Design and Evaluation of Impact Investment Interventions to rebuild South Pacific Hake (*Merluccius gayi gayi)* populations in Chile

Image: Gonzalo Banda-Cruz

A group project submitted in partial satisfaction of the degree of Master of Environmental Science And Management for the Bren School of Environmental Science & Management

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Finding the ways that work

Investment Strategies to Recover the Chilean Hake Fishery

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

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Acronymns and Abbreviations

CORFO	Corporación de Fomento (Development Corporation).
EDF	Environmental Defense Fund
IUU	Illegal, unregulated and unreported
IFOP	Instituto de Fomento Pesquero
ITQ	Individual Transferable Quota
SERNAPESCA	Servicio Nacional de Pesca
SONAPESCA	La Sociedad Nacional de Pesca
SUBPESCA	Subsecretarıa de Pesca y Acuicultura
TAC	Total Allowable Catch
TPM	Terminal Pesquero Metropolitano

Abstract

South Pacific Hake (*Merluccius gayi gayi)* is an important economic and cultural fishery in Chile. It is the primary target fish for both industrial and artisanal fleets, which employ thousands of fishers, processors, and distributors. However, the hake stock collapsed in the early 2000s after experiencing record catch. High prevalence of illegal and underreported fishing within the artisanal sector has hampered recovery for the last decade. Managers are reluctant to simply enforce more heavily on this sector as hake artisanal fishers often reside near the Chilean poverty line and are politically organized to protest rigorous changes. Therefore new solutions need to found to support the simultaneous recovery of the fishery and maintaining fishers' income. Impact investing is a new, popular class of investment where investors willingly receive lower returns to generate measurable, beneficial social and environmental impacts. Our project designed and evaluated three potential impact investment interventions aiming to recover the stock, improve fishers' legal income, and provide an attractive return to impact investors. Tradeoffs exist between all three objectives across the interventions, but our model results demonstrate potential improvements from impact investment to facilitate incentives to support the recovery of the hake population.

Executive Summary

The South Pacific hake (*Merluccius gayi gayi*) ("hake") is a fish species of high social significance in Chile: it is the most locally consumed fish, sold mainly in open markets at relatively affordable prices, and is a main source of income for many artisanal fishers in the central southern regions of the country. Management of the hake fishery has been difficult and filled with controversies. After large increases in the total allowable catch and landings in the late 1990's and early 2000's, the biomass began to decline. The government consistently reduced the quota for both the industrial and artisanal sector until 2014, when quota allocations stabilized around 25,000 tons. Overfishing and high levels of unreported and illegal fishing in the last 15 years have prevented the fishery from recovery, despite implementation of new regulatory reforms created to address this problem.

Governments around the world commonly lack the necessary resources to support the recovery of overexploited fish stocks. Private capital may provide some of the funds needed to rebuild fish stocks, creating value for the future. In this line, impact investing is a new, popular class of investment where investors willingly receive lower returns to generate measurable social and environmental benefits. The goal of this project was to design and evaluate a suite of impact investment strategies (or "interventions") aimed at restoring the biomass back to maximum sustainable yield, while generating economic incentives that would reduce unreported fishing, and providing returns to the investors.

To be able to design an appropriate and effective set of interventions, we began by performing a thorough literature review of the biological condition of the stock, financial landscape of fisheries in Chile, and socioeconomic standings of stakeholder groups. Following our literature, we conducted onsite interviews with stakeholders through which we validated and consolidated our assessment of the key problems that were preventing the fishery to recover. Based on this collection of information and insights, we designed five main financial interventions that would correct the pervasive problems hampering the recovery of the fishery. We presented these five interventions to stakeholders in December 2017 in order to understand and incorporate their opinions and concerns on the viability of the interventions. Based on stakeholder feedback, we selected three of the interventions to conduct further qualitative and quantitative assessment of their feasibility. These strategies were:

a) *Buyback and Quota Lease*: In this strategy, investors may purchase quota shares from fishers willing to sell. These investors can then lease part of that quota to other fishers - for example - in regions where the cost of fishing is lower. Cost disparities arise between fishers due to shifting spatial distributions of hake. Transferring quota across these regions will allow the fishing effort to more appropriately match ecological distributions. Leasing quota provides a revenue stream to the investor which they could use to support additional conservation actions or to pay out as dividends, depending on the investors' goals. Leased quota allows more fishers to fish within legal limits and earn greater income. The investors could choose to hold some other part of the purchased quota unused to increase the rate of recovery of the stock.

b) *Caleta Certification*: This strategy is a market-based approach that would provide an incentive for fishers to increase compliance with the regulations, while providing motivations for self-enforcement. An investor funds the creation of a certification agency. The agency certifies *caletas* (fishing communities along the Chilean coast) that adapt rigorous catch and reporting standards. Standards include: documentation of catch, installation of cold storage facilities, traceability measures for catch reporting, and compliance with all regulations. A certified caleta will receive a higher price per catch (either coming from an investor or from the development of a differentiated market), while encouraging the participation of both fishers and consumers in a higher value chain. The certification incentivizes fishers to reduce illegal fishing by improving compensation. After an initial startup period funded by seed capital, the certifying agency charges for certification status and transfer excess profits through equity to the investor.

c) *Implementation of a New Clean Fish Market*: Construction of a new high-quality standard building for trading fish in Santiago. Investors would either provide a corporate loan or equity in the new managing company. This new building would provide the incentives for a better hake market, improving traceability, facilitating enforcement, and promoting the development of formal agreements (contracts) with certified and accountable intermediaries and/or fishers. Consumers would actively seek the higher quality fish provided by the new market and willingly pay a higher price premium. Additionally, by reducing excess distributors in the supply chain, more value can be transferred back to the fishers in the caleta.

