, n.d.). The desired forms are dependent on demand from specific players in the industry. For example, 90% of lobster sold in US grocery stores is live, whereas restaurants purchase 50% tails and 50% mixture of other forms (Sackton, 2010). In the past, Galápagos fishermen used spears to harvest spiny lobster, preventing them from marketing whole lobster because of the damage to the body. The limitation of selling lobster only in tail form contributed to the low rates of product diversification and difficulty in entering new markets. By restricting their

Photo 3.6. Joint campaign by Rare and CI to discourage take of under-sized or egg-bearing lobsters

product to tails Galápagos fishermen were only able to market to a portion of the global lobster demand. A shift to harvesting live lobster for sale in the local market began in 2009 due to the drastic decrease of the international price for lobster. In the last two years, with the assistance of the conservation-focused nonprofits Rare and Conservation International (CI), Galápagos fishermen have

begun a shift in fishing practices from spear to hand capture (M. Vera & J. Moreno, personal communications, August 5, 2013). This method allows fishermen to sell diversified products and appeal to a larger portion of the global and local market.

The Galápagos Islands are one of many global producers of spiny lobster. The Galápagos lobster fishery is centered around two species: red spiny lobster, *Panularis penicillatus*, and blue or green spiny lobster, *Panularis gracilis*. Landings for lobster peaked at 95 tons in 1964, decreased to 30 tons by 1980, and has fluctuated between 15 and 95 tons during the '80s and '90s (Bustamante, Reck, Ruttenberg, & Polovina, 2000). Landings have averaged around 35 tons per year over the past 40 years with considerable inter-annual variation (Bustamante et al., 2000). The Galápagos lobster fishery has historically contributed 92% of the national lobster exports for Ecuador (Bustamante et al., 2000).

The commercial lobster fishery has been of great importance to the local culture and economy since the development of an export market in the 1960s. The Galápagos fishing industry, currently dominated by the lobster, provides valuable income and employment for artisanal fishermen and the local community (Ramírez et al., 2012). The spiny lobster fishery has been the most consistent and significant source of income for local fishermen (Bustamante et al., 2000). Despite its local importance Galápagos lobster has little influence on a global scale. Galápagos has customarily exported the majority of the lobster harvest as frozen tail to the US (Baine, et al., 2007). Due to the relatively low volume of product produced Galápagos is a 'price taker' in the global market.

Photo 3.7. Fishing boats

In the last few years three issues have affected the lobster fishery and fishermen in the Galápagos: the strong presence of intermediaries in the export value chain, the world economic crisis, and the lack of diversification of products. During the 2012 fishing season, there were approximately 362 active lobster fishermen in the Galápagos (Galápagos National Park, 2013). Because fishing is a time-intensive process, most fishermen do not have the ability to market their products directly to customers. Instead, they rely on exporters and intermediaries to sell their catch. As lobsters leave the Galápagos, they typically pass through exporters, distributors, and wholesalers before reaching their final destination. Each of these intermediaries captures a piece of the margin, leaving less for the Galápagos fishermen as the supply chain lengthens.

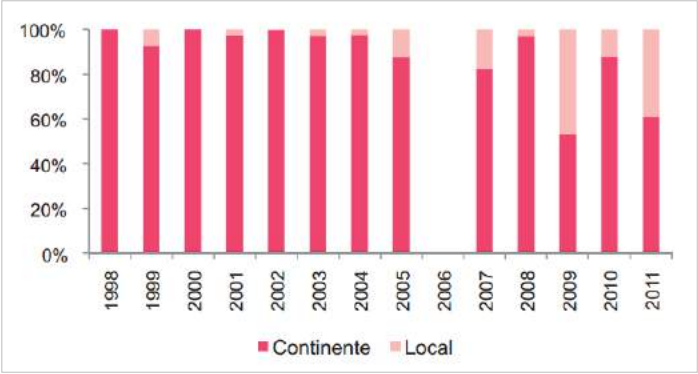

Figure 3.1. Proportion of lobster sold as exports vs. sold locally. WWF Report (2012)

At the start of the global economic recession in

the fall of 2008, lobster prices were high. As global consumer demand dropped, inventories of frozen lobster began to increase (Tselikis & McCarron, n.d.). The ensuing decline in price was dramatic, falling from $26 per pound of tail in 2008 to $17.60 per pound of tail in 2009 (Castrejón, 2013). In response to low export prices, more lobster was sold locally within the Islands. Local sales increased from 10% to 54% of total landings. Increasing the percentage of lobster was sold locally in Galápagos allowed fishermen to capture higher prices for their catch as the middlemen were eliminated from the value chain (Ramírez et al., 2012). Although export prices have rebounded since 2009, the proportion of lobster that has remained in the local market has experienced considerable annual variability. This variability demonstrates that export price is not the only driver of the amount of lobster that remains in the local market.

Existing Knowledge of the Lobster Market in the Galápagos

World Wildlife Fund (WWF) published a compilation of studies and technical papers in their December 2012 report titled "Improving the Spiny Lobster Fishery in the Galápagos Marine Reserve." This report featured two studies focused on the lobster market on Santa Cruz Island, the main point of entry for all tourists traveling to Galápagos. One of these studies by Mauricio Castrejón (2012) focused on developing a strategy to improve the value chain of the lobster fishery. Economic and fisheries research combined with interviews of fishermen, middlemen, exporters, and cooperative leaders provided the general context for the production and commercialization of lobster and characterized the current value chain. Castrejón evaluated the impacts of varying the actors dominating the value chain and marketing of differentiated lobster products on the income of fishermen of Santa Cruz's fishing cooperative using an economic model. The results of this analysis suggest that fishermen actually maximize profit through the sale of whole lobster (live, fresh, or frozen) and through a fully integrated cooperative-led value chain (Ramírez et al., 2012). Local fishermen receive higher prices when selling to local businesses and individuals as opposed to selling to the global export market. The direct sale of their catch to restaurants allows fishermen to capture a greater percentage of the margin because the lobster does not pass through several hands.

"fishermen actually maximize profit through the sale of whole lobster"

The second study, conducted by Martín Velasco et al. (2012) assessed the current and potential demand for spiny lobster on Santa Cruz Island. Velasco et al. used secondary research and interviews conducted with restaurants, hotels, and tourism operators. The results suggest that demand for lobster on the island is primarily from affluent tourists from North America and Europe. By estimating the number of tourists of this demographic who visit the island during the lobster season and assuming that each tourist would eat one lobster per visit, the study found a potential market in Santa Cruz of 20,844 whole lobsters. These findings imply that, compared to current demand, there is a large untapped potential market in Santa Cruz for whole lobster. This study will be important for comparison to the study of the lobster market on San Cristóbal Island.

Mauricio Castrejón, in conjunction with Jorge Ramírez and others at WWF, has compiled relevant data on the lobster fishery into a database that was used throughout this study to provide parameters for demand curves, contextual information, etc. This database contains summaries of the lobster fishery including effort, total catch, catch per unit effort (CPUE), proportion of lobster sold locally versus exported, and average export price per lobster tail. While the work of researchers at WWF provides insight into the overall lobster fishery and market and the work of Castrejón and Velasco et al. focuses on Santa Cruz, a comprehensive study of the lobster market on San Cristóbal Island has yet to be completed.

Photo 3.7. Purchasers at the lobster market

Photo 3.6. The dockside market in San Cristóbal

GENERAL METHODS

Lobster Market

A baseline for current demand for lobster on San Cristóbal Island was constructed using data collected from restaurants, tourism operators, and tourists. The potential demand was then explored through a number of market scenarios. Each scenario assessed the consequences of changing one or more variables of the demand:

1. An increase in tourism on San Cristóbal Island
2. Influence of a marketing campaign
3. Impacts of a certified lobster program
4. Changes in the export price of lobster tail

Secondary research was collected to obtain information such as the number of tourists visiting Galápagos annually, the number of restaurants and tourism operators, fisheries landings data, etc. Primary data for this study was collected by conducting surveys for tourists, tourism operators, and restaurant owners and managers.

Survey Design

The surveys for restaurants, tourism operators, and tourists were designed through a collaborative effort between our team, CDF, CI, and WWF. A complementary study of the lobster market on Santa

Cruz by Martín Velasco et al. (2012) was used as a foundation for the surveys so that the two studies could be readily compared. Many of the survey questions from the Velasco (2012) study were incorporated into the San Cristóbal market study. Our surveys also include additional questions proposed by CDF and CI. Throughout the survey design process we sought to limit the number of assumptions made to obtain the most representative results possible. Michael Henderson, Ph.D., Senior Director or West Coast Operations at Maritz Research, evaluated the efficacy of each survey. The surveys were designed to be administered in person with an interviewer reading and marking answers once the interviewee responded. The restaurant and tourism operator surveys were both in Spanish, while the tourist survey was in both Spanish and English.

Data Entry

The team entered data for each survey into three separate Excel spreadsheets, one for each group. The spreadsheets were designed to account for each question and its response, as well as all relevant data with regard to the individual or business surveyed, date the surveys were administered, and the name of the person who administered the survey. All original survey data were cataloged, numbered, and hardcopies were retained. During data entry, a coding system for troublesome or questionable survey responses was applied. This allowed for the team member entering data to consult with the survey administer for clarification.

Analysis of Data

Questionable survey responses and errors were removed from the final version of the data set prior to analysis. The categorical nature of the data made analysis in Excel effective. As such, the majority of the analysis was done in Microsoft Office Excel 2007 using existing Excel functions. Check counts were done using the =COUNTIF function, while cross-column check counts were done using the =COUNTIFS function. Survey questions that were "check all that apply" were summed for each option to give indication of the number of times an option was selected. Questions that asked survey takers to rank in order of preference were analyzed by calculating an average "rank" for each option, and compared to the number of times each option was chosen as the highest rank. Visuals for all the data were also created using Excel.

R Statistical Software was used to run chi-squared tests to determine significance between responses in surveys for our categorical data. Standard error and distribution patterns were also calculated or analyzed in R. Our raw survey data were first converted to a format usable by R Statistical Software, to ensure compatibility and uniformity.

Photo 3.8. Lobster season for restaurants

Photo 3.8. Lobster meal.

RESTAURANTS

Methods

Forty-eight restaurants on San Cristóbal are currently operating. Two restaurants known to sell lobster declined requests to be surveyed, resulting in a total of 46 completed surveys, or 96% of all restaurants on the island. The two restaurants were still incorporated into the study and the methods for these calculations are addressed in the section for calculating demand.

The restaurant survey was systematically implemented on San Cristóbal by the team and two local volunteers. The town of Puerto Baquerizo Moreno was divided into sections so that all restaurants could be accounted for. The team and volunteers were assigned sections to complete surveys in order to achieve a census. All of the surveys were administered in-person with the team member or volunteer reading the question and all possible responses. Team members would visit restaurants during slower business times so as to limit the disruption. Upon arriving at a restaurant to be surveyed the manager or owner would be requested. A screening question of whether or not the establishment serves lobster was asked. If the response was negative, a follow up question for the reason the restaurant did not serve lobster was asked.

Among other questions, we asked each establishment whether their main customers were international tourists, national tourists, or locals. We asked how often each group orders lobster and the most important factors for clients when ordering lobster in their establishment. We also asked

restaurants about their customer's perceived interest in a certification for lobster that would state the lobster the restaurant carried was caught locally and legally in Galápagos, as well as the restaurant's interest in such a certification.

Limitations/Assumptions

There are restaurants on the island that are not officially recognized by the Ministry of Tourism. We believe we reached all officially recognized and unrecognized restaurants on the island. However, we did not have the ability to fact-check a list of establishments with the Ministry of Tourism. All restaurants, regardless of status, were included in order to gain a more accurate understanding of the demand for lobster.

Results

Ninety-six percent of food-serving establishments on San Cristóbal, 46 out of 48 restaurants, were surveyed. Over half (54%) of all restaurants on San Cristóbal serve lobster (Figure 3.2) during the lobster season. Regulations forbid the sale of lobster outside of the lobster season to prevent poaching and illegal harvest. Of the 22 restaurants that do not serve lobster the most common reasons for not doing so were the type of food typically offered (fast food only, 19%), no interest from clients (19%), and doesn't offer value to the menu (13%) (Figure C1).

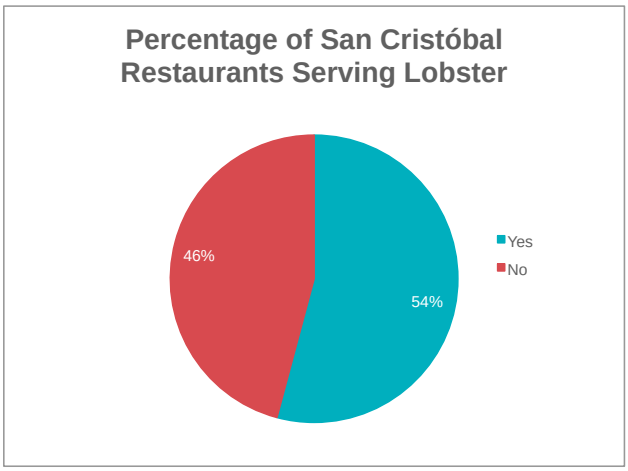

Figure 3.2. Percentage of restaurants that serve lobster on San Cristóbal

A greater level of coordination between fishermen and restaurant owners may increase efficiency and translate into financial gains for both the fishermen and the buyers. Information regarding the source and the frequency with which lobster is purchased can be important for determining if efficiency can be increased throughout the supply chain. Of the restaurants that purchase lobster, the most frequent response was that they purchase lobster 1-2 times per week. No restaurants purchased lobster more than 4 times per week. Seventy-six percent of establishments purchase directly from the fishermen and 16% purchase from the docks, which implies purchasing directly from fishermen or their wives (Figure C2). Both of these channels are assumed to be synonymous with direct sale, as the transaction is made either by the fisherman or his relative. Only 8% of restaurants surveyed reported purchasing from the market, but may also be referring to the 'fisherman's market' at the dock (Figure C2). When questioned why restaurants purchased from their chosen supplier the most frequent response (41%) stated that it was cheapest, followed by most convenient (21%) (Figure C3).

To determine whether trust or reliability of suppliers was a problem for restaurants when purchasing lobster, they were asked if they held contracts or agreements for lobster purchases with any providers. Although the majority (74%) of restaurants have always sourced lobster from the same provider

(Figure C4), only two restaurants have purchasing agreements arranged (Figure C5). This allows the majority of restaurants to determine their purchasing frequency and volumes on a day-to-day basis.

Factors that influence the purchasing habits for restaurants can provide information as to the barriers associated with offering different types of lobster. All of the restaurants surveyed purchased red spiny lobster while only 5 purchase both red and green species (Figure C6). Barriers to purchasing green lobster exist in the supply chain as 43% of respondents stated that fishermen do not offer it. In addition to a lack of availability, appearance and taste (both 14%) were cited as reasons the green spiny lobster was not purchased (Figure C7). Historically, the only form of lobster available for purchase on the island was tails, due to the use of spearing as the main method of capture, which punctures the cephalothorax. With a recent transition from spear to hand captured lobster, 78% of restaurants currently purchase lobster in the whole form: 66% purchase whole live lobsters, 12% purchase whole fresh lobsters, while only 22% purchase tails (Figure 3.3).

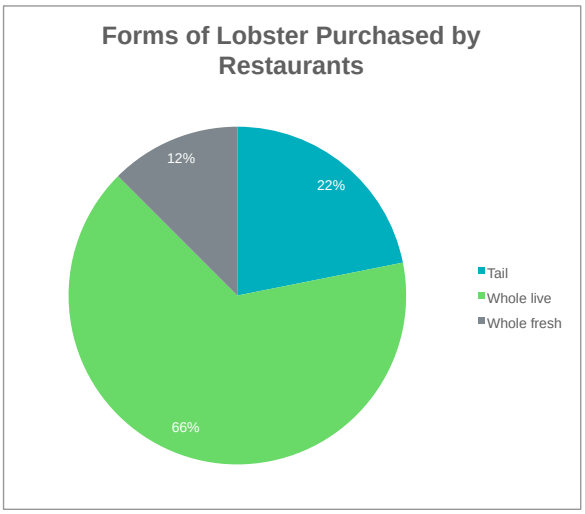

Figure 3.3. Percentage of restaurants that purchase whole lobster versus just tails

The form purchased is largely a result of what dishes are offered in a particular restaurant. The majority (56%) of restaurants serve whole lobster. Tail and ceviche were the other main forms offered, with 22% and 17% of restaurants offering these dishes, respectively (Figure C8). When tails were listed as the form restaurants preferred to purchase, it was because they only offered lobster in ceviche.

The size of a lobster can be an important characteristic for restaurants when making purchasing decisions. For example, a 6-pound lobster will not fit on a restaurant plate. According to our survey, 51% of restaurants prefer medium size lobsters. The preferences for small and large were 20% and 29% respectively (Figure C9). When asked to *rank* preferences for lobster sizes, a more detailed picture on size preferences can be drawn. Small sizes were ranked last more frequently, represented 65% of the third choice rankings. Medium sizes were never ranked as a last preference and large sizes were ranked with the same frequency for first, second, and third (Figure C10).

Purchasing frequency is related to the restaurants storage capacity. All restaurants surveyed either stored their lobster in a freezer (72%) or refrigerator (28%) (Figure C11). This can be linked to how long these establishments are able to store their products. Almost all restaurants (73%) store their lobster for one week or less. Freezer storage for up to one week was the most common response (31%) followed by immediate consumption the day of purchase (23%) and refrigeration for one day (19%) (Figure C12). No establishments have the storage facilities for live lobster.

In addition to size and storage capacity, other factors such as freshness, quality, and color can influence the decisions of restaurants when purchasing lobster. When questioned about the importance of these factors when buying lobster, freshness, quality, size, and price were most often ranked as the top three influencers (Figure C13). Freshness had the highest rankings overall and was most frequently ranked as the number one factor. Size was also often ranked as number one and had higher rankings overall than quality. Quality had higher combined number one and two rankings than freshness. Price was chosen as the fourth most influential factor for rankings overall. The only other factors to be ranked as number one were: provider can deliver sufficient quantities and reliability of provider.

As we have seen through our survey results, price has a large influence on restaurant purchasing habits. Because restaurants buy lobster in both tail and whole (live and fresh/not live) forms, maximum and minimum prices for each form and size were obtained through our survey. The price per pound of lobster tail ranged from $4 to $30 (Table 3.1).

Table 3.1. Minimum and Maximum Prices for Lobster Tail 2012 Season

	1 Pound of Lobster Tail
Lowest Price	$4.00
Average Lowest Price*	$8.43
Highest Price	$30.00
Average Highest Price*	$13.39

*Average minimum and maximum prices were calculated based on survey data requesting the highest and lowest prices paid by individual establishments during this time period.

Table 3.2. Minimum and Maximum Average Prices for Sizes of Live Lobster By Size 2012 Season

	Small Lobster	Medium Lobster	Large Lobster
Lowest Price	$2.86	$4.00	$4.00
Lowest Avg Price	$8.34	$11.41	$17.15
Highest Price	$10.00	$25.00	$30.00
Highest Avg Price	$8.57	$12.19	$18.43

Table 3.3. Minimum and Maximum Average Prices for Sizes of Live Lobster By Size Converted to Dollars per Pound of Tail 2012 Season

	Small Lobster	Medium Lobster	Large Lobster
Lowest Price	$8.41	$7.84	$4.71
Lowest Avg Price	$24.53	$22.37	$20.18
Highest Price	$29.41	$49.02	$35.29
Highest Avg Price	$25.21	$23.90	$21.68

Table 3.4. Minimum and Maximum Average Prices for Sizes of Fresh/Not Live Lobster Season 2012

	Small Lobster	Medium Lobster	Large Lobster
Lowest Price	$6.25	$8.33	$12.00
Lowest Avg Price	$7.08	$10.83	$19.25
Highest Price	$8.00	$15.00	$25.00
Highest Avg Price	$7.08	$12.08	$20.00

Table 3.5. Minimum and Maximum Average Prices for Sizes of Fresh/Not Live Lobster Converted to Dollars per Pound of Tail Season 2012

	Small Lobster	Medium Lobster	Large Lobster
Lowest Price	$18.38	$16.33	$14.12
Lowest Avg Price	$20.82	$21.24	$22.65
Highest Price	$23.53	$29.41	$29.41
Highest Avg Price	$20.82	$23.69	$23.53

The primary clientele of a restaurant has the potential to influence demand from restaurants. Of the restaurants that do serve lobster, the majority of restaurants responded that their main clientele group is international tourists (38%), which is illustrated in Figure 3.4. Only 17% of the restaurants indicated locals to be their main clients, reflecting the importance of tourism to the local economy (Figure 3.4). In addition, international tourists order lobster most frequently (Figure C14), followed by Ecuadorian tourists (Figure C15) and Galápagos locals. When asked about their clients' motivations for purchasing lobster, restaurants perceived freshness and quality to be the two most important factors. Size, price, and service/attention were all ranked fairly equally as third most important (Figure C16).

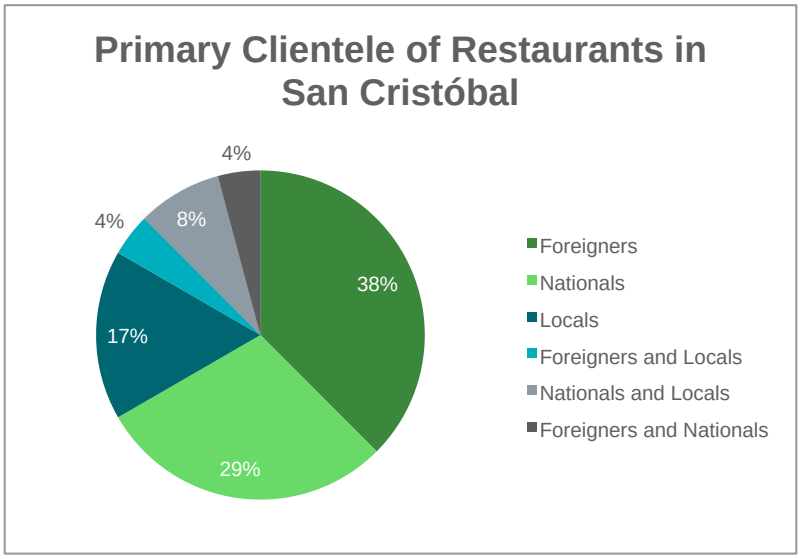

Figure 3.4. Breakdown of primary clientele for restaurants on San Cristóbal

An equal percentage of restaurants (39%) believed that their clients would and would not be interested in a certification program (Figure C17). During a few of our surveys, some interviewers observed qualitatively that younger interviewees tended to respond yes more frequently than older restaurant owners when asked about interest in certifications. Only 35% of restaurants believe that their customers would actually pay more for a certified lobster (Figure C18). The average range of a typical lobster dish in restaurants was determined through our interviews (Figure C19). Of the

restaurants that believed a higher price could reasonably be charged for a certified lobster the average acceptable increase was 15% to 21% (Figure C21).

Restaurants were questioned as to whether or not they believed problems existed in the lobster fishery. Only 17% responded yes, while 83% believed the fishery to be problem-free (Figure C21). Problems highlighted by restaurants included the lack of adherence to the legal size limit and an inability to sell lobsters outside of the lobster season.

Discussion

Restaurants that currently do not sell lobster will most likely not sell lobster in the future, as the number one reason cited for not selling lobster was the type of restaurant venue (i.e. fast food). Therefore, efforts to increase the amount of lobster sold to local restaurants should be directed towards those already offering lobster or other seafood entrees.

Almost all of the restaurants surveyed purchase lobster directly from fishermen without an established contract. Direct sale from fishermen to restaurants restricts the supply chain to a small number of players allowing for the highest freshness and quality, the most important factors for restaurants when purchasing lobster. Size also plays an important role for restaurant owners and managers when selecting lobster to purchase and the ability of the restaurant to see the product when the fisherman delivers it allows full disclosure for the restaurant to choose the product that suits their needs.

While the current system of sale between fishermen and restaurant meets the needs of the restaurants, creating consistency in the sales of lobster would increase efficiency. Due to the increased volume of lobster moving through the supply chain, the cooperative would likely serve as the intermediary through which transactions occur. Funneling all lobster through the co-op would allow for a price floor to be established. This would ensure that no fisherman undercuts another. Ease and consistency of sale may also benefit fishermen by giving them more time for other wage earning activities. A potential barrier to a fixed relationship is that some restaurants are satisfied with their current situation because they are not held to purchasing a specific volume on a consistent basis.

Our findings show that restaurants prefer to purchase medium sized lobster. This is relevant information for the promotion of legal fishing in Galápagos where one third of the catch is under the legal size limit (Hearn, 2004). Fishermen capturing illegal or small lobster may not be able to sell their catches as easily based on these restaurant preferences. It should be noted that some restaurants identified undersized lobster as a 'problem' with the fishery. This awareness may provide the opportunity to influence the size of lobster that is harvested. This is important because the capture and removal of undersized lobsters could negatively affect the biological stability of the population. An interesting observation is that price was not ranked highly as a reason for choosing a provider when purchasing lobster. This indicated that willingness to pay from the restaurants is higher than other channels. This may be because the mark up of lobster dishes in these establishments is high enough that they are not concerned about purchase price.

Finally, some restaurant owners agreed that their clients might be interested in a certification for lobster, but enthusiasm was not overwhelming. However, this information is speculative and a better indicator of whether a certification would be viable is the response from the tourists directly (see next section).

Photo 3.8. Restaurant owners in San Cristóbal.

In summary, our data show that more than half of the restaurants on San Cristóbal serve lobster and prefer to purchase whole, medium sized, red lobsters. These restaurants purchase lobster a few times a week directly from fishermen who bring their catch to the restaurant. This system would benefit from contracts or consistency in providers. Most restaurants' main customers are tourists, which underlines the importance of this demographic in increasing the amount of lobster absorbed locally.

Photo 3.11. Tour group at Sierra Negra, Isabela Island

TOURISM OPERATORS

Methods

Tourism operators are licensed businesses that currently own and operate a multi-day cruises around the archipelago. Through our research we found that ten tourism operators are based in San Cristóbal. Given the small number, we were able to survey all tourism operators. Isabel Haro, a researcher at CDF, initially administered surveys for this group. Upon receiving the results of these surveys, we developed follow-up questions for those that serve lobster. Team members administered these follow-up questions while on San Cristóbal. All surveys were administered in-person.

Limitations/Assumptions

Although all operators based in San Cristóbal were surveyed, many cruises are offered around the islands. It is possible that tour boats based on other islands purchase lobster on San Cristóbal. While on the island, we did not witness such events and do not believe such events to be commonplace due to third-party information. Tourism operators based on other islands were not surveyed and unaccounted purchases of lobster from San Cristóbal may occur and have an impact on the local demand. However, we believe this impact is likely small.

Results

All 10 of the tourism operators based in San Cristóbal were surveyed. These operators were all cruise ships that offered overnight trips. Out of these 10 tourism operators three companies (a total of four boats) purchase and serve lobster on their cruises. Thirty percent of operators currently offer lobster during the season (Figure C22). Of the seventy percent of operators that do not offer lobster on their tours the largest barrier to offering lobster was cited as cost (71%) followed by not operating during the season (14%) and environmental reasons (14%) (Figure C23). All three of the tourism operators currently purchasing lobster only buy red spiny lobster. The reasons they cited for not purchasing green lobster were that it is not offered as an option when purchasing and that the species is not common or unknown (Figure C24). All operators purchase their lobster on the island of San Cristóbal. These companies all source directly from fishermen and tend to vary their suppliers during and between seasons.

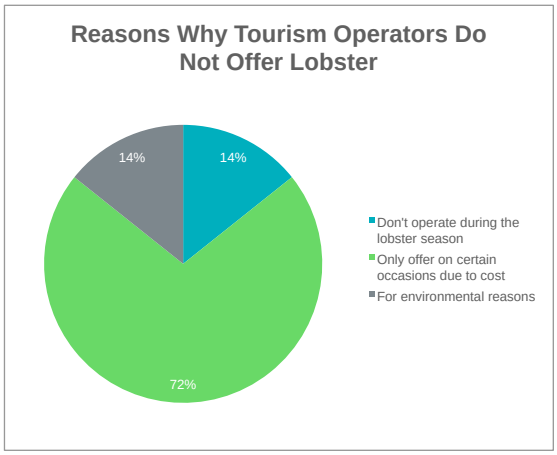

Figure 3.5. Responses for reasons tourism operators do not serve lobster

Several factors such as quality and freshness are major considerations when tourism operators purchase lobster. Tourism operators purchase lobster in a variety of forms including whole frozen, whole fresh, or tail only (Figure C25). Because the meat is primarily located in the tail section, the form can drastically affect the price and, therefore, the willingness to purchase. Among the most important factors when selecting lobster

Photo 3.12. Tourism cruise boat

for purchase are price, quality, and freshness. These factors are followed by size, reliability of the provider, logistical capacity of provider, color, and processing amount/form. All companies store their lobster in freezers onboard their vessels and do not have the ability to offer live lobster onboard.

Tourism operators in San Cristóbal do not purchase green lobster largely because their providers do not offer it. In addition to a lack of availability, appearance and taste (both 14%) were cited as reasons the green species was not purchased. When considering the amount of green lobster relative to red lobster landed on San Cristóbal, 106 kg and 13,919 kg in 2012, respectively, the reason for this is clear. It is likely that this small amount of green lobster is exported as tails. Furthermore, green lobster is more typically found off the coast of Isabela Island, comprising almost half of the total landings for green lobster in 2012.

The tourism operators surveyed cater mainly to foreign passengers from a variety of countries. The cruises range from 7 to 15 days and have a capacity of 16 clients per cruise. All of the companies believe their clients would be interested in a certification for Galápagos lobster.

Lastly, two of the operators that offer lobster shared their perceived problems within the lobster fishery. Their main concern was that the price of lobster often fluctuated due to the timing of the season or season length as well as the availability of buyers. This price volatility affects cruise operating costs. A lack of year-round supply of lobster and an insufficient amount of buyers to support the local fishermen were also cited as problematic.

Discussion

The primary reason tourism operators expressed for not buying lobster was cost. This is a difficult barrier to remove, as the price of lobster is high due to the costs associated with harvest. If tourism

Photo 3.13. Tourists enjoying a snorkeling trip

operators are able to provide their clientele with provisions sourced elsewhere for a more economical rate it is unlikely that they will transition to purchasing a high value item such as lobster. Operators may be able to differentiate from their competitors by offering certified lobster. However, this would most likely have to be incorporated into the pricing for the trip package as an upgrade. Buying lobster from the same fishermen throughout the season and offering a set price may provide an incentive for fishermen to sell their catch for a lower wholesale price, knowing that they are guaranteed a consistent sale. Considering the opportunity costs associated with the current method of selling their lobster (primarily door-to-door sales), a consistent sale would benefit the fishermen. Operators recognize the detriment that inconsistency in price and buyers can have to the fishing community and may be open to a cooperative agreement.

TOURISTS

Photo 3.14. Tourists enjoying the sun

Methods

We consider tourists to include anyone who does not live on the islands. Due to the large population size of annual visitors to the Galápagos, we calculated a sample size of tourists that would give us 99% confidence in the survey responses. To calculate the sample size we considered our population to be tourists visiting during the current lobster season (mid-August through December). Using the tourism data from 2012 provided by Daniel Orellana at CDF, we summed the total tourists that visited each month during the lobster season. It should be noted that although six years of tourist data were available to us, we decided to only use the 2012 data for this calculation. Since tourism is growing, averaging the last six years of data would underestimate the current and future population values. The length of lobster season changes annually, but generally begins the middle of August and lasts through the end of December. August was divided in half, taking the number of tourists for the final two weeks of that month and all tourists visiting from September to December were included. The total number of tourists for this time frame was 61,380, which was set as our target population. With this total population number we set target confidence levels and intervals and calculated the requisite sample size for surveys. Our target survey response was 205 surveys, which yields a 99% confidence level in our responses with a

Photo 3.15. Tourists eating lobster

confidence interval of 9 around the mean responses. We were able to obtain 256 interviews, of which 231 were tourists.

The tourist survey was administered at the airports on Baltra and San Cristóbal. A local volunteer administered 20 in-person surveys at the airport on San Cristóbal. The team conducted 236 surveys at the airport on Baltra. Credentials were obtained at the price of $3 per person per day from the airport manager after a brief screening process. These credentials provided each team member access to the waiting areas beyond the security checkpoints where we were able to restrict our survey to only tourists leaving the islands. As travelers entered the terminal waiting area, team members approached them and inquired whether they would be interested in participating in a short survey. Each tourist was asked which language was preferred (English or Spanish) and the appropriate survey was given. An initial screening question was asked to ensure that the full survey was only administered to tourists and not residents of Galápagos. The only information requested from Galápagos residents was if they eat lobster and, if so, approximately how many they eat per year.

Limitations/Assumptions

The major assumption for the data collected for this group was that the tourists surveyed were representative of all tourists visiting the islands. Baltra and San Cristóbal airports are not the only exit points on the islands and either airport can serve tourists visiting all islands. We assumed that the decision of a tourist to eat a lobster while on vacation is not determined by which island they are traveling to. Any potential differences in consumption between islands would be due to barriers or limitations associated with lobster availability or visibility specific to individual islands, not a change in preferences by the tourists based on location.

Another limitation of the tourist survey was the fact that it was offered only in English and Spanish. While the majority of tourists approached had enough proficiency in one or both languages in order to complete the survey, there were a few tourists who were unable to participate given the language barrier. This is an expected limitation during any study targeting a diverse group of international travelers.

Galápagos residents were excluded from the tourist demographic through an initial screening question and accounted for approximately ten percent of the total individuals surveyed. The only question asked of locals was the number of lobsters they eat annually.

Results

The majority of tourists surveyed (59%) were international (non-Ecuadorian) and the remainder (41%) were Ecuadorian nationals (Figure C26). Of all tourists surveyed 74% responded that they do eat lobster while 26% of all tourists never eat lobster (Figure C27). The tourists who do eat lobster were further broken down into those who did eat lobster in Galápagos and those who did not (Figure C28). While almost half of all tourists ate lobster during their trip to Galápagos, a significant proportion of tourists who typically do eat lobster did not consume lobster while visiting Galápagos (Table 3.6).

Table 3.6. Responses for whether tourists ate lobster in Galápagos or not

Do You Eat Lobster (Did you eat it in Galápagos)	Number of Tourists	Confidence Interval
Yes (Ate)	114	[105, 123] or
	49%	[45%, 53%]
Yes (Didn't Eat)	58	[49, 67] or
	25%	[21%, 29%]
No	59	[50, 68] or
	26%	[22%, 29%]

The 25% of tourists that generally eat lobster but did not while in Galápagos are a key factor when considering the potential growth of the market. If this group could be persuaded to consume lobster, the impact on the local lobster market could be significant.

For those tourists that consumed lobster during their stay in Galápagos, the mean number of lobsters eaten was 1.89 per person (Standard Error = ±0.14). This number includes both red and green lobster.

The main reason individuals who usually eat lobster did not eat it while in Galápagos was because they were on an all-inclusive trip where it wasn't offered (43%). Other frequent responses included that it was not seen on the menu (16%) and the cost of lobster was prohibitive (15%) (Figure C29). Of the tourists who did eat lobster, the majority ate red (75%), whole (58%) lobster.

When asked about potential interest in purchasing a lobster that was certified as locally and legally harvested, 64% of all respondents said they would be interested. Fourteen percent were neutral to a certification and 22% were not interested in buying a certified lobster (Figure 3.6).

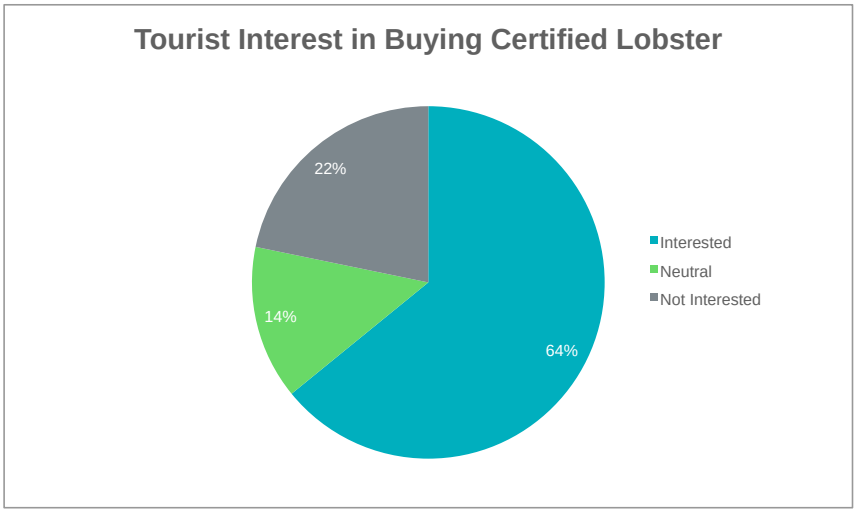

Figure 3.6. Percentage breakdown of tourists interested in purchasing certified lobster

In addition, 68% of international tourists and 56% of Ecuadorians expressed interest in a certification. A chi-squared test was run to determine the relationship between interest in a certification and the country of origin. We found the result to be statistically insignificant. The highest favorable response was from tourists from the UK (86%) (Figure C30). Although tourists from the UK expressed a high desire for certified lobster, these tourists represent only 4% of our total sample (Figure C31). Among those interested in purchasing certified lobster, the majority (42%) were willing to pay 20% to 25% more for that lobster than the current average price of a lobster meal (Figure C32). A chi-squared test showed that the level of income is statistically significant in affecting whether or not a tourist is interested in a certification.

When asked to rank their preferences for the form of lobster preferred, tourists ranked live lobster as their first choice most frequently (34%). This was followed by whole (29%), tail (24%), and portions (13%) (Figure C33). When considering a number of factors motivating the purchase of a lobster meal, tourists overwhelmingly ranked taste as the most important driver (54%), with all other factors as less important (ranging from 5% to 13%) (Figure C34). A chi-squared test failed to reject the null hypothesis that origin (National or International) does not affect ranking live lobster as first preference. The same test to determine if origin affects ranking live lobster last found a significant difference. International tourists were much more likely to select live lobster as their number one preference while national tourists were likely to select it as their least preferred.

Most of the tourists surveyed (77%) did not know that they could take lobster home from the islands (Figure C35). Of these tourists, 22% said that they would have taken lobster home if they had known they were able to (Figure C36).

Questions regarding annual household income indicate that 90% of tourists from mainland Ecuador earn less than $50,000 a year (Figure C37). The same question for international tourists demonstrates a much more diverse range of incomes, with approximately 23% percent of tourists earning less than $50,000, 41% percent earning between $50,001 and $100,000, and 36% percent earning greater than $100,000 (Figure C38). When examining the relationship between income and lobster consumption, 81% of the highest income bracket ate lobster compared to 64% in the lowest (Figure C39). A chi-squared test to determine whether income affects whether or not a tourist will consume lobster reported that income does not impact your decision to purchase lobster.

Tourists that visit the Galápagos Islands stay for an average of 8.63 days (SE = ±0.82) according to our surveys. According to databases at the Ministry of Tourism, the average stay for tourists on San Cristóbal Island is 2 days. To include time calculations in our current demand, we calculate percentage of time spent on San Cristóbal for the average tourist to be 2.00 days /8.63 days = 23%.

Photo 3.16. Lobster meal for tourists

Discussion

The most significant impact that tourists could have on expanding the local lobster market would be increasing the percentage of individuals with a propensity to eat lobster who actually eat lobster during their stay. When tourists cite their reason for not eating lobster, the most common response was that it was not offered on their all-inclusive trip. This would indicate that the largest group of potential people to eat lobsters could be reached through more tourism operators serving lobster. However, as mentioned previously, cost is a significant limiting factor for tourism operators when it comes to offering lobster to their clients. Work could be done to analyze ways in which it would be more cost-effective for tourism operators to purchase lobster for their menus. For example Forty-six percent of tourists stay on boats, which may be enough volume to create an economies of scale effect and allow tourism operators to purchase lobster in bulk at a discounted rate.

Tourists that stay on land have more access to lobster, so this group is the easier demographic to target for transition from not eating lobster to eating it. Initial efforts to increase the number of tourists eating lobster should be targeted toward the land-based group in particular because they are the 'low-hanging fruit.' Many tourists expressed an uncertainty as to whether or not lobster harvested in Galápagos was sustainably caught as well as hesitation about consuming seafood from a locale known for its conservation efforts. A campaign to create awareness for tourists about the health and responsibility of the artisanal fishery may be an effective means of increasing sales of local lobster to tourists on land.

Photo 3.17. Menu for lobster

Those tourists who cite the expense of lobster as preventing them from ordering it also represent a demographic whose behavior will be difficult to change, as the price of lobster is fairly consistent. A small amount of tourists also expressed that they did not see lobster on menus in local restaurants. Working closely with local restaurants to expand offerings to include lobster may also enhance the local market.

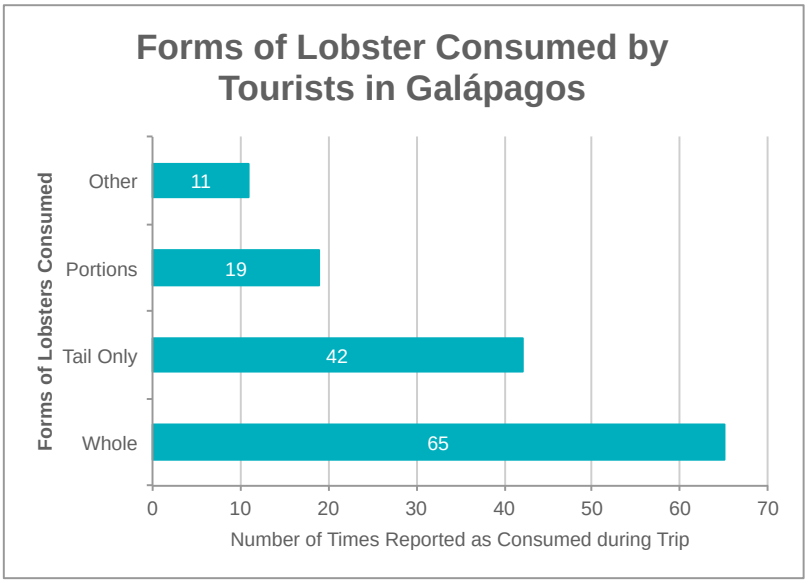

Figure 3.7. Presentation of lobster ordered in restaurants by tourists while in Galápagos

The majority of tourists who ate lobster during their trip ate red (75%), whole (58%) lobster. When ranking their preferences, live and whole lobster were the top two. The preferences of tourists tie in well with the management objective of live capture only (no spearing), which has been growing in the past few years.