Finally, we used a bioeconomic model to evaluate how the Buyback and Quota Lease, and Caleta Certification would perform in terms of biomass recovery, impact on fishers' income, and potential for investment returns. While complex business planning beyond the scope of the project prevented us from quantitatively evaluating the New Clean Fish Market, we focused on assessing its qualitative merits. A distinct tradeoff emerged between providing economic incentives for fishers to reduce underreported fishing and investor return. The Buyback and Quota Lease was able to achieve high internal rate of returns for the investor (>5%), but did not recoup fishers' income from illegal fishing. Caleta Certification increased fishers' income 34% relative to a straight reduction in underreported catch. However, investors were unable to earn positive returns (-18.8% IRR). We predict that by combining either two or three interventions, the weaknesses in any one intervention could be overcome by the strengths of the other. Our analysis also showed that a significant increase in enforcement is a fundamental enabling condition for all of the strategies.

After garnering support from stakeholders in Chile and assessing potential impacts, the interventions must be presented to potential impact investors to begin acquiring funding. Ideally, implementing the proposed interventions will achieve all three environmental, socioeconomic, and financial goals resulting in the recovery of the fishery. The methodologies and results described in this report could serve as a reference for future development of impact investment strategies in different fisheries and countries, but are not likely to be directly replicated, since they were built based on the specific context of the hake in Chile.

1. Project Significance

The South Pacific hake (*Merluccius gayi gayi*) ("hake") is an important cultural and commercial fish in Chile, and is the primary seafood caught for human consumption in the country. The fishery directly employs thousands of fishers, mainly concentrated in the artisanal sector. Hake fishing is a primary source of income for artisanal fishers, whom on average earn $260 per month compared to the national average of $710 per month (Pinto, 2014).

Comprehensive management plans authorized under the General Fishing and Aquaculture Law attempt to manage the fishery through stakeholder engagement and scientifically based tradeable quotas. However, despite the strong fishery institutional structure, hake biomass has dramatically declined since 2001. Climatic fluctuations, increased predation from jumbo squid (*Dosidicus gigas*), overestimation of the biomass, and high levels of illegal, unreported, and unregulated fishing are the most likely catalysts for the decline (Arancibia and Neira, 2008; Gatica et al., 2015; CEDEPESCA, 2016). In response, total allowable catch was iteratively reduced from 150,000 tons in 2001 to 25,000 tons in 2016 (SERNAPESCA, 2018). The state of the stock remains imperiled as juveniles less than 35 cm long make up the majority of the catch and the stock, limiting reproductive effectiveness and recovery potential (Queirolo & Flores, 2016; Gatica et al., 2015). Artisanal fishers protest the low levels of allowable catch as it reduces their income. A palatable tension exists between the necessity of reducing fishing pressure to recover hake stocks and supporting short run economic livelihoods of a key stakeholder group that current management plans are ill-equipped to address.

Impact investment is a potential alternative to traditional fishery management tools that could supplement fishers' income while biomass recovers to healthy levels. Due to the poor state of the fishery, it is urgent to identify effective impact investment strategies that may inject capital to assure a timely, steady, and sustainable recovery of the resource. Our Master's Project "Merluccius" has designed a model based on Chile's hake fishery that we hope may provide not only an example that can be adapted to other fisheries in the region, but will also help generate further interest in the use of impact investing to finance conservation worldwide.

2. Current Condition of the Hake Fishery in Chile

2.1 *Fishing industry*

The hake is a demersal fish that lives off the coast of Chile between 29°S to 42°S (Plotnek et al., 2016) (Figure 1). It is culturally important to Chile and supports a significant fishing industry (Cerda et al., 2003). Extraction of hake began in the early 1940s with two period of high abundance in 1951-1973 and 1990-2003 (Lillo et al., 2015).

Figure 2.1: Diagram of South Pacific Hake. South Pacific hake, *Merluccius gayi gayi* (MAR, 2013)

Two fishing fleets, one industrial fleet and one artisanal fleet, catch hake in Chile. The industrial fleet is made up of commercial fishing companies using vessels longer than 18 meters. This fleet is the smaller fleet of the two, with just 19 vessels registered in 2015. Of these 19 vessels, two vessels conduct most of the fishing and are responsible for 80% of the industrial landings (SUBPESCA, 2016a). The five nautical miles off the coast of Chile are reserved for artisanal fishers, and so the industrial fleet fishes in the deep waters farther offshore, primarily using bottom trawls (Plotnek et al., 2016). The industrial fleet exports its catch with much of the hake exported to the USA, Germany, and Italy (Plotnek et al. 2016).

The larger artisanal fleet is comprised of individual fishers and families doing small-scale fishing. This fleet fishes in the first five nautical miles off the coast, primarily uses longlines and gillnets, and sells its catch domestically (Plotnek et al., 2016). The artisanal fleet uses vessels shorter than 18 meters, with most vessels no more than 12 meters long (SUBPESCA, 2016b). About 900 artisanal vessels were operating within the fishery as of 2015. Artisanal fishers conduct their operations out of the fishing communities, called *caletas*, which line the coast of Chile. Within the caletas, fishing organizations, called syndicates, organize fishers and represent fisher interests (Plotnek et al., 2016). Artisanal fishers on average earn less money than the national average and approach the poverty line in Chile (Pinto, 2014). Though income for fishing activities varies greatly between caletas and syndicates, their political organization makes them formidable stakeholders (Gelcich et al., 2009).

2.2 *State of the Stock*

The hake is both widely consumed and heavily fished in Chile. This has contributed a sharp decline in the stock over the past 20 years. Landings in the early 2000s of about 120,000 tons decreased dramatically to 50,000 tons in 2005. In 2016, reported landings decreased even further to 21,000 tons (SERNAPESCA, 2016). **Figure 2.1** illustrates the decline in landings for both the industrial and artisanal sectors from the late 1990s to 2016.

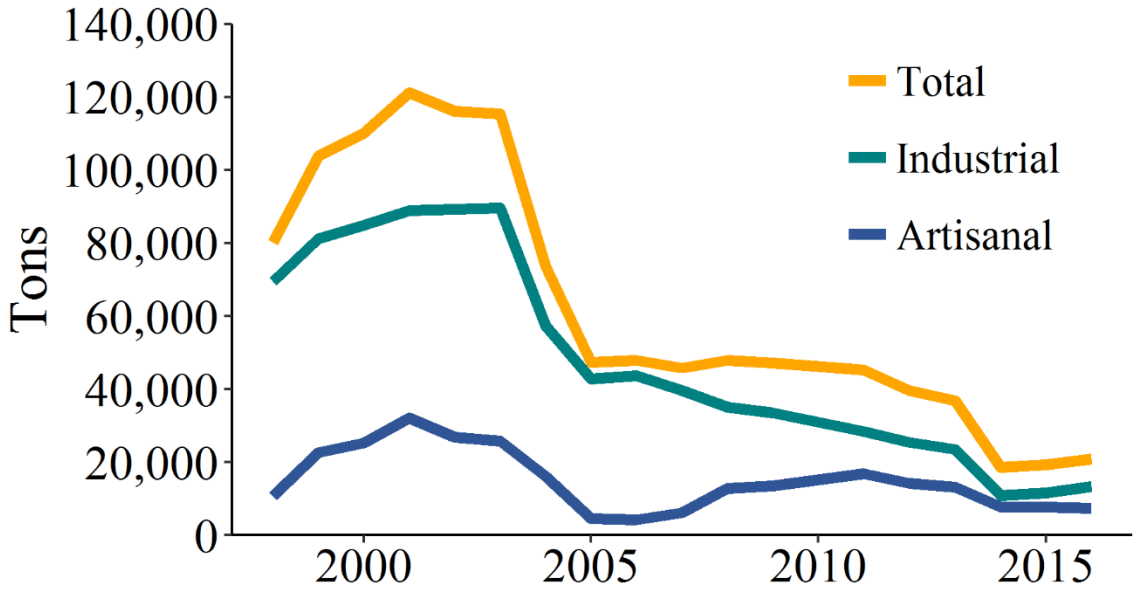

Figure 2.2: Common Hake Landings in Chile – 1998 to 2016. Landings of hake from 1998 to 2016. Data compiled from SERNAPESCA annual statistics reports (SERNAPESCA, 2016).

Additional biological indicators corroborate stock vulnerability in addition to reduced biomass. According to the 2016 stock assessment, hake spawning biomass is barely over 20% of virginal spawning biomass (SUBPESCA, 2016a). The average maximum length of hake in the current stock is only about 30 – 40 cm, which is barely above size at sexual maturity. The majority of the stock is composed of juveniles and adult age classes within the stock have largely disappeared (Queirolo & Flores, 2016; Gatica et al., 2015).

In 2014 and 2015, the Fisheries Development Institute (Instituto de Fomento Pesquero, or IFOP), a publicly funded scientific research institute, classified the hake stock as depleted due to the decrease in biomass and low spawning biomass. In the years since, IFOP has re-classified the stock as over-exploited (SUBPESCA, 2017). Though the Subsecretaria de Pesca y Acuicultura (SUBPESCA), the government agency responsible for fisheries decision-making and planning, has introduced management rules to recover the stock, the biomass has not recovered.

Further complicating the situation, the hake stock has recently shifted from the Northern regions of Chile to the Southern regions. Before 2002, the stock was largely in the northern-central portion of the coasts, but after 2002 the stock has begun to shift southward (San Martín et al., 2013; Gatica et al., 2015). The reduction in biomass, fragile state of the stock, and geographic shift all pose management challenges for the Chilean hake.

2.3 *The Hake Market in Chile*

Market and supply chain conditions create perverse incentives further propagating stock decline. Artisanal fishers supply the domestic market through a complex and extensive

supply chain. Between 70-90% of all artisanal catch moves through the centralized seafood market in Santiago called the *Terminal Pesquero Metropolitano* (TPM) and the rest is sold directly to consumers immediately at the beach (Plotnek et al., 2016). An intermediary network of distributors originating from the caletas exchange hake 3-5 times on the way to the TPM (Encourage Capital, 2015). During transportation, no improvements are made to add value to the hake product, yet the final price is often 500% higher than the beach price paid to the fishers (Future of Fish, 2017). Once at the TPM, verification of legality of catch and health inspections are difficult as brokers in the TPM have been reported to use extortion and threats of violence or death against enforcement officials (Future of Fish, 2017). Additionally, organized crime peddling drugs and prostitution have also been observed inside the current market (Future of Fish, 2017). Buyers at the TPM often require the consistent and large wholesale quantities provided by the TPM (Encourage Capital, 2015). Open air markets called *Ferias Libres* are the primary purchasers of hake at the TPM. Final domestic consumers purchase 80% of hake in these ferias libres (Future of Fish, 2017). With most of the hake sent to the TPM, there are few alternatives for the consumers to meet their demands. Final consumers are unaware and minimally concerned about the legality of catch and poor market conditions at the TPM, though consumers are concerned about the freshness of the catch (Future of Fish, 2017). The non-profit Oceana in partnership with WWF and the Environmental Defense Fund have started an awareness campaign to motivate consumers to know if the fish they are consuming is legal (WWF, 2018).

Fishers have little influence on the conditions of the market and possess weak bargaining positions with the intermediaries (Plotnek et al., 2016). Potential for spoilage leads the fishers to sell their catch at lower prices or risk receiving no compensation. Fishers often take loans from the intermediaries to pay for living costs or to fund gear repairs (Jacinto and Pomeroy, 2011). Some intermediaries may then encourage fishers to underreport their catch, especially when the intermediaries also assist the fishers in filing catch reports to SERNAPESCA, to pay off debt (Future of Fish, 2017). Tracing the origin of underreported fish becomes exceedingly difficult once it enters the supply chain and is exchanged multiple times.

2.4 *Chilean Hake Management*

Chile possesses strong legal powers for fisheries management. The Ley General de Pesca y Acuicultura establishes the overarching regulatory mechanisms for all fisheries management in Chile. It grants powers to SUBPESCA to establish management actions including determining a total allowable catch (TAC) and rules regulating individual transferable fishing quotas (ITQ). It also enables SERNAPESCA to ensure compliance with all laws through monitoring and enforcement (Ley General de Pesca y Acuicultura, 1991). SUBPESCA released management plans for hake from the early 1990s to 2015. However, the collapse of the stock in addition to new amendments to the Ley General de Pesca y Acuicultura mandating scientific evaluation of resources led to a new Management Plan in 2016 (SUBPESCA, 2016b). New components of the management plan include the formation of a committee comprised of key stakeholders, identification of 26 problems confounding recovery, and 16 explicit scientifically based metrics for recovery (SUBPESCA, 2016b).