A large proportion of surveyed tourists (64%) expressed an interest in a certification for lobster, stating that they would be more inclined to purchase a certified lobster and would be willing to spend up to 25% more for a certified lobster versus a lobster without the certification. This information could be useful in promoting the sale of lobster in local restaurants and to show restaurants that tourists can be influenced by certifications. Although studies show that reported willingness to pay is consistently

over-stated in surveys, Galápagos tourists are a differentiated demographic that is likely to be highly receptive to eco-labeling. The interest in certifications could potentially increase the revenues from the lobster fishery because certified lobster is a value-added product.

Projected Tourism Growth

A comprehensive database for all Galápagos tourism statistics over the past six years was obtained from Daniel Orellana at CDF. This database provided us with an accurate number of tourists visiting the islands annually. Using the number of incoming tourists each year, we ran a linear regression using data from the past six years. From this regression we made projections on likely increases in tourism growth for the future.

Limitations/Assumptions

We only used data from the previous six years to make projections about the future growth of tourism. We assumed that this data will be most representative of the likely patterns in tourism in the future rather than the extensive data on historical tourism patterns that date back to 1979.

Although tourism numbers have fluctuated up and down in the past 6 years, a linear regression analysis of the past 6 years of tourism data gave a growth equation of:

Equation 3.1. $$Y = 4014\,x + 158795$$

The equation uses X-values of 1 through 6, corresponding to the years 2007 to 2012. The slope of the equation represents our estimation of average tourism increase at 4,014 visitors per year.

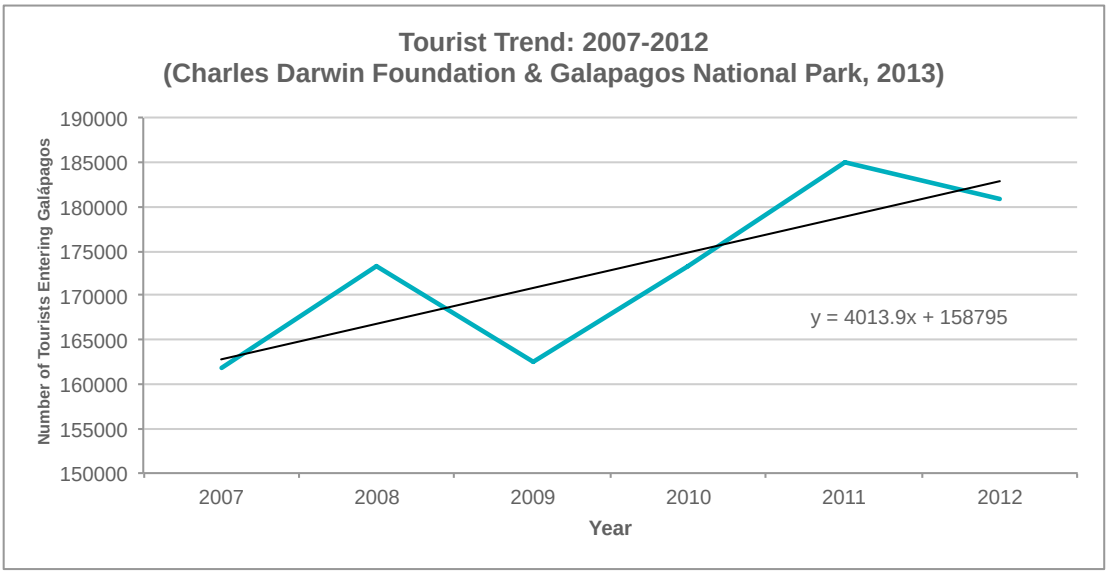

Figure 3.8. Historical tourism trends for the Galápagos from 2007-2012

Determining Lobster Sizes

Methods

Photo 3.18. Measuring lobster tail length

In Galápagos, the price of lobster is based on three size classifications: small, medium, and large. These size classifications are not formally established on the islands, rather casually understood by all stakeholders. Each size has an associated range of prices. In order to calculate demand from the survey responses, a formalized estimate of weight for each size class was required. To obtain a standard estimate for the weight of each class of lobster, all available biological data from the shared database compiled by Mauricio Castrejón was accessed. The historical length and weight data for red spiny lobster were divided equally into thirds, with the lowest third signifying the small size lobster, the middle third values representing the medium sized lobsters, and the upper third relating to the largest lobsters. With the sizes broken down into these three classes based on length, the median lengths and weights of each category were found (Table 3.6.). The median was used due to a large range of values and outliers that skewed the mean. The median weights from each category were then applied to the demand calculations to provide reliable estimates of total weight in pounds purchased.

Results

Using the database compiled by Mauricio Castrejón that contains all biological data from 1995-2011, we were able to summarize lengths and weights of lobster into three sizes (Table 3.6). We used this information to determine a size to weight relationship for the categories of lobster sold in Galápagos (small, medium, large). From our calculations:

Table 3.6. Average sizes and respective weights for Galápagos lobsters

Size of Lobster	Total Length (cm)	Median Length (cm)	Median Weight (lbs.)
Small	12.8 and 25.7	24	1
Medium	25.8 and 28.5	27	1.5
Large	28.6 and >	31	2.5

CURRENT DEMAND

Methods

Current demand for lobster was calculated using responses from our restaurant and tourism operator surveys. Responses were received in two units: pounds of lobster purchased per week and number of lobsters purchased per week. Using the size to weight relationship we calculated for small, medium, and large lobsters, we converted all responses from number of lobsters to pounds of lobster. Because the lobster quota is measured in metric tons of lobster tail and individual lobsters are measured in pounds, we converted all responses to weight in pounds for individual lobsters and kilograms for season totals. Season totals were then converted to kilograms of tail for direct comparison to the quota. Weekly totals for lobster purchases from each restaurant were summed to calculate the totals from both restaurants and tourism operators for the year.

Photo 3.19. Buying lobster

For the two restaurants that declined interviews but were known to serve lobster, we used an average of the converted pounds per week from other restaurants to estimate their purchases. These numbers were multiplied by the duration of the 2012 lobster season (19 weeks) to obtain a season total. It should be noted there is variation in local consumption and supply throughout the season. However, there is a lack of quantitative data documenting it. As such, for the purpose of this calculation, we assume consistency in both local supply and demand. Season totals were compared to records of the GNP to determine alignment of numbers for local purchases versus exports.

Other data provided by the GNP helped to determine the overall total demand. This included the year-end summaries of total landings, the amount of lobster tail exported commercially, and the amount of lobster shipped to the mainland by local residents. The GNP calculates the amount of lobster tail exported through monitoring certificates that are administered to fishermen by the GNP. This certificate allows lobster fishermen to sell their catch legally. The GNP monitors the amount of lobster tail exported through commercial mobilization guides (or commercial guides) that are required for the export and commercialization of lobster tail. Lastly, GNP monitors the amount of lobster shipped to the mainland by local residents through domestic mobilization guides (or domestic guides), which are checked by GNP officials at the airport. Data from these sources and our estimation of local demand from restaurants and tourism operators were used to establish an estimate for overall total demand.

Comparing Tourists, Restaurants and Tourism Operators

A majority of the local demand flows through one channel with three actors: fishermen to restaurants/tourism operators to tourists. To ensure the legitimacy of our data, we compared the demand calculated for the restaurants and tourism operators to the current demand calculated for the

tourists. The volume of demand from the two should be comparable since the tourism operators and restaurants fulfill the tourists' consumption of lobster. From the restaurant and tourism operator surveys, the amount of lobster in pounds was known for the entire season. Using the tourist surveys, the summation of the number of lobsters consumed by each tourist was multiplied by the average weight of a lobster, to provide an estimate for the weight of lobster consumed by tourists in a given year.

We used the following equation to determine current demand from the tourist surveys:

Equation 3.2.

% of tourists that ate lobster in Galápagos * # of tourists during lobster season * % of tourists entering San Cristóbal * % time spent on San Cristóbal * # lobsters per visit * # pounds for the average lobster

We calculated the mean number of lobsters eaten per visit from tourists who responded that they did eat lobster during their trip. The percentage of time an average tourist spends on San Cristóbal was calculated by dividing the average amount of time tourists spend on San Cristóbal (gathered to be 2.0 days from Ministry of Tourism information) by the average amount of time tourists spend on their visit to the Galápagos Islands. In the results section, this number is compared to the total lobster purchased by restaurants and tourism operators.

Limitations/Assumptions

Using the data collected in our survey on tourists' length of stay, we calculated an average stay of 8.63 days on the Islands. We used this value instead of the 6.2 days reported in the 2007 Epler study, which we determined was likely to be outdated. Tourism has continued to grow over the past six years, so we believe that our recent data may be more representative of current tourists.

Results

Two approaches for measuring current demand were used:

1) Overall total current demand, which accounts for all lobster caught
2) Current local demand, which accounts only for lobster consumed in the Galápagos

Total Current Demand for Lobster

The total demand for lobster includes local consumption, lobster that is exported as gifts to the mainland by Galápagos residents, and exported lobster tail. The Galápagos National Park documents these last two exchanges through a permitting process for all exported lobster. In each GNP season summary, only commercially exported tail and total landings are documented. Local consumption is not distinguished in the data, but includes lobster consumed locally by residents at home and the amount bought by restaurants and tourism operators. The amount of lobster bought by locals and shipped to mainland is also not identified in the year-end summaries but is documented in a separate

Equation 3.3.

Local Consumption + Domestic Guides ("Gifts") + Commercial Guides (Tails Exported) = Total Demand (Landed)

GNP database. Using these two summaries, local consumption should, in theory, be easily calculated with local consumption encompassing demand from restaurants, tourism operators, and locals purchasing lobster for home consumption. The total amount of lobster purchased by these players is representative of the total demand both red and green lobster. This number should be equivalent to the quota set annually (in kg of tail), as illustrated by the equation below:

Current Local Demand for Lobster

This study focuses only on the local demand for lobster in San Cristóbal in order to evaluate the potential economic benefits for fishermen, restaurant owners, and tourism operators there. Local consumption can be broken down into lobsters bought by restaurants and tourism operators for consumption by clients, as well as lobsters consumed by residents at home, which is illustrated by the following equation:

Equation 3.4.

Restaurants + Tourism Operators + Home Consumption by Locals = Local Consumption (Demand)

As mentioned above, the amount of lobster consumed by local residents specifically is not

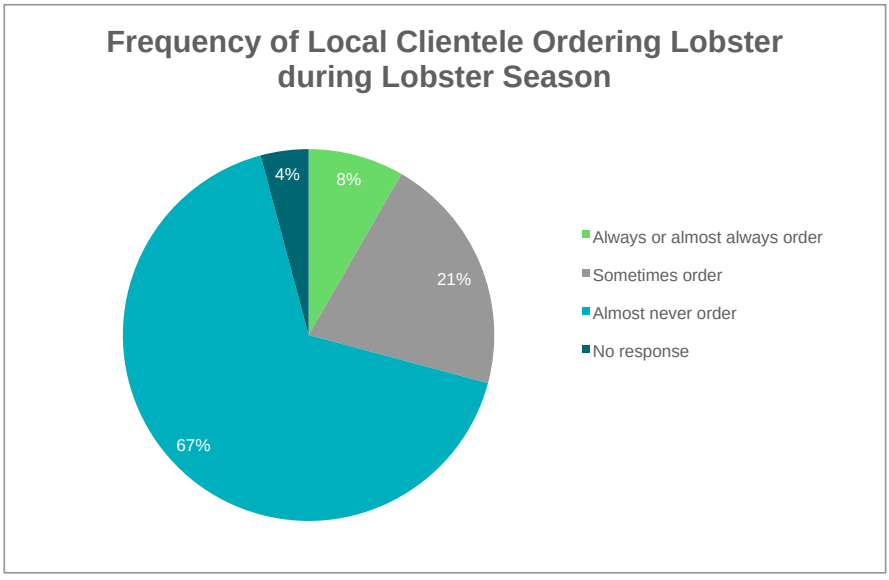

Figure 3.9. Frequency with which local Galápagos clientele orders lobster in local restaurants

distinguished in the GNP data. In our tourist surveys, we asked local residents how many lobsters they eat per year and found the average to be 6.52 lobsters. This number is does not distinguish between home and restaurant consumption. These purchases may be accounted for twice if locals are primarily eating lobster at restaurants. We assume that the amount actually consumed at home is small relative

to other parts of the market. Our assumption is based on restaurants responses that locals do order lobster in their establishments, although not nearly as much as international and national tourists.

In addition, the home consumption portion of the market is assumed to have minimal barriers in accessing lobster because local fishermen are well integrated into the San Cristóbal community and the fish market is common knowledge. Therefore, this part of the market is assumed to be relatively saturated and has been left out of our calculations. Some population growth for San Cristóbal will occur, although the influence this will have on the lobster market is unknown. We consider the total influential local demand, which focuses on demand from restaurants and tourism operators and is calculated with the following equation:

Equation 3.5.

Restaurants + Tourism Operators = Total Influential Local Demand

Restaurants and Tourism Operators

Of the 46 restaurants surveyed on San Cristóbal, 24 purchased and sold lobster in their establishments. Two restaurants informed us that they do serve lobster but declined to take the survey. Purchases were separated into three categories: red, green, and unidentified. Red lobster weekly totals are 483.75 pounds per week (9191.25 pounds per season), green lobster totals are 34.75 pounds per week (660.25 pounds per season), and unidentified (red or green) species are 10 pounds per week (190 pounds per season). The two restaurants that declined survey were assumed to sell red lobster because all establishments sold this species while only five sold both species. The average amount of red lobster purchased is 21.03 pounds per week (399.62 pounds per season) per restaurant. This totals to 42.06 pounds per week (799.24 pounds per season) for both restaurants. Therefore, the total current purchases for spiny lobster from San Cristóbal restaurants is the sum of the red, green, combined, and 2 declined restaurants and is 570.57 lbs/week (10840.74 lbs/season).

Of the 10 tourism operators surveyed, only three purchase lobster. All three purchase red lobster directly from fishermen on San Cristóbal. Demand from tourism operators sums to 89.40 pounds per week (1698.60 pounds per season).

The current local demand is the sum of the restaurant and tourism operator totals and is estimated to be 659.97 pounds per week (12539.34 pounds per season).

Comparison Between Tourists, Restaurants, and Tourism Operators

According to our percentage of tourists entering the islands:

Equation 3.6.

% of tourists that ate lobster in Galápagos * # of tourists during lobster season * % of tourists entering San Cristóbal * % of time spent on San Cristóbal* 1 lobster per visit * 1.5 lbs. for avg. lobster

Equation 3.7.

49.35% * 61,380 * 57.5% * 23.17 * 1.89 lobsters per visit * 1.5 lbs. = 11,443 lbs. or 5.19 MT total weight

This number is close to our calculated demand from restaurants and tourism operators (12,539 lbs. or 5.69 MT total weight, 1.94 MT tail weight). Therefore, we assume that the data we have collected is representative of actual demand on the island. Lobster consumed by Galápagos residents and the use of averaged values for calculations likely accounts for the disparity between the two values.

Galápagos Residents

Although not included in our calculations for local consumption, Galápagos locals purchase lobster for consumption at home as well as exporting lobster as gifts to mainland Ecuador by obtaining a domestic guide. The amount shipped to the mainland as gifts represented a significant greater amount than was accounted for in the total landings for 2012. Between Galápagos residents and visitors, about 1,300 people purchased lobster in 2012 to ship to the continent as gifts: 12,493 red lobsters and 85 green lobsters, for a total of 12,578 lobsters. Using the average weight of a medium sized lobster (1.5 lbs.) and the total weight to tail conversion factor of 0.34 for red lobster and 0.36 for green lobster, the total weight in tail can be calculated for the amount shipped to the continent through domestic guides for 2012 was approximately 2.911 MT (2,911 kg).

Comparison to GNP Documentation

The summary from the GNP for 2012 shows the total amount landed to be 14.025 MT (14,025 kg) and the total amount of commercial exports to be 12.668 MT (12,668 kg). The difference between the two should account for the amount consumed locally on the islands and the amount shipped to the mainland as gifts via domestic guides.

Using the following equation and data from the GNP, the amount of lobster available for local consumption and domestic guides (gifts) is calculated:

Equation 3.8.

Local Consumption + Domestic Guides (“Gifts”) + Commercial Guides (Tails Exported) = Total Demand (Landed)
Local Consumption and Domestic Guides (“Gifts”) should equal 1.357 MT

The difference is only 1.357 MT (1,357 kg) of tail for local consumption and gifts combined, while the total amount of lobster shipped to the mainland through domestic guides was 2.911 MT (2,911 kg) of tail in 2012. This is more than twice the amount that was calculated to account for these categories according to GNP totals. The amount of local consumption in restaurants and on cruises was 5.688 MT (5,688 kg), or 1.941 MT (1,941 kg) in converted tail weight. The summation of commercial exports, domestic guides, and calculated local consumption gives us a total of 17.584 MT (17,584 kg), which is significantly higher than total landing amount reported for 2012 (14.025 MT or 14,025 kg). This calculation is illustrated below and does not include lobster consumed by locals at home:

To calculate the discrepancy between the data from our findings and Park records, the recorded total landings is subtracted from the total amount from this study's findings:

Equation 3.9.

Local Consumption + Domestic Guides ("Gifts") + Commercial Guides (Tails Exported) = Estimate of Total Demand
1.941 MT + 2.911 MT + 12.688 MT = 17.540 MT

Equation 3.10.

Underestimation = Estimate of Total Demand = Total Landed Recorded by GNP
Underestimation = 17.540 MT – 14.025 MT = 3.515 MT

The amount of landed lobster potentially being underestimated is 3.515 MT (3,515 kg) of lobster tail. However, this value could potentially be even higher because the amount consumed by local residents is not included. The reasons for this discrepancy and its implications will be discussed in the following section.

Photo 3.20. Landed lobsters

Discussion

Potential Underestimation of Total Lobster Caught

Several scenarios could account for the fact that our estimation of the market demand is greater than the total landings recorded by the GNP. The first potential scenario is that more lobsters are actually being landed than are being recorded. Lobster fishermen fish at night and often arrive when dockside monitors are off-duty. Fishermen are supposed to return the following morning to register their catch and receive a monitoring certificate. However,

this may not be the case. Additionally, to ship lobster to the mainland as a gift, a resident or visitor only needs to submit a domestic guide and not a monitoring certificate (J. Ramírez, personal communications, December 13, 2013). This means that lobster that are included in the domestic guide data may not be included in monitoring certificate data, which is used to calculate total landings.

The second potential reason that the numbers do not align is that there are errors in data collection, transcription, or processing. The implications of this potential underestimation are significant from a biological perspective because the total landings calculated are much higher than the TAC. In addition, this exceedance of the TAC is a conservative estimate since it does not include consumption of locals in their homes. Because our study was only conducted for San Cristóbal, it is unknown if these problems exist on the other islands as well. Should this problem exist on other islands the total amount that the TAC is exceeded by would be even more drastic.

Photo 3.21. Cooking food in town

A further source of the differential could stem from errors in our own calculations. The amount of lobster purchased by restaurants may have been overstated in our surveys, which may have led to an overestimate of current local consumption. Also, domestic guide calculations were done using data from the GNP, which contained no units for volume. We had to make an assumption about the units, which could have been an incorrect calculation. Despite the potential for calculation errors, the discrepancy between the TAC and the calculated current demand is significant; the calculated current demand is 25% higher than the recorded landings and requires further examination.

POTENTIAL DEMAND

Methods

Once current demand was established, we aimed to project the maximum potential demand that could reasonably be found on San Cristóbal. There were two major scenarios considered: passive increases in demand and active increases in demand. Passive increases in demand rely only on growth in number of tourists entering the island and can be calculated with the following equation:

Equation 3.11.

Projected increase in the number of tourists entering Galápagos per year * % that visit during lobster season (Aug 15 - Dec 31) * % of those entering San Cristóbal * % time spent on San Cristóbal * % of tourists that eat lobster * # lobster/visit * # pounds for the average lobster

Working under the assumption that our surveys are representative of the behavior of all tourists in Galápagos this equation will provide a rate at which the local lobster demand will increase in pounds per year.

Active increases in demand are directed attempts to increase the amount of lobster sold locally and include social and educational marketing programs. Active increases can alter the following factors:

1) Increase the percentage of tourists that eat lobster while on vacation
2) Increase the number of lobsters eaten per tourist per trip

The ratio of the current number of tourists who ate lobster in Galápagos (L) to the total current demand can be used to calculate maximum potential demand with the addition of potential tourists who would eat lobster but did not (L_p). Both of these can be achieved using the following equation:

Equation 3.12.

$$\frac{L}{Current\ Demand} = \frac{L + L_p}{Potential\ Demand}$$

Using the equation, these projections can be altered and projected for different scenarios including:

1) With the current projected increases in tourism numbers
2) If Galápagos tourism were to be capped (no increase in the number of tourists)
3) Introduction of a marketing campaign to target either tourism operators or restaurants
4) Introduction of a lobster certification

Based on a regression analysis of the past six years of tourism data from the database provided by Daniel Orellana we assumed a linear increase in the number of tourists would continue.

Results

The range of potential growth of demand for lobster in the Galápagos Islands was determined by examining both the percentage of visitors from our survey that eat lobster (49%) and those that eat lobster but *did not eat* any during their trip to the Galápagos (25%). The remaining 25% of visitors are not considered part of the potential growth because they do not usually eat lobster and cannot be considered as potential lobster consumers while in the Galápagos.

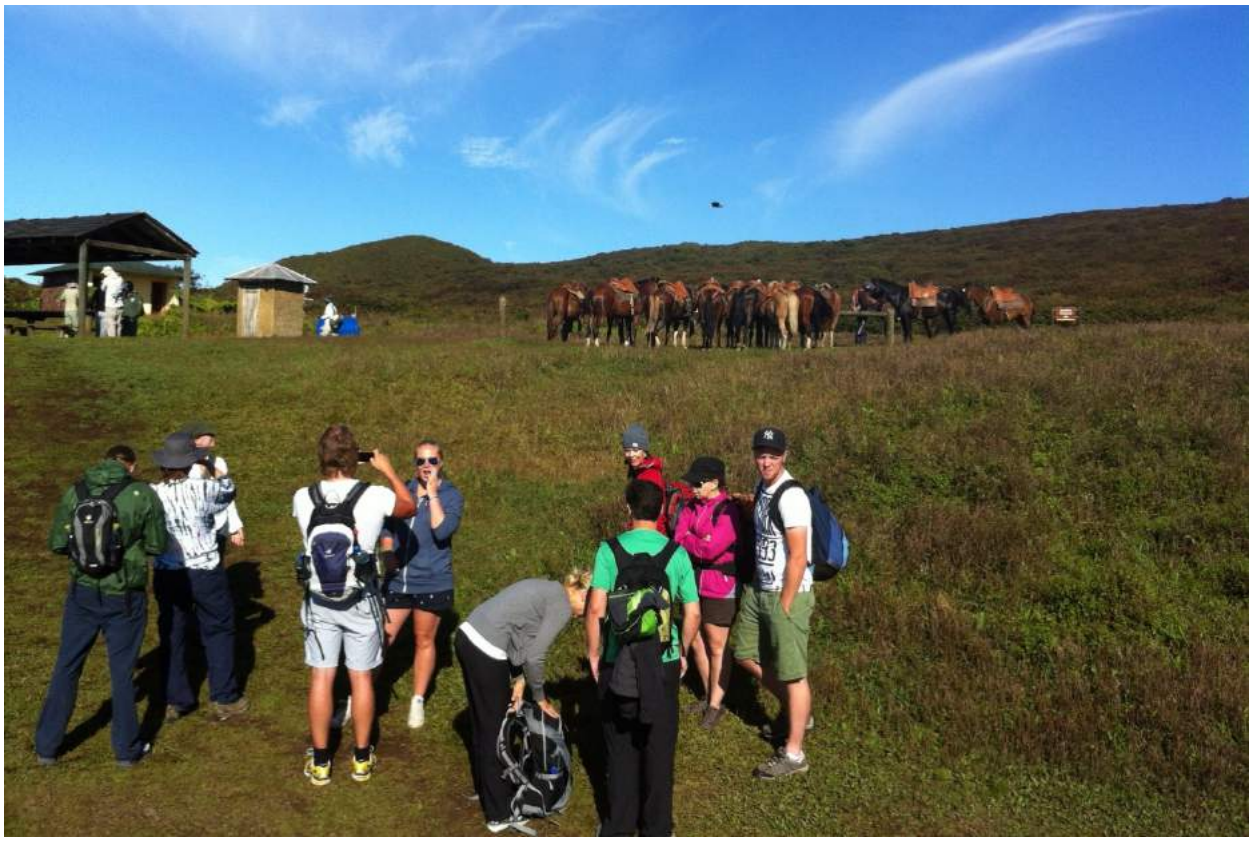

Photo 3.22. Tourists in Galápagos

Passive Increase in Potential Demand

For the first part of our calculation of potential demand we wanted to determine the possible growth in demand only from the continued increase in tourism that has been observed over the past few

Equation 3.13.

$$4{,}014 \text{ visitors/year} * 34\% * 58\% * 49\% = \text{Growth of } 387 \text{ lobster consumers/season}$$

years. Using a regression analysis of the past 6 years of data from 2007 to 2012 (Charles Darwin Foundation & Galápagos National Park, 2013), we determined that tourism in the Galápagos Islands grows at an average rate of 4,014 visitors per year. We assume that this rate of tourism growth will remain relatively constant in future years. Since lobster season is typically between the months of September and December, we calculated that 34% of all tourists enter during lobster season. We also determined through analysis of our tourist surveys that 58% of all tourists entering the Galápagos stayed overnight or spent time on San Cristóbal Island. This can be multiplied by the 49% of tourists who consume lobster while in the islands. Using these numbers, we can calculate:

Using this number with the average time spent on San Cristóbal of 2 days, or 23.17% of their trip:

Equation 3.14.

$$387 * 23\% = 90 \text{ lobster consumers/season on San Cristóbal}$$

Based on a rate of consumption of 1.89 lobsters per the average 5 day visit, and converting this number to actual growth in sale of lobster per year, we take into account the assumption that each lobster weighs an average of 1.5 pounds and that each visitor to the Galápagos will eat an average of 1.89 lobsters, with the result:

Equation 3.15.

90 visitors/yr. * 1.89 lobster * 1.5 lbs. = growth of 115.29 kg of lobster (254.17 lbs.) per year

With only the current trend of growth from the tourist sector and no change implemented by the GNP, local demand for lobster should increase by a rate of 115.29 kg of lobster per year (39.20 kg of lobster tail).

If there were no other change in market dynamics, it would take over a century for the growth in tourism alone to encompass the entire current supply of lobster.

Equation 3.16.

Current demand from tourism sector: 1941 kg tail per year
Demand growth in tourism: 39.20 kg of tail per year
Current exports (2012): 12,668 kg of tail
At current rate, natural growth in tourism demand will encompass all of current supply in
12,668 kg tail / 39.20 kg tail per year = 323 years

Given the duration that the current rate of tourism growth alone would take to absorb the current lobster supply, this outlet as the sole driver of market demand to absorb more lobster is infeasible.

Active Increase in Potential Demand

Next, we analyzed the possible change in local demand if the GNP were to create additional visibility and access for tourist consumption of lobster. This could be done through campaigns to either: 1) increase the number of people eating lobster each year to a proportion greater than the current 49% (with a maximum increase of 25%, the segment that eats lobster but did not

Photo 3.23. Restaurant and its owner in San Cristóbal

eat it in the Galápagos), or 2) increase the average number of lobsters eaten per person per year to a number greater than the current 1.89 lobster per person.

1) Increasing local demand by increasing the number of visitors consuming lobster

To understand the segment who eats lobster but did not while in the Galápagos, or 'potential lobster eaters' (25%), we have to refer to actual demand numbers based on our results. Restaurant demand from our data amounts to 4,917.28 kg (10,840.74 pounds) per season, while demand from tourism operators comes to 772.47 kg (1698.6 pounds) per season. This adds up to a total of 5,687.75 kg (12,539.34 pounds) -- which corresponds to the 49% of tourists that consume lobster while in Galápagos.

Since we know the actual weight of lobster corresponding with 49% of tourists, we can determine the weight of lobster that represents total potential demand:

Equation 3.17.

$$5{,}687.75 \text{ kg} = 49\%$$
$$X \text{ kg} = 25\%$$
$$5{,}687.75 \text{ kg} * (25\% / 49\%) = 2{,}894.01 \text{ kg lobster per season}$$

This number represents the total weight of lobster that can be sold per year if the entire segment of potential lobster eaters is convinced to eat lobster at the same average of 1.89 lobster per visitor (0.44 lobster per visitor to San Cristóbal).

2) Increasing local demand by increasing the average number of lobsters consumed

The potential demand can be increased significantly by raising the average number of lobsters eaten per person for the time spent in San Cristóbal. To determine a possible range, we made the following calculation:

Equation 3.18.

$$0.44 \text{ average} \rightarrow 5{,}687.75 \text{ kg}$$
$$0.48 \text{ average (10\% increase)} \rightarrow 5{,}687.75 \text{ kg} * (0.48 / 0.44) = 6{,}256.53 \text{ kg}$$

We looked at changes in average number of lobsters eaten from an average of 0.44 lobsters per person per trip (status quo) to 0.48, 0.53, 0.57, 0.66, and 0.88 lobsters (10%, 20%, 30%, 50%, 100% increases) to determine the potential demand if the same proportion of tourists ate lobster, but ate more on average (Table 3.7).

Table 3.7. Demand with an Increase in Amount of Lobster Consumed

Average lobsters Eaten (in individuals)	Kg of lobster eaten by current eaters (49.35%)	Converted to Kg of lobster tail	Percent of 2012 Total Landings San Cristóbal
0.44	5687.75	1933.84	14%
0.48 (+10%)	6256.53	2127.22	15%
0.53 (+20%)	6825.30	2320.60	17%
0.57 (+30%)	7394.08	2513.99	18%
0.66 (+50%)	8531.63	2900.75	21%
0.88 (+100%)	11375.50	3867.67	28%

3) Combining projections of increase in both number of people eating & average number of lobsters

Table 3.8. Demand with Increase in Lobster Eaters and Average Number per Person

Average lobsters Eaten (individuals per 2 days on San Cristóbal)	Kg of lobster for current lobster eaters (49%)	Kg of lobster for potential lobster eaters (25%)	Total kg of lobster with both	Converted to Kg of tail	Percent of 2012 Total Landings San Cristóbal
0.44	5687.75	2894.01	8581.76	2917.80	21%
0.48 (+10%)	6256.53	3183.41	9439.94	3209.58	23%
0.53 (+20%)	6825.30	3472.81	10298.11	3501.36	25%
0.57 (+30%)	7394.08	3762.21	11156.29	3793.14	27%
0.66 (+50%)	8531.63	4341.02	12872.64	4376.70	31%
0.88 (+100%)	11375.50	5788.02	17163.52	5835.60	42%

Passive + Active Increase in Potential Demand

Table 3.9 shows the increases in potential demand based on both passive (standard annual increase in tourism of 4,014 visitors per year) and active (increasing the number of people eating lobsters or the number of lobsters eaten per person) growth.

Table 3.9. Demand with Increase in Number of Lobster Eaters, Average Lobsters per Person, and Tourism

Average lobsters Eaten (individuals per 2 days on San Cristóbal)	Kg of lobster for current lobster eaters (49%)	Kg of lobster for potential lobster eaters (25%)	Total kg of lobster with both	Converted to Kg of tail	Percent of 2012 Total Landings San Cristóbal
0.44	5803.28	2952.79	8756.07	2977.06	21%
0.48 (+10%)	6383.61	3248.07	9631.68	3274.77	23%
0.53 (+20%)	6963.94	3543.35	10507.29	3572.48	26%
0.57 (+30%)	7544.26	3838.63	11382.90	3870.19	28%
0.66 (+50%)	8704.92	4429.19	13134.11	4465.60	32%
0.88 (+100%)	11606.56	5905.59	17512.15	5959.13	43%

A More Realistic Look at Potential Demand

For a more realistic look at how we calculate potential growth in demand, we input additional modifiers based on what we know about lobster market dynamics in the Galápagos Islands.

Tourists who stayed on boats vs. hotels

Table 3.10. Percentage of Tourists Who *Usually* Eat Lobster But *Didn't* As Categorized by Accommodation Type.

	Boat	Hotel	Both	Total No
Number of tourists	35	23	3	58
% Of Total	60%	**40%**	5%	

The largest number of tourists who eat lobster but did not while in Galápagos stayed on boats. So the largest potential gains would come from directing efforts to increase demand on cruises. Also, considering the majority of tour operators (70%) reported they do not ever offer lobster on their trips and knowing that the majority of these operators (71%) cited cost as the biggest reason for not offering lobster, we determined that the growth of demand in this segment of the market is restricted and not likely to expand. This indicates that the true potential for growth in demand in number of people is from people that stay in hotels, which is actually closer to 40% of our calculated potential demand. Therefore a more realistic calculation for potential demand:

Equation 3.19.

2894.01kg (our original potential demand) * 40% = 1,147.76 kg

Table 3.11. Demand with Increase in Number of Lobster Eaters Who Stay at Hotels and Average of Lobsters per Person without Passive Increase in Tourism.

Average lobsters Eaten	Current lobster eaters (50%)	Potential lobster eaters in Hotels (25%)	Total With Both	Converted to Kg of tail	Percent of 2012 Total Landings San Cristóbal
0.44	5687.75	1147.62	6835.37	2324.03	17%
0.48 (+10%)	6256.53	1262.39	7518.91	2556.45	18%
0.53 (+20%)	6825.30	1377.15	8202.45	2788.83	20%
0.57 (+30%)	7394.08	1491.91	8885.99	3021.24	22%
0.66 (+50%)	8531.63	1721.44	10253.06	3486.04	25%
0.88 (+100%)	11375.50	2295.25	13670.75	4648.06	33%

Table 3.12. Demand with Increase in Number of Lobster Eaters Who Stay at Hotels and Average of Lobsters per Person with Increase in Tourism

Average lobsters Eaten	Current lobster eaters (50%)	Potential lobster eaters in Hotels (25%)	Total With Both	Converted to Kg of tail	Percent of 2012 Total Landings San Cristóbal
0.44	5803.28	1170.94	6974.22	2371.23	17%
0.48 (+10%)	6383.61	1288.03	7671.64	2608.36	19%
0.53 (+20%)	6963.94	1405.12	8369.06	2845.48	20%
0.57 (+30%)	7544.26	1522.22	9066.48	3082.60	22%
0.66 (+50%)	8704.92	1756.40	10461.32	3556.85	25%
0.88 (+100%)	11606.56	2341.87	13948.43	4742.47	34%

Discussion

Implications of findings for potential demand

Our calculations show that there are two ways to produce the same increase in potential local demand:

1. Target the segment of tourists that usually eat lobster but did not while in the Galápagos and convince them to eat lobster
2. Increase the average number of lobsters eaten by each tourist on San Cristóbal from 0.44 to 0.66.

If both of these targets are realized, total exports would be absorbed by local demand; total export of lobsters on the Galápagos Islands was 12,668 kg in 2012 and these two scenarios combined would result in a demand of 12,872.64 kg.

Our analysis indicates that increasing local demand to acquire the entire amount of lobster landed will not be a quick and easy fix and will require the creative employment of multiple methods. It will be important to use a combination of increasing the average number of lobsters eaten and increasing the percentage of people who eat lobster in the Galápagos, assuming the projected growth in tourism will continue. Of course, each method will be associated with different costs and the most efficient method for cost and outcome must be determined.

It is important to consider the costs and efforts associated with each approach when assessing the viability of each method for increasing local demand. The least costly method of achieving the desired outcome would be the desired choice. If campaigns that target either growth in average consumption of lobster or conversion of potential eaters turn out to be less effective than expected, natural growth in tourism will provide contribution to absorbing exports.

What would increase in tourism mean for the Galápagos?

If local demand from tourism on the Galápagos Islands continues to increase at a steady rate (115.29 kg or 254.17 lbs. per year), and assuming that total current demand of lobster does not change significantly, it would take about 110 years for tourism demand to encompass all demand on the

Photo 3.24. The kiosks at night

Islands. This indicates that if local consumption of lobster is to be expanded-- thus reducing exports of lobster--it would take an extraordinary amount of time to absorb the total lobster landed by relying solely on natural growth in tourism. As stakeholders are likely to be more interested in a quicker shift

in market demand, this would imply that a passive approach to management would be ineffective at reducing the proportion of exported lobsters in the short-term.

Offsetting TAC restrictions through active increases in demand

Our results for potential active increases in demand can be translated into a percentage of the annual quota for San Cristóbal (Table 3.13). As an increasing proportion of quota is absorbed into the local market, revenues within the fishery will increase accordingly due to higher prices paid for lobster sold into the local market. Our study also finds a significant amount of underreporting of landings and confirms that overfishing is occurring. Both of these factors point to the need to reduce catch in the immediate future. This reduction in catch is not likely to be favorably received by fishermen due to the implications this would have for income. Our analysis identifies a method of maintaining the economic rents of the fishery through increases in demand within the local market.

When a larger portion of the quota can be absorbed locally (as in the case of our active demand scenarios), fishermen can offset the reduction in catch by increasing the proportion of lobster sold into the local market. Table 3.13 documents the reduction in landings the GNP could implement under different local demand scenarios while still maintaining the current revenue within the fishery.

Table 3.13. Percentage of landing absorbed (Active increases) and associated decrease in landings able to be offset.

Lobsters eaten per person per trip	% Landings absorbed by current eaters	% Of landings absorbed by potential eaters	Combined % of landings	Decrease in catch while maintaining current revenue
1.89	13.8%	7.0%	20.8%	8.3%
2.08 (10%)	15.2%	7.7%	22.9%	10.8%
2.27 (20%)	16.5%	8.4%	24.9%	13.1%

Increasing lobster consumption by 20% coupled with an increase in the number of lobster eaters can support a 13.1% decrease in catch while maintaining stable revenue within the fishery. When factoring in annual growth in tourism to this analysis, the numbers are even greater (Table 3.14). Including the projected increases in tourism each year, catch on San Cristóbal can be reduced up to 13.8% under the same scenario.

Table 3.14. Percentage of landing absorbed (Active and Passive increases) and possible decrease in landings able to be offset, including growth in tourism.

Lobsters eater per person per trip	% Landings absorbed by current eaters	% Of landings absorbed by potential eaters	Combined % of landings	Decrease in catch while maintaining current revenue
1.89	14.1%	7.2%	21.3%	8.9%
2.08 (10%)	15.5%	7.9%	23.4%	11.6%
2.27 (20%)	16.9%	8.6%	25.5%	13.8%

Implications

It is imperative that an accurate means of documenting all lobster landed and sold from the islands is developed prior to attempting to increase local demand, as increasing demand can have negative effects on the fishery if catch limits are not strictly enforced. This can result in higher rates of illegal fishing in order to obtain a higher price. Once succinct monitoring, documentation, and enforcement are established within the management system, increasing demand within the local market can be considered as a tool for garnering support of TAC reductions from fishermen.

COMPARISON TO VELASCO'S STUDY

Methods

One of the main motivations for developing the methodologies for this study came from a report by Martín Velasco et al. about the local lobster market in Santa Cruz. In order to compare the markets on the two islands, the results from the Velasco et al. study (2012) of the Santa Cruz lobster market are compared to the results of this study for San Cristóbal. Much of the methodology for Velasco et al. was similar to the methodology used in this study so most of the results can be compared directly. However, the methodology for certain results, such as the potential demand for each island's market, did differ and these differences must be considered when comparing the results. Additionally, Velasco et al. interviewed hotels, restaurants, and tourism operators, while this study interviewed only restaurants and tourism operators. However, in several sections, only the results for restaurants are compared, as they comprised the vast majority of the market for San Cristóbal Island.

For the Santa Cruz study, Velasco et al. interviewed 15 out of 26 hotels, 13 out of 30 restaurants, and 18 out of 65 Category A vessels in 2010. We interviewed 46 out of 48 restaurants and all 10 tourism operators on San Cristóbal. Because our study was conducted at the start of the lobster season, we assume that respondents were basing their answers on information from the previous lobster season (2012).

Prices

In the Santa Cruz lobster market study by Velasco et al., the authors found the market price per pound of tail to be between $8.00 and $10.50 for companies buying lobster locally. This study for San Cristóbal found an average minimum price of $8.43 and an average maximum of $13.39. The market price for whole lobster for Santa Cruz is estimated in the Velasco et al. study to be between $10 and $20 ($10 /small; $15/medium; $20 /large). With data from restaurants, this study for San Cristóbal found a range between $8.46 and $17.79 ($8.46/small, $11.70 /medium, $17.79 /large).

Tourists

The tourism data used by Velasco et al. for the Santa Cruz study came from the study *Tourism, the Economy, Population Growth, and Conservation in Galápagos* by Epler (2007) and from the Galápagos National Park. The tourism information used in this study came from CDF (2007-2012) and from information collected from surveys administered to tourists. In the tourism data used by Velasco et al., 65% of visitors were foreigners and 35% of the visitors were Ecuadorian. In our study, the majority of tourists surveyed (59%) were international (non-Ecuadorian) and the remainder (41%) was Ecuadorian nationals. In Velasco et al. 46% of the visitors stayed on cruise ships and 44% stayed in hotels. In our study, we found that 60% of tourists stayed on cruise ships, while 40% stayed in hotels.