Each of the new management plan components add vital support for the recovery of hake. The new management committee includes representatives from the government agencies

tasked with managing hake as well as three industrial and seven artisanal representatives from each hake fishing region and a representative from the processing plants (SUBPESCA, 2016b). Input from all sectors ensure hake recovery benefits each group in this politically contentious fishery. The addition of clearer biological targets for recovery provided by IFOP to the management committee also create achievable goals. Three metrics of importance include resorting virginal spawning biomass to 40% by 2023, increasing average size of catch from 2015 levels, and monitor 80% of all landings (SUBPESCA, 2016b).

Numerous problems have been proposed to be the cause of the stock collapse. Illegal and unreported fishing, excessive predation pressure from Humboldt Squid (*Dosidicus gigas*), overcapacity of the industrial fleet, and overestimation of stock abundance leading to unreasonable quotas are all suggested culprits of collapse (SUBPESCA, 2016b; Arancibia and Neira, 2008; Gatica et al., 2015). The management committee top 5 identified problems in the fishery include socioeconomic barriers preventing the effective management of the fishery. In order, the problems are: illegal and unreported fishing, lack of enforcement, unemployment, high dependence on hake, and low beach prices (SUBPESCA, 2016b). One outcome of this project was to determine the barriers to recovery of the fishery through stakeholder interviews and site visits. More details on the problems we identified are presented in **Section 5.1**.

By law, the management committee must divide the total allowable catch between the industrial sector (60%) and the artisanal sector (40%) (Gatica et al., 2015). Each year the management committee establishes the total quota allocation for each artisanal fishing region and the industrial fleet. In 2017 management committee set the TAC at 25,000 tons (SUBPESCA, 2016c). In the industrial fleet, companies and vessels directly receive their individual quota allocations based on their permitted holdings. They may trade permits amongst each other or lease rights to artisanal fishers. Artisanal fishers are either allocated their permitted quota amounts directly from the regional fishery offices or through the fishing syndicates if they are a member (Peña-Torres, 2002). Fishers may trade, sell, or lease permits amongst each other like the industrials, but cannot trade between regions or transfer to the industrial fleet. SERNAPESCA oversees trading applications to ensure permitted holders fish their prescribed amount.

In addition to fisheries law, two new legislative acts will influence the management of hake. First, the Ley de Caletas, which was passed in August of 2017, provides artisanal fishers in Chile the ability to designate a section of beach for 30 years as a legal entity provided the fishers using the grounds are registered fishers (SUBPESCA Prensa, 2017). Now entitled to the property they use for landings, artisanal fishers have the ability to construct and own facilities related to their fishing enterprises such as processing, tourism, or small-scale aquaculture. Enabling property rights to the artisanal fishers allows the caletas to be formally recognized both as investable entities and political units.

Second, the SERNAPESCA Modernization Law, which was in the process of approval in Congress at the time this report was written (June 2018), aims to support compliance with the existing management plan and strengthens the ability of SERNAPESCA for enforcement measures (AQUA, 2018). The regulation classifies the illegal possession and commercialization of collapsed or overexploited resources as a crime. Further, it sets an

emphasis on the punishment of retailers and industries found with illegal or unreported fish. Moreover, it establishes new obligations, more funding, and improved technology for a better inspection of fishing activity along the entire supply chain. Passage of this law facilitates the management committee's goal of monitoring 80% of landings.

Despite the improved management plan and additional legislative acts, the hake fishery remains in a precarious position. Problems limiting recovery expand beyond biological into socioeconomic dimensions that fisheries management and government intervention by their selves may not be able to adequately address. Acquiring sufficient funding is also not guaranteed to ensure the success of the new legislative acts. Significant problems equally arise from market conditions driving incentives to overexploit hake. Therefore, new solutions from the private sector ought to be explored. One potential option that demonstrated success in other environmental fields is impact investing.

3. Impact Investing – Existing Tools & Opportunities

Overexploitation diminishes economic and ecological benefits and is not unique to the hake fishery. If fisheries across the globe were reformed, they could yield an additional 10-16 million tons of wild caught seafood with an expected annual gain of $50 billion, contributing to food security, job creation and ocean sustainability (Costello et al., 2016; UNEP, 2011). Reforming fisheries however is not cheap and doing so at the global level would require an investment of $240 billion dollars (UNEP, 2011).

Despite the high costs, governments, regional bodies and NGOs invest worldwide in fisheries reforms to correct overexploitation and create sustainable stocks. The capital needed to reform a fishery is usually referred to as the "fisheries finances gap", defined as *"the lack of resources available to support the early stages of governance reform (policy instrument design and delivery), where returns are not easily monetizable and private capital is thus less likely to invest"* (EDF and Nicholas Institute for Environmental Policy Solutions at Duke University, 2018).

Traditionally, philanthropic capital covers this gap. However, philanthropic capital is limited, and can be unreliable in the long-term horizon. It has been suggested that private capital and traditional investment can help to cover the funding gap in fisheries, through different mechanisms; in particular through impact investments (Holmes et al., 2014). Impact investment is a private capital asset class that deliberately aims to achieve positive social and environmental outcomes alongside a financial return (Social Impact Investment Taskforce, 2014). Impact investments use traditional investment vehicles such as bonds, equity, or real assets to channel funds to companies and projects aimed at providing a measurable benefit outside only financial returns. For example, the first social impact bond reduced juvenile recidivism in the UK by 9% sufficiently activating the outcome payment (Anders and Dorsett, 2017). Reduced incarnation rates lowered government expenditures that allowed the government to pay a 3% return back to the initial investors. Lower incarnation rates provided a positive impact to society.

Impact investing is gaining popularity as a viable asset class and managers expect to incorporate it into more portfolios moving forward. Projections indicate impact investing could reach a market capitalization of $0.4 - $1 trillion by 2020 (O'Donohoe et al., 2010). Social enterprises such as education possess the most assets under management now, but current investors plan to increase investment allocations to Food and Agriculture as well as Environmental sectors at a higher rate (Saltuk et al., 2014). Currently, fisheries as a sector have yet to be widespread investing targets despite the numerous beneficial examples of impact investing and the prodigious amount of capital ready for deployment. One reason for this could be the dearth of fisheries projects available to receive funds. A lack of projects in specific sectors was the greatest concern for investors (Saltuk et al., 2013; Saltuk et al., 2014). Asset managers need investable entities for their capital.

Only three impact investment funds have explicitly raised or plan to raise funds for investment into fisheries: Encourage Capital (~$10 million), the Meloy Fund (~$20 million), and Althelia Ecosphere Oceans Fund (~$100 million). These are not encompassing of all impact investments in fisheries up to this point as other portfolios opportunistically invest in fisheries, but these funds represent the largest and most consistent source of funding for fisheries investment. Encourage Capital has demonstrated interest in fisheries recovery in Latin America including in Chilean hake (Encourage Capital, 2015). This project assists filling the project gap in fisheries by developing strategies suitable for investment. Chile also offers a practical financial landscape for impact investing by possessing strong institutions, government-funding agencies, and domestic impact funds further supporting the viability of this project. See **Appendix A** for a complete description of the financial landscape of Chile.

Hake's depleted status represents a unique opportunity to recover and restore value. Impact investing can supplement initial funds and assist restructuring incentives in the hake market. New investable products must be designed to entice investors to deploy capital, initiate change, and capture a portion of the value catalyzed by the growth of the hake stock.

4. Objectives of the Merluccius Project

The overall objective of the Merluccius Project is to design and evaluate impact investment interventions aimed at recovering the hake stock in Chile. With these interventions, we want to generate incentives that mitigate the short-term economic impact on the artisanal fishers, and involve private, public, or blended funding. Specifically, we endeavor to:

1. Collect and compile ecological and socioeconomic information to build a solid understanding of the opportunities, and, challenges for the recovery of the Chilean hake stock.
2. Develop one or more viable investable interventions, designed to enable the recovery of the stock, establish an economically and ecologically sustainable fishery, and provide investment returns.
3. Build quantitative models to assess the interventions' performance, using ecological, financial, and socioeconomic metrics.

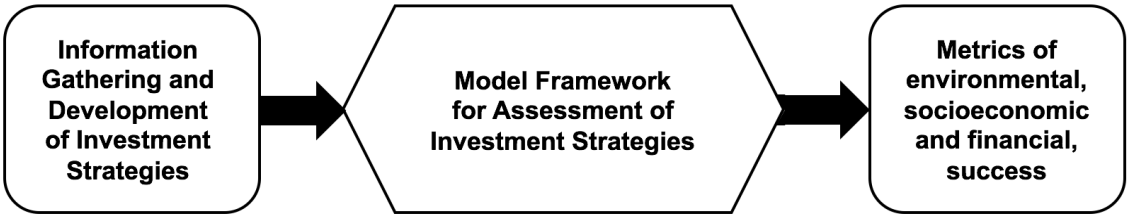

Figure 4.1: **Merluccius Project Objectives**. Schematic diagram of the objectives of the Merluccius Project to design a strategy recommendation for the recovery of the hake stock in Chile and the establishment of a sustainable fishery.

5. Results: Intervention Design

5.1 *Design Methods*

5.1.1 Research Methodology

To appropriately understand the social, political, environmental, and cultural context that shape the hake fishery in Chile, we conducted a thorough literature review covering the biological, socioeconomic, regulatory, and financial situation of the hake fishery in Chile. The Financial Landscape Analysis (**Appendix A**) summarizes some of these findings. From this literature review, we identified key reoccurring problems throughout the fishery.

We validated our assessment of key problems by conducting a serious of interviews with stakeholder throughout Chile during July 2017. These interviews included representatives from the government (SERNAPESCA, SUBPESCA, CORFO, IFOP), NGOs (Walton Family Foundation, OCEANA), academia, Open Market National Association (ASOF), artisanal fishers, and the Industrial Association (SONAPESCA). In addition, we worked collaboratively with Future of Fish, an organization hired by the Walton Family Foundation to perform an assessment of the hake fishery value chain in Chile. With them, we compared and corroborated findings, and discussed areas suitable for investment interventions.

Finally, we built a set of interventions for the recovery of the Chilean hake fishery. Each intervention addresses problems identified in the fishery from interviews and stakeholder input. We presented a set of five interventions to the different stakeholders in a workshop organized by EDF in December 2017 in Valparaiso, Chile. After discussing viability with the stakeholders, we decided to further assess three of those five interventions (see EDF's December 2017 workshop description, and stakeholder's intervention evaluation in **Appendix C**). We developed a bioeconomic model for the evaluation of those interventions, which is detailed in **Chapter 6**.

5.1.2 Key Findings for the Fishery

Based on our literature review and our interviews with stakeholders, we identified the following key findings for the fishery:

a. The hake fishery is extremely complex and holds high political leverage. Because of this, the political willingness to deal with necessary, albeit controversial, political decisions has been relatively lacking. Artisanal fishers' organizations have strong political power and dealing with IUU by increasing enforcement has been considered so far to have high political cost for leaders in the public sector. Additionally, fines for underreporting under the current regulation are broadly perceived to be disproportionate against artisanal fishers, thus reducing the willingness to enforce further.

b. IUU is highly prevalent in the fishery, especially in the VIIth Region of Maule, and the VIII Region of Bio-Bio. Some estimates suggest a minimum of approximately 26,000 tons of unreported fishing, and a maximum of 43,500 for artisanal fishers (CEDEPESCA, 2016; WWF, 2017).

c. Fishers have little control over beach prices: they are mainly price takers. There is high beach price variability, where in some cases a box of hake (27kg) would be sold for as low as $5,000clp (approximately $8 dollars) (Future of Fish, 2017). For example, we observed in some exchanges with intermediaries, fishers would be told what price they would receive for their fish after the hake was loaded onto the truck. There is little to no communication or collaboration between the caletas, and thus, fishers have no information about the price hake is being sold in nearby areas.