Restaurant Preferences

The results for the preferences, storage location, and frequency of purchase for restaurants were similar between the two studies. Red spiny lobster represented a significant proportion of the amount purchased for both islands. For size, medium lobsters were most preferred but a higher preference for small lobster existed in Santa Cruz. The Velasco et al. study for Santa Cruz found that 58% of restaurants prefer medium lobsters and 44% prefer small lobsters. For San Cristóbal, our study found that the preferred size of lobster was medium (51%), followed by large (29%) and small (20%). The top factors influencing purchase were almost exactly the same. In the Santa Cruz study, the most influential factors were freshness, quality, size, and color. In the San Cristóbal study, the most influential factors were freshness, quality, size, and price. The Santa Cruz study by Velasco et al. found that restaurants on that island were purchasing lobster more frequently. While almost half (43%) of the restaurants did not make a distinction for purchasing frequency, 29% bought lobster daily while the same amount bought lobster weekly. In this study for San Cristóbal, most restaurants purchased lobster 1-2 times per week. Lastly, the percentage of lobster stored in freezers was similar between the two studies. The amount stored in refrigerators was less for Santa Cruz because lobster is typically served the day of purchase. Of the restaurants interviewed in Santa Cruz, 71% stored lobsters in freezers, 14% stored them in refrigerators, and 14% served lobster immediately. For San Cristóbal, 72% store them in freezers while 28% store them in refrigerators. Overall, these results were very comparable.

For the frequency of tourists ordering lobster according to origin, the two studies found similar results. For the Santa Cruz study, the hotels, restaurants, and cruises interviewed reported that foreign tourists "always order lobster" (31%) or "often order lobster" (25%). When interviewing restaurants on San Cristóbal, the most common responses for international tourists were "always or almost always order lobster" (33%) and they "sometimes order lobster" (34%). In the Santa Cruz study, the most common

response for nationals (including national tourists and local residents) was that nationals "sometimes order lobster" (44%), followed by the response "almost never order lobster" (25%). The "nationals" category was broken down into tourists and locals for the San Cristóbal study. For national tourists, the most common response was that they "many times order lobster" (46%) or "sometimes order lobster" (33%). For locals, the most common response was that they "almost never order lobster" (67%). Both of these studies conclude that international tourists more frequently order lobster than nationals.

Current Demand

While the Velasco et al. study calculated a current demand on Santa Cruz we were unable to directly compare their results to ours due to different time frames and methodologies.

Potential Demand

In the calculation for potential demand, Velasco et al. found there were 20,844 visitors with high consuming power that entered during the lobster season according to 2010 data from GNP. This was established by creating different categories for tourists based on certain criterion to for tourists with high purchasing power. Velasco et al. then used an assumption that each visitor could potentially eat one lobster per trip and determined potential demand by multiplying the number of visitors by the assumed number of lobsters eaten, resulting in 20,844 potential lobsters consumed.

In our study for San Cristóbal, we compared a number of potential demand scenarios including an increase in lobster eaters, an increase in the amount of lobster eaten, and an increase in tourism. However, the closest methodology to the potential demand calculation for Santa Cruz considers only an increase in the number of tourists consuming lobster. We calculated that 61,380 visitors entered during lobster season. Because the mean number of lobsters eaten was 1.89 per visit, we used this value and multiplied it by 23% to account for the amount of time spent on San Cristóbal versus other islands. This gives us a consumption rate of 0.44 lobsters per two-day visit to the island. The total number of lobsters eaten accounts for the difference in consumption across all categories of tourists. The amount of potential lobster consumed if all lobster eaters ate lobster during their trip to the Galápagos was 8,582 kg, which does not include those who do not normally eat lobster. Velasco's calculation for Santa Cruz converts to 14,211 kg of lobster (using a 1.5 lb. average lobster), which is significantly higher than our projections for San Cristóbal. However, the Velasco study does not account for people who do not eat lobster or the amount of time spent on a specific island. When comparing potential demand in pounds, it is also important to consider that Velasco et al. used 1.28 pounds as the average weight of a lobster, while we used an average weight of a lobster of 1.5 pounds, which we calculated was the average weight of a lobster from Mauricio Castrejon's database of landings.

Implications of Comparison Studies

The existence of a study for the lobster market on Santa Cruz Island in 2010 served as a comparison for this study on San Cristóbal. Overall, many of the results were similar, particularly for restaurant preferences and habits (i.e. size and color preferences, characteristics influencing purchasing, length of storage, clientele purchasing habits, etc.). These similarities suggest that the establishments that serve lobster, particularly restaurants, on both islands are comparable in many aspects, including in purchasing, maintaining, and serving lobster. Because of these similarities, interventions for one island's market could have similar impacts on restaurants, and these businesses could learn from each other on the same island, as well as across islands, to learn how to effectively adapt to increasing demand. While methodologies for current and potential demand in the two studies differed, both studies showed substantial potential demand given an increase in the number of tourists consuming lobster. Because of the presence of untapped demand for both Santa Cruz and San Cristóbal islands, stakeholders should consider collaborating to design and implement interventions to leverage

Photo 3.25. Packing lobsters for delivery

resources and efforts to increase local lobster consumption for both islands.

RECOMMENDATIONS

With our knowledge of the San Cristóbal market, we have developed ten recommendations that will help to increase local economic conditions and improve the future of the lobster fishery. Our

recommendations are separated into three categories: market implications for management, focusing on local demand, and future studies. The categories are then broken down into their respective recommendations.

1. Market Implications for Management

Increasing economic conditions of fishermen and local businesses can only be done through strict adherence to guidelines adopted by the Galápagos National Park. Increases in local demand for lobster may not be sustained ecologically if proper management is not enforced, as overfishing will lead to declines in the lobster population. Therefore, we suggest the following two recommendations, which must be employed before any increases to local demand are considered.

Improving the Monitoring System for Lobster

Photo 3.26. Collecting data to monitor catch

The discrepancy between the total landings found in this study and the total landings reported by the GNP illustrates that more lobster is being landed than is being monitored. The 2012 WWF Report mentions that many lobsters enter the market without being monitored. This suggests that a better monitoring program is needed. This would include hiring staff to conduct monitoring after 6pm and preferably 24 hours per day, since many fishermen return from fishing after this time (Ramírez et al., 2012). Around-the-clock observation would ensure more accurate monitoring of lobster for fishermen coming to port at night or early in the morning. In addition to extending monitoring schedules to cover more hours, the methodologies used by port samplers should be checked for consistency between islands and should involve the use of standardized equipment to accurately and precisely collect data needed such as lobster weight and length. Further, because it is not clear that all lobsters with domestic guides also have monitoring certificates, it should be required that all lobster shipped to the mainland by residents and visitors as gifts should have both a domestic guide and a certificate of monitoring. These improvements would help to improve the accuracy of GNP statistics, including overall total landings, number of lobster with domestic guides, and amount remaining locally, which is important information for stakeholders to use in decision-making for the lobster market in San Cristóbal and overall management of the fishery.

"more lobster is being landed than monitored"

Leveraging Restaurant Preferences to Promote Legal Fishing

The biological database for the lobster fishery, as compiled by Mauricio Castréjon, shows that one third of all lobster landed in the Galápagos from the 1970s until present has been under the legal size

limit. This has major implications for the health of the stock as the removal of undersized individuals eliminates the possibility that they will spawn at least once before maturity. In our surveys with restaurants we found the capture of undersized lobster to be recognized as a problem within the fishery. Additionally, our findings show that the majority of restaurants prefer medium sized lobsters. Small sized lobsters were ranked last by the majority and first by only five establishments. Our calculations found that the median size of a medium (preferred sized lobster) is 27cm. The current legal size limit for lobster is 26cm. Restaurants expressed a clear desire for lobsters within the legal

Photo 3.27. Cooking lobster

limit. This information can be used to motivate adherence to fishing regulations, as restaurants will be unlikely buyers for undersized lobster. Previous campaigns within the fishing community spearheaded by Rare and CI and supported by community members have successfully facilitated change in the past, such as promoting the transition from spear to hand capture. A campaign highlighting the benefits associated with selling medium sized lobster within the local market while educating fishermen on the detriment of harvesting undersized individuals is recommended.

2. Focus on Local Demand

It is evident that there is potential for local demand to increase substantially enough to offset future reduction in the TAC. We have determined that focused efforts on tourists, particularly those that stay on land, could increase local consumption of lobster. Examples of ways to reach tourists and encourage an increase in lobster consumption are listed below in order of their anticipated effectiveness. The following recommendations are applicable only for whole lobster. If spearing for lobster becomes a popular capture method again and lobster tail reemerges as the predominant form sold, this set of recommendations will need to be revisited.

Social/Educational Marketing

Predicting the actions of consumers can be a daunting task, particularly with regard to sustainable or environmentally friendly purchasing habits. According to previous research, consumers select primarily by taste, price, and convenience when determining items to purchase. Health benefits or environmental friendliness tend to play a secondary role in consumer decision-making (Verbeke, 2008). These preferences aligned with our findings for tourists. A further challenge to predicting consumer behavior is their lack of rational action. For example, if a consumer were a rational decision maker, when provided with information about unhealthy food options they would choose the healthy option. Consumer behavior often shows that even after undergoing active reasoning the shopper still chooses the unhealthy option (Verbeke, 2008).

Social marketing campaigns are designed to raise awareness about a particular issue and to motivate change in consumer behavior based on a given message. These campaigns have been heavily used in the public health sector for issues such as drunk driving and childhood obesity with varying success rates (Kahn & Canny, 2008). The use of similar campaigns to influence consumer behavior to motivate environmentally conscious consumer habits is a more recent development. Environmental issues can be complicated because a consumer may not see a direct benefit--but instead views it as a dispersed benefit--from the consumption of an environmentally friendly product. Environmental campaigns that have been effective at driving change in consumer behavior tend to emphasize financial benefits, control given to the individual, enhanced or achieved personal goals, and status recognized by others (Maibach, 1993).

The importance of identifying the target audience for environmental marketing campaigns, such as sustainable seafood, is key. Members of the target audience and those most willing to change behavior will have an interest in the issue prior to the start of the campaign. Psychographics, a group of attributes including attitudes, cognitions, personalities, and lifestyle habits, can be used to define the target audience, or individuals best served for the product you are looking to promote (Maibach, 1993). For sustainable seafood, this could be individuals who are already environmentally and health conscious, have an interest or hobbies involving the ocean, or are accustomed to purchasing value added food products. Determining those who can be easily swayed first is essential, as they will be the influencers for others to follow their behaviors. For the Galápagos, we suggest targeting international and national tourists that are staying on land. Although convincing cruise owners to purchase lobster would have drastic effects on the market, this may be difficult to achieve. Many owners cited expense as the largest barrier to purchasing lobster.

Photo 3.28. Lobsters for sale

Therefore, we suggest focusing efforts on land-based tourists.

Another type of campaign that could increase tourists' consumption of lobster is an educational campaign. If tourists were informed about the significance of the lobster fishery and encouraged to support it, via an educational campaign, it could potentially increase the local consumption of lobster. An educational campaign could manifest itself in many ways including, but not limited to, videos on the airplane during the flight to the islands, information in the pamphlet given to everyone arriving when they pay the park entrance fee at the airport, as well as messages on menus in restaurants. Increasing the exposure of tourists to lobsters as well as information about the fishery could positively impact local consumption rates.

Photo 3.29. Children approaching lobsters on sale

Fisheries Management and Marketing

Marketing campaigns have been employed by fisheries around the world as a mechanism to promote seafood products from a specific location or fishery in order to increase revenues for fishermen. Marketing campaigns have a wide range of effectiveness when influencing consumers to purchase seafood products. Some of the first and most successful campaigns were employed by the Fishery Management Organizations (FMOs) in Japan. The FMOs are coastal communities that were granted private rights to a plot of ocean and all the resources contained within that area. The FMOs are completely self-governed and the amount of exploitation and protection of the resource is determined solely by the community members. Some communities employ regulations for seafood marketing practices such as live-catch and quality control. Others use arrangements such as pooling agreements or profit sharing. Uchida (2007) conducted an analysis to determine predictors and indicators of high revenue for fishermen and individuals participating in FMOs. The highest indicators for elevated profitability were through the use of pooling agreements and collaborative marketing practices with quality control. Marketing alone did not result in higher revenues, most likely because "engaging in marketing is different from being effective at marketing" (Uchida, 2007). A further caveat is that seafood marketing also heavily dependent on the product. For well-known species such as spiny lobster, marketing high levels of quality control and traceability can be effective whereas for lesser-known species promotional marketing or new market creation can be more applicable.

"engaging in marketing is different from being effective at marketing"

Following the FMOs lead for effective marketing, Sea Grant has been working with Michigan sturgeon fishermen who

were experiencing a decrease in revenues and catch in the Great Lakes. Sea Grant assisted in establishing a product-marketing cooperative for fishing operations around the Great Lakes where they collaboratively designed websites and promotional materials. The co-op also established high quality control standards for freezing, packaging, and shipping with traceability requirements, which included the "story" of their seafood products. Since the establishment of the co-op and the subsequent continuation of coordinated efforts, demand and price for Great Lakes sturgeon has increased (Sea Grant Michigan, n.d.)

Other types of marketing arrangements, while used less frequently, have proven successful for seafood products of small-scale fisheries. In Peru, stakeholders aimed to change the use of anchovies from fishmeal to household consumption because they would receive a higher price. Promoters for the campaign used time-intensive tactics such as inviting consumers to try the new products in their homes. One year after the campaign began, demand had risen 46% for fresh anchovies and 86% for canned (Jacquet et al., 2009). Chilean TURFs have employed the use of contracts and arrangements for purchases prior to harvesting. This allows fishermen to harvest close to the contract date for higher quality assurance and enables them to accept contracts only when under favorable market conditions. Collectively, these fishermen achieve a larger market pull, higher revenues, and possess the ability to sell to differentiated markets abroad (Cancino, Uchida, & Wilen, 2007).

'Home-Packs' for Lobster

In popular tourists destinations where a healthy fishing industries exist, it is common for tourists to purchase seafood to bring home. This is particularly popular in places such as Mexico, USA (Alaska, Florida, Louisiana, Maine, etc.), and Canada.

A marketing campaign to encourage tourists to bring lobster home from Galápagos may provide an alternate means of enhancing the local market. Our study showed that only 23% of tourists were aware that it was possible to bring home seafood from Galápagos. Of this 23%, 60% were, in fact, bringing lobster home. That means a remaining 77% of tourists could be informed and as many as 60% would be realistically bringing them home. If 60% of tourists passing through Galápagos during the lobster season (61,380) purchased one average sized (1.5 lb.) lobster to bring home, the impact would be 92,070 lbs. (41,762 kg) of lobster or 13,781 kg of tail.

In addition to the value of bringing lobster home for personal consumption, the novelty of gifting lobsters from such a unique location may incentivize purchase. Setting up the sale of lobster in the airport may be an

Photo 3.30. Restaurant owner and lobster

effective means of increasing amount sold, as many tourists make last chance souvenir purchases. This has been effective in Boston's (USA) Logan International Airport where tourists may purchase live lobster to be packaged for their trip home. Regulations on the number or weight of a particular seafood item depend on the shipment's destination. To make this approach to marketing to tourists most effective, all relevant customs data would be provided for tourists at the point of sale.

Photo 3.31. Boy at the lobster market

Certification

WWF and the Charles Darwin Foundation are interested in implementing a certification for lobster in the Galápagos, which could have impacts on demand. WWF is designing the Origen Seal for fishing products of Galápagos. It would indicate five components: legality of the product, traceability, social and environmental responsibility, quality, and safety (J. Ramírez, personal comm. March 2014). Lobster sold with this certification would have to pass through one of the fishing cooperatives to gain the Origen Seal. Currently, it is illegal to sell lobster outside of the season and restaurants and tourism operators must sell their lobster products within one week of the season end. In 2013, a cruise ship was cited and fined for unknowingly serving illegal lobster out of season. Fear of harsh sanctioning has been a barrier for some establishments and boats to offer lobster. The certification CDF has been considering would signify that lobsters were caught legally, met minimum size requirements, and were locally caught within Galápagos waters during the season. In theory, it would allow for companies to offer lobster year-round and offer a value-added product for their clientele. While restaurants showed a small positive response to a certification program, many tourists expressed interest. The certification type and implementation may alter interest levels of both stakeholders and provide a better indication of potential success. Tourist interest will be the largest driver in shaping a certification for the Galápagos.

Worldwide, certifications and eco-labels are becoming increasingly widespread for all consumer products. Both tactics are intended to indicate the sustainability or environmental friendliness of products. For seafood, several exist such as dolphin-safe tuna and the Marine Stewardship Council. Despite the increasing use of eco-labels, there is little market-based evidence as to whether eco-labels increase consumer willingness to pay for product attributes linked to ecological sustainability or to alter household consumptive patterns. Some researchers believe that the overabundance of certifications has led to more consumer confusion and actually been detrimental to the seafood

awareness campaign (Jacquet & Pauly, 2007). In fact, a study conducted by Hallstein and Villa-Boas in 2013 found evidence that the Seafood Advisory Council had caused or contributed to a 15% decline in overall seafood sales driven primarily by a 41% decline in the sale of yellow labeled seafood on a mercury safe list. For the spiny lobster fishermen of Baja California, MSC certification did not bring fishermen the intended benefits of higher incomes for a certified product. However, they experienced other benefits such as publicity for being the first artisanal fishery promoting sustainability (Ramírez et al., 2012). The Maine lobster fishery experienced the same issues when MSC certification did not allow them to achieve a price premium (Goyert, Sagarin, & Annala, 2010).

Eco-labels and certifications do have the potential to increase demand. However the distinction should be made that certifications, as a sole marketing tool, do not always lead to higher demand and may lead to more consumer confusion (Hallstein & Villas-Boas, 2013). In many instances, the information that certifications guarantee does not align with consumers' highest priorities, indicating why no increase in sales or price premiums is achieved (Goyert et al., 2010). If a certification is to be successful, alignment with priorities must be guaranteed for tourists (taste), restaurants, and tourism operators (quality, size, and freshness).

Photo 3.32. Fishing boats at the dock

Changing the Timing of Lobster Season

Based upon responses from some fishermen and restaurants, changing of timing of the lobster season may have effects on potential demand. Currently, lobster season occurs during the slowest month for tourism in September (Charles Darwin Foundation & Galápagos National Park, 2013). If the lobster season was moved to include the highest rate of tourism for each year, around April to mid-August, it would encompass 41% of all tourists that visit each year, rather than 34% of tourists that enter during the current lobster season. We can take into account the growth in local demand due to greater number of tourists present during this "new" lobster season (thus, more lobster eaters). We calculate this by extrapolating from the change in % of tourists between the "old" season vs. the "new" season:

Equation 3.20.

Old lobster season: Growth of 39.20 kg of tail (254.17 pounds) per year
New lobster season: Growth of 47.45 kg of tail (307.65 pounds) per year
47.45 kg of tail – 39.20 kg of tail = Increase in potential local demand by 8.25 kg of tail.

Next, we can also look at the new lobster season in terms of growth in potential demand every year. Doing the same calculations we find that this new lobster season brings in:

Equation 3.21.

Old lobster season: Current local demand of 5687.75 kg
New lobster season: 5687.75 kg / 34% * 41% = New local demand of 6884.54 kg
6884.54 kg – 5687.75 kg = Increase in local demand by 1196.79 kg (406.91 kg of tail).

Adding this with the natural growth in tourism demand, under *new* lobster season, we can calculate how long it takes for exports to be absorbed by local demand:

Equation 3.22.

Current exports (2012): 12,668 kg
Natural growth in tourism demand, under *old* lobster season, to encompass all exports:
12,668 kg/ 39.20 kg per year = 323 years

Natural growth in tourism demand, under *new* lobster season, to encompass all export, while taking into account the increase in local demand due to new season:
(12,668 kg – 406.91 kg of tail) / 47.45 kg of tail per year = 258 years

Although this does change our projections for encompassing all exports, the impact is quite small. An increase in local demand of 1196.79 kg is sizeable but not more than the possible growth that would result from convincing people to eat more lobster, and would not do much to increase the demand from natural growth in tourism.

Changing the lobster season would be a viable avenue to consider if there were no social barriers or biological downsides to shifting the lobster season earlier. Reasons for current season timing are that, historically, sea cucumber season fell in June and July while lobster season occurred afterwards. Since the sea cucumber fishing season has been closed for several years with no anticipated opening in the future, this may provide an argument for pushing the lobster season earlier to capture the increased rates of tourism.

Moving the lobster season earlier may have direct impacts on whether lobsters are able to reproduce before being caught. Currently, it is unknown whether lobsters spawn constantly or in pulses (Hearn & Murillo, 2008). If reproduction occurs at multiple times, lobster recruitment could be affected, potentially decreasing population levels. Without more information, a cautionary approach is recommended for this issue, since impacting the sustainability of lobster populations will have major unintended consequences for the economic viability of lobster as well.

Contracts or Buying Agreements

Members of both restaurant and tourism operator sectors explicitly stated that a lack of consistency of buyers is problematic for the lobster fishery. However, our findings show that only two restaurants have contracts or buying agreements with their lobster providers. Consistency in sales provided by contracts can reduce opportunity costs for fishermen associated with finding a buyer for their product and allow them to focus their efforts on fishing. Contracts between fishermen and local restaurants and tourism operators would ensure local sales and increase efficiency in the sales process. However, such contracts may not be feasible due to the competitive nature of the current method of sales. In

response to maintaining a guaranteed buyer through a contract, fishermen may be willing to offer restaurants and tourism operators a discounted wholesale price for lobster. While this approach should, in theory, increase efficiency for both ends of the supply chain, this may be difficult to implement from a cultural perspective. In the future, the cooperative may play a prominent role in motivating changes that increase efficiency in the supply chain.

Working with Restaurants to Expand Offerings

One way to increase the amount of lobster consumed locally would be to increase the variety of offerings for lobster. Most restaurants that offer lobster serve whole lobsters in a limited number of lobster dishes (i.e. steamed lobster, lobster with garlic, ceviche). As part of a marketing campaign to promote the image of lobster as a quality product on the island, the campaign could incorporate a culinary component to work with restaurants to explore new dishes incorporating lobster. Some tourists who stayed in hotels responded that they did not eat lobster because it they did not see it on the menu. By offering more lobster dishes and the visibility of lobster as a product, this could increase the average amount of lobster eaten by tourists, thus increasing the total local demand.

3. Future Studies

Photo 3.33. Bargaining for lobster

Better Understanding of Local Residents' Home Lobster Consumption on San Cristóbal Island

Although we received a small set of responses about the lobster consumption of local Galápagos residents when conducting interviews at the airport, the locals of San Cristóbal were not specifically targeted by our study. The amount of lobster consumed by local residents at home was the only portion of the market that could not be readily quantified in this study. This part of the market,

however, is thought to be small compared to the amount of lobster consumed by tourists. Future studies for the San Cristóbal lobster market should consider the incorporation of a survey about lobster consumption for a representative sample of residents to shed more light on this aspect of the market.

Lobster Market of Isabela Island

Tourism in the Galápagos has seen significant continued growth over the last few decades, with an increase of about 4,000 tourists a year. The increased demand characterized by the need for more hotels, cruises, restaurants, tourism operators, and other infrastructure was first seen in Santa Cruz, followed by San Cristóbal shortly after. Isabela is the third largest island by population in the archipelago. Visits to the island have been increasing through its town, Puerto Villamil, as cruise ships and ferries shuttle tourists from nearby islands. Despite this rise in tourism, infrastructure has been slow to follow. Other attributes that set it apart from Santa Cruz and San Cristóbal are that it is geographically the largest island, it does not have its own airport, and cultural differences exist.

Isabela represents another area of potential demand for the Galápagos spiny lobster fishery if tourism and infrastructure continue to increase here in the future. Much of the red spiny lobster and the majority of green spiny lobster landed in Galápagos are caught in the waters around the Isabela, demonstrating that the supply is readily available. Currently, most of it is exported to the mainland and other countries. The unique attributes of this island warrant a separate analysis of the potential growth in the local lobster market. We recommend that the potential local lobster market of Isabela be the focus of the next market study to determine the amount of the lobster catch that can be absorbed into the local market.

Photo 3.34. Boat landed at Isabela Island

Conclusions

Photo 4.1. Sunset over the harbor on Santa Cruz Island

Conclusion

The Galápagos National Park is working to improve the management of the lobster fishery to ensure the sustainability of the resource for the future and maintain balance within the marine ecosystem. In order to develop sound management strategies, the GNP requires a clear indicator of the health of the lobster stock on an annual basis. This study explored the application of a data-poor assessment to this fishery to facilitate effective management within the GNP. Through the initial analysis of twelve existing data-poor assessments, we determined that the Catch Curve model was best suited for application to the lobster fishery. This assessment, along with an established control rule, will allow the GNP to make better-informed fisheries management decisions. In the future, target F/M values based on the GNP's management objectives will have to be set so the model can be used to adjust fishing effort that correspond to specific goals for the lobster fishery. The economic implications of such regulations will have to be considered in the future to shape the goals that are best-suited for fisheries regulation in the Galápagos.

Through the application of this assessment to the historical fishery data, the outputs suggest that some overfishing of lobster is occurring in the Galápagos lobster fishery. This is demonstrated by a high fishing mortality, a high ratio of F/M, and decreased mean lobster length. The results also indicate a positive correlation between the recent increase in landings and an increase in fishing effort for the last three years, which suggests that the recent increases in catch are not likely the result of a rebound in biomass. The presence of overfishing (as seen in the assessment results) indicates that a reduction of fishing effort will be necessary in the future. Considering the high level of influence that the local

fishing community has on the advancement of management decisions, this reduction should be strategically paired with innovative management strategies that can effectively offset the associated loss of income.

The implementation of a TURF is one such innovative management strategy that was explored for the Galápagos lobster fishery. By applying our evaluative framework for a TURF to the current situation in the Galápagos Islands, we conclude that a TURF management system for the lobster fishery is feasible to implement from the biological, legal, and economic perspectives. The geographic, social, and management perspectives, however, may present some barriers to implementation. Starting primarily with a small-scale, voluntary, opt-in project may circumvent these issues. Within this management plan, fishermen would be required to capture lobster live. A TURF will likely lead to both short term and long term benefits, minimizing inefficiencies and creating stewardship of the resource into the future. This initial project would serve as a pilot and, if successful, could demonstrate the benefits of a TURF management system and build local support with other stakeholders. A successful TURF in the Galápagos is one method of incentivizing responsible fishing behavior while providing both short- and long-term economic returns to the fishery.

Given the perceived obstacles with TURF implementation, we conducted a market study to determine whether there might be a way for fishermen to maintain income while reducing the level of harvest. Because fishermen receive higher prices when selling locally, they could therefore offset revenues lost through a catch reduction with increased revenues. Our market study shows that there is significant opportunity for local demand to increase from the tourism sector through a marketing campaign. However, we also determined that there is a possibility that 25% of lobster being caught is not accounted for in GNP's current landings data monitoring system, which further contributes to the uncertainty within the fishery. We have determined that the local market is a viable pathway for the GNP to approach in supporting local economic growth if they can effectively manage a reduction in catches and improve sampling and documenting methodologies. This market mechanism can be used in conjunction with our prior recommendation of reducing lobster with minimal effect on fishermen income. We recommend that the GNP consider options for expanding local consumption of lobster for tourists, which will bolster economic prosperity for fishermen and allow the GNP to leverage support for other regulations in reaching a sustainably harvested lobster fishery.

The Galápagos red spiny lobster supports the livelihoods of hundreds of fishermen and their families and plays a key role in the marine ecosystem of this renowned place. The economic and ecological stability of the Islands depends upon effective management of this resource. The Galápagos National Park has requested a tool for annual evaluation of the status of the fishery to guide decision-making. A data-poor assessment will allow the GNP to work within their means to establish scientifically based adjustments to their management strategy. In addition, we have identified two innovative management approaches that, through careful development, could be applied to the fishery in order to increase economic rents and long-term sustainability of the fishery. Through adaptive and innovative management on behalf of both the GNP and the fishermen, this fishery will continue to provide lasting support for the community and fulfill its crucial role in the ecosystem of Galápagos.

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Appendix A: Data-Poor Assessment

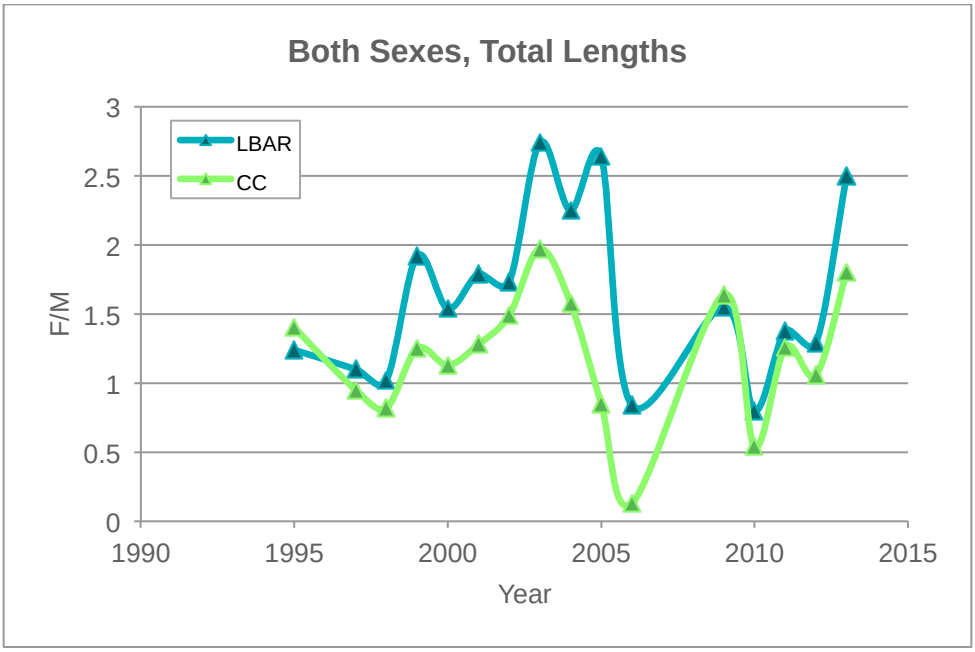


Figure A1. The F/M ratios for both sexes, total lengths for both the LBAR and Catch Curve models. LBAR predicts consistently higher F/M values.

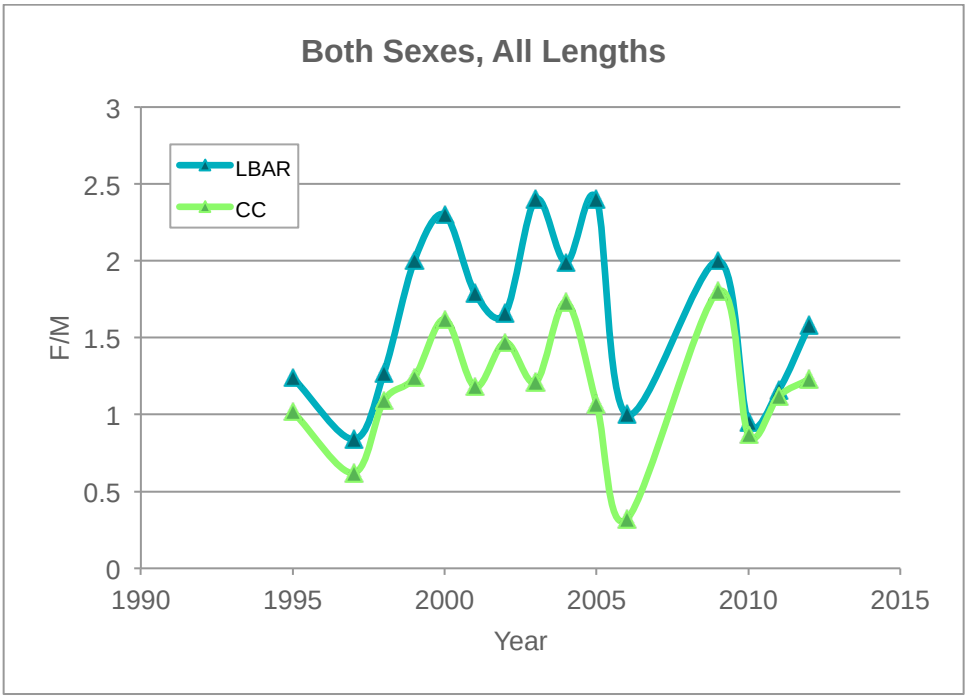


Figure A2. The F/M ratios for both sexes, all lengths which includes both total length measurements and converted tail to total length measurements. LBAR predicts consistently higher F/M values.

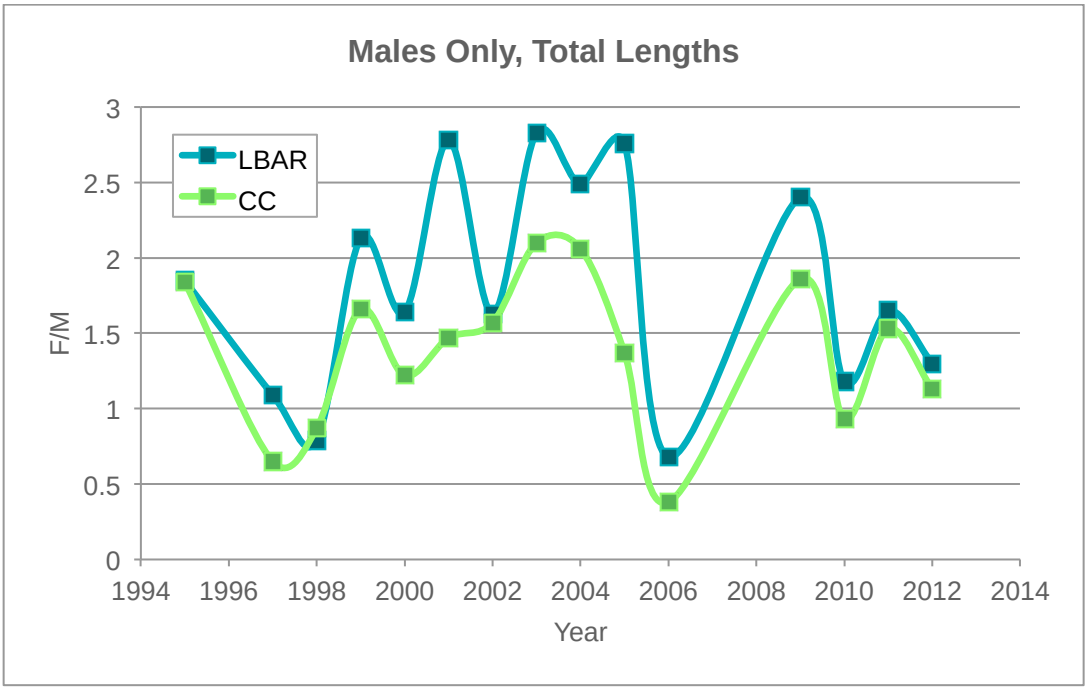


Figure A3. The F/M ratios for males only, total lengths for both the LBAR and Catch Curve models. LBAR predicts consistently higher F/M values.

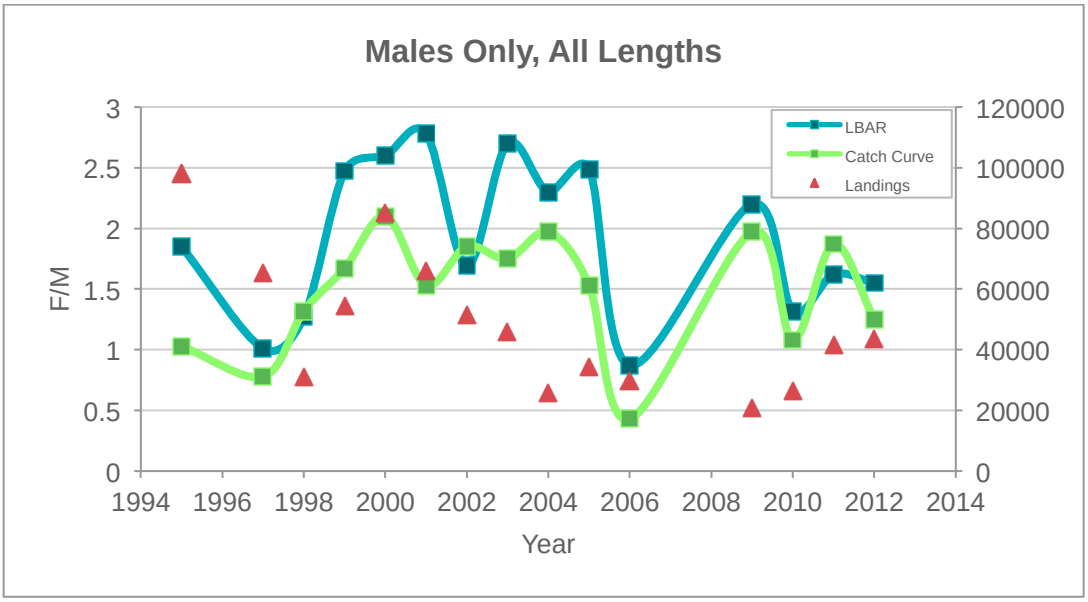


Figure A4. The data used for primary analysis was males only, all lengths. This included both total length measurements and tail to total length conversions. LBAR continues to predict higher F/M values. The landings data shows that increased catch results from an increase in F/M, indicating overfishing.

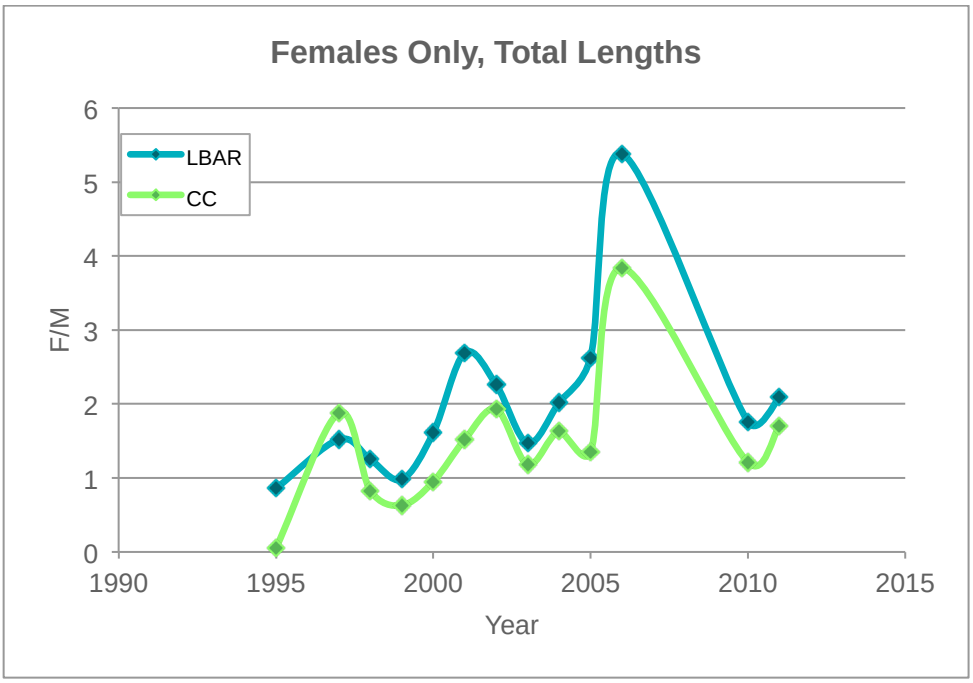


Figure A5. The F/M values for female only, total length data shows an increase in F/M through time. LBAR predicts higher F/M for female only data.

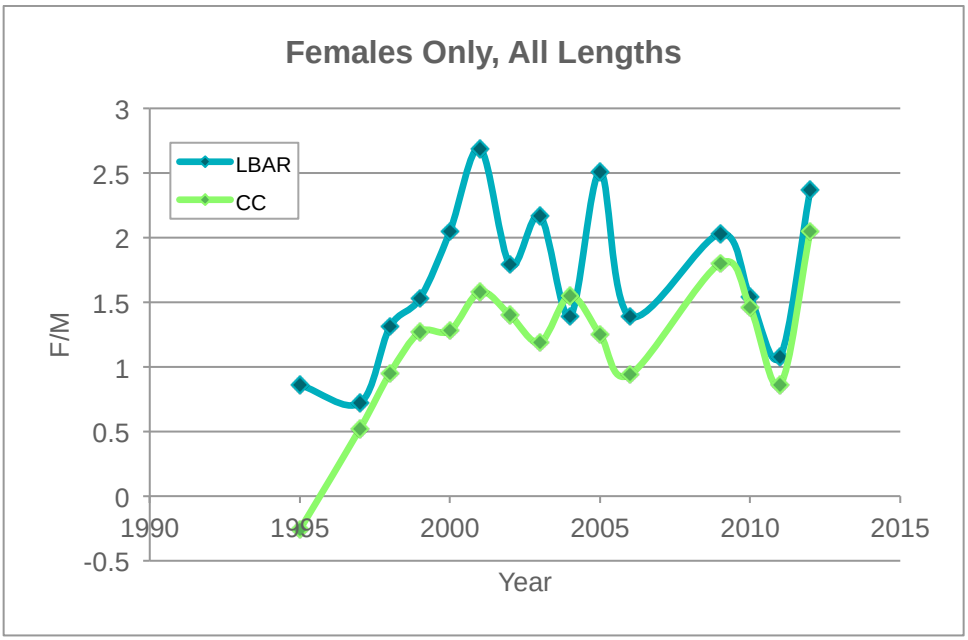


Figure A6. Females only, all length data includes measured total lengths and converted tail to total lengths. LBAR predicts higher F/M values than Catch Curve. Catch Curve shows a consistent increase in F/M over time.