d. Certain actors in the chain concentrate a disproportionate amount of the monetary value of the catch where little to no real value is added. This happens mainly with the intermediaries between the caletas and the Terminal Pesquero Metropolitano in Santiago (where more than 70% of the hake passes through). There is a high variability in the number of traders/intermediaries between the fishers and the final seller (mainly the open markets), with estimates ranging from two to more than seven links.

e. The industrial fleet has significantly decreased their fishing activities for hake along the Chilean coast, and the few industrial vessels remaining reportedly comply with current fishing laws (FIP, 2014; Encourage Capital, 2015). Because of this, our project does not focus on changing the behavior of the industrial fleet to facilitate the recovery of the fishery. The industrial fleet will only tangentially be subject of the evaluation of this project.

f. There is a lack of knowledge of the consumers about the state of the fishery. Most consumers are unaware of the depleted state of the fishery. Additionally, they lack information about the quality (cold chain storage and transportation) and legality of the products (lack of traceability information for the consumers).

g. Passage of new regulatory measures such as the SERNAPESCA Modernization Law and Ley de Caletas enhance financial and political enabling conditions for investments to take place.

h. The new Ley de Pesca (Fishing Law) lacks support from artisanal fishers. After the approval of the law, corruption cases involving some of the industrial fishing companies and politicians involved with the design of the bill were made public, situations that deeply damaged the public's perception of the new law, taking away credibility.

i. There are significant bottlenecks throughout the chain that can be used as leverage points:

    - Terminal Pesquero Metropolitano: where most of the locally consumed fish passes through before being distributed to ferias libres or direct consumers.

    - Ferias Libres: main selling point for the hake (more than 80% of the hake consumed in Chile is sold through the ferias libres) (CORFO, 2015). The local market is heavily driven by the ferias libres.

    - Most of the IUU is concentrated in a few caletas in the VIIth region, and some caletas in the VIIIth region. Being able to properly control those caletas's IUU will count for a significant part of the problem.

In summary, the status quo of the hake fishery in Chile is complex with many stakeholders (**Figure 5.1**). Our key findings from our interviews and literature review unveil a dynamic system with observable but correctable problems given the existence of established leverage points. To illustrate the status quo of the fishery, we created a systems map to simplify the flow and interactions of stakeholder groups throughout the fishery (**Figure 5.2**). As we attempt to correct the system, modifications from our intervention designs will restructure the system dynamics.

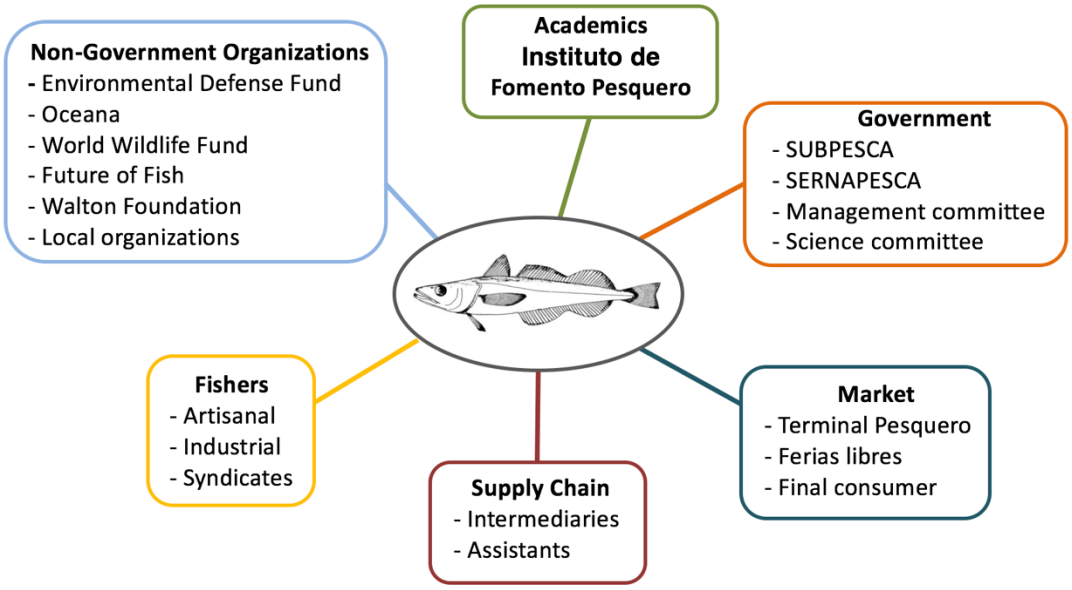

Figure 5.1: **Chilean Hake Fishery Stakeholders**. Stakeholder groups involved in the hake fishery and the commercialization of hake products in Chile.