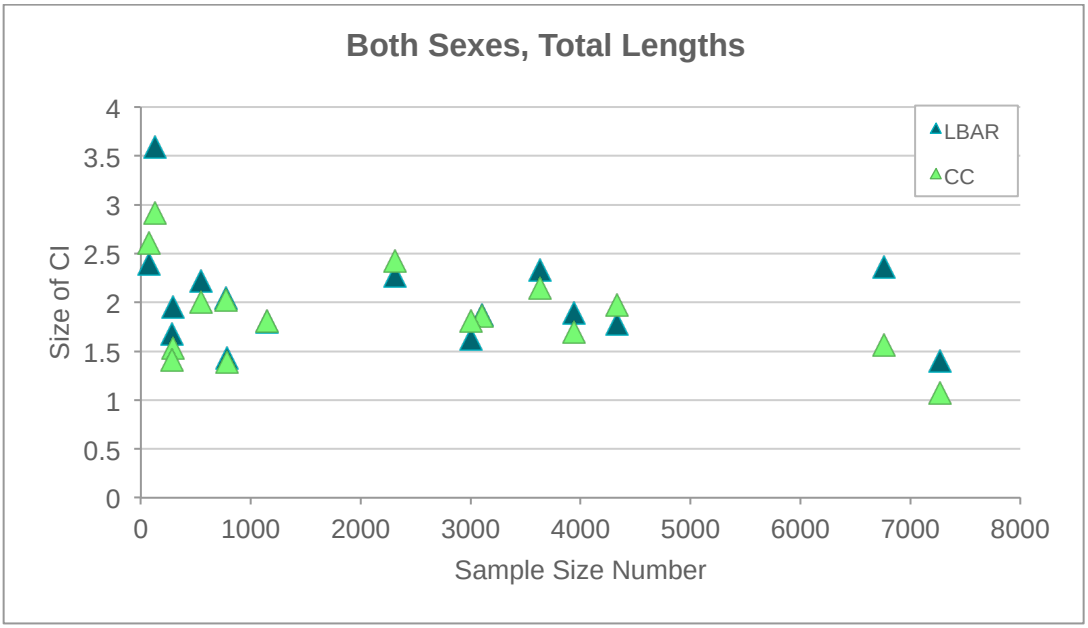


Figure A7. The relationship between the number samples and size of the confidence interval indicates that an increased sample size contributes to greater confidence. This is more consistent for Catch Curve, potentially because the model uses a larger portion of the data.

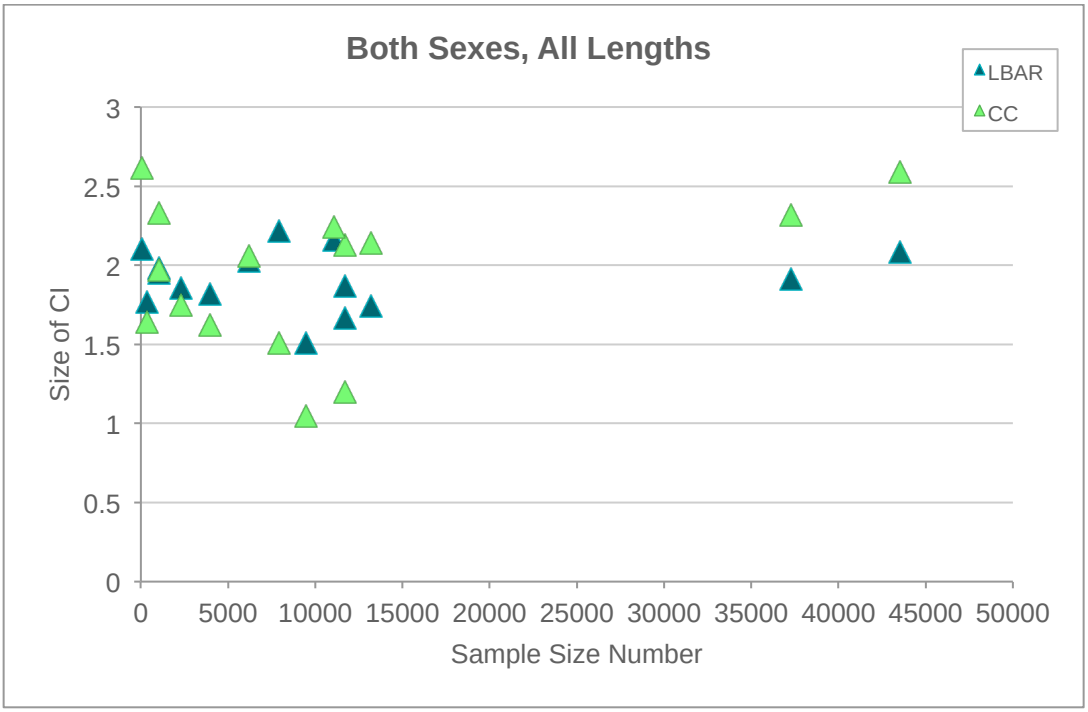


Figure A8. The relationship between the number of samples and the size of the confidence interval for the both sexes, all lengths data set has greater variability than for both sexes, total lengths.

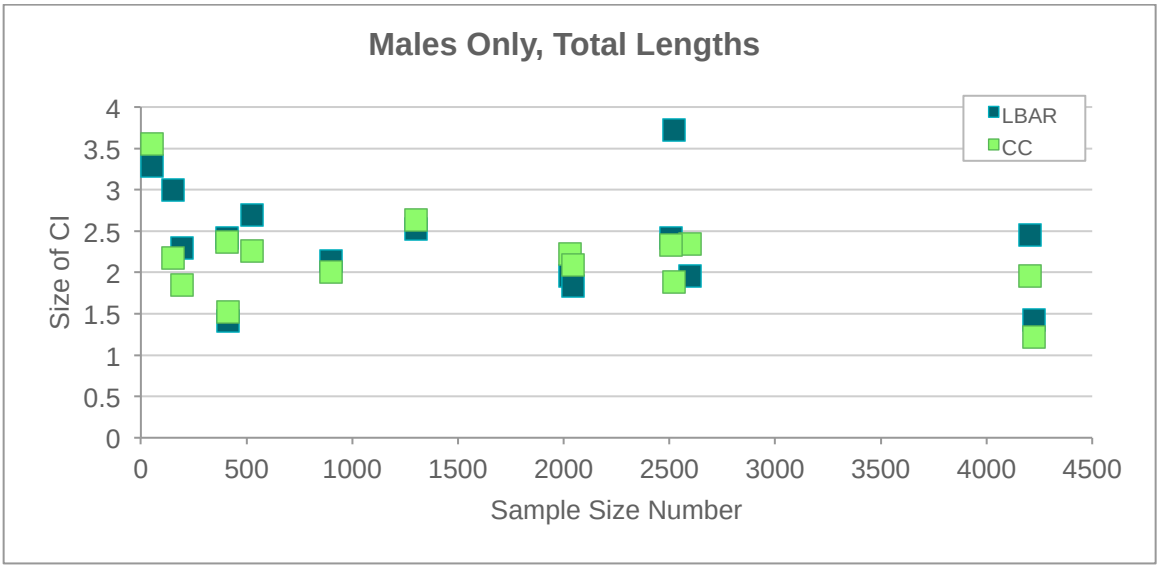


Figure A9. The males only, total lengths data set showed a negative correlation between the size of the confidence interval and the sample size, particularly for Catch Curve.

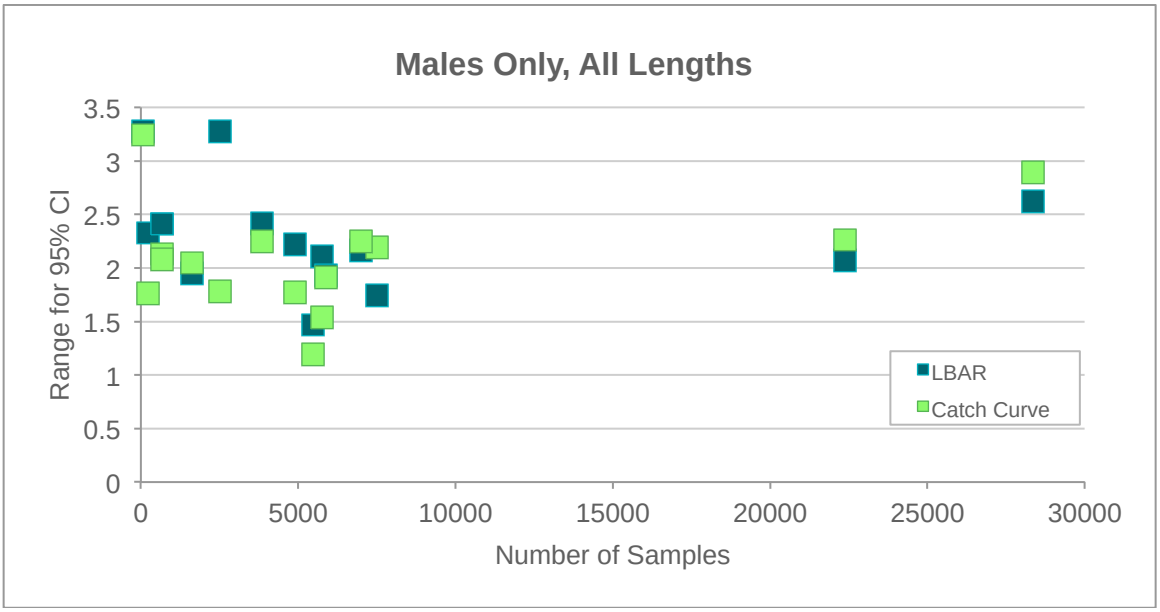


Figure A10. For the male only, all lengths data set, the relationship between size of the confidence interval and the number of samples is slightly negatively correlated between 0-5000 samples but potentially shows no relationship with the largest sample size.

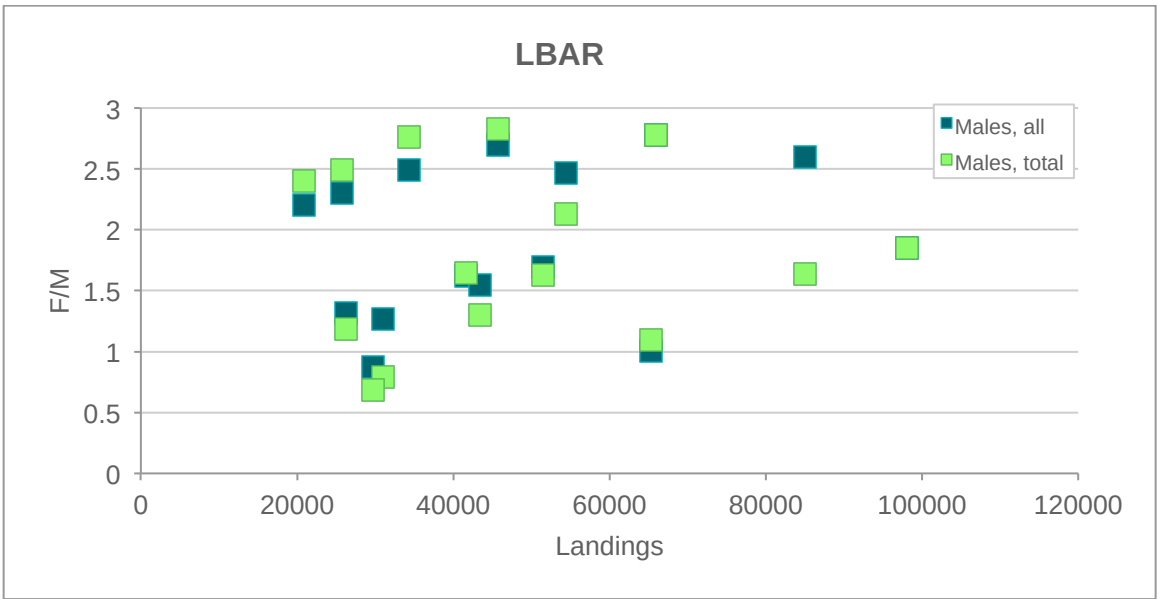


Figure A11. The F/M values from LBAR and associated landings for the year are not correlated and do not indicate that an increase in population has occurred. High F/M values can be associated with years with both high and low landings. Both data sets follow a similar trend.

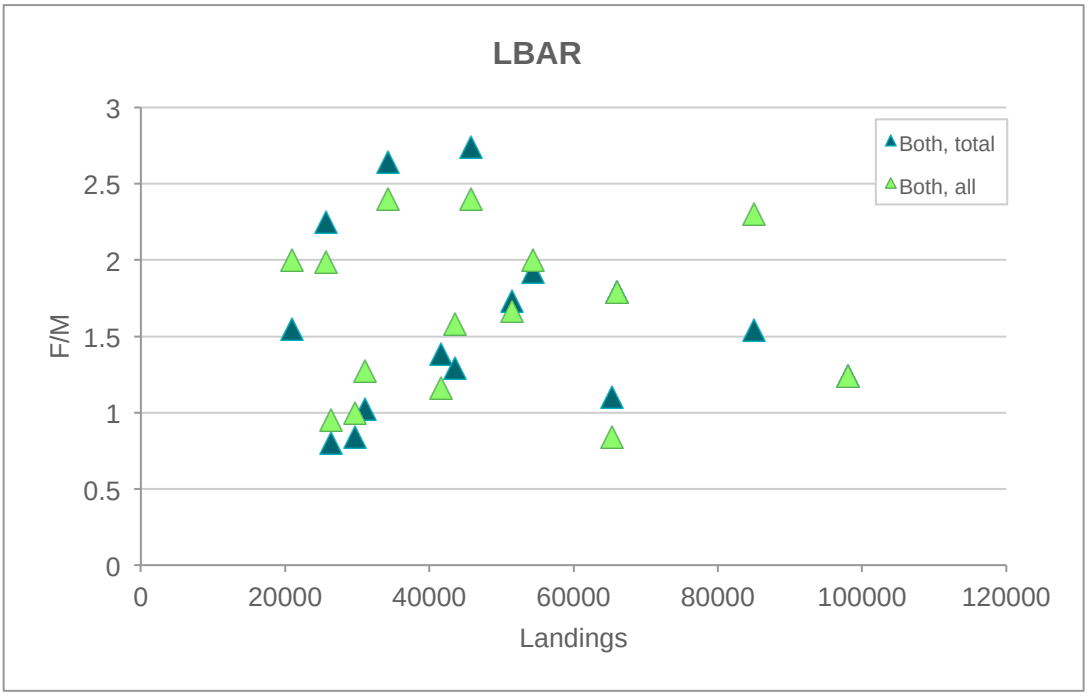


Figure A12. The F/M values from LBAR do not indicate that an increase in population has occurred. High F/M values can be associated with years with both high and low landings. The data set for both sexes, total length exhibits the highest F/M values.

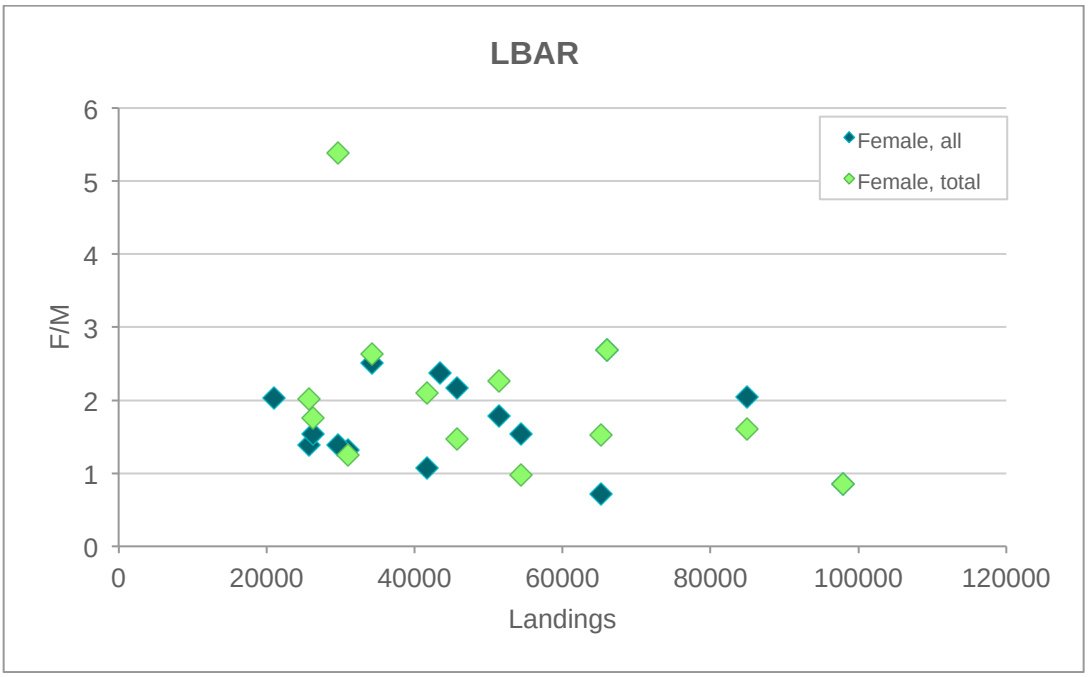


Figure A13. For female data sets, both all and total lengths, there is no clear trend between landings and F/M values from LBAR.

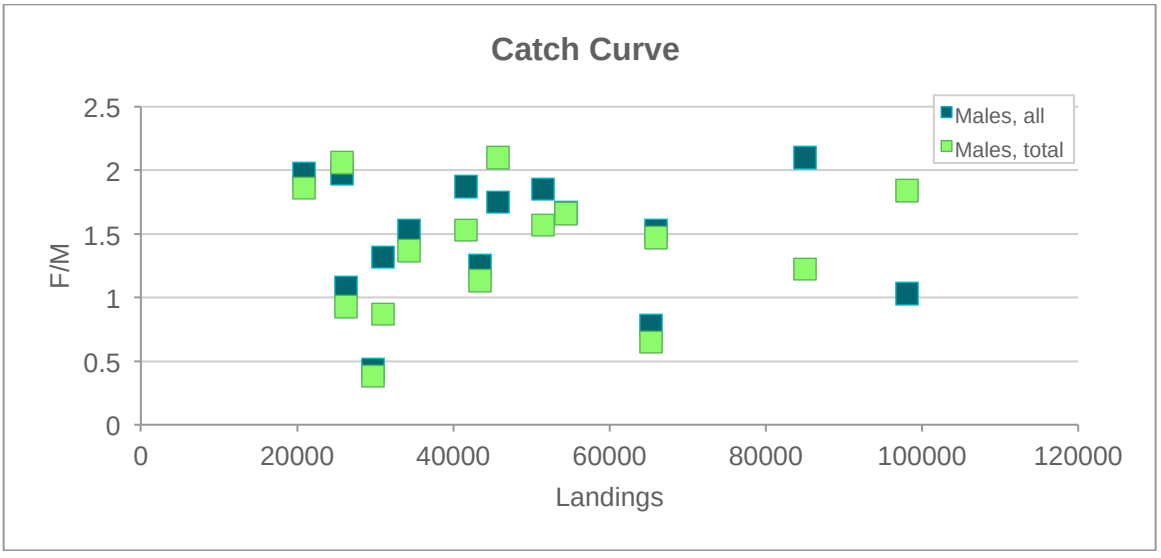


Figure A14. Catch Curve similarly predicts variable F/M values for year-to-year landings data for males all lengths and males total length data sets. Years with high landings have high F/M values, as do years with low landings. This is not indicative of a potential rebound in stock.

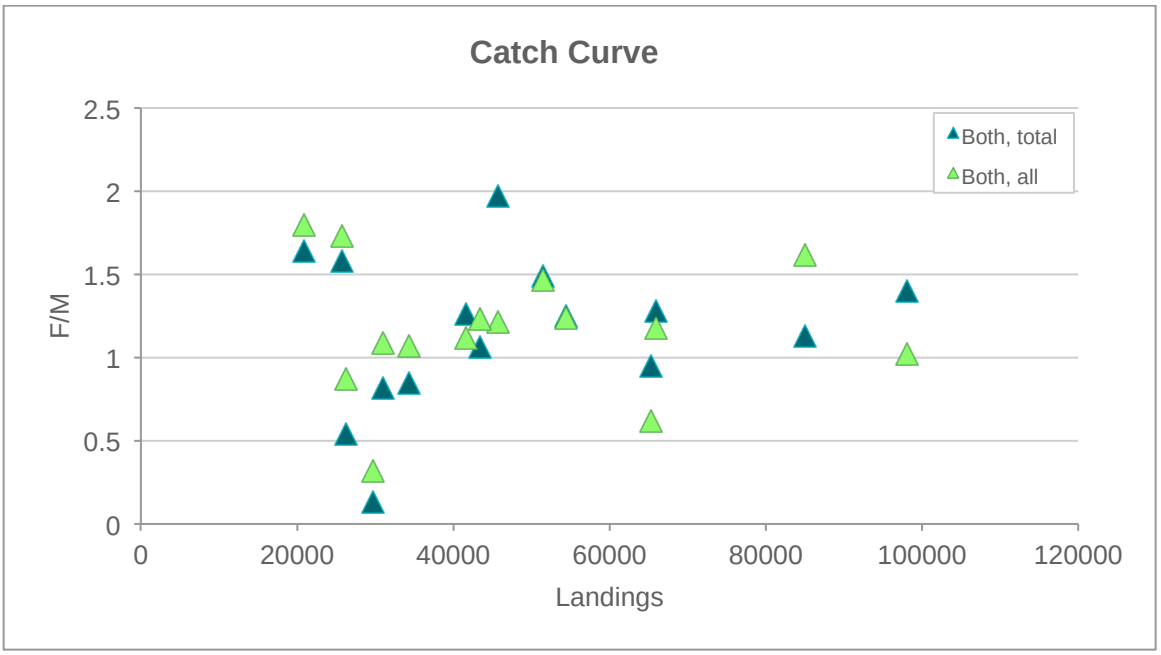


Figure A15. Catch Curve shows fairly consistent F/M values for both all lengths and both total length data sets. No correlation between landings and F/M values is demonstrated for these datasets.

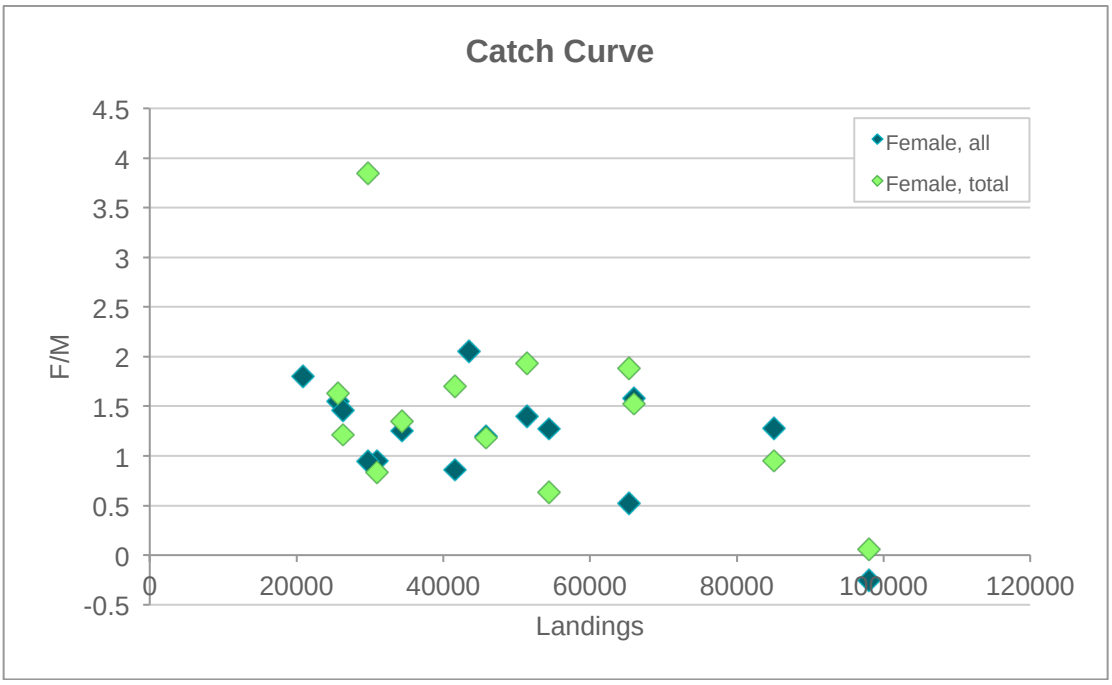


Figure A16. For female all lengths and female total lengths data, Catch Curve shows a negative correlation between F/M values and landings data. This may indicate higher survivorship or decreased selectivity for females.

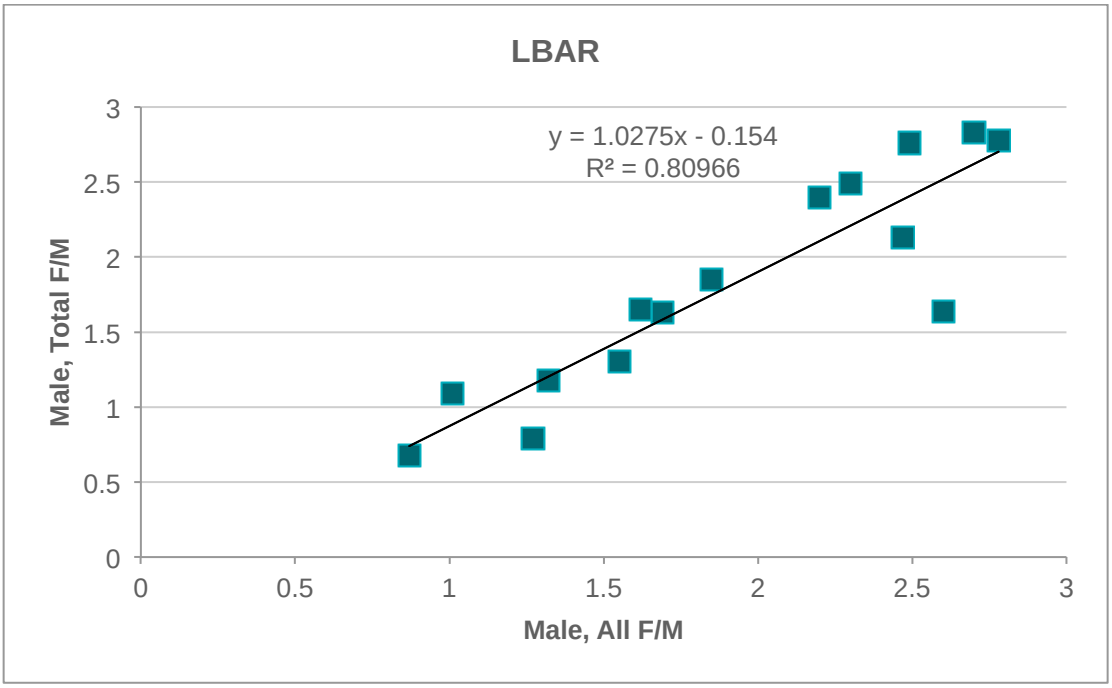


Figure A17. The relationship between the male all lengths data and male total lengths data from LBAR shows a close linear relationship for F/M values below 2. This relationship is more variable as F/M values exceed 2.

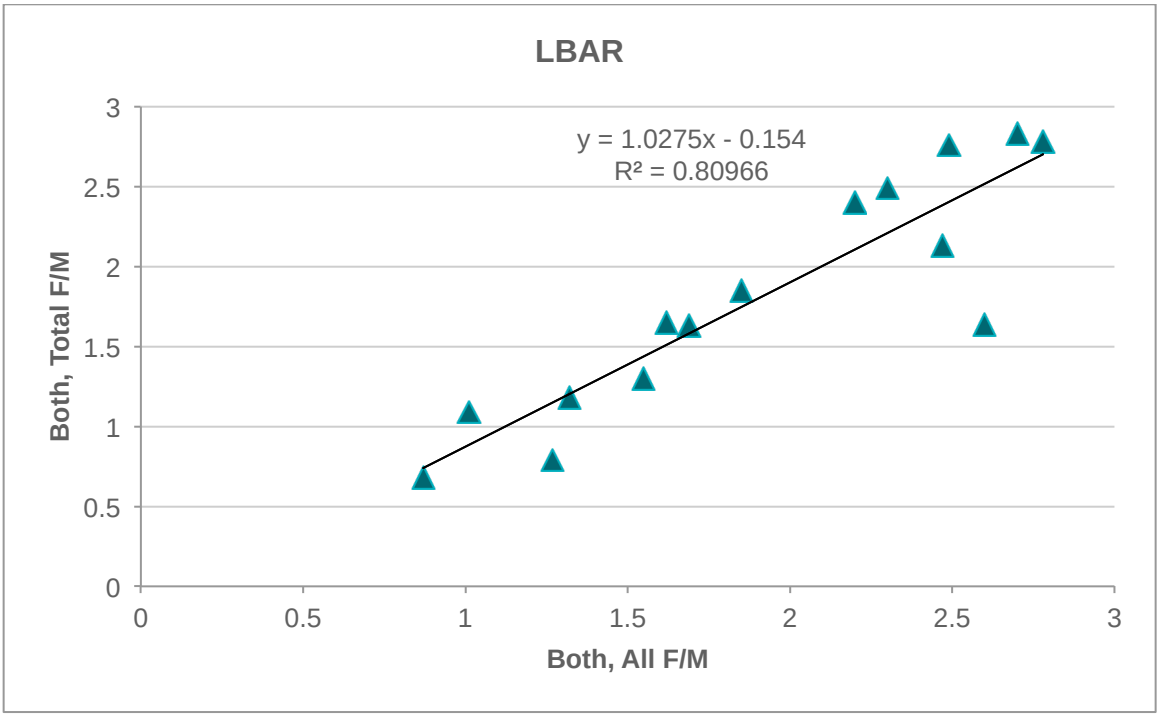


Figure A18. The relationship between the both sexes all lengths data and both sexes total lengths data from LBAR shows a close linear relationship for F/M values below 2. This relationship is more variable as F/M values exceed 2.

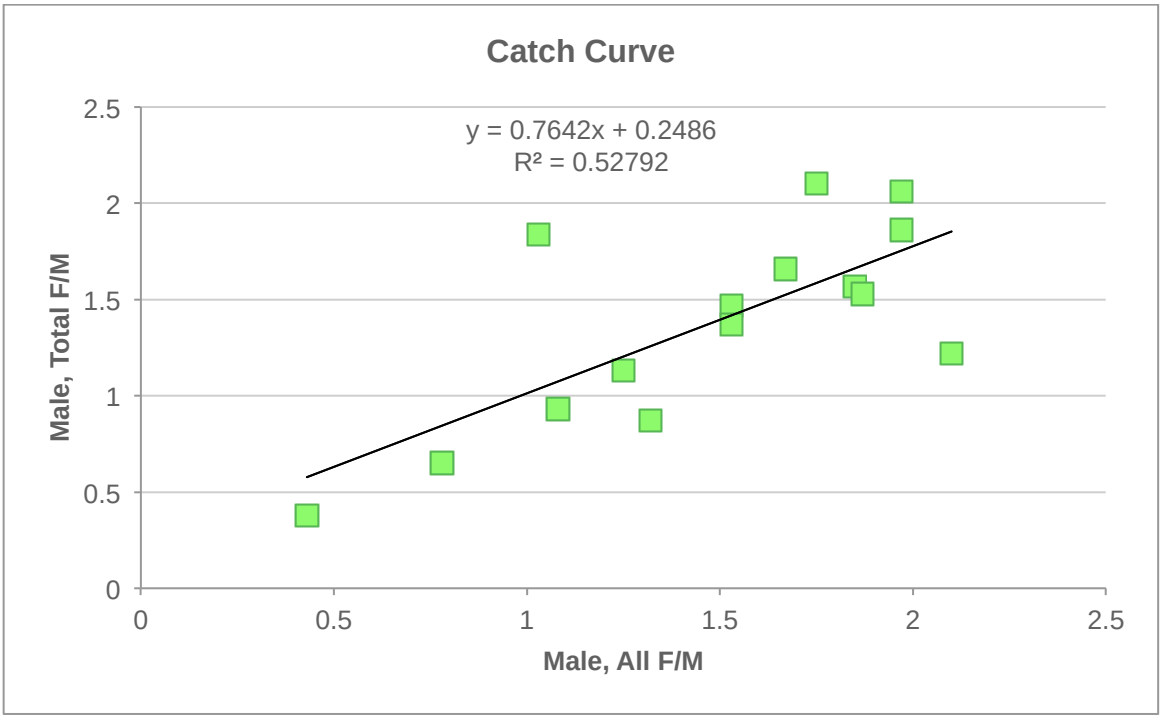


Figure A19. The data for F/M values from Catch Curve show that the male all lengths data set typically predicts higher F/M values than the male, total length data set for F/M values of 1 or greater.

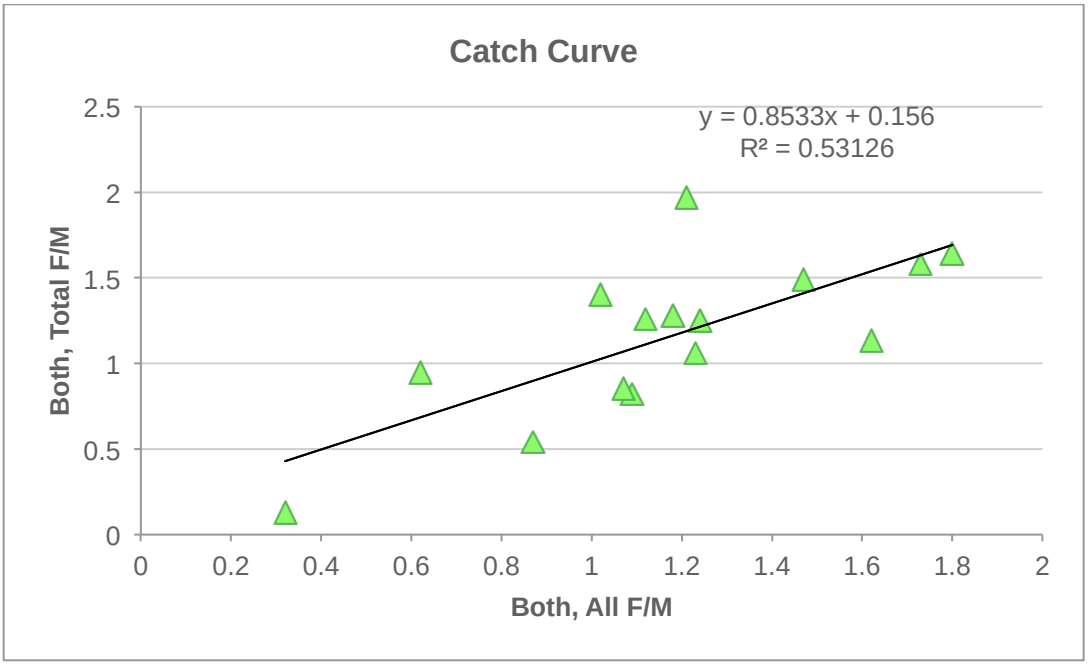


Figure A20. F/M values from Catch Curve demonstrate that both sexes total lengths produces higher values than both sexes total lengths for F/M outputs of 1 or greater. Between the two datasets, there is higher variability in which data set predicts a higher F/M.

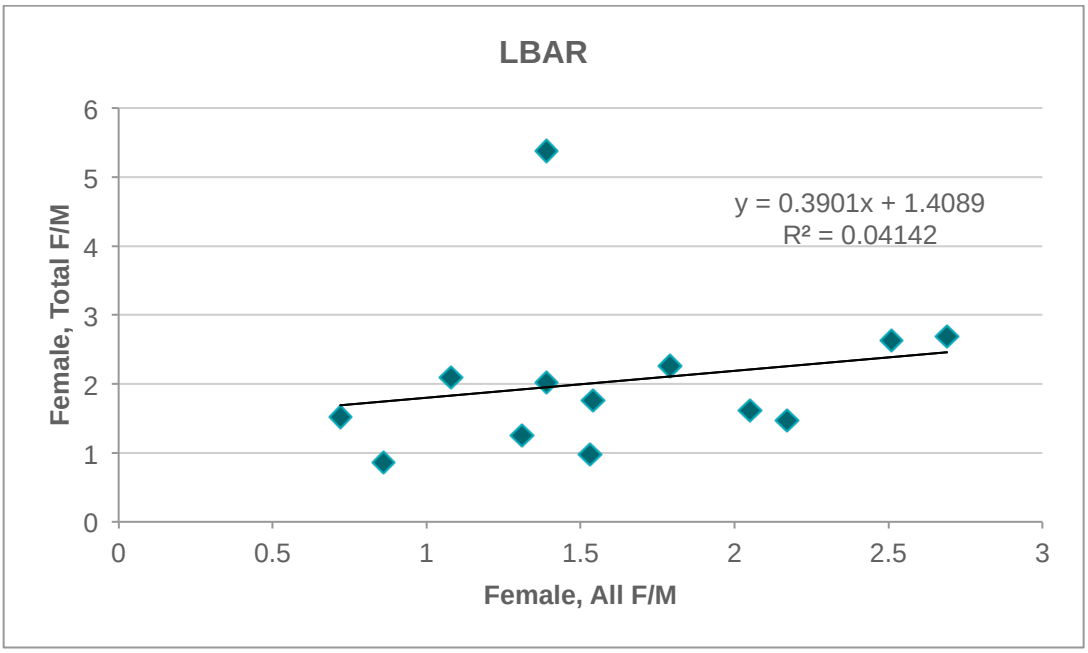


Figure A21. F/M outputs from LBAR for females all lengths and females total lengths shows that total lengths produce fairly consistent results. F/M values for all lengths increased for the same years.

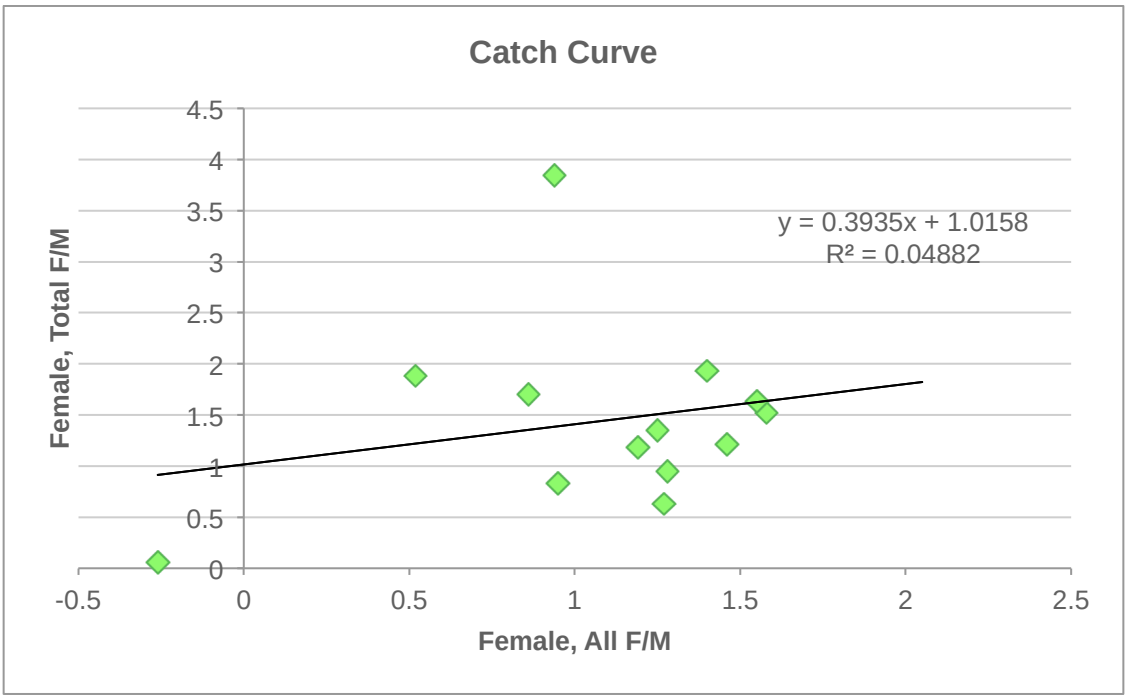


Figure A22. F/M outputs from Catch Curve for females all lengths and females total lengths shows that there is little correlation between outputs for the two datasets in the same given year. F/M values for total lengths tend to be lower results while values for all lengths are between 0.5 and 1.5.

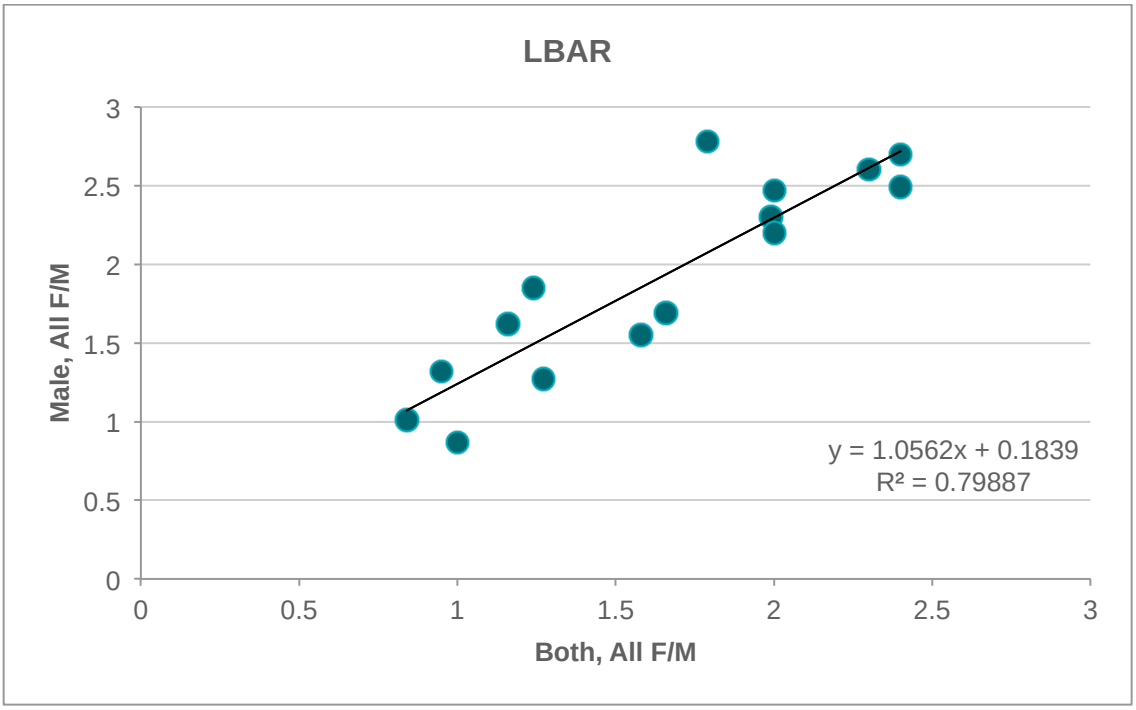


Figure A23. For LBAR, the male only all lengths predicts higher F/M values than the data set for the both sexes, all lengths, as expected.

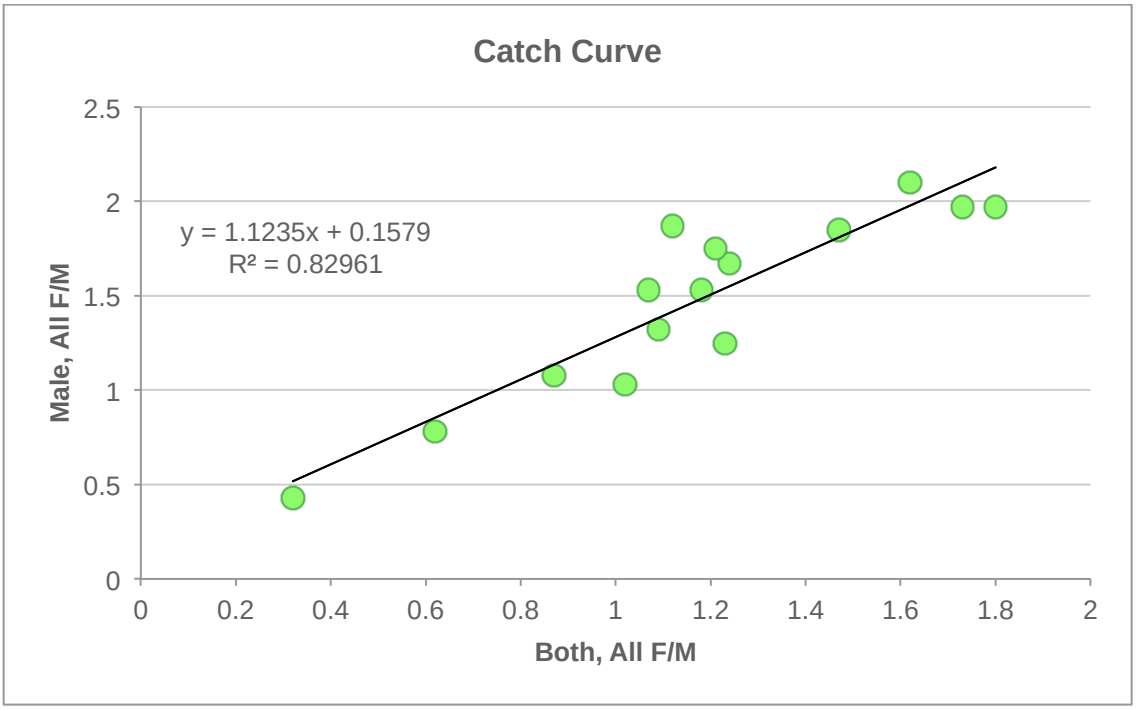


Figure A24. The Catch Curve F/M values for male all lengths data and both sexes, all lengths show a strong positive correlation. However, male only data produces higher F/M values.

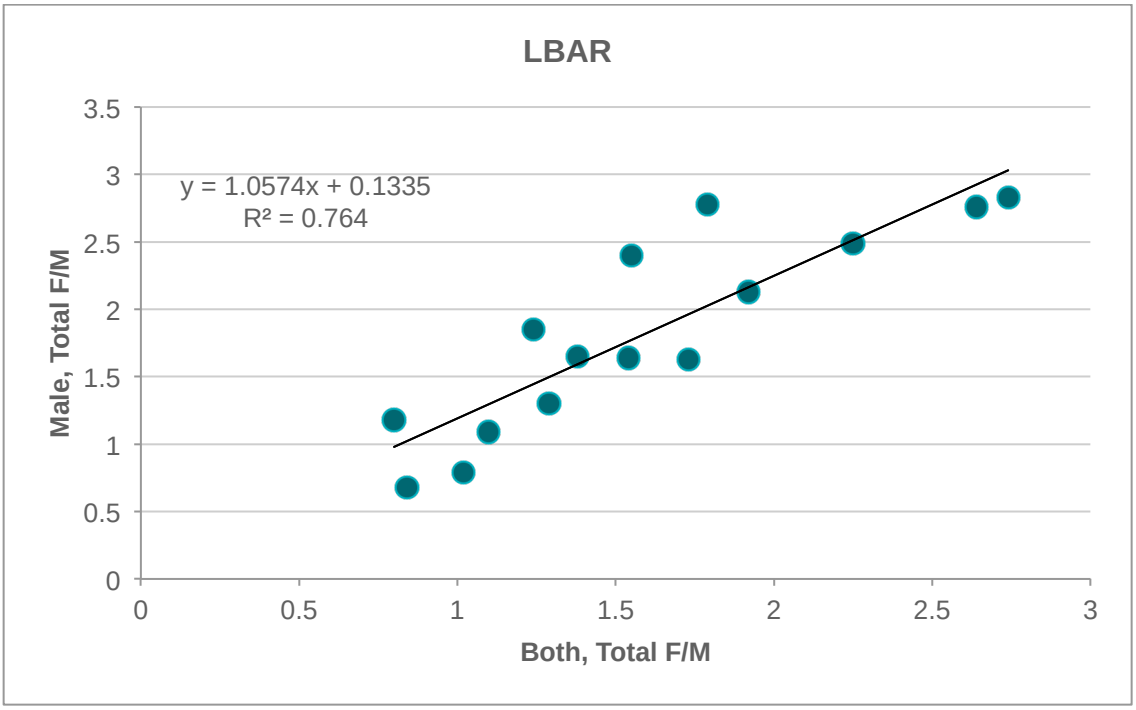


Figure A25. The LBAR F/M values for male total length data shows a positive correlation with both sexes total length data. Male only data produces higher F/M estimates than both sexes.

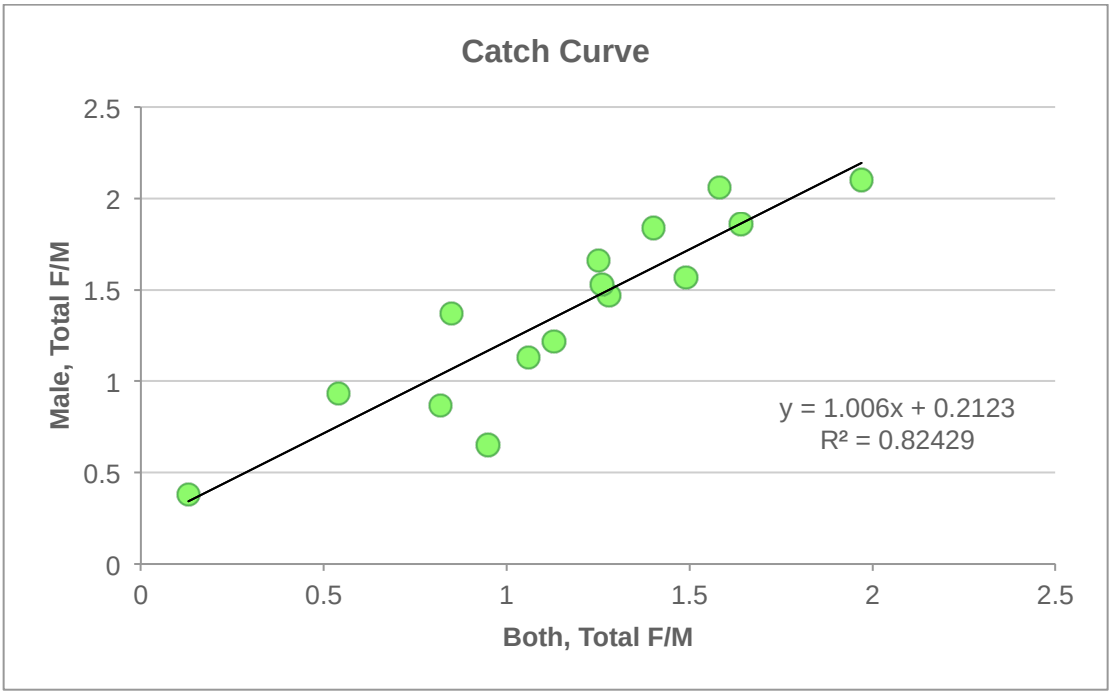


Figure A26. The Catch Curve F/M values for male total length data shows a positive correlation with both sexes, total length data. Male only data produces higher F/M values than both sexes data.

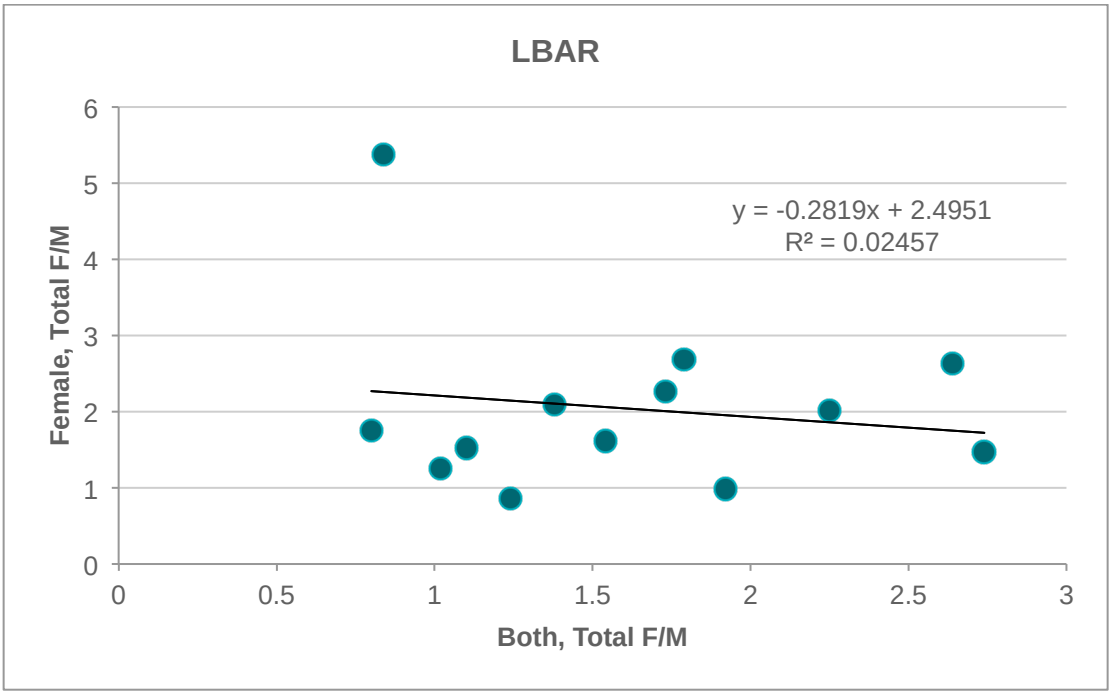


Figure A27. LBAR shows little relationship between the F/M values for female total lengths data and both sexes total length data. Female only F/M values are variable and do not correlate with increases in both sexes predictions.

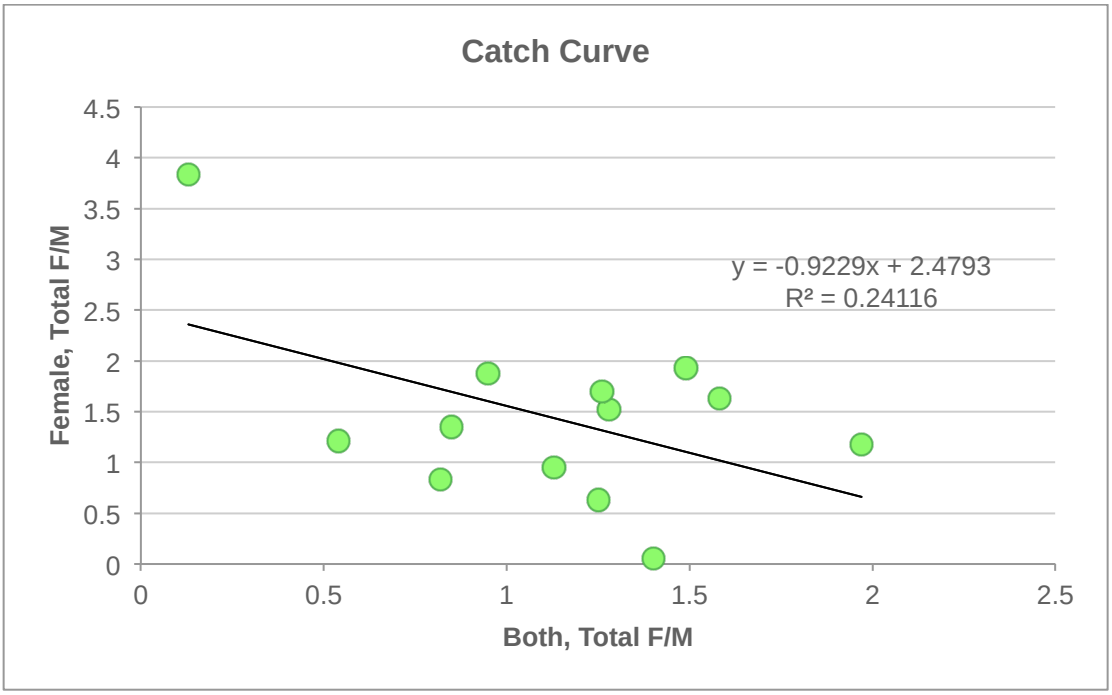


Figure A28. The female total length F/M values from Catch Curve show a slight negative correlation with the Catch Curve values for both sexes, total lengths. This would indicate decreased selectivity for females as fishing mortality increases.

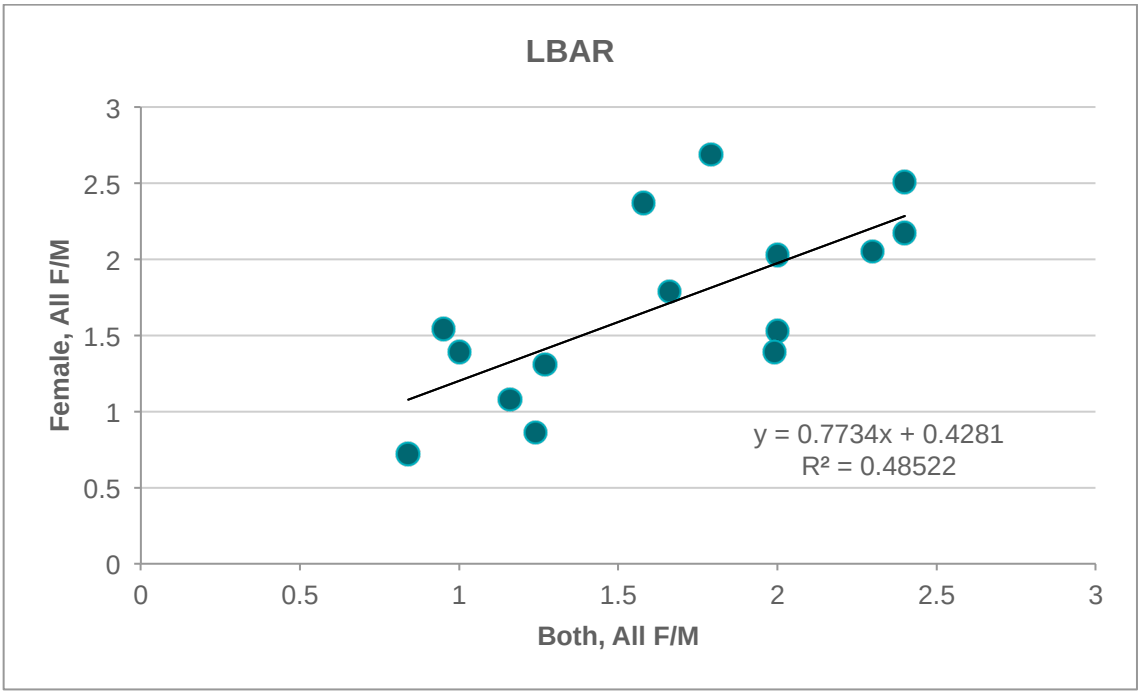


Figure A29. LBAR F/M for both sexes, all lengths and females, all lengths show a positive linear correlation between F/M values. For values under 2, females all length have a higher F/M value than both sexes, all lengths.

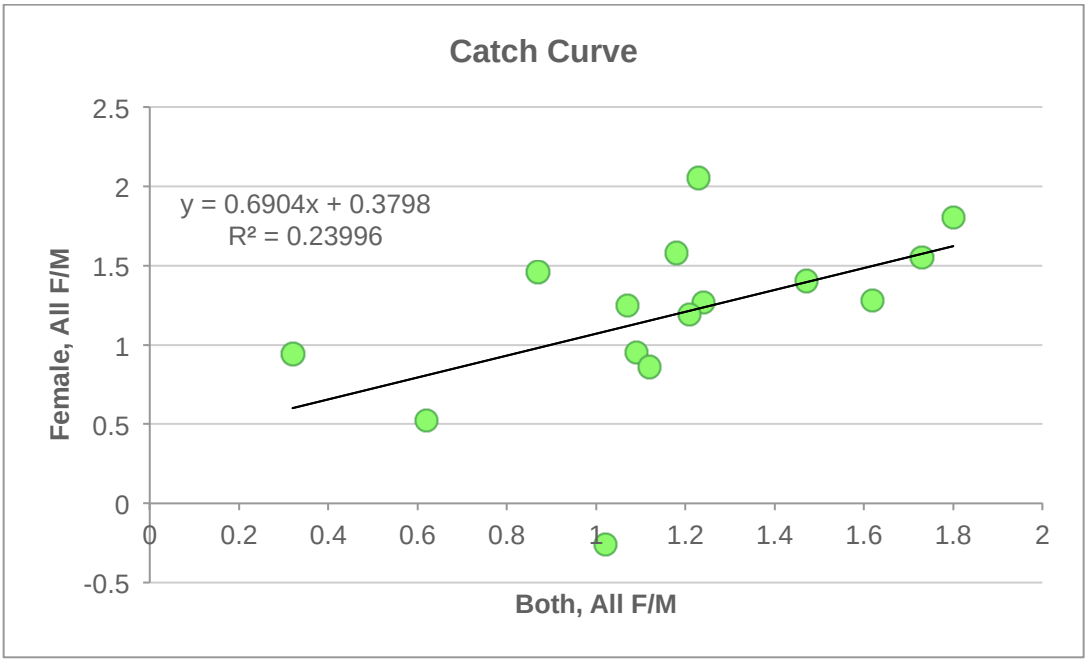


Figure A30. Catch Curve F/M for both sexes, all lengths and females, all lengths show a loose positive correlation. For F/M values greater than 1, both sexes, all lengths produces higher predictions.

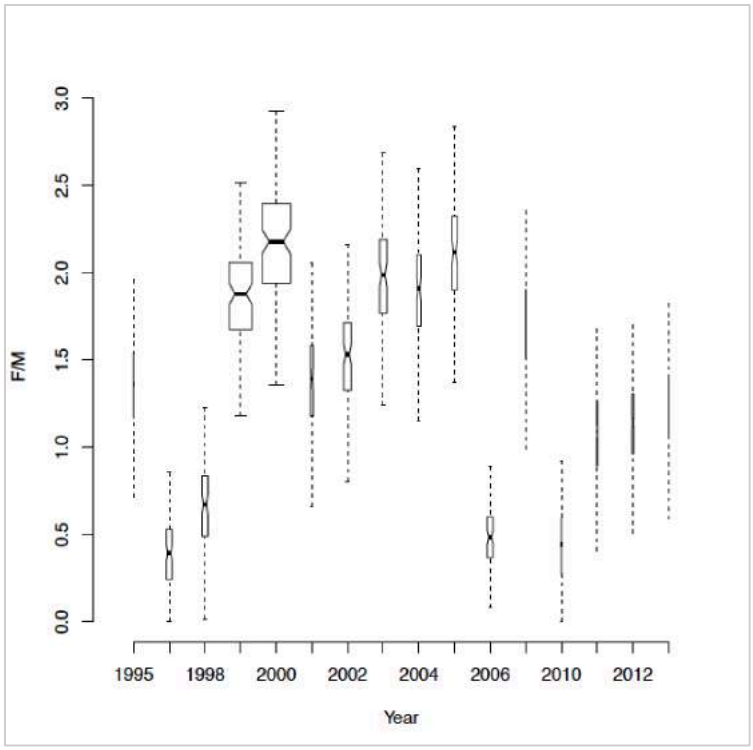


Figure A31. LBSPR F/M Boxplots, Males, All lengths. The F/M boxplots for LBSPR show highest F/M values in the early 2000s. There are fewer samples for years following 2006, as indicated by the thin boxes.

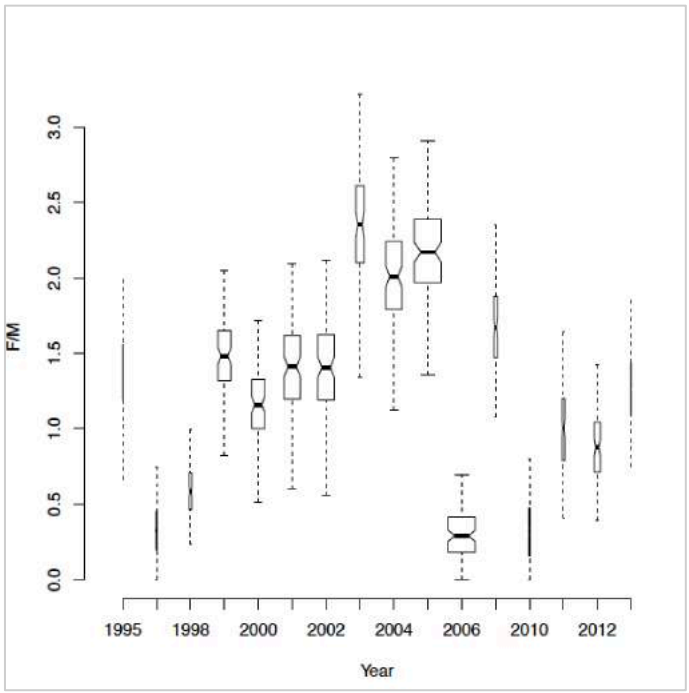


Figure A32. LBSPR F/M Boxplots, Males, Total lengths. The F/M values for this data set are highest for year with the most samples, as indicated by the thicker boxes.

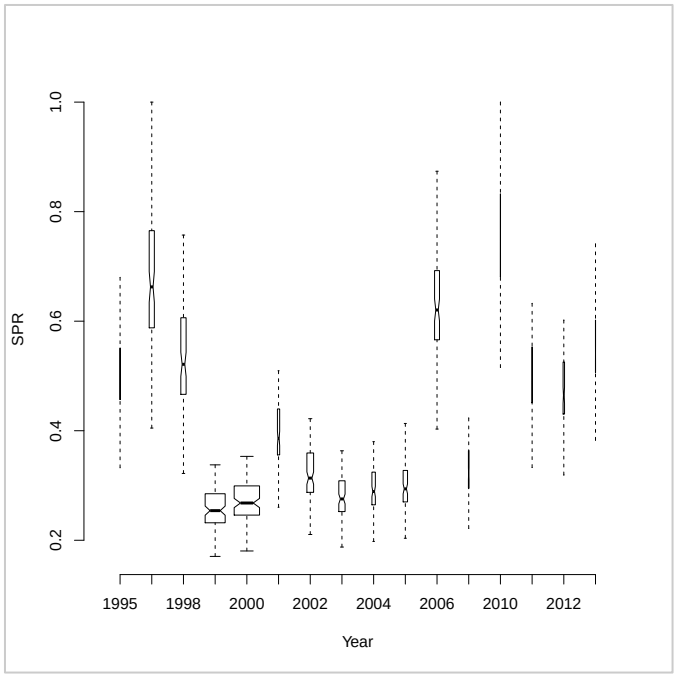


Figure A33. LBSPR Boxplots for SPR, Males, All lengths. The spawning potential ratio for the males, all lengths dataset shows low SPR with high confidence in years with large amount of data. In recent years the SPR appears to increase, however there are significant error bars for these years.

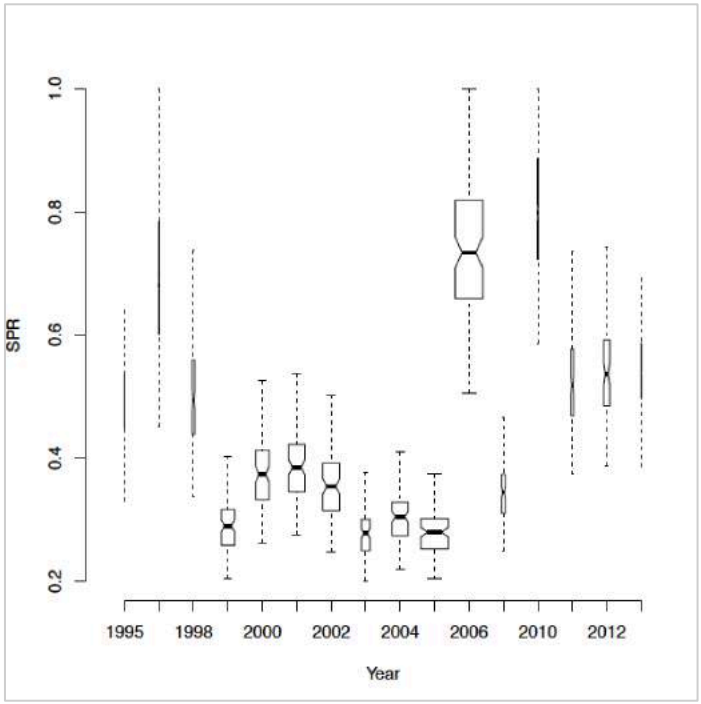


Figure A34. LBSPR Boxplots for SPR, Males, Total lengths only. The spawning potential ratio for the males, total lengths only data set shows low SPR with high confidence in years with large amount of data. In recent years the SPR appears to increase, however there are significant error bars for these years.

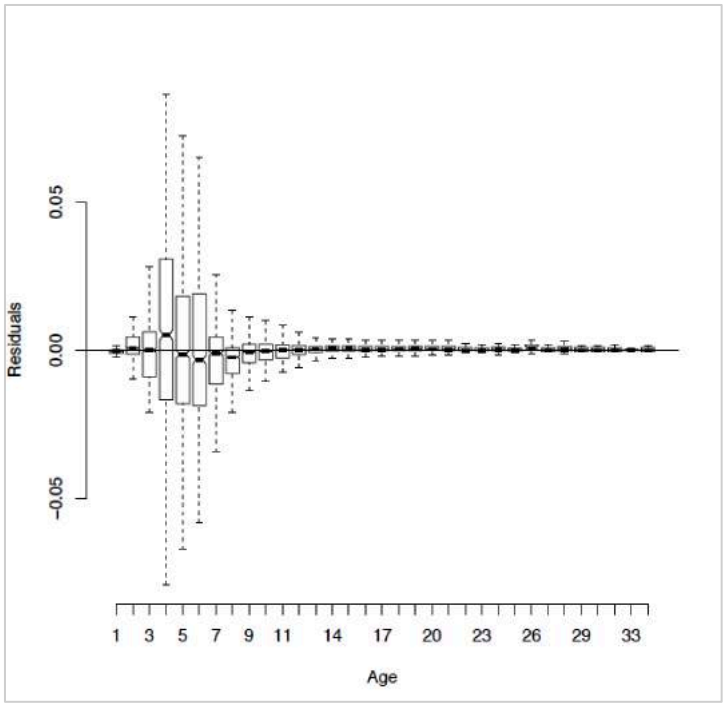


Figure A35. LBSPR Age residuals Boxplot, Males, All lengths. The age residual plots show high variability and large error bars associated with the younger lobster ages (4-7). This can be attributed to the length to age conversion for these years, or due to high variability in lobster growth for young animals.

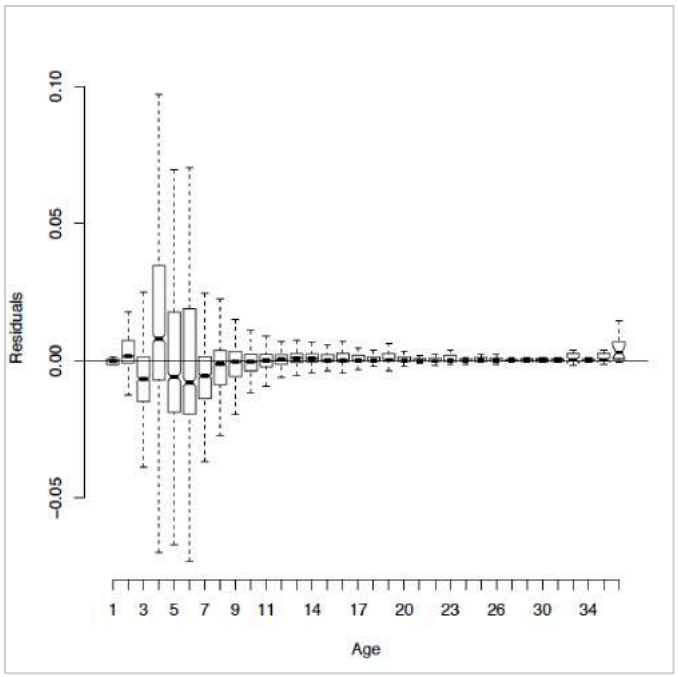


Figure A36. Age Residual Boxplots for Males, Total lengths. The age residual show the greatest amount of variability for ages 4-7 years. This can be attributed to the length to age conversion for these years, or due to high variability in lobster growth for young animals.

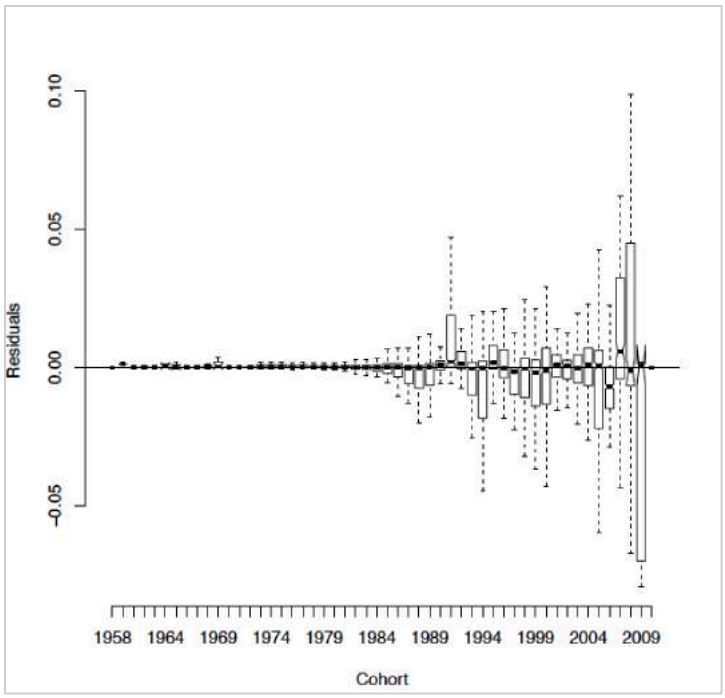


Figure A37. LBSPR Cohort Residuals Boxplot, Males, All lengths. Cohort residuals show high levels of variability and outliers in 2005, 2007, 2008, and 2009. This may be attributed by low sample sizes for these years.

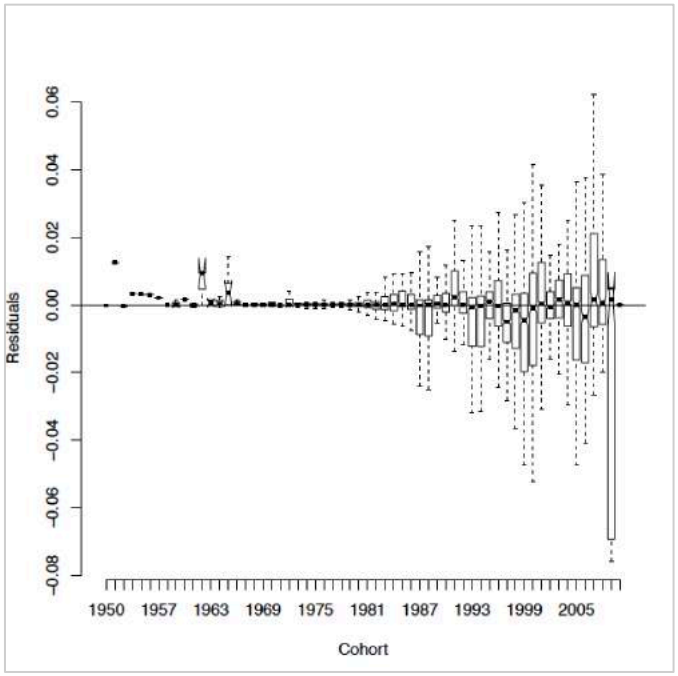


Figure A38. Cohort Residual Boxplots for Males, Total Lengths. Cohort residuals show high levels of variability and outliers in data from the early 1990s and on. This may be attributed by low sample sizes for these years.

Appendix B: TURF Feasibility

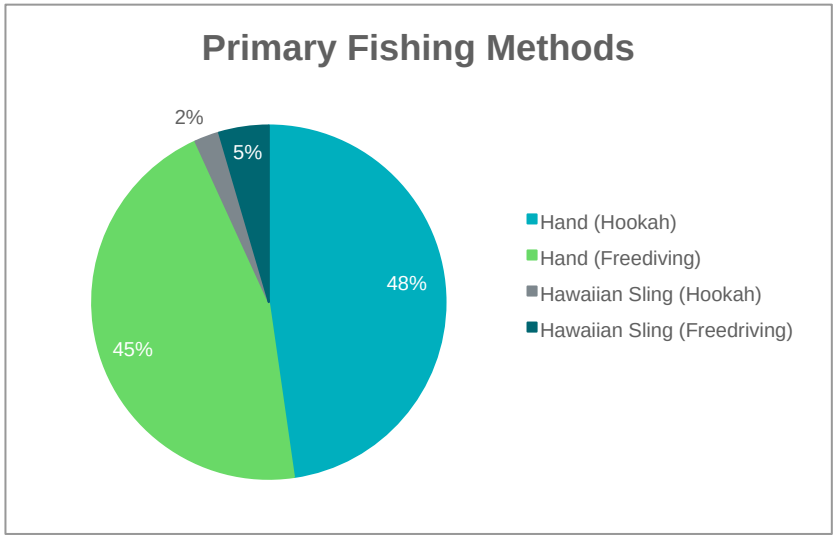


Figure B1. Primary fishing methods for lobster. Fishermen were asked whether they fish for lobster by hand or with a Hawaiian Sling, and if they use hookah or freedive while fishing. Many fishermen use more than one fishing method, but these are the *primary* methods reported.

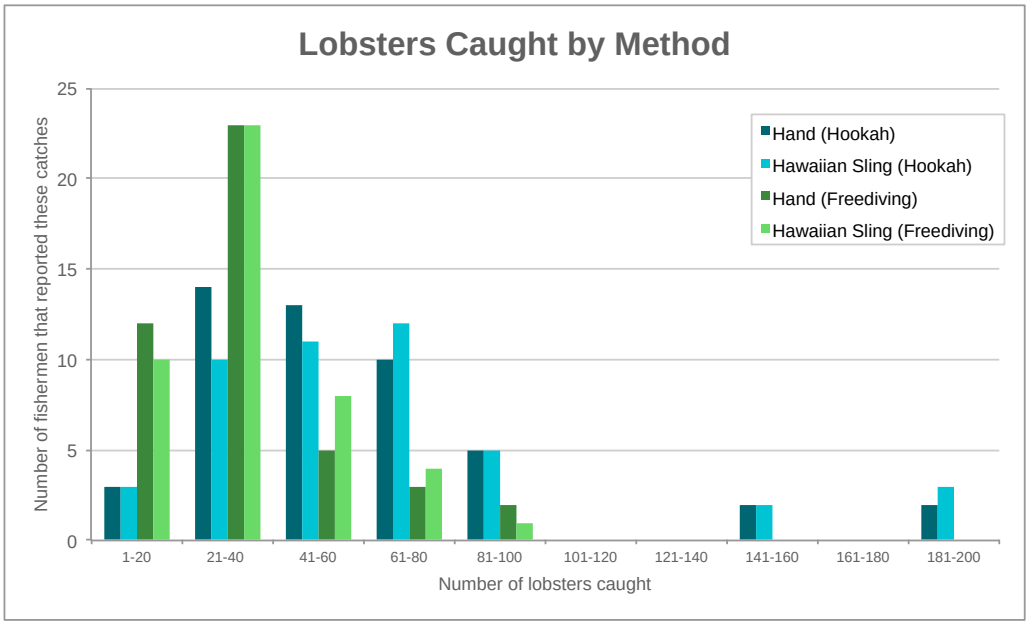


Figure B2. Lobsters caught by method. Fishermen were asked how many lobsters they caught on average, for each method of capture. If the fishermen said they did not use a certain method of capture, we asked them to estimate the number of lobster they thought they could catch using that method. In this way we could better understand perceptions of catch – especially to understand perceptions of catching by hand since that is how they would have to catch lobster to participate in the TURF.

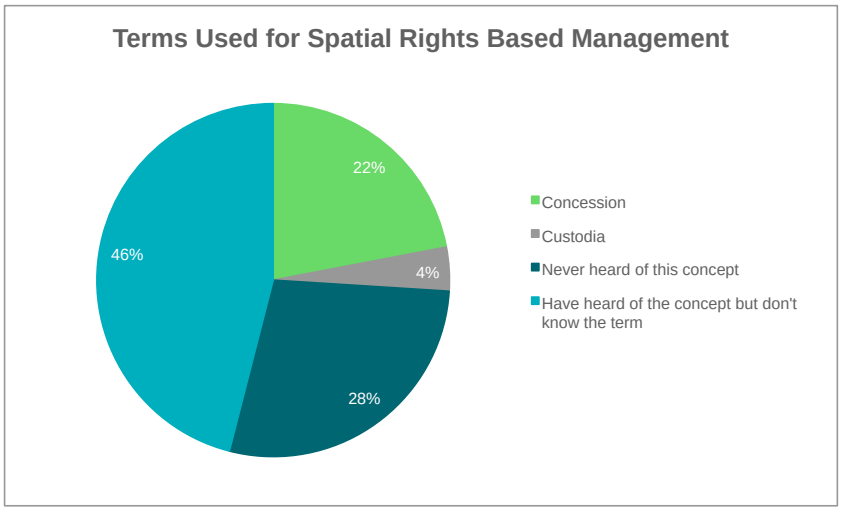


Figure B3. Terms used for spatial rights based management. Before asking fishermen about their willingness to participate in a TURF, the general concept of a TURF was explained. They were then asked if they had heard a concept like that before and, if so, what it was called.

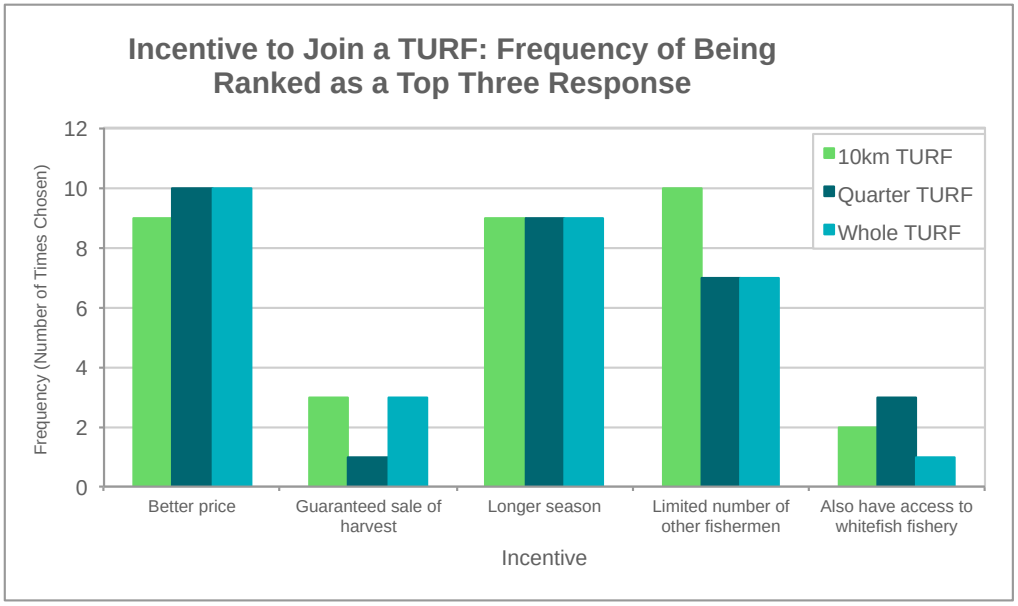


Figure B4. For fishermen that replied they did not want to join a TURF under the initial circumstances, they were asked to rank the influence that various additional incentives would have on convincing them to join a TURF (1 being the most important). The frequency of each incentive being ranked in the top three, for various TURF sizes, is shown here.