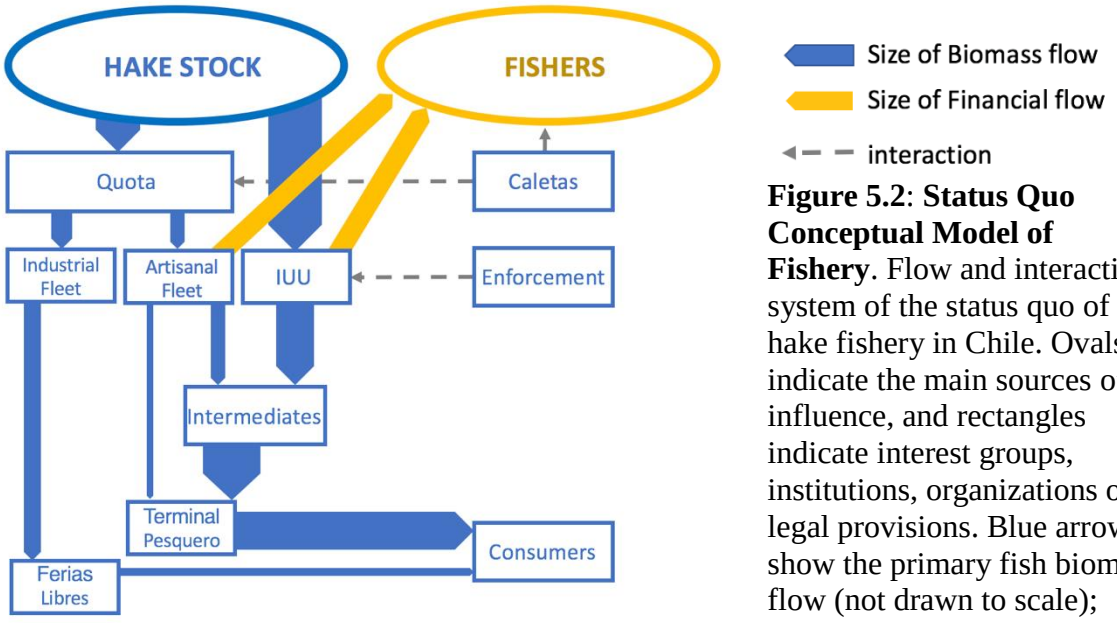

Figure 5.2: **Status Quo Conceptual Model of Fishery**. Flow and interaction system of the status quo of the hake fishery in Chile. Ovals indicate the main sources of influence, and rectangles indicate interest groups, institutions, organizations or legal provisions. Blue arrows show the primary fish biomass flow (not drawn to scale); financial flows to fishers are displayed as yellow arrows and main interactions as grey arrows.

5.1.3 Main Problems Identified for the Fishery

Considering our previous key findings, we identified the following to be the main underlying problems in the Chilean hake fishery. Many of these problems mimic other analysis by stakeholders (e.g. the 2016 SUBPESCA Management Plan), but we synthesized results most pertinent for an impact investment intervention and most likely to change.

i. High IUU: Especially in the artisanal sector, which is estimated to fish between 2 to 4.5 times their quota amouont.
ii. Excess in fishing capacity: The artisanal fleet used for fishing hake is large and efficient. In the VIIth region, for example, fishers typically fish no more than three days a week and still exceed their quota allocations relatively easily.
iii. Inefficient supply chain: A significant percentage of the monetary value is captured in the transactions between intermediaries, where little to no value is added.
iv. Lack of traceability: There are traceability platforms in place, but there does not seem to be an appropriate level of use of these platforms. In addition, the technology behind this system seems to be inappropriate for the amount and type of enforcement that should be done
v. Maintaining fishers' income: The reduction of hake biomass in the early 2000's along with the reduction in quota amount that occurred in 2012 after IFOP was appointed with the final responsibility of defining the quotas resulted in a drop in fishers' income (at least the "legal" income). Lack of alternative livelihoods and economically vulnerable communities make it a politically complex situation for government officials to properly enforce regulations that heavily punish fishers.
vi. Lack of Enforcement: There seems to be little enforcement from SERNAPESCA. We believe that this is mainly due to the political issues mentioned above, rather than a lack of budget. As mentioned before, most of the IUU is concentrated in just a few caletas that would not be too expensive to enforce.

Using these six problems as a template, we designed interventions in an impact investing framework to restore hake biomass, grow fisher's livelihoods, and achieve a financial return.

5.2 *Interventions*

In this section we describe each of the three main interventions we pursued to achieve our objectives. For the Buyback and Quota Leasing intervention, the Caleta Certification intervention, and the New Clean Fish Market intervention we:

- Offer a detailed description of the intervention;
- Provide a conceptual model;
- Discuss problems addressed by the intervention;
- List enabling conditions necessary for the intervention to be effective;
- Explain the financial mechanisms through which the intervention would be funded and generate returns;
- Analyze the sustainability for each intervention;

We do not discuss risk in this section but we do acknowledge that all interventions could have unintended consequences and therefore pose a degree of risk. Implementing safeguards can reduce the likelihood that the interventions will have unintended consequences. Safeguards are listed in **Section 8.1**, Safeguards.

For none of the interventions do we consider the intermediaries (those involved in the transportation of the fish from the caletas to the market) in our quantitative or qualitative analysis. From the interviews conducted by our team over the summer of 2017 and from discussions with Future of Fish, we confirmed that value is lost in the middle of the supply chain and that the intermediaries occasionally take advantage of the fishers (Plotnek et al., 2016; Encourage Capital, 2015). The composition of this sector is extremely convoluted and difficult to understand. Most of the interventions seek to either create new supply chains outside of this tangled chain or provide leverage to empower the fishers in their negotiations with intermediaries. If future research on the extent and coverage of this group comes to light, investment strategies could be used to bolster their support provided they achieve compliance with all rules and regulations. At the present time, we forego their inclusion in our analyses.

In the early stages of our intervention development we considered two additional interventions - one focused on transitioning hake fishers to an alternative fishery and one focused on extending the current fishery closure to cover a greater portion of the spawning period. However, we eliminated these interventions from further analysis following the stakeholder workshop in Chile in December (**Appendix C**).

Additionally, we considered a set of secondary, or supporting, interventions which could help mitigate some of the problems identified in the fishery. We categorized these interventions as secondary due to the magnitude of the intervention's anticipated impact, the inability of the intervention to generate a return on investment, or the inability of the intervention to stand on its own. These secondary interventions for example included developing a price sharing platform to improve fishers' negotiating power, using technology to increase traceability in the supply chain, funding an increase of cold storage infrastructure in caletas, and opening a fund to finance additional enforcement. While these interventions are not robust enough to meet our metrics alone, if coupled with the primary interventions they could increase the primary intervention's effectiveness. Both the eliminated primary interventions and the secondary interventions are discussed in detail in **Appendix B**, Interventions Considered but Eliminated.

5.2.1 Buyback and Quota Lease

Quota Buybacks are a common tool used in fisheries management (Squires, 2010). Because of this, we used it as the basis for this intervention design. To meet the unique needs of the Chilean hake fishery, we added a leasing component to the traditional buyback tool to account for the shifted hake biomass and incongruous distribution of quota.