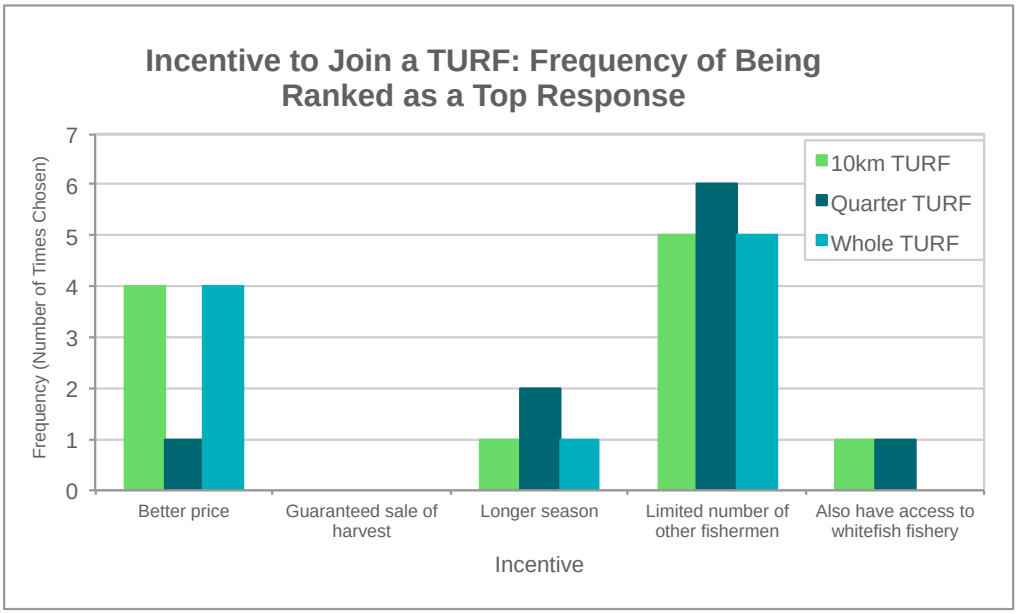


Figure B5. For fishermen that replied they did not want to join a TURF under the initial circumstances, they were asked to rank the influence that various additional incentives would have on convincing them to join a TURF (1 being the most important). The frequency of each incentive being ranked as the top choice, for various TURF sizes, is shown here.

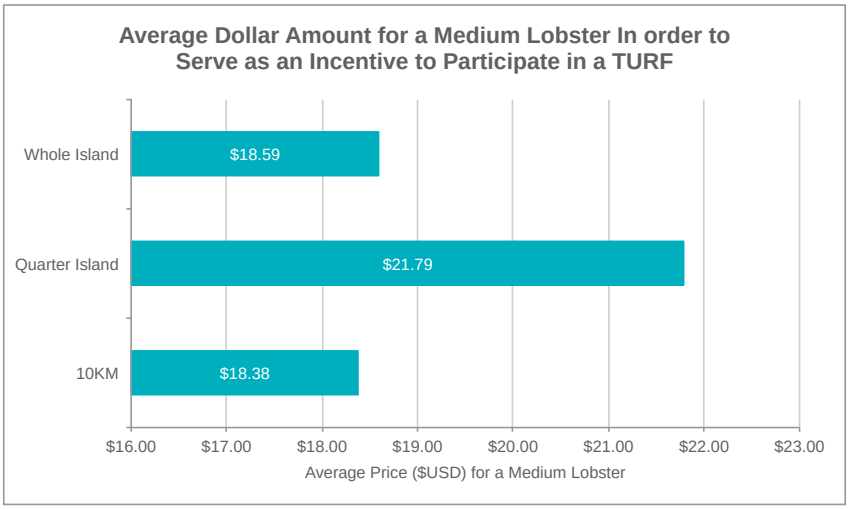


Figure B6. For fishermen that ranked 'better price for lobster' as an appealing incentive, they were asked what price they would want for a medium-sized lobster. The average price for each of the three TURFs is shown here.

Appendix C: San Cristóbal Market Study

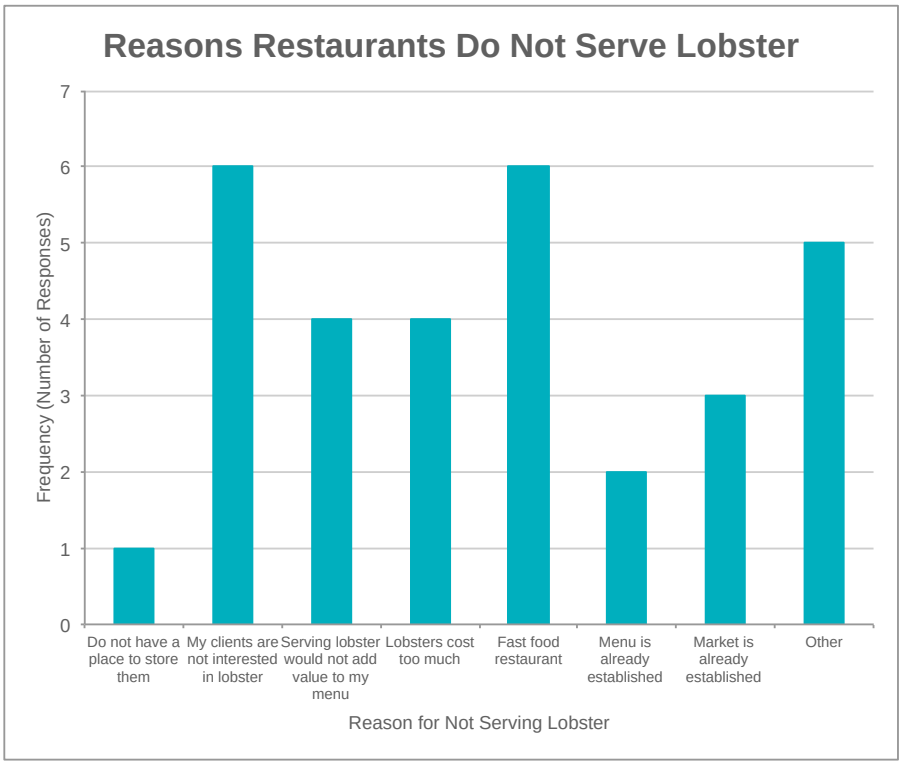


Figure C1. Number of responses for reasons restaurants don't serve lobster in their establishments.

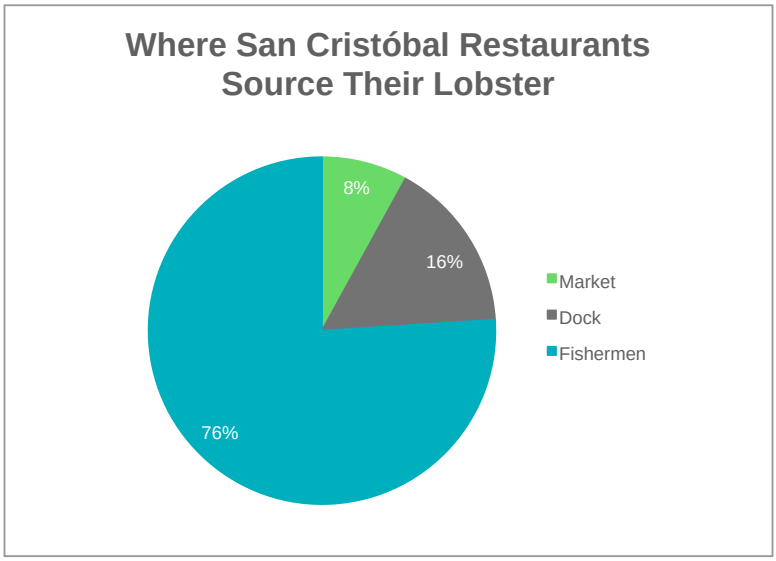


Figure C2. Channels restaurants use to sources their lobster.

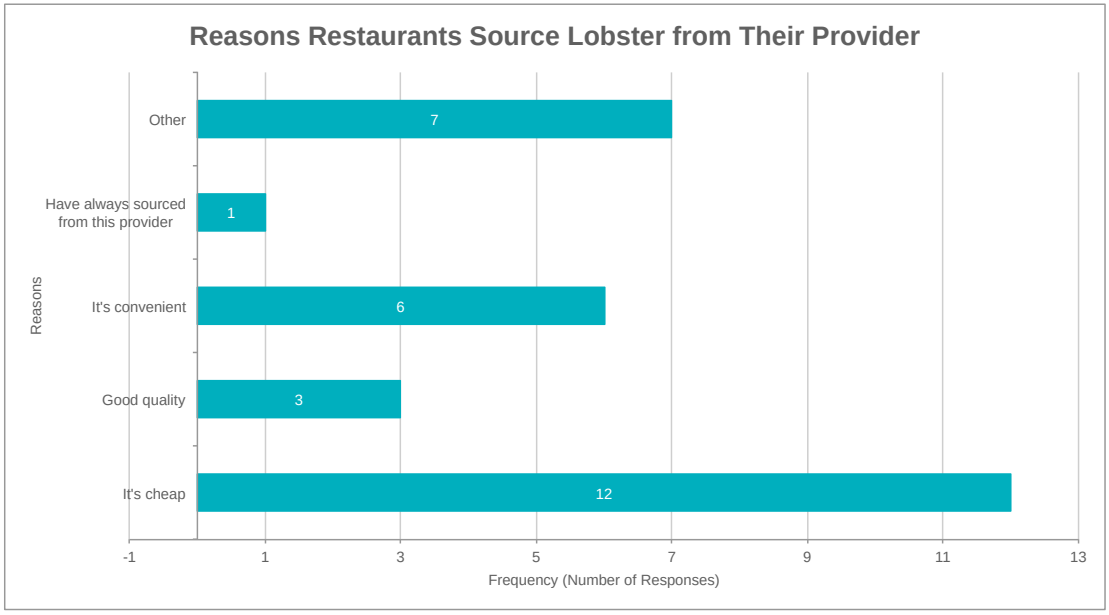


Figure C3. Restaurant responses for reasons they source through a particular channel.

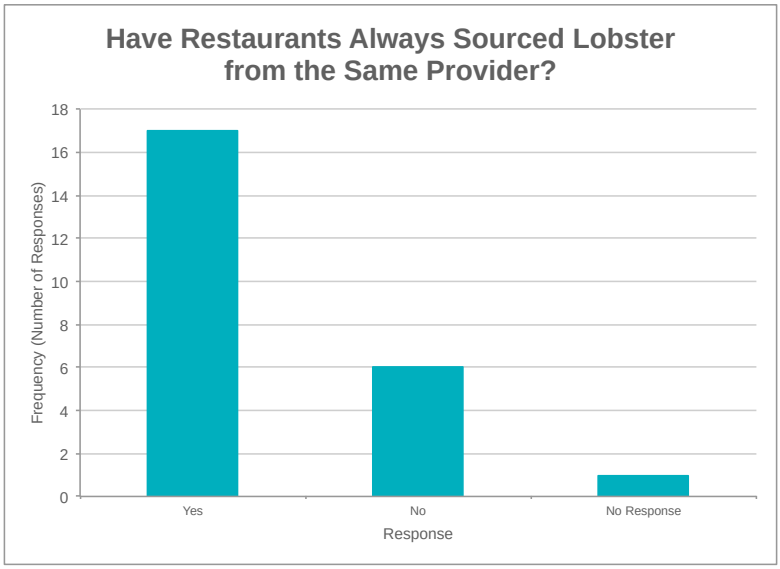


Figure C4. Responses on whether restaurants have always purchased lobster from the same provider.

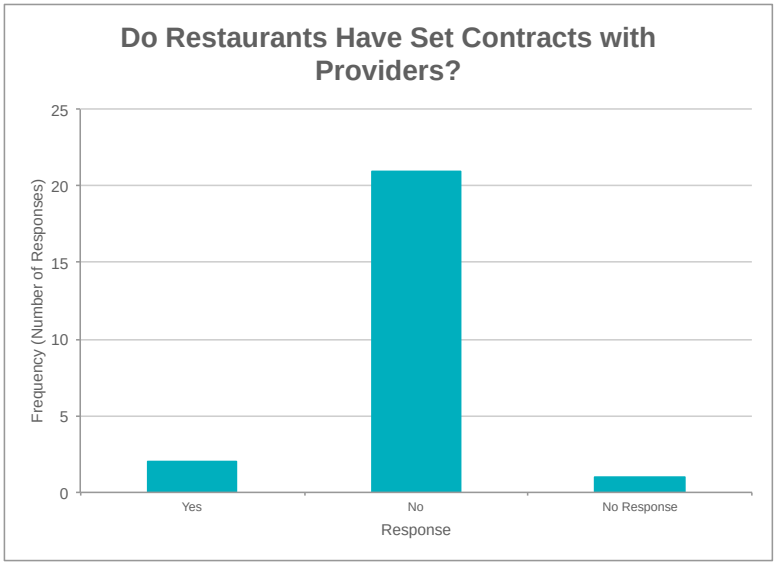


Figure C5. Responses on the presence of contracts between restaurants and fishermen.

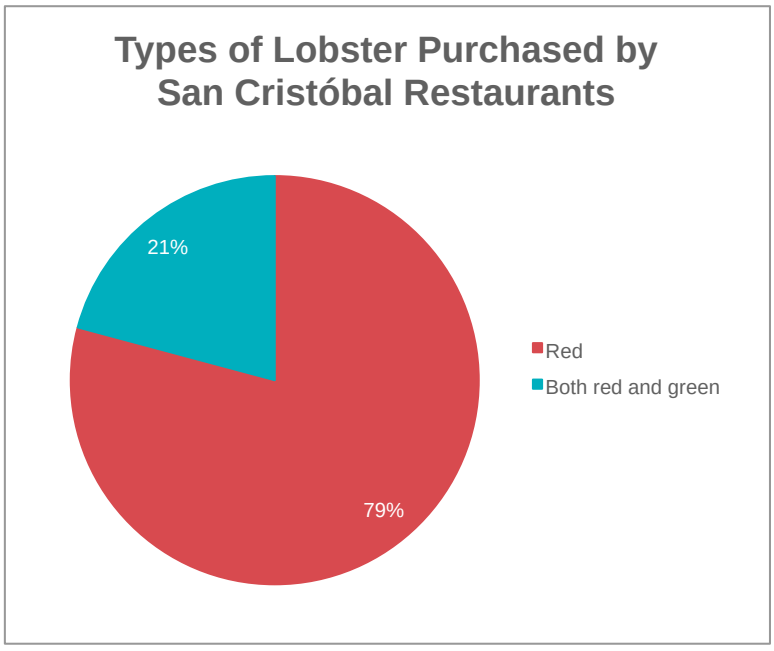


Figure C6. Species of lobster purchased by restaurants.

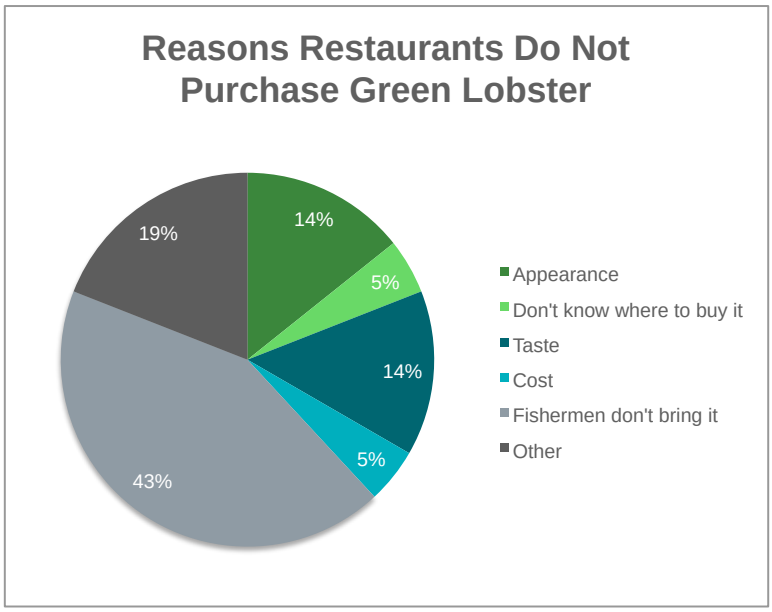


Figure C7. Restaurant responses on reasons for not purchasing green lobster

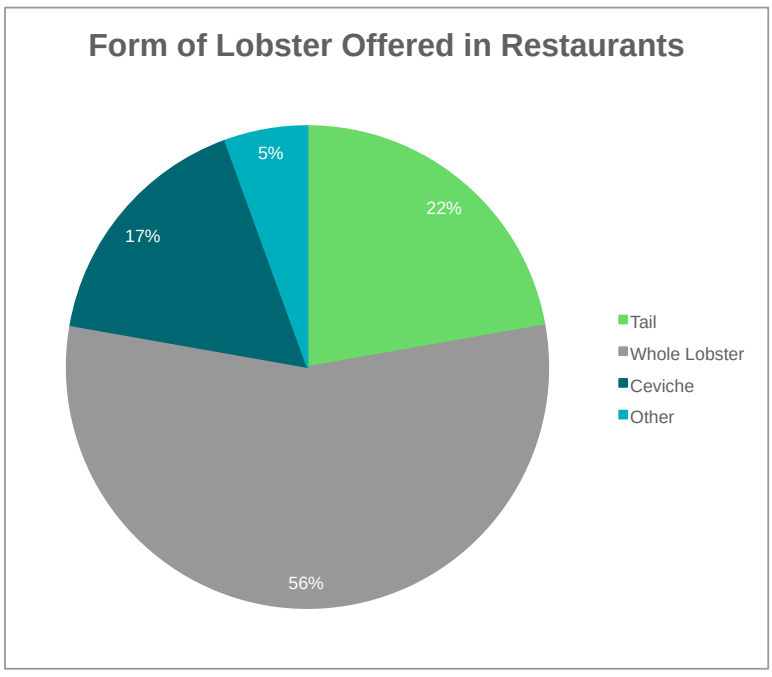


Figure C8. Presentation of lobster offered in restaurants on San Cristóbal

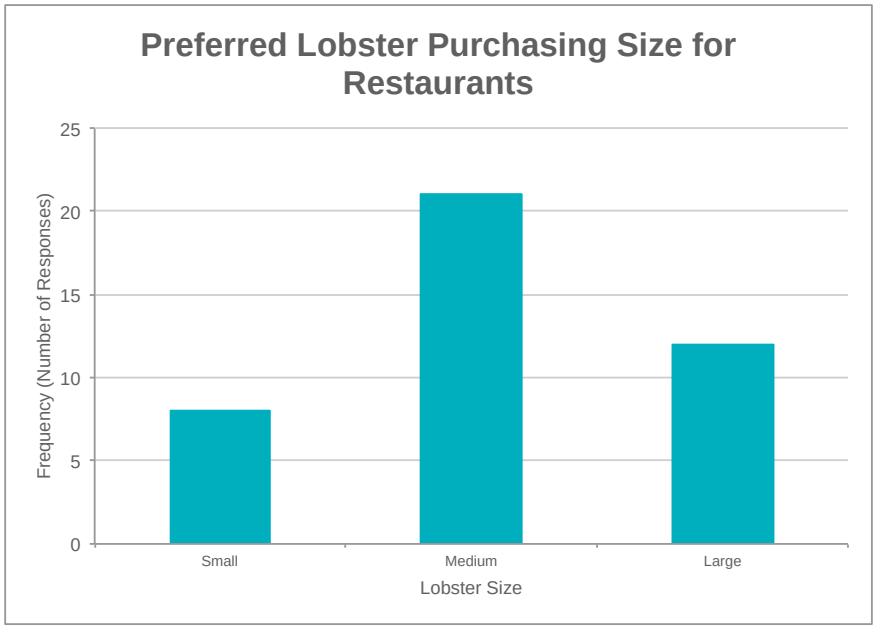


Figure C9. Preferred size of lobster purchased by restaurants.

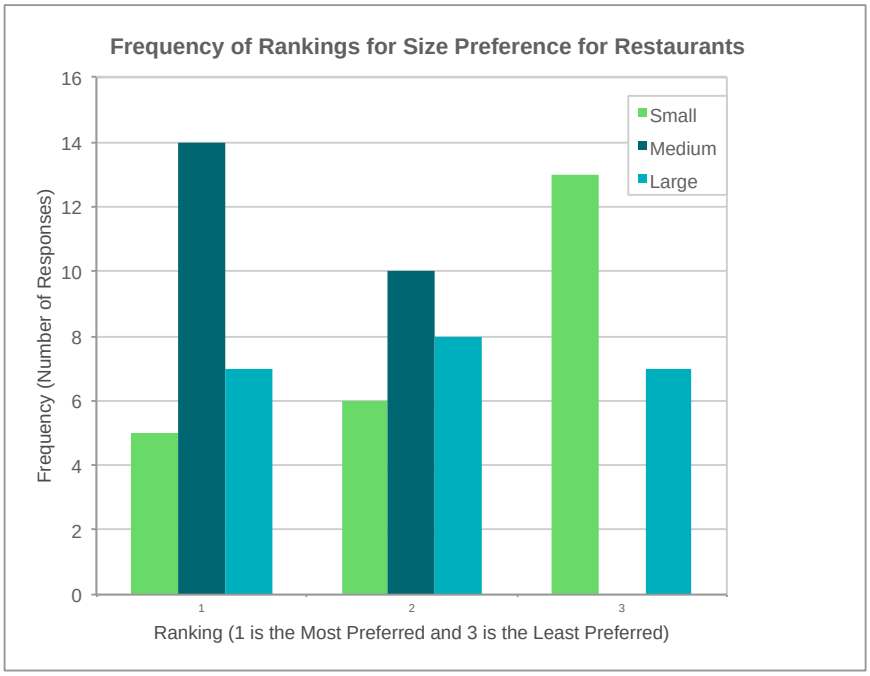


Figure C10. Frequency of rankings for restaurants' preferred lobster sizes for purchases.

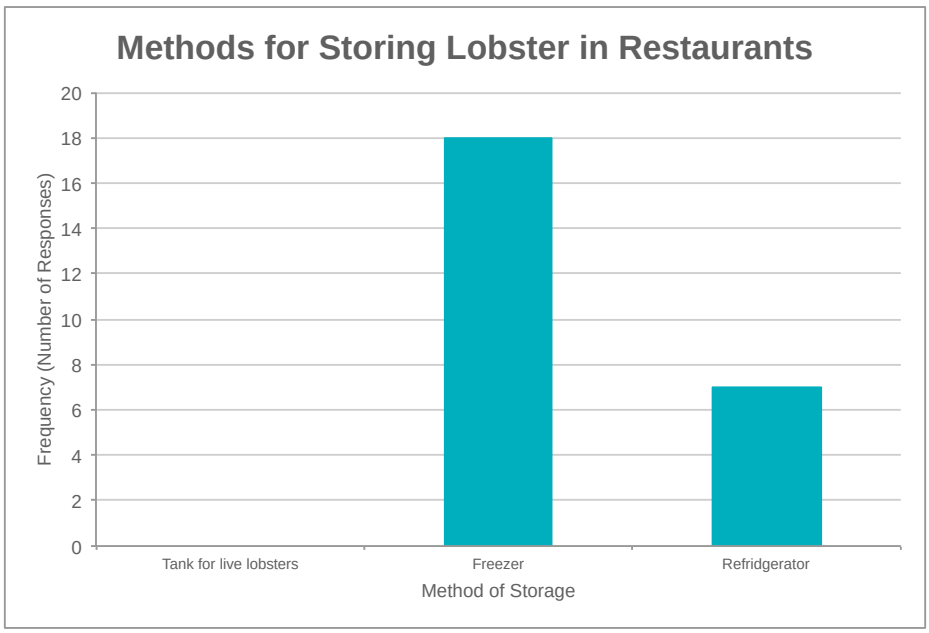
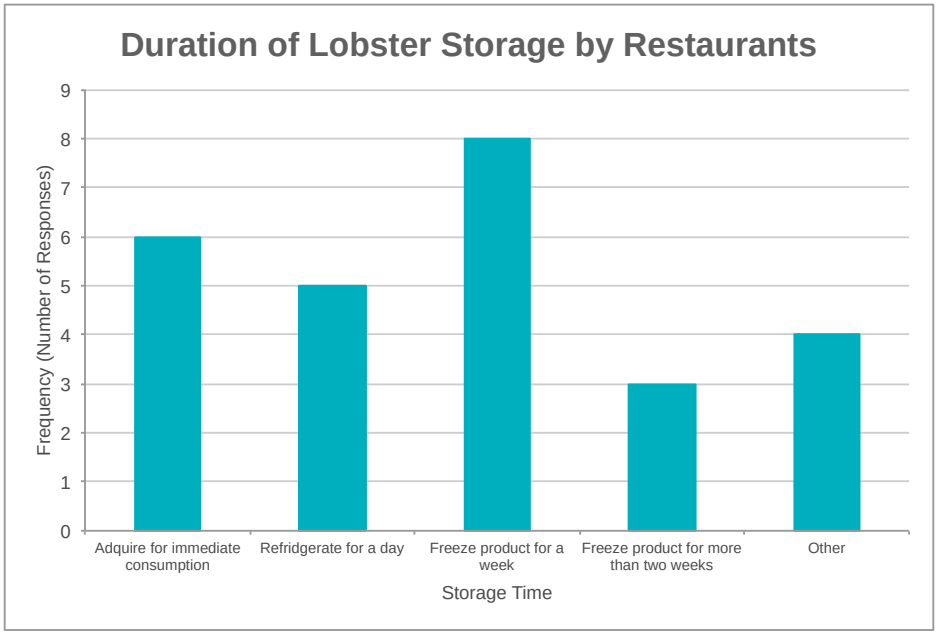


Figure C11. Methods and locations where lobster is stored in restaurants



C12. Timeline for duration that lobster can be stored in local restaurants.

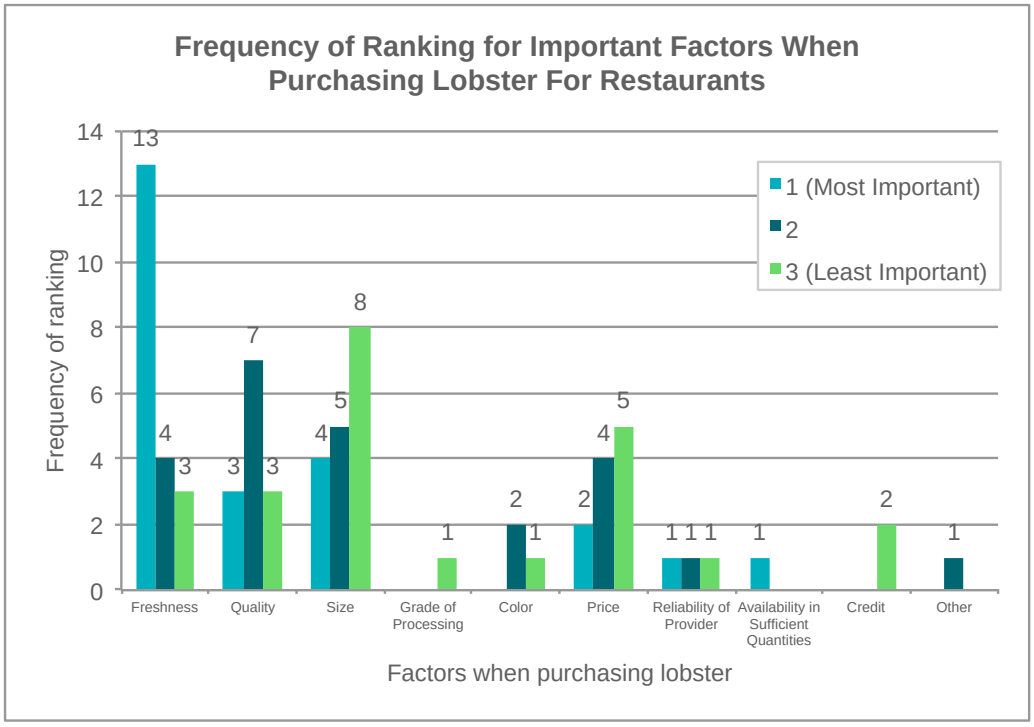


Figure C13. Frequency of rankings for important factors considered by restaurants when purchasing lobster

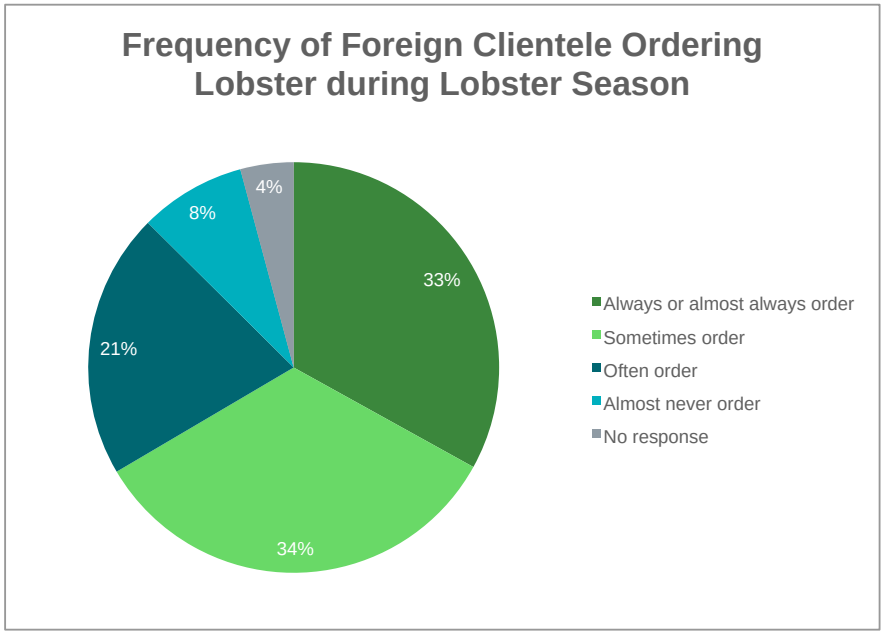


Figure C14. Frequency with which international clientele orders lobster in local restaurants

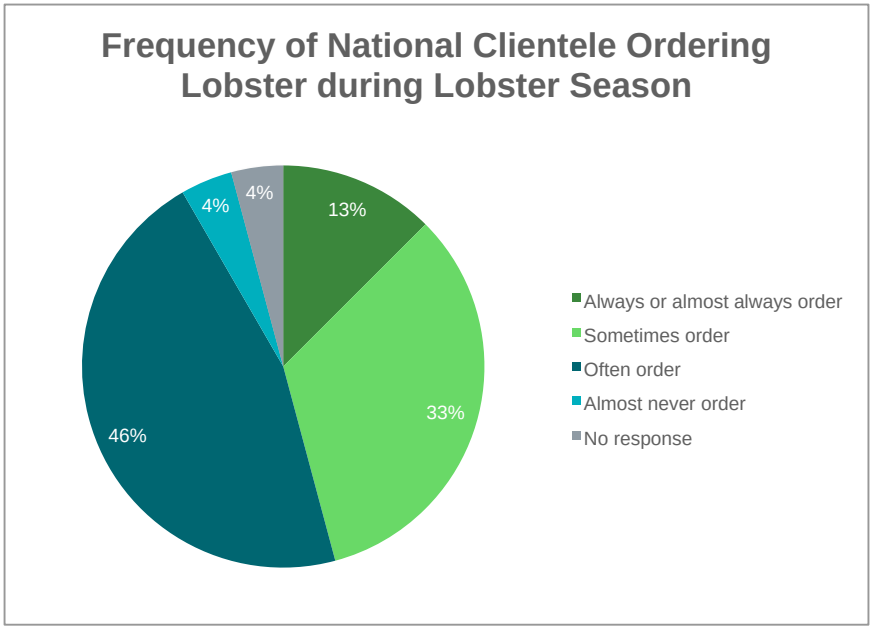


Figure C15. Frequency with which Ecuadorian/National clientele orders lobster in local restaurants

Figure C16. Responses on restaurant perceptions for important characteristics to their clientele with respect to ordering lobster in their establishment

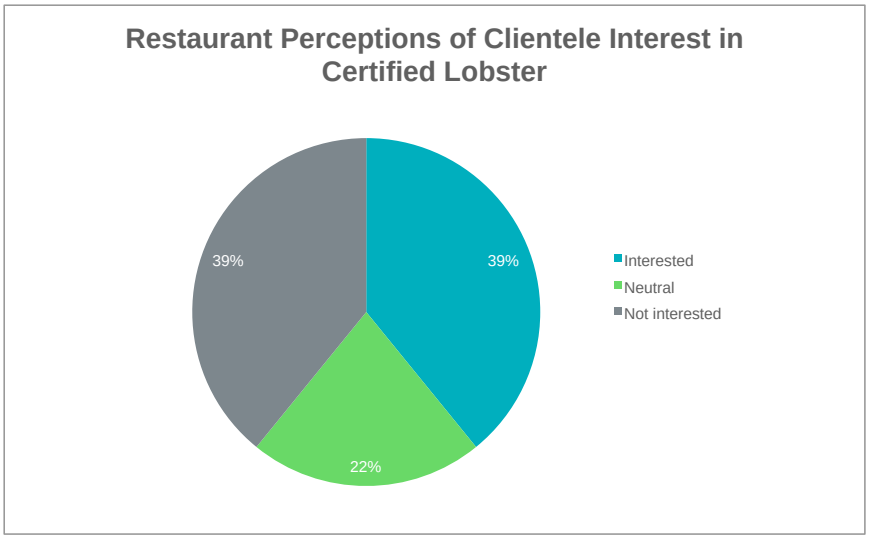


Figure C17. Responses on restaurant perceptions on whether their clientele would be interested in seeing certified lobster on their menus.

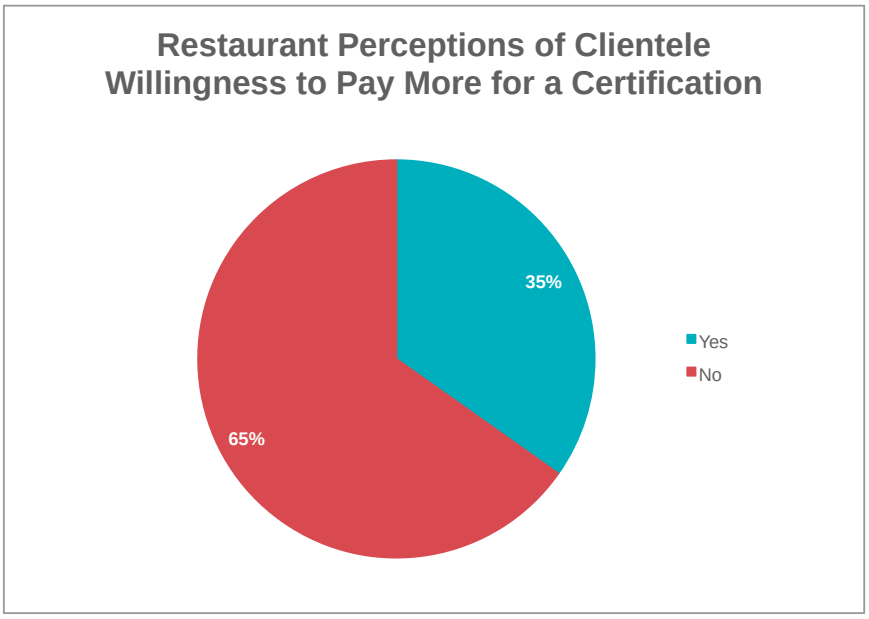


Figure C18. Responses on restaurant perceptions on whether their clientele would be willing to pay more for a lobster dish in their establishment that advertised certified lobster.

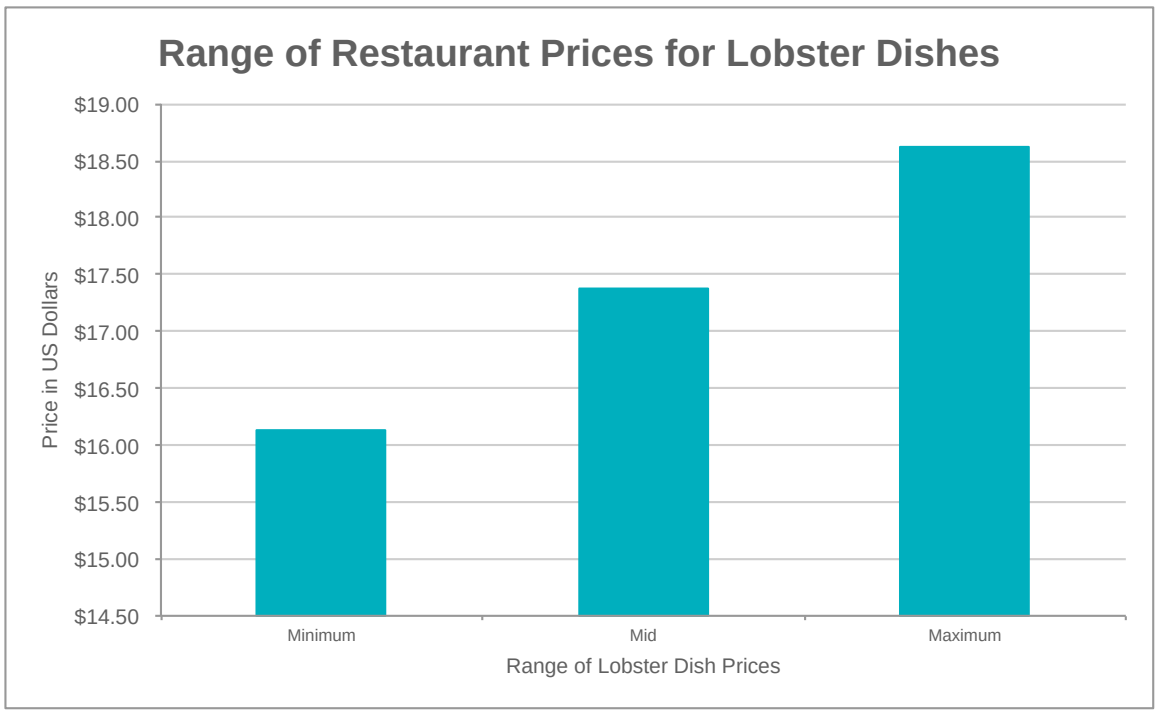


Figure C19. Minimum, average, and maximum prices for lobster dishes in local restaurants

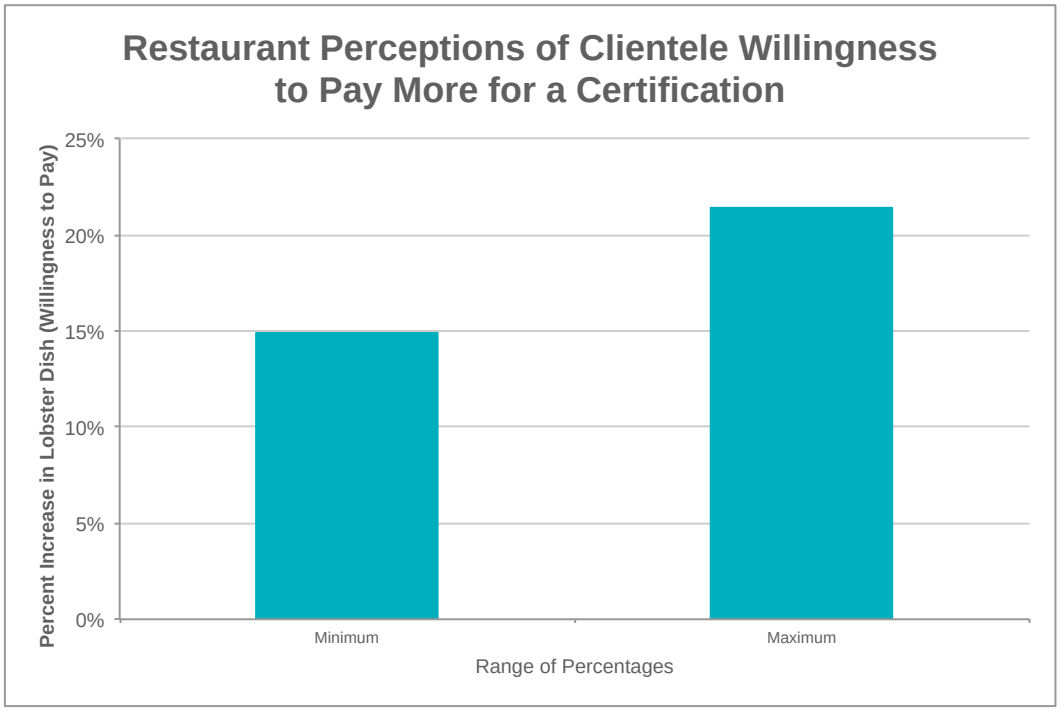


Figure C20. Responses from restaurants for minimum and maximum price increases clients would be willing pay for certified lobster.

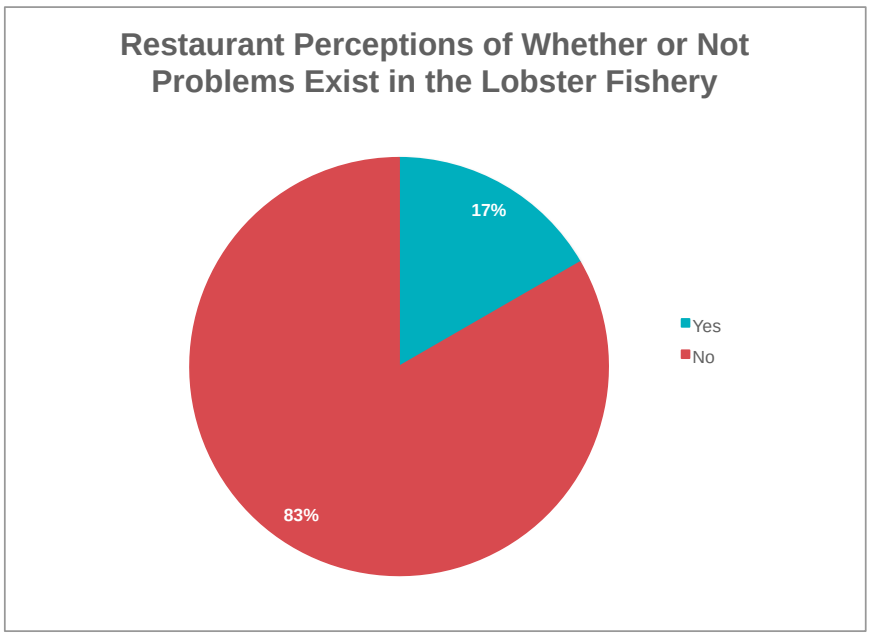


Figure C21. Restaurant perceptions of problems currently existing within the lobster fishery

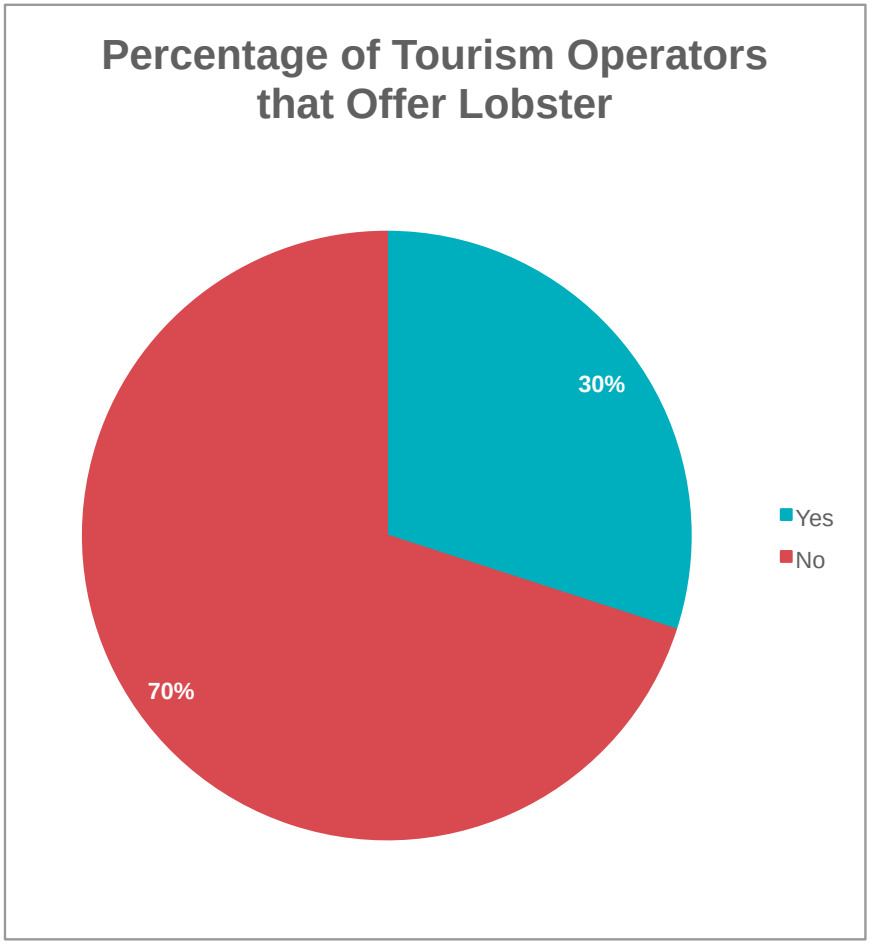


Figure C22. Percentage of tourism operators that serve lobster on San Cristóbal

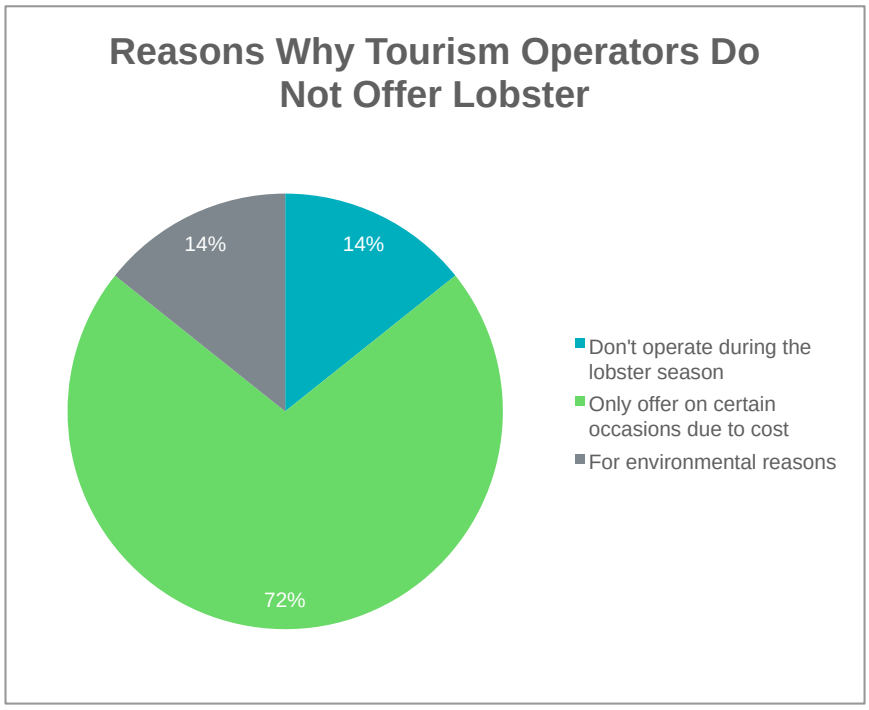


Figure C23. Responses for reasons tourism operators do not serve lobster.

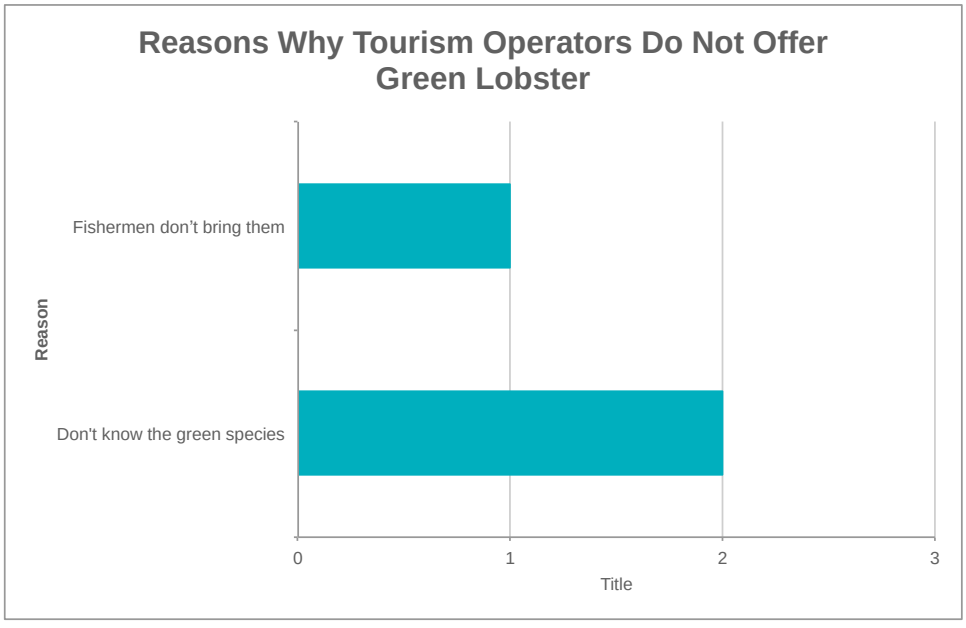


Figure C24. Responses for reasons tourism operators do not serve green lobster.

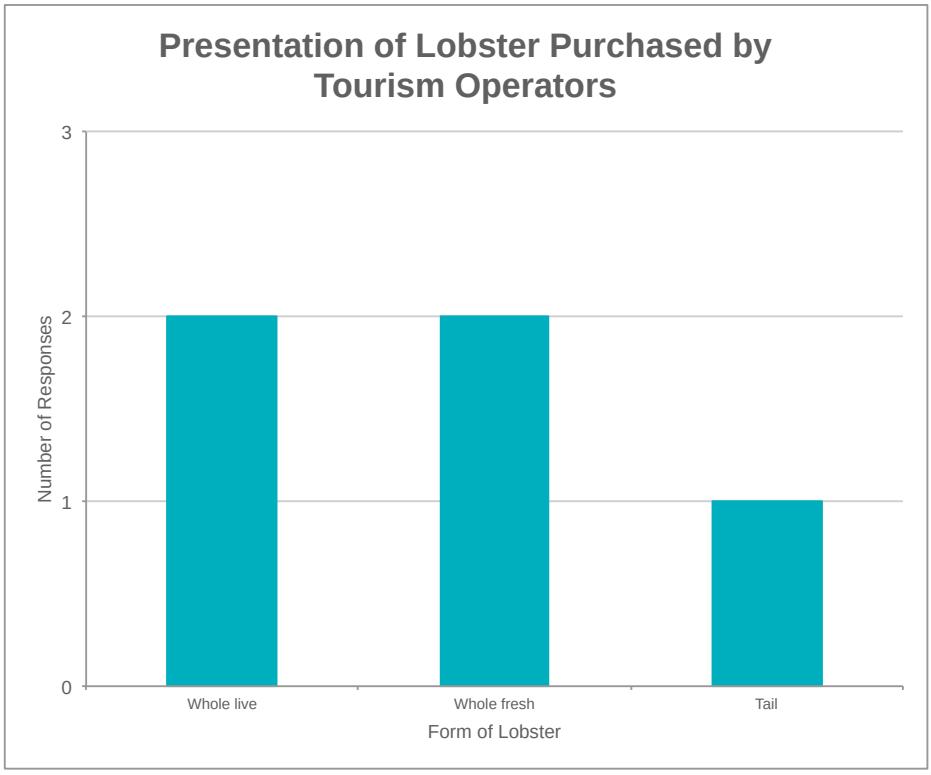


Figure C25. Forms of lobster purchased by tourism operators.

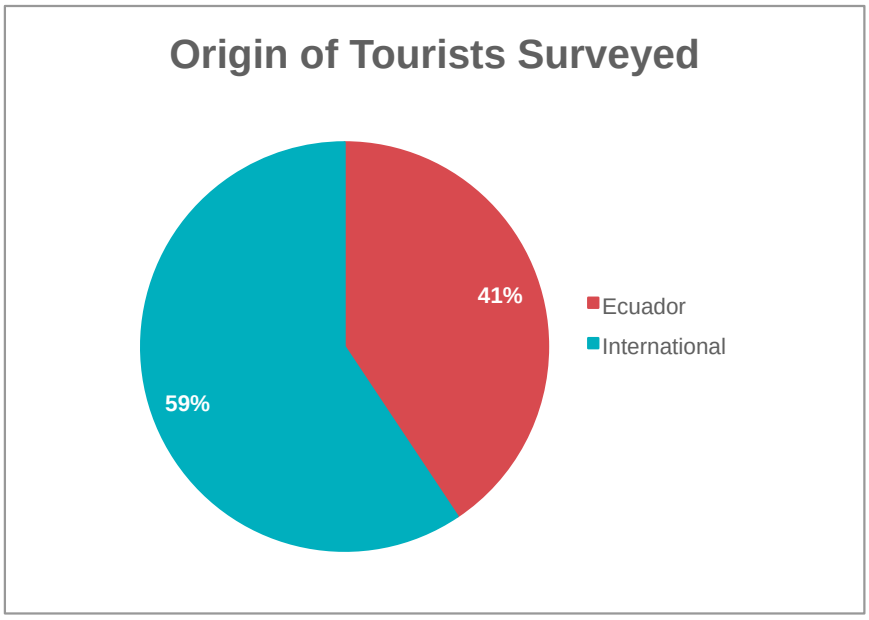


Figure C26. Percentage of tourists by origin surveyed at Baltra and San Cristóbal airports.

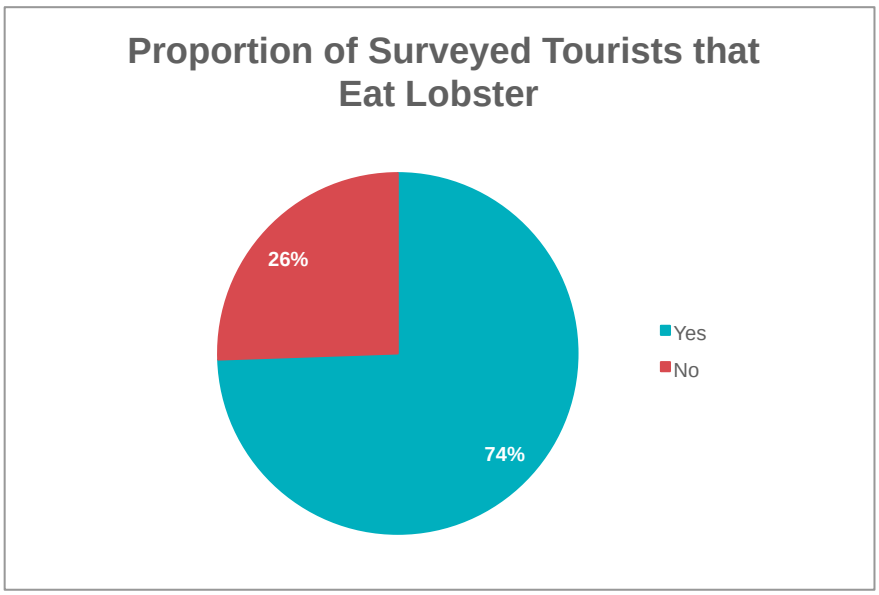


Figure C27. Percentage of tourists surveyed that typically eat lobster

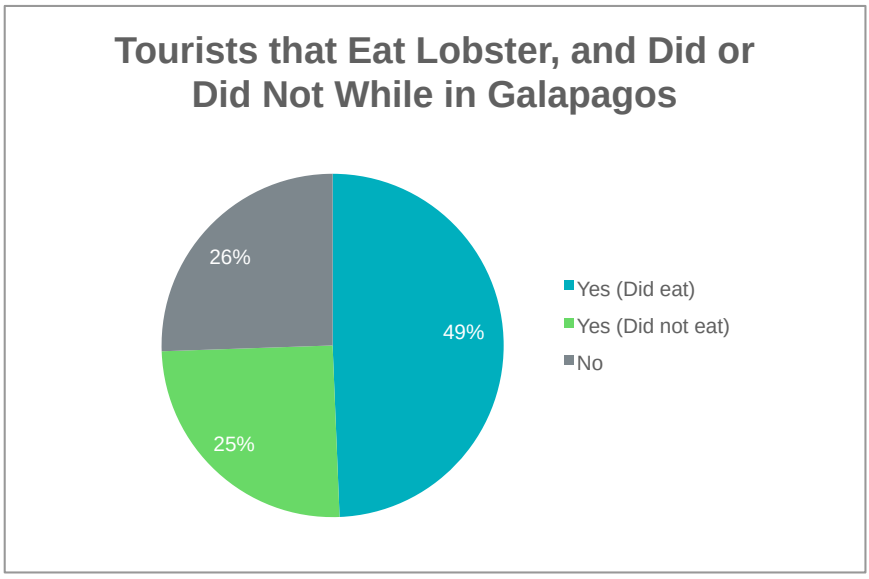


Figure C28. Percentage of lobster eaters, potential lobster eaters, and non-lobster eaters for the Galápagos Islands

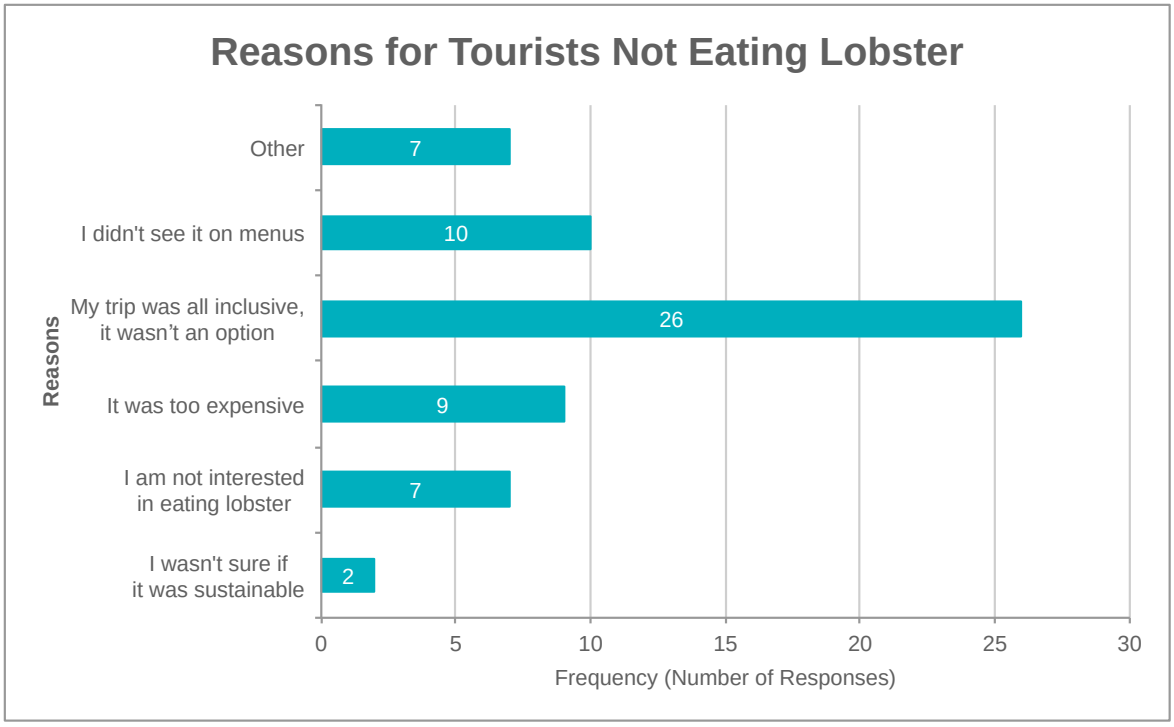


Figure C29. Reasons why tourists did not purchase lobster while on vacation in the Galápagos

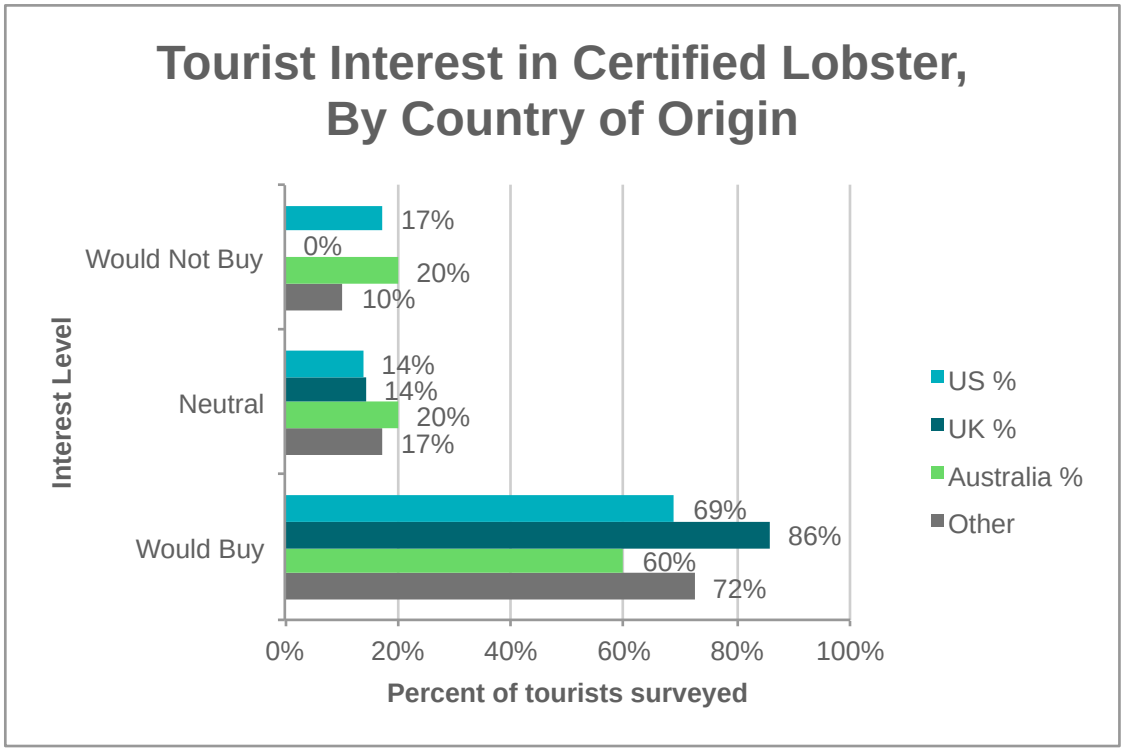


Figure C30. By tourist nationality, percentage interest in purchasing certified lobster.

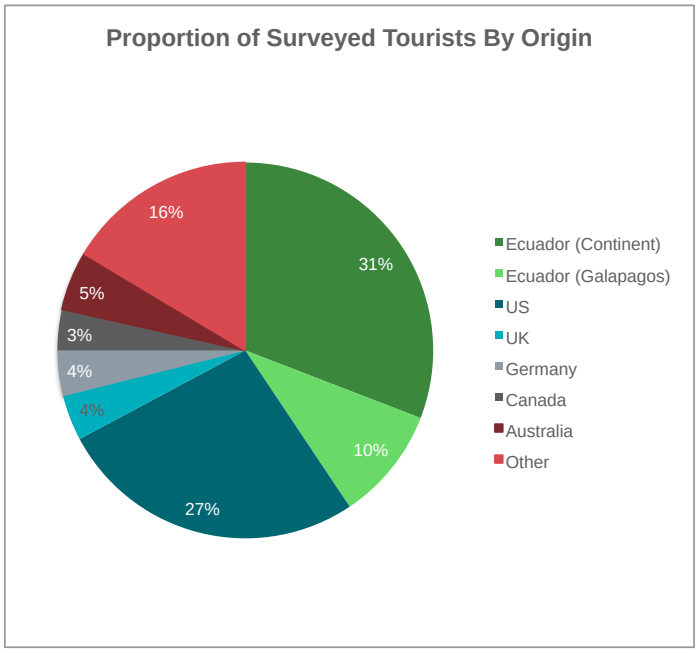


Figure C31. Origin of tourists surveyed by country.

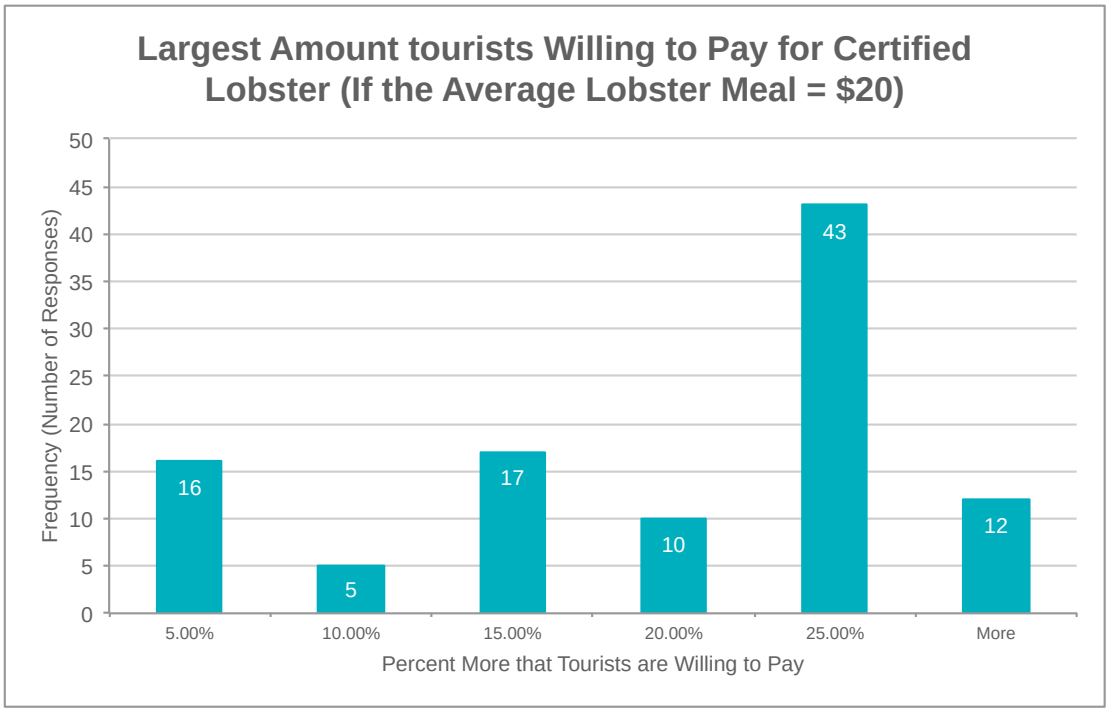


Figure C32. Percentage increase in price tourists are willing to pay for certified lobster while on vacation.

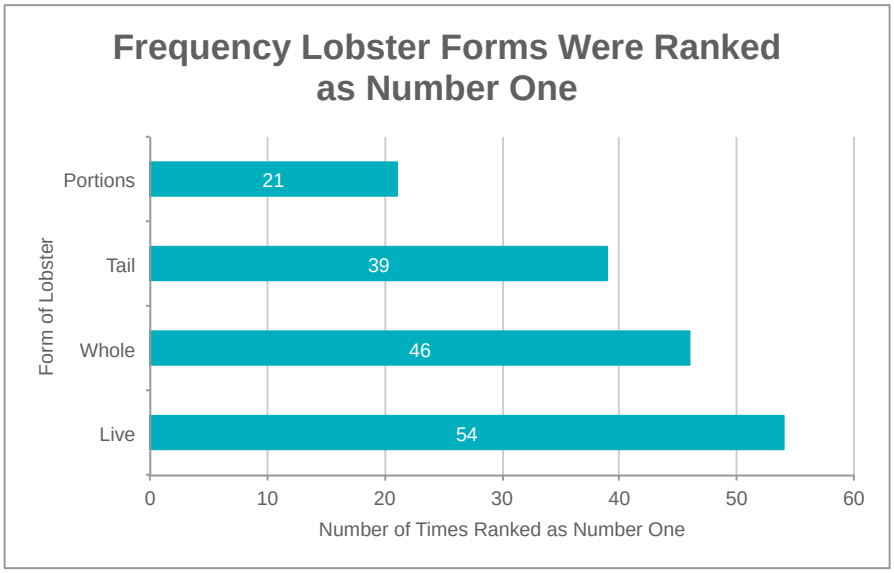


Figure C33. Tourist primary preferences for lobster presentation when purchasing or ordering lobster in a restaurant

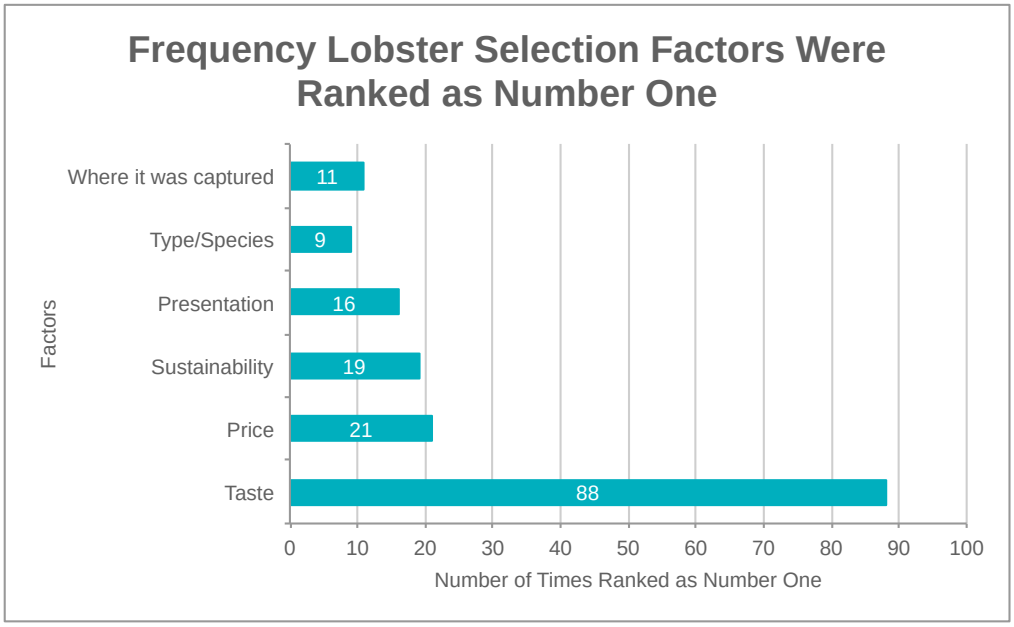


Figure C34. Tourist primary considerations when purchasing or ordering lobster in a restaurant.

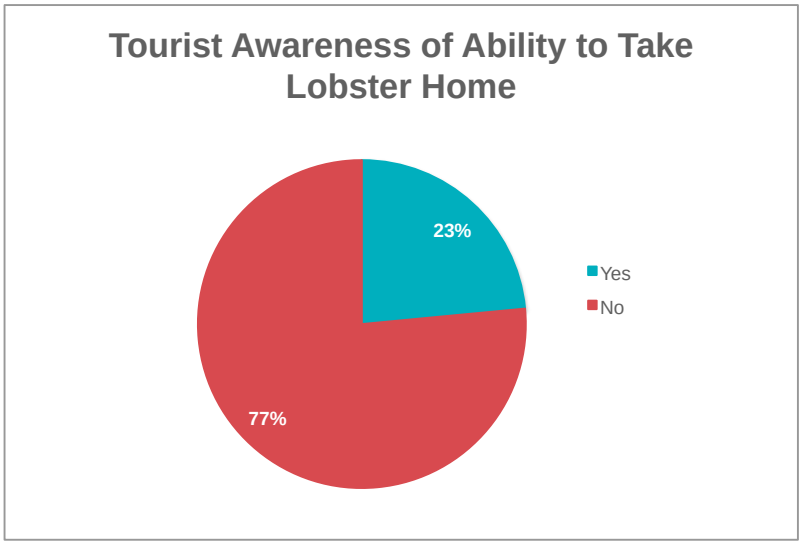


Figure C35. Percentage of tourists that are aware of the ability to bring lobster or seafood back to their home country

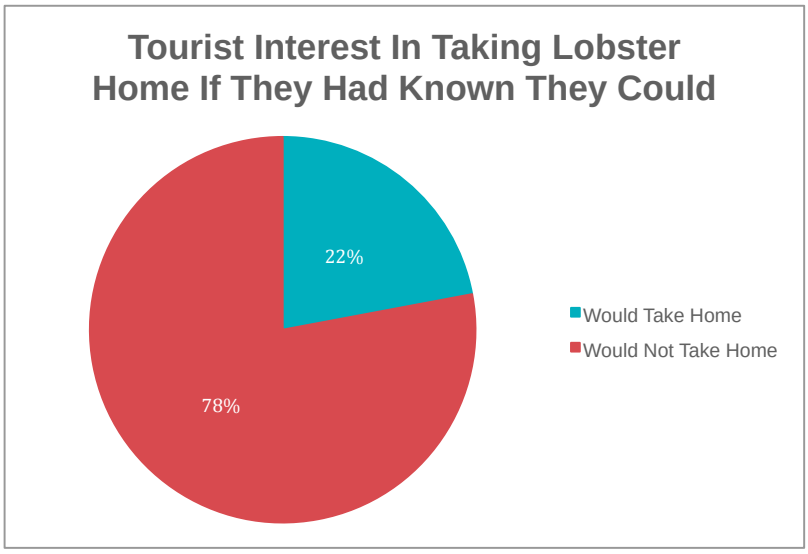


Figure C36. Percentage of tourists interested in purchasing and taking lobster back to their home country

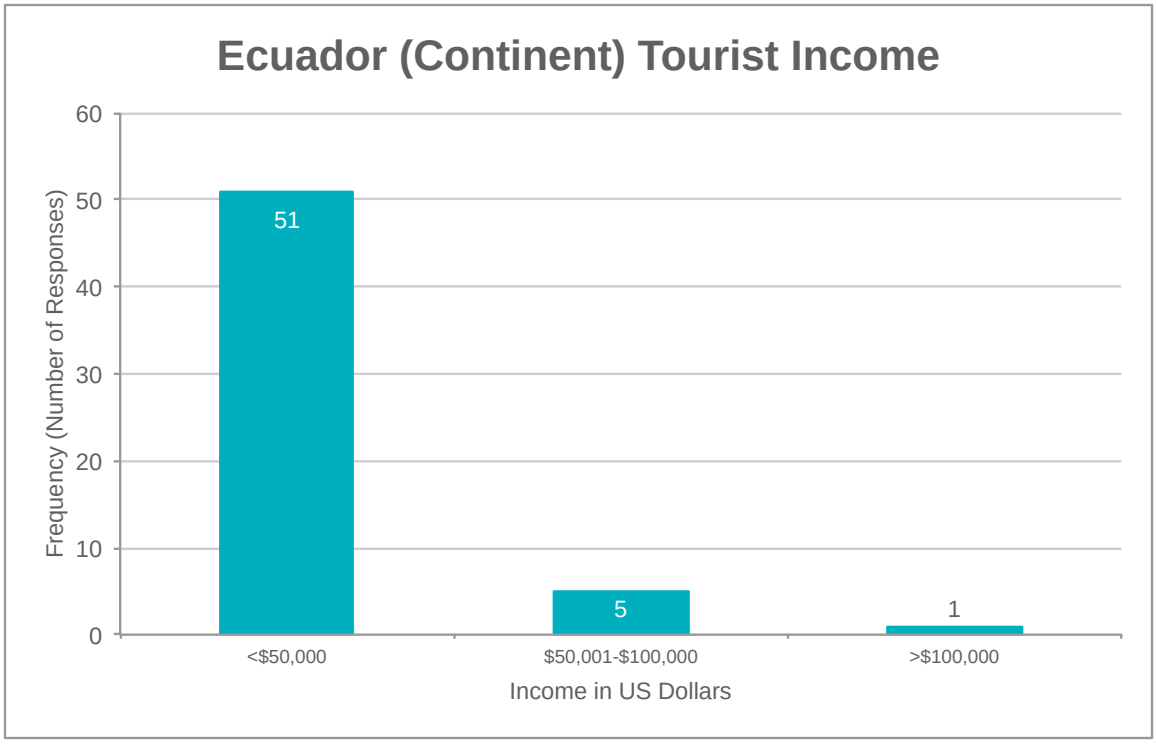


Figure C37. Average income for Ecuadorian or national tourists (in US Dollar)

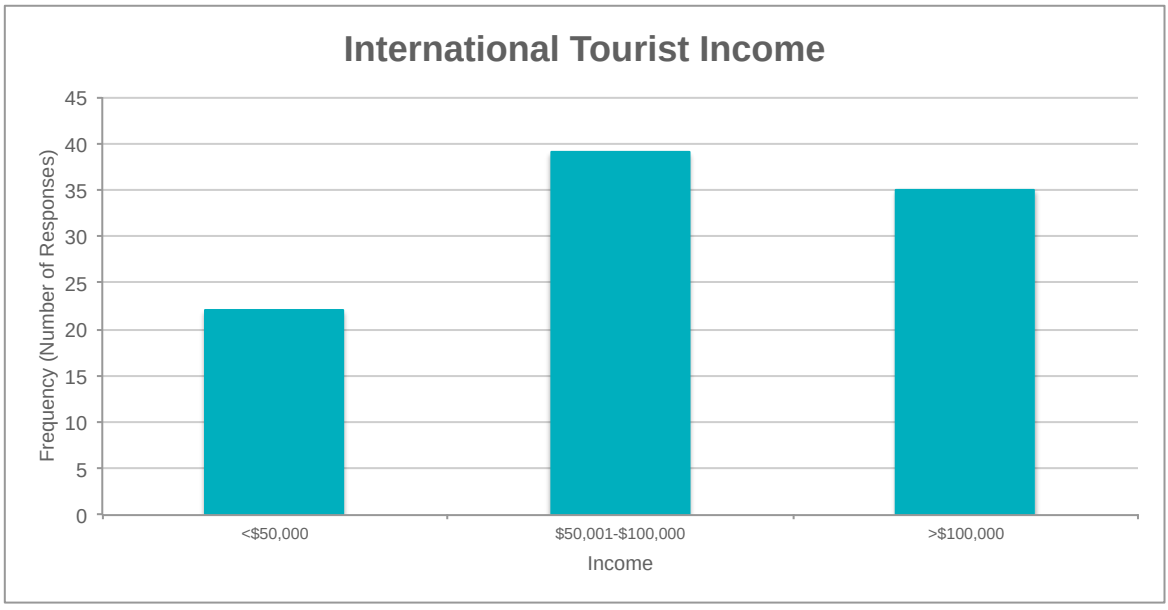


Figure C38. Average income for international tourist (in US Dollar)

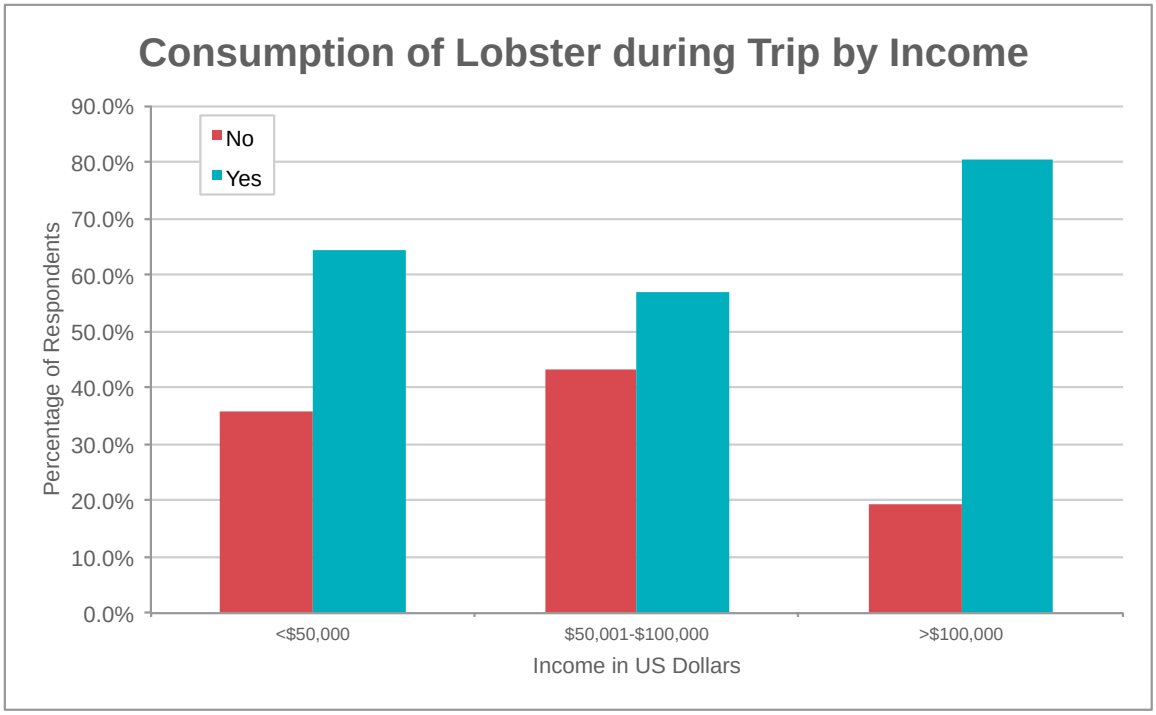


Figure C39. Percentage of tourists that ate lobster on vacation by income

Análisis de las Percepciones acerca de la Pesquería de Langosta en Santa Cruz

Consentimiento de Ser Entrevistado
Gracias por ofrecerse a participar en esta encuesta. La discusión que tendremos con ustedes hoy pretende explorar la posibilidad de la participación voluntaria en una concesion para la pesca de langosta en las Islas Galápagos. La investigación que se obtenga ayudará con la desarrollo de nuestro Proyecto de Grupo en la Escuela Bren de la Universidad de California, Santa Barbara, y contribuirá a la comprensión de la pesca de langosta con el fin de lograr poblaciones de langosta que sean sostenibles.

Esta encuesta debe tomar aproximadamente 40 minutos. Hay riesgos mínimos asociados con esta entrevista. Absoluta confidencialidad no puede ser garantizada, ya que los documentos de la investigación no están protegidos en caso de una citación (resolución dictada por un juez o tribunal). Su participación es voluntaria y puede ser terminada en cualquier momento. Usted debe tener al menos 18 años de edad para participar en esta encuesta. Si usted es menor de 18 años, los datos que nos haya proporcionado serán eliminados y no se tomarán en cuenta para el proyecto.

Si usted tiene alguna pregunta o duda acerca de esta encuesta, envíe un correo electrónico a galapagos@lists.bren.ucsb.edu. Si usted tiene alguna pregunta acerca de sus derechos así como su participación como un sujeto de investigación, por favor póngase en contacto con el Comité de Sujetos Humanos al (805) 893-3807 o hsc@research.ucsb.edu o escriba a la Universidad de California, Comité de Sujetos Humanos de la Oficina de Investigación, Santa Barbara, CA 93106-2050. Le agradecemos su participación.

Atentamente,

Taylor Debevec
Norah Eddy
Laura Johnson
Jonathan Sim
Katie Westfall

La participación en esta encuesta es voluntaria y usted puede optar por no responder a cualquier pregunta individual o todas las preguntas. Sin embargo, sus opiniones son importantes para nosotros y espero que participe. ¿Puedo empezar la entrevista ahora?
☐ Sí ☐ No

****

ESTA SECCION ES PARA SER LLENADA POR EL ECUESTRADOR Y SE LLENARA PREVIO A LA ENCUESTA.

Nombre del entrevistador: _____

Fecha de la entrevista: _____

****

****Durante esta encuesta, cuando está mencionado la langosta, se refiere a la <u>langosta roja</u>.****

SECCION 1: HABITOS DE PESCA

1. Se dedica a la pesca de:
   ☐ Langosta roja ☐ Langosta roja y Pesca blanca | ☐ Pesca blanca ☐ Ningún de los dos
   Continúe a #2 | *Su encuesta está completa. Gracias.*
2. ¿Pescó langosta el último año?
   ☐ Sí | ☐ No
   Continúe a #3 | *Su encuesta está completa. Gracias.*
3. ¿En cuáles islas pesca por langosta? *(Marque todos que aplican)*
   ☐ Santa Cruz ☐ San Cristóbal ☐ Floreana ☐ Isabela
   ☐ Darwin/Wolf ☐ Española ☐ Otro: _____
4. ¿Conoce a los otros pescadores que pescan por langosta en los sitios que usted pesca normalmente?
   ☐ Sí ☐ No
5. ¿Usted es armador (dueño de embarcación)?
   ☐ Sí ☐ No

SECCION 2: METODOS DE PESCA

6. ¿Cuáles son sus métodos actuales de captura para langosta roja? *(Marque todos que aplican y dibuje un círculo para el método principal)*

☐ Vara Hawaiiana al pulmon ☐ Vara Hawaiiana con hookah
☐ Por mano al pulmon ☐ Por mano con hookah ☐ Otro: _____

7. ¿Por qué prefiere este método (a mano o por vara Hawaiiana)? *(Marque todos que aplican)*

☐ Es fácil ☐ Estoy familiar con este método ☐ Es rápido ☐ Es barato ☐ Otro: _____

8. ¿Cuantas langostas promedio captura por dia usando: *(Si no usa el método, pregunte cúantos que piensa que capturaría)*

Vara Hawaiiana al pulmón?_____ langostas/dia Vara Hawaiiana con hookah? _____ langostas/dia
Mano al pulmón? _____ langostas/dia Mano con hookah? _____ langostas/dia

9. ¿Generalmente en que presentación vende la langosta roja que pesca? *(Marque todos que aplican)*

☐ Cola de langosta ☐ Langosta viva ☐ Langosta entera congelada ☐ Langosta entera fresca (no viva)

10. ¿Ha intentado una vez capturar langostas vivas?

☐ Sí

a) ¿Por cúantas temporadas lo ha hecho? _____

b) ¿Qué método ha utilizado para la captura?

☐ Por mano ☐ Por lazo ☐ Otro: _____

c) ¿Ha tenido éxito en la captura viva?

☐ Sí

(Continúe a d)

☐ No

¿Por qué no?
☐ No tengo a quien vendérsela
☐ Capturó menos langostas
☐ No le gustó este método
☐ Otro: _____

d) ¿En qué presentación vendió las langostas ***vivas*** que capturó durante la temporada pasada? *(Marque todos que aplican)*

☐ Colas ☐ Entera congelada
☐ Entera fresca (no viva) ☐ Entera viva

☐ No

e) ¿Qué fue lo que le impidió a capturar langosta vivas?

☐ Necesité nuevo equipo
☐ Capturé menos langostas
☐ No me gustó este método
☐ Otro: _____

11. ¿Cuál era el precio ***mínimo*** y el precio ***máximo*** por libra que esperaría si vendiera **cola de langosta** durante la temporada pasado?

$_____ - $_____ / libra

12. ¿Durante la temporada pasada, cuál era el precio promedio por tamaño que esperaría si vendiera:

Langosta viva?	Pequeña: $_____	Mediana: $_____	Grande: $_____	☐ No vendo este producto
Langosta entera congelada?	Pequeña: $_____	Mediana: $_____	Grande: $_____	☐ No vendo este producto
Langosta entera fresca (no viva)?	Pequeña: $_____	Mediana: $_____	Grande: $_____	☐ No vendo este producto

SECTION 3: EJEMPLO DE PUNTA ABREJOS, MEXICO

Aquí tenemos un mapa del pueblo de Punta Abreojos en Baja, México. Hay un grupo de pescadores que tienen permiso para pescar langosta roja en esta zona donde nadie más tiene permiso para pescar langosta aquí (MOSTRAR EN EL MAPA Y MOSTRAR EL AREA DE PESCA). Sin embargo, estos pescadores están de acuerdo con ciertas reglas para tener acceso exclusivo para esta zona. El punto de esta zona y sus reglas es ayudar en la protección de la langosta roja e asegurar la estabilidad de ganancias para los pescadores y sus familias para el futuro.`

* 13. **¿Si ha escuchado de algún concepto así, como se llamaba?**

☐ Nunca he escuchado de un concepto así

☐ Concesión ☐ Custodia ☐ Derechos territoriales ☐ Otro: _____ ☐ He escuchado pero no se como se llama

Queremos saber lo que piensa de la utilización de un concepto así para la pesca de langosta en Galápagos y vamos a jugar un juego con 3 escenarios imaginarios. Queremos saber sus opiniones, y este ejercicio solo es para investigación académica para un grupo de estudiantes.

Primer escenario:

Aquí está una zona de pesca de langosta en Santa Cruz (MOSTRAR CON UNA CUERDA Y UN MAPA). Es 10 kilómetros de distancia y se extiende 1 kilómetro fuera de la costa. Esta zona puede estar en cualquier lugar alrededor de la costa de Santa Cruz, excepto en áreas donde de no está permitido la pesca (MOSTRAR QUE EL AREA PUEDE ESTAR EN CUALQUIER LUGAR EXCEPTO LAS AREAS DE NO PESCA). Suponga que la pesca es buena en esta zona.

Esta zona es parecida al ejemplo que explicamos antes. Un grupo de pescadores puede tener acceso exclusivo si siguen estas reglas:

- **Hay que capturar langostas vivas**
- **Hay que liberar langostas ovadas e individuos de tallas menores**
- **Todos las reglas de Parque Nacional Galápagos continuarán siendo aplicas, incluyendo la cuota**
- **Usted no puede pescar langosta afuera de esta zona**

Todos los pescadores que pescan langosta en esta zona tiene que cumplir las mismas reglas.

14. ¿Con este escenario, usted escogería pescar langosta dentro de esta zona, y renunciaría a la pesca de langosta en otros áreas fuera de esta zona?

☐ Sí

a) ¿Con cúantos otros pescadores compartiría esta zona?

____ pescadores

☐ No

b) Aquí están algunos de los posibles beneficios si usted decide pescar aquí. (LEER LA LISTA, MARCAR LAS OPCIONES QUE PIENSA QUE ES UN INCENTIVO BUENO, Y LLENAR LAS PREGUNTAS EXTRAS.) Ahora, ordene los siguientes beneficios dándoles un valor entre 1 y 5 (1 es el mas importante y 5 es menos importante).

☐ ____ Un precio mejor de langosta
--> **¿CUÁNTO POR LANGOSTA MEDIANA?**_____

☐ ____ La venta garantizada de toda su captura por un precio fijo por langosta en la cooperativa

☐ ____ Una temporada de langosta más larga
--> **¿EXTENDIDA POR CUANTO TIEMPO?**_____

☐ ____ Un número limitado de otros pescadores permitidos en la participación de esta zona.
--> **¿CUÁNTOS PESCADORES?** _____

☐ ____ También tener acceso exclusivo para la pesca blanca en esta zona.

☐ Ningún de estos beneficios me influiría pescar en esta zona.

Continúe al segundo ejercicio

c) ¿Si se dieran los 2 beneficios mas importantes que usted escogió arriba, escogería pescar dentro de esta zona?

☐ Sí ☐ No (REPITIR LAS DOS RESPUESTAS MAS IMPORTANTES DE ARRIBA)

15. ¿Estarías dispuesto a ayudar en el funcionamiento de esta zona en ciertas tareas como el procesamiento, la venta, control de vigilancia, etc.?

☐ Sí ☐ No

16. ¿Quién prefiere que haga cumplir las reglas de la zona?

☐ Parque Nacional Galápagos ☐ Pescadores participantes

☐ Un esfuerzo compartido entre el Parque Nacional Galápagos y los pescadores

Segundo escenario:

Este escenario es casi igual al primer escenario, pero en esta situación, la zona imaginaria es mas grande. Es un cuarto de la isla (casi 40 kilómetros) y extiende 1 kilómetro hacia afuera de la costa. Esta zona puede estar en cualquier lugar alrededor de la costa de Santa Cruz, excepto en áreas donde no está permitido la pesca (MOSTRAR AREAS DE NO PESCA EN EL MAPA Y MOSTRAR QUE EL AREA PUEDE ESTAR EN CUALQUIER LUGAR). Suponga que la pesca es buena en esta zona.

En esta zona también aplican las mismas normas que explicamos antes. Un grupo de pescadores puede tener acceso exclusivo si siguen estas reglas:

- **Hay que capturar langostas vivas**
- **Hay que liberar langostas ovada e individuos de tallas menores**
- **Todos las reglas del Parque Nacional Galápagos continuarán siendo aplicas, incluyendo la cuota**
- **Usted no puede pescar langosta afuera de esta zona**

Todos los pescadores que pescan langosta en esta zona tiene que cumplir las mismas reglas.

17. ¿Con este escenario, usted escogería pescar langosta dentro de esta zona, y renunciaría a la pesca de langosta en otros áreas fuera de esta zona?

☐ Sí

a) ¿Con cúantos otros pescadores compartiría esta zona?

____ pescadores

☐ No

b) Aquí están algunos de los posibles beneficios si usted decide pescar aquí. (LEER LA LISTA, MARCAR LAS OPCIONES QUE PIENSA QUE ES UN INCENTIVO BUENO, Y LLENAR LAS PREGUNTAS EXTRAS.) Por favor, ordene los siguientes beneficios dándoles un valor entre 1 y 5 (1 es el mas importante y 5 es menos importante).

☐ ____ Un precio mejor de langosta
--> **¿CUÁNTO POR LANGOSTA MEDIANA?**_____

☐ ____ La venta garantizada de toda su captura por un precio fijo por langosta en la cooperativa

☐ ____ Una temporada de langosta más larga
--> **¿EXTENDIDA POR CUANTO TIEMPO?**_____

☐ ____ Un número limitado de otros pescadores permitidos en la participación de esta zona.
--> **¿CUÁNTOS PESCADORES?** _____

☐ ____ También tener acceso exclusivo para la pesca blanca en esta zona.

☐ Ningún de estos beneficios me influiría pescar en esta zona.

Continúe al tercer ejercicio

c) ¿Si se dieran 2 de los beneficios mas importantes que usted escogió arriba, escogería pescar dentro de esta zona?

☐ Sí ☐ No (REPITIR LAS DOS RESPUESTAS MAS IMPORTANTES DE ARRIBA)

18. ¿Estarías dispuesto a ayudar en el funcionamiento de esta zona en ciertas tareas como el procesamiento, la venta, control de vigilancia, etc.?

☐ Sí ☐ No

19. ¿Quién prefiere que haga cumplir las reglas de la zona?

☐ Parque Nacional Galápagos ☐ Pescadores participantes

☐ Un esfuerzo compartido entre el Parque Nacional Galápagos y los pescadores

Tercer escenario:

Aquí está una zona para la pesca de langosta en Santa Cruz (MOSTRAR CON UNA CUERDA Y UN MAPA) Esta abarca costa de la isla entera (excepto áreas de no pesca) y se extiende 1 kilómetro hacia afuera de la costa. Esta zona puede estar en cualquier lugar alrededor de la costa de Santa Cruz, excepto en áreas donde de no está permitida la pesca (MOSTRAR AREAS DE NO PESCA EN EL MAPA Y MOSTRAR QUE EL AREA PUEDE ESTAR EN CUALQUIER LUGAR). Suponga que la pesca es buena en esta zona.

Las normas de esta zona son parecidas a las que explicamos antes. Un grupo de pescadores puede tener acceso exclusivo si siguen estas reglas:

- **Hay que capturar langostas vivas**
- **Hay que liberar langostas ovada e individuos de tallas menores**
- **Todos las reglas del Parque Nacional Galápagos continuarán siendo aplicas, incluyendo la cuota**
- **Usted no puede pescar langosta afuera de esta zona**

Todos los pescadores que pescan langosta en esta zona tiene que cumplir las mismas reglas.

20. ¿Con este escenario, usted escogería pescar langosta dentro de esta zona, y renunciaría a la pesca de langosta en otros áreas fuera de esta zona?

☐ Sí

a) ¿Con cúantos otros pescadores compartiría esta zona?

____ pescadores

☐ No

b) Aquí están algunos de los posibles beneficios si usted decide pescar aquí. (LEER LA LISTA, MARCAR LAS OPCIONES QUE PIENSA QUE ES UN INCENTIVO BUENO, Y LLENAR LAS PREGUNTAS EXTRAS.) Por favor, ordene los siguientes beneficios dándoles un valor entre 1 y 5 (1 es el mas importante y 5 es menos importante).

☐ ____ Un precio mejor de langosta
--> **¿CUÁNTO POR LANGOSTA MEDIANA?_____**

☐ ____ La venta garantizada de toda su captura por un precio fijo por langosta en la cooperativa

☐ ____ Una temporada de langosta más larga
--> **¿EXTENDIDA POR CUANTO TIEMPO?_____**

☐ ____ Un número limitado de otros pescadores permitidos en la participación de esta zona.
--> **¿CUÁNTOS PESCADORES? _____**

☐ ____ También tener avcceso exclusivo para la pesca blanca en esta zona.

☐ Ningún de estos beneficios me influiría pescar en esta zona.

c) ¿Si se dieran 2 de los beneficios mas importantes que usted escogió arriba, escogería pescar dentro de esta zona?

☐ Sí ☐ No (REPITIR LAS DOS RESPUESTAS MAS IMPORTANTES DE ARRIBA)

Continúe

21. ¿Estarías dispuesto a ayudar en el funcionamiento de esta zona en ciertas tareas como el procesamiento, la venta, control de vigilancia, etc.?

☐ Sí ☐ No

22. ¿Quién prefiere que haga cumplir las reglas de la zona?

☐ Parque Nacional Galápagos ☐ Pescadores participantes

☐ Un esfuerzo compartido entre el Parque Nacional Galápagos y los pescadores

****

23. ¿Ahora que usted ha terminado este ejercicio, hay otro beneficio que influiría a pescar dentro de esta zona?

☐ Sí *[Si responde "Sí", pregunte que sería el beneficio]* ☐ No

_____

24. ¿En su opinion, qué sería la distancia ideal en kilómetros para una zona como las que hemos hablado?

_____ kilómetros _____ número de pescadores

25. ¿Usted es socio a COPROPAG? ☐ Sí ☐ No

****

Gracias por toda su ayuda al contestar este cuestionario de encuesta.

Encuesta para Hoteles y Restaurantes acerca del Mercado de Langosta en la Isla San Cristóbal

Consentimiento de Ser Entrevistado
Gracias por ofrecerse a participar en esta encuesta. La discusión que tendremos con ustedes hoy pretende explorar la posibilidad de la participación voluntaria en una concesion para la pesca de langosta en las Islas Galápagos. La investigación que se obtenga ayudará con la desarrollo de nuestro Proyecto de Grupo en la Escuela Bren de la Universidad de California, Santa Barbara, y contribuirá a la comprensión de la pesca de langosta con el fin de lograr poblaciones de langosta que sean sostenibles.

Esta encuesta debe tomar aproximadamente 20 minutos. Hay riesgos mínimos asociados con esta entrevista. Absoluta confidencialidad no puede ser garantizada, ya que los documentos de la investigación no están protegidos en caso de una citación (resolución dictada por un juez o tribunal). Su participación es voluntaria y puede ser terminada en cualquier momento. Usted debe tener al menos 18 años de edad para participar en esta encuesta. Si usted es menor de 18 años, los datos que nos haya proporcionado serán eliminados y no se tomarán en cuenta para el proyecto.

Si usted tiene alguna pregunta o duda acerca de esta encuesta, envíe un correo electrónico a galapagos@lists.bren.ucsb.edu. Si usted tiene alguna pregunta acerca de sus derechos así como su participación como un sujeto de investigación, por favor póngase en contacto con el Comité de Sujetos Humanos al (805) 893-3807 o hsc@research.ucsb.edu o escriba a la Universidad de California, Comité de Sujetos Humanos de la Oficina de Investigación, Santa Barbara, CA 93106-2050. Le agradecemos su participación.

Atentamente,

Taylor Debevec
Norah Eddy
Laura Johnson
Jonathan Sim
Katie Westfall

La participación en esta encuesta es voluntaria y usted puede optar por no responder a cualquier pregunta individual o todas las preguntas. Sin embargo, sus opiniones son importantes para nosotros y espero que participe. ¿Puedo empezar la entrevista ahora?
☐ Sí ☐ No

****

ESTA SECCION ES PARA SER LLENADA POR EL ECUESTRADOR Y SE LLENARA PREVIO A LA ENCUESTA.

Nombre del entrevistador: _____

Fecha de encuesta: _____

****

1. ¿Ofrece langosta en su menú durante la temporada de langosta (Agosto - Diciembre)?

☐ Sí

Continúe a #2

☐ No

a) ¿Por qué no ofrece langosta?

- ☐ No tengo un lugar para guardar/mantener la langosta
- ☐ Mis clientes no les interesa comer langosta
- ☐ No tengo un abastecimiento consistente
- ☐ Servir langosta no añadiría mucho valor a mi menú
- ☐ Las langostas cuestan demasiado
- ☐ Otro: _____

Después de esta pregunta, su encuesta está completa.

****

VOLUMEN, FREQUENCIA, Y PROVEEDOR

2. ¿Cuántas langostas compra por semana?

_____ libras/semana de langosta ***roja*** _____ libras/semana de langosta ***verde***

_____ libras/semana de langosta en total (No sé cuál especie de langosta compro)

_____ no sé en libras: _____

3. ¿Cuántas veces compra Ud. langosta por semana?

☐ Menos de 1 ☐ 1 - 2 ☐ 3 - 4 ☐ 5 - 6 ☐ Diario

4. ¿Dónde adquiere la langosta roja?

☐ Un mercado ☐ Alguien lo trae (comerciante) ☐ Muelle ☐ Pescador(es) ☐ Otro: _____

5. ¿Por qué prefiere comprar langosta a este proveedor? (*Marque todos que aplican)*

☐ Es barato ☐ La calidad es buena

☐ Es conveniente ☐ Porque siempre he trabajado con este proveedor

☐ Seriedad del proveedor ☐ Ya conozco al proveedor

☐ Otro: _____

A. ¿Siempre le ha comprado la langosta a este proveedor?

☐ Sí

Continúe a #6

☐ No

a) ¿A quién le compró anteriormente? (*Todos que aplican)*

☐ Un mercado ☐ Muelle

☐ Algiuen lo trae (comerciante) ☐ Pescador(es)

☐ Otro: _____

b) ¿Por qué usted cambió su proveedor?

_____

_____

6. ¿Tiene un contrato con su proveedor para una cierta cantidad de langosta regularmente?

☐ Sí

a) ¿Qué volumen?

_____ libras

b) ¿Qué tan frecuente?

☐ Diario ☐ Por semana

☐ Otro: _____

☐ No

Continúe a #7

****

ESPECIE, FORMA, PRESENTACION, Y PRECIO

7. ¿Qué especie de langosta ofrece?

☐ Verde ☐ Los dos

Continúe a #8

☐ Roja (sólo)

a) ¿Por qué no ofrece langosta verde? *(Todos que aplican)*

☐ Apariencia ☐ No sé dónde comprarla

☐ Tamaño ☐ Sabor

☐ Costo ☐ Otro: _____

8. ¿En qué presentación lo compra? *(Marque todos que aplican)*

☐ Cola ☐ Entera congelada
☐ Entera viva ☐ Entera fresca (no viva)

a) Si marca más que una opción, cuál es la presentación principal?

☐ Cola ☐ Entera congelada
☐ Entera viva ☐ Entera fresca (no viva)

☐ Cola (sólo)

b) ¿Por qué no compra langosta entera? (*Todos que aplican)*

☐ Requiere demasiado espacio ☐ Costo
☐ No sirvo langosta entera ☐ No sé dónde comprarla
☐ Mi proveedor no lo ofrece
☐ Otro: _____

9. ¿Qué tamaño de langosta normalmente compra? *(Marque todos que aplican)*

☐ Pequeñas (cola: 15 a 20 cm; entera: _____)
☐ Medianas (cola: 21 a 26 cm; entera: _____)
☐ Grandes (cola: mas de 26 cm en adelante; entera:_____)

A. Ahora, ordene los siguientes tamaños dándoles un valor entre 1 y 3 **según las preferencias de sus clientes** (1 es el más preferible y 3 es menos preferible).

_____ Pequeñas
_____ Medianas
_____ Grandes

☐ No tienen preferencia de tamaño

10. ¿En qué presentación/presentaciones ofrece la langosta a sus clientes? *(Marque todos que aplican. Dibuje un círculo para la presentación principal si marca más que 1.)*

☐ Cola ☐ Langosta entera ☐ Otros: _____

11. ¿Cuál es el precio mínimo y el precio máximo por libra compra cola de langosta (temporada pasada)?

$_____ -$_____ / libra

12. ¿Cuál es el precio promedio por tamaño por (temporada pasada):

Langosta viva?	Pequeña: $_____	Mediana: $_____	Grande: $_____	☐ No compro este producto
Langosta entera congelada?	Pequeña: $_____	Mediana: $_____	Grande: $_____	☐ No compro este producto
Langosta entera fresca (no viva)?	Pequeña: $_____	Mediana: $_____	Grande: $_____	☐ No compro este producto

13. ¿Cuáles son **sus requerimientos** de compra? *Seleccione hasta cinco factores y ordénelos en términos de importancia (1 sería muy importante y 5 sería menos importante)*

_____ frescura
_____ calidad
_____ tamaños
_____ grado de procesamiento
_____ color
_____ precio
_____ seriedad de proveedor
_____ disponibilidad en volúmenes suficientes cuando se le require
_____ crédito
_____ otro: _____

14. ¿Cuál es el tiempo máximo por el cual Ud. conserva las langostas? *(Marque todos que aplican)*

☐ Lo adquiero para consumo inmediato ☐ Refrigero por un día
☐ Congelo el producto por una semana ☐ Congelo el producto por mas de 2 semanas

15. ¿Dónde mantiene sus langostas?

☐ Tanque para langostas vivas ☐ Congelador
☐ Refrigeradora ☐ Otro: _____

Encuesta para Operadores de Turismo del Mercado de Langosta

Nombre de compañía:

Fecha de Encuesta:

1. ¿Ofrece langosta en su menú como parte de un tour durante la temporada de langosta (Agosto - Diciembre)? Sí / No [SI RESPONDE "NO," SIGA A #A. SI RESPONDE "SI", CONTINUE A PREGUNTA #2]
    A. ¿Por qué no ofrece langosta? [DESPUES DE ESTA PREGUNTA, LA ENCUESTA SE ACABA PARA ESTE ENCUESTADO]
        _____ no tengo infraestructura para el acopio
        _____ mis clientes no les interesa comer langosta
        _____ no tengo un proveedor confiable
        _____ servir langosta no añadiría mucho valor a mi tour
        _____ las langostas rojas cuestan demasiado
        _____ otro: _____

2. ¿Qué tipo de langosta ofrece? Roja / Verde / Los dos [SI NO OFRECE LANGOSTA VERDE, SIGA A #A. SI OFRECE VERDE O LOS DOS, SIGA A #3]
    A. ¿Por qué no ofrece langosta verde?

3. ¿Cómo lo compra? Cola / Entera congelada / Entera viva

4. ¿Que tan frecuente sirve langosta en sus viajes durante la temporada de langosta? Muy frecuente / Frecuente / A veces / Casi nunca / Nunca

5. ¿Dónde adquiere su langosta roja?

6. ¿A quién le adquiere?

7. ¿En qué volúmenes compra su langosta? ____libras/semana de langosta roja ____libras/semana de langosta verde

8. ¿Cuáles son **sus requerimientos** de compra? Seleccione hasta cinco factores y clasifíquelos en términos de importancia (1 sería muy importante y 5 sería menos importante).
        _____ frescura
        _____ calidad
        _____ tamaños
        _____ grado de procesamiento
        _____ color
        _____ precio
        _____ seriedad de proveedor
        _____ capacidad logística del proveedor
        _____ otro: _____

9. ¿Qué tipo de infraestructura tiene para mantener su langosta durante el viaje?

10. ¿Cuáles son sus clientes habituales?

11. ¿Cuál es la duración de sus viajes por grupo?

12. ¿Cuantos pasajeros y tripulantes lleva en su embarcación?

13. ¿Cuánto cuesta sus tours en la temporada de langosta y que incluyen en el precio?

14. ¿Cuál es el costo promedio que usted gasta en comida por viaje?

15. ¿Cuáles son los **requerimientos de sus clientes** con respecto a la langosta? Seleccione hasta cinco factores y clasifíquelos en términos de importancia (1 sería muy importante y 5 sería menos importante).
    _____ frescura
    _____ calidad
    _____ tamaños
    _____ grado de procesamiento
    _____ color
    _____ precio
    _____ seriedad de proveedor
    _____ capacidad logística del proveedor
    _____ otro: _____

16. ¿Qué tan interesados estarían sus clientes en comer langosta con una "certificación del origen"?
Muy interesados / Interesados / Neutrales / No interesados / No interesados en absoluto

17. ¿Cree que sus clientes pagarían mas para un tour que incluye langosta con una "certificación del origen"? Sí / No [SI RESPONDE "SI", SIGA A #A. SI RESPONDE "NO", SIGA A #18)
    A. ¿Cuánto mas? $1-2 / $3-4 / $5-6 / $6-7 / $6+

18. ¿Estaría dispuesto/a a servir langosta entera congelada? [SI RESPONDE "NO", SIGA A #A. SI RESPONDE "SI", SIGA A #19]
    A. ¿Qué factores le impide servir langosta entera congelada?

19. ¿Estaría dispuesto/a a servir langosta viva? Sí / No [SI RESPONDE "NO", SIGA A #A. SI RESPONDE "SI", SIGA A #20]
    A. ¿Qué factores le impide servir langosta viva?

20. ¿Encuentra usted algún problema o dificultad en la compra/procesamiento/venta de la langosta? ¿Cual es son y cuales cree usted que podrían ser posibles soluciones?

Encuesta para Operadores del Tourismo acerca del Mercado de Langosta

Nombre de compañía:
Fecha de Encuesta:

VOLUMEN, FREQUENCIA, Y PROVEEDOR

1. ¿Con qué frequencia compra Ud. langosta para su embarcación?

2. ¿Dónde adquiere la langosta roja (Marque todo que aplica)?
   ☐ Un mercado ☐ Alguien lo trae (comerciante) ☐ Muelle ☐ Pescador(es) ☐ Otro _____

3. ¿Por qué prefiere comprar langosta de este proveedor? (Marque todo que aplica)

☐ es barato ☐ es conveniente ☐ ya conozco al proveedor ☐ la calidad es buena ☐ seriedad del proveedor ☐porque siempre he trabajado con este proveedor ☐Otro _____

A. ¿Siempre le ha comprado la langosta a este proveedor?
☐ Sí ☐ No [SI RESPONDE QUE NO, CONTINUA A #a]

i. ¿A quién le compró anteriormente?
☐ Un mercado ☐ Alguien lo trae (comerciante) ☐ Muelle ☐ Pescador(es) ☐ Otro _____

ii. ¿por qué usted cambió su proveedor?

4. ¿Tiene un contrato con su proveedor para una cierta cantidad de langosta regularmente?

☐ Sí ☐ No

[Si responde "sí"] ¿Qué volumen? _____libras

¿Qué tan frecuente? ☐ diario ☐ por semana ☐Otro _____

ESPECIE, FORMA, PRESENTACION, Y PRECIO

5. ¿En qué presentación lo compra? (Marque todos que aplican, y dibuje un círculo para la presentación principal si marca más que 1)
   ☐Cola ☐Entera congelada ☐Entera viva ☐Entera fresca (pero no viva) [SELECCIONE TODOS QUE APLICAN.

   SI NO RESPONDE QUE COMPRA ENTERA, SIGA A #A]

   A. ¿Por qué no compra langosta entera? (Marque todos que aplican)

☐ costo ☐ no sé dónde comprarla ☐ requiere demasiado espacio ☐ no sirvo langosta entera ☐ mi proveedor no lo ofrece ☐Otro _____

6. ¿Qué tamaño de langosta normalmente compra? [SELECCIÓN TODOS QUE APLICAN]
   - ☐Pequeñas (cola: 15 a 20 cm; entera: 26-31 cm)
   - ☐Medianas (cola: 21 a 26 cm; entera: 32-37 cm)
   - ☐Grandes (cola: más de 26 cm en adelante; entera: más de 37 cm)

Ahora, ordene los siguientes tamaños dándoles un valor entre 1 y 3 según las preferencias de sus clientes (1 es el más preferible y 3 es menos preferible).

___ pequeñas
___ medianas
___ grandes
☐ no tienen preferencia de tamaño

7. ¿En qué presentación/presentaciones ofrece la langosta a sus clientes?) [SELECCIÓNE TODOS QUE APLICAN, y dibuje un círculo para la presentación principal si marca más que 1]
   ☐ Cola ☐ Langosta entera ☐ Otros: _____

8. ¿Cuál es el precio ***mínimo*** y el precio ***máximo*** por libra compra **cola de langosta** (temporada pasada)?
$_____ -$_____ / libra

9. ¿Cuál es el precio promedio por tamaño por: (temporada pasada)
langosta viva? Pequeña: $_____ Mediana: $_____ Grande: $_____ (☐ No compro este producto)
langosta entera congelada? Pequeña: $_____ Mediana: $_____ Grande: $_____ (☐ No compro este producto)
langosta entera fresca (no viva)? Pequeña: $_____ Mediana: $_____ Grande: $_____ (☐ No compro este producto)

10. ¿Cual es el tiempo máximo por el cual Ud. conserva las langostas? [SELECCIONE TODOS QUE APLICAN]
    ☐ Lo adquiero para consumo inmediato ☐ Refrigero por un día ☐ Congelo el producto por una semana ☐ Congelo el producto por más de 2 semanas

Encuesta para Turistas acerca del Mercado de Langosta

Consentimiento de Ser Entrevistado
Gracias por ofrecerse a participar en esta encuesta. La discusión que tendremos con ustedes hoy pretende explorar la posibilidad de la participación voluntaria en una concesion para la pesca de langosta en las Islas Galápagos. La investigación que se obtenga ayudará con la desarrollo de nuestro Proyecto de Grupo en la Escuela Bren de la Universidad de California, Santa Barbara, y contribuirá a la comprensión de la pesca de langosta con el fin de lograr poblaciones de langosta que sean sostenibles.

Esta encuesta debe tomar aproximadamente 15 minutos. Hay riesgos mínimos asociados con esta entrevista. Absoluta confidencialidad no puede ser garantizada, ya que los documentos de la investigación no están protegidos en caso de una citación (resolución dictada por un juez o tribunal). Su participación es voluntaria y puede ser terminada en cualquier momento. Usted debe tener al menos 18 años de edad para participar en esta encuesta. Si usted es menor de 18 años, los datos que nos haya proporcionado serán eliminados y no se tomarán en cuenta para el proyecto.

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Atentamente,

Taylor Debevec
Norah Eddy
Laura Johnson
Jonathan Sim
Katie Westfall

La participación en esta encuesta es voluntaria y usted puede optar por no responder a cualquier pregunta individual o todas las preguntas. Sin embargo, sus opiniones son importantes para nosotros y espero que participe. ¿Puedo empezar la entrevista ahora?

☐ Sí ☐ No

****

ESTA SECCION ES PARA SER LLENADA POR EL ECUESTRADOR Y SE LLENARA PREVIO A LA ENCUESTA.

Nombre del entrevistador: _____

Fecha de encuesta: _____

****

1. ¿De dónde es usted?

☐ Ecuador

a) ¿Dónde?

☐ Islas Galápagos

i) ¿Cuántas langostas come por año?

_____ / año

(Encuesta completa)

☐ Continente

Continúe a #2

☐ International

b) ¿Dónde?

☐ Estados Unidos - EEUU
☐ Inglaterra – Reina Unidos
☐ Alemania
☐ Canadá
☐ Australia
☐ Otro: _____

2. ¿Usted come langosta?

☐ Sí

Continúe a #3

☐ No

(Encuesta completa)

3. ¿Usted comió langosta durante su estadía en las Galápagos?

☐ Sí

a) ¿Qué tipo de langosta comió, y cuántas veces lo comió?

☐ Roja: _____#
☐ Verde: _____#
☐ Langostino: _____#
☐ No sé cuál era: _____#

b) ¿Cómo se la ofrecieron? *(Seleccione todos que aplican)*

☐ Entera ☐ Solo cola
☐ Porciones ☐ Otro: _____

c) ¿Dónde la comió? *(Seleccione todos que aplican)*

☐ Restaurante ☐ Hotel
☐ Embarcación ☐ Otro: _____

☐ No

d) ¿Por qué no? *(Seleccione todos que aplican)*

☐ No estaba seguro/a si era sostenible consumirla
☐ No me interesa comer langosta
☐ Era demasiada cara
☐ Mi viaje tuvo todo incluido y no era una opción
☐ No la vi en los menús
☐ Otro: _____

****

PREGUNTAS ACERCA DE LAS PREFERENCIAS Y EL CONSUMO DE LANGOSTA

4. ¿Si hubiera langostas con certificación que indique que fueron capturadas legalmente y localmente en las Islas Galápagos, las compraría?

☐ Sí, las compraría ☐ Neutral ☐ No, no las compraría

5. ¿Qué tan frecuente compraría langostas con esta certificación?

☐ Más frecuente que unas sin certificación ☐ La misma que una sin certificación
☐ Menos frecuente que unas sin certificacion ☐ Depende del precio

6. ¿Estaría dispuesto/a pagar más por langosta con esta certificación? (Suponga que el plato promedio de langosta cuesta $20)?

☐ Sí

a) ¿Cuánto seria lo máximo que pagaría por langosta con esta certificación (considerar que el plato promedio de langosta cuesta $20)?

☐ $20.01-$21 ☐ $21.01-$22
☐ $22.01-$23 ☐ $23.01-$24
☐ $24.01-$25 ☐ Más:_____

☐ No

Continúe a #7

7. ¿Sabía usted que se puede llevar o mandar a casa langosta y pescado de Galápagos?

☐ Sí

a) ¿Ud. está llevando o mandando a casa langostas de Galápagos?

☐ Sí

☐ No

i) ¿Por qué no? *(Marque todos)*

☐ Demasiado difícil
☐ Demasiado caro
☐ No estoy interesado/a
☐ No estoy viajando directo a casa
☐ Otro: _____

b) ¿Ud. está llevando o mandando a casa pescado de Galápagos?

☐ Sí ☐ No

☐ No

c) ¿Estaría interesado en llevar o mandar lo siguiente? *(Marque todos)*

☐ Langosta
☐ Pesca blanca

8. Ordene sus preferencias de cómo le gustaría se la ofrecieran langosta dándoles un valor entre 1 a 4 (1 es el mas preferido y 4 el menos preferido)

_____ viva (usted puede escoger la langosta)
_____ entera
_____ solo cola
_____ porciones

☐ No tengo preferencia

9. Ordene la importancia de los factores siguientes cuando pide langosta en un restaurante (1 es el mas importante y 6 es el menos importante)

_____ sabor
_____ precio
_____ sostenibilidad
_____ presentación
_____ tipo/especies
_____ dónde fue capturado

10. ¿Hay otros factores que considera cuando pide langosta en un restaurante?

☐ Sí, (¿cuáles son?):_____ ☐ No

_____

****

INFORMACION GENERAL

11. ¿Dónde se hospedó durante su tiempo en los Galápagos? *(Seleccione todos que aplican)*

☐ Embarcación: _____ ☐ Hotel: _____
(nombre) (nombre)

12. ¿Cuántos días duró su viaje?

_____ días

13. ¿Cuántas personas viajaron con usted (no incluyendo usted)?

_____ personas

14. ¿Qué edad tiene?

_____ años

15. ¿Cuál es su género?

☐ Masculino ☐ Femenino

16. ¿Cuál es su ingreso anual (en dólares US)?

☐ < $50,000 ☐ $50,001-100,000 ☐ > $100,000

☐ No sé en $US: _____ en _____
(cantidad) (su moneda)

****

Gracias por toda su ayuda al contestar este cuestionario de encuesta.

Survey for Tourists about the Lobster Market

Consent to be Surveyed
Thank you for offering to participate in this survey. The discussion we will have with you today is intended to explore the lobster market of San Cristóbal Island. The research that we obtain here will help with the development of our Group Project at the Bren School of UC Santa Barbara and will contribute to the understanding of the lobster fishery in order to work towards sustainable lobster populations.

This survey should take approximately 10 minutes to complete. With your permission, we would like to tape-record the survey/interview to ensure accuracy of recorded information and will immediately erase any recordings once this is verified. Only researchers will have access to any identifiable information. There are very minimal risks associated with this interview. Some information about income/expenses and fishing practices may be gathered, but your answers will be anonymous once we have ensured the accuracy of the recorded responses. Absolute confidentiality cannot be guaranteed, since research documents are not protected from subpoena. Your participation is voluntary and may be terminated at any time. You must be at least 18 years of age to participate in this survey. If you are younger than 18, we will remove your submission from the data we receive.

If you have any questions or concerns regarding this survey, please email galapagos@lists.bren.ucsb.edu. If you have any questions regarding your rights and participation as a research subject, please contact the Human Subjects Committee at (805) 893-3807 or hsc@research.ucsb.edu or write to the University of California, Human Subjects Committee, Office of Research, Santa Barbara, CA 93106-2050
Your participation is greatly appreciated.

Sincerely,

Taylor Debevec
Norah Eddy
Laura Johnson
Jonathan Sim
Katie Westfall

Your participation in this survey is voluntary and you may opt to not respond to any or all of the questions in the survey. However, your opionion is important for us and we hope that you participate. May I begin the survey now?
☐ Yes ☐ No

****

THIS SECTION IS TO BE FILLED BY THE SURVEYOR

Name of Surveyor: _____

Date of Survey: _____

****

1. Where are you from?

☐ Ecuador

a) Where?

☐ Galápagos Islands

i) How many lobsters do eat per year?

_____ / year

(Survey complete)

☐ Mainland

Continue to #2

☐ International

b) Where?

☐ USA
☐ UK
☐ Germany
☐ Canada
☐ Australia
☐ Other: _____

2. Do you eat lobster?

☐ Yes

Continue to #3

☐ No

(Survey complete)

3. Did you eat lobster while in the Galápagos Islands?

☐ Yes

a) What kind of lobster did you eat, and how many times did you eat it?

☐ Red: _____#
☐ Green: _____#
☐ Langostino: _____#
☐ Don't know for sure: _____#

b) How was it served? *(Check all that apply)*

☐ Whole ☐ Tail only
☐ Pieces in a dish ☐ Other: _____

c) Where did you eat it? *(Check all that apply)*

☐ Restaurant ☐ Hotel
☐ Boat ☐ Other: _____

☐ No

d) Why not? *(Check all that apply)*

☐ Wasn't sure if it was sustainable
☐ Not interested in eating it
☐ Too expensive
☐ Trip was all-inclusive and it wasn't an option
☐ Didn't see it on any menus
☐ Other: _____

****

PREFERENCES AND CONSUMPTION OF LOBSTER

4. If there were lobster with a certification indicating that they were caught legally and locally in the Galápagos Islands, would you buy them?

☐ Yes, I would buy ☐ Neutral ☐ No, I would not buy

5. How often would you buy certified lobster? *(Please read the options)*

☐ More often than uncertified ☐ Same as uncertified ☐ Less often than uncertified ☐ Depends on price

6. Would you be willing to pay more for a lobster with this certification (Say the average lobster meal costs $20)?

☐ Yes

a) What would be the most you would be willing to pay for a lobster with this certification (considering an average lobster meal costs $20)?

☐ $20.01-$21 ☐ $21.01-$22
☐ $22.01-$23 ☐ $23.01-$24
☐ $24.01-$25 ☐ More:_____

☐ No

Continue to #7

7. Did you know that people can take or send home lobster and fish from the Galápagos?

☐ Yes

a) Are you taking or sending lobster home?

☐ Yes

☐ No

i) Why not? *(Check all that apply)*

☐ Too difficult
☐ Too expensive
☐ Not interested
☐ Making other stops before going home
☐ Other: _____

b) Are you taking fish home?

☐ Yes ☐ No

☐ No

c) Would you be interested in taking or sending the following home *(Check all that apply)*:

☐ Lobster
☐ White fish

8. Rank how you would prefer lobster be served (1 is most preferred, 4 is least preferred):

_____ Live (picked it yourself)
_____ Whole
_____ Tail only
_____ Pieces in a dish

☐ No preference

9. Rank the importance of the following factors when ordering lobster in a restaurant (1 is most important, 6 is least important):

_____ Taste
_____ Price
_____ Sustainability
_____ How it's served
_____ Type/species
_____ Where it was caught

10. Are there any other factors you consider when ordering lobster in a restaurant?

☐ Yes, (what are they?):_____ ☐ No

_____

****

General Information

11. Where did you stay during your time in Galápagos? (check all that apply)

☐ Boat: _____ ☐ Hotel: _____
(name) (name)

12. What was the length of your stay?

_____ days

13. How many people other did you travel with (besides yourself)?

_____ people

14. What is your age?

_____ years

15. What is your gender?

☐ Male ☐ Female

16. What is your annual household income (in US dollars)?

☐ < $50,000 ☐ $50,001-100,000 ☐ > $100,000

☐ Unknown in $US: _____ in _____
(amount) (your currency)

****

THANK YOU VERY MUCH!