Explanation of the intervention

In the Buyback and Quota Leasing intervention, investors purchase quota from fishers looking to leave the fishery. These may be fishers who are not using part or their entire quota, or who are looking to leave the fishery for other reasons—such as high costs or desire to retire–have an incentive to exit. The investors would then lease part of that purchased quota to other fishers with lower costs who want to fish more legally, but do not have enough quota to do so.

Most of the hake biomass is located in the southern regions of Chile (Gatica et al, 2015). As such, fishers in the north (IV and V regions) are not reaching their quota levels, and fishers in the south, though nominally are also not reaching their quotas, are estimated to be extracting much more than their quota allows them to do (SERNAPESCA, 2018). Due to this, it is likely that fishers in the IV-V regions would be willing to sell their unused quota and likely that fishers in the VIIth and VIIIth regions would be interested in leasing additional quota from the investor. Redistributing the quota via leasing would enable the quota distribution to more accurately reflect the distribution of the stock and allow currently underreporting fishers to mitigate the economic impact they will likely receive from partial or full enforcement. In addition to leasing some of the purchased quota to fishers, the investors may retire a portion of the quota, leaving that portion unused, to increase the rate of recovery of the stock.

The reduced effort on the stock would lead to eventual recovery of the hake stock. Because the quota is a percentage of the total allowable catch, value of the quota would increase alongside the biomass. After a period of time, investors would be able to sell the quota for a higher price than it was purchased, making a profit.

The intervention creates new avenues of investment to lower available quota in the system (**Figure 5.3**). Reducing fishing pressure both legally and illegally through redistribution will assist the recovery of the hake stock relative to the status quo of the system.

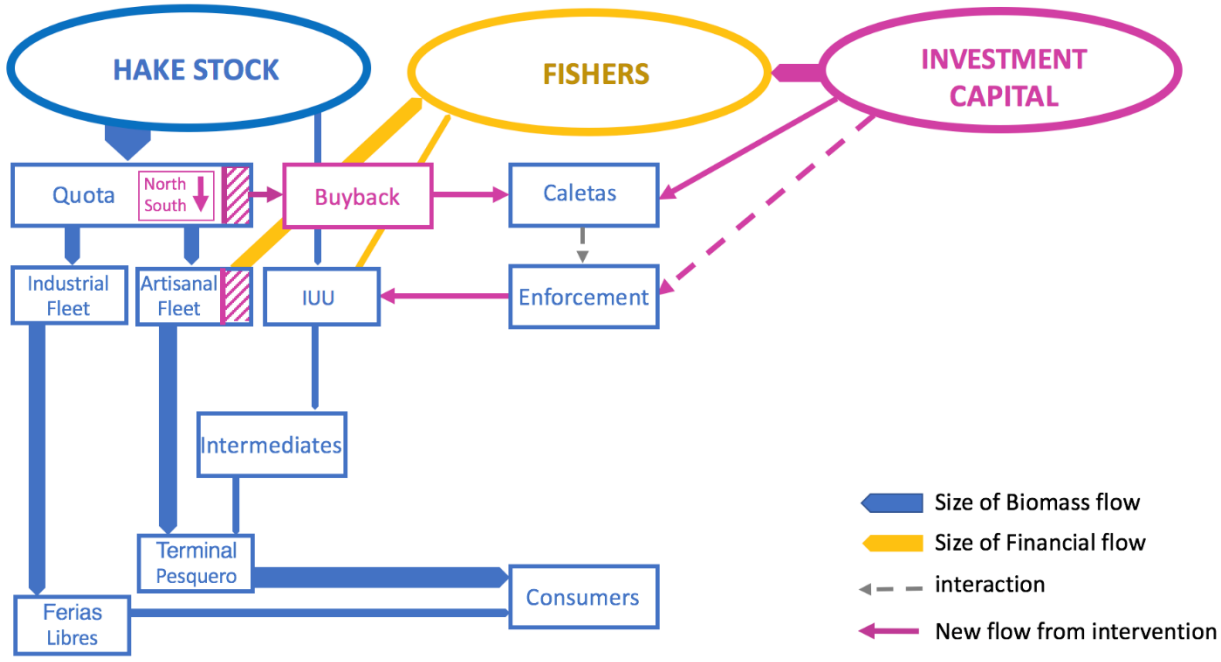

Figure 5.3: Buyback and Quota Leasing Conceptual Model. Conceptual model illustrating flows and interactions in the hake fishery after the implementation of the Buyback and Quota Leasing intervention. A partial re-allocation of quota permits purchased in Northern regions to Southern regions results in a reduction of the amount of IUU fishing. The IUU fishing flow (indicated in blue and arrow width) has decreased compared to the status quo conceptual model (**Figure 5.2**). Changes to the status quo are indicated in pink.

Problems addressed by the intervention

Reduce IUU: The Buyback and Quota Lease intervention would reduce IUU by providing the opportunity for fishers currently participating in IUU fishing to purchase additional quota and do more of their fishing legally. Additionally, through the buyback process the government would have another mechanism through which to gather more accurate data about quota owners and capacity. A more robust fishery registry would increase transparency. These changes would help to strengthen existing institutions and develop new institutions related to leasing and market for quota.

This intervention would also reduce IUU by enabling fishers engaged in unreported fishing to lease quota and therefore do more of their fishing legally.

Reduce excess fishing capacity: The buyback would reduce the number of fishers in the fishery by reducing the amount of legal fishing that is permitted. Underutilized quota would be removed from the system. Additionally, fishers who were using their quota but who felt the financial benefits of selling their quota outweighed the benefits of remaining in the fishery would also likely sell their quota. Through the buyback effort in the fishery would be reduced.

Sustaining Fishers' Income: This intervention would provide financial support to fishers that are not generating sufficient profits from fishing by offering them the opportunity to sell their quota. Leasing the quota provides fishers currently engaged in IUU with the opportunity to avoid the risk of fines by having the opportunity to purchase quota and designate more of their fishing as legal. Any fishers not utilizing all of the quota will also be able to participate in the leasing option to provide them with an opportunity to generate additional legal income. The funds generated from leasing would be put into a trust that could support caleta activities or could provide community financial support.

Enabling conditions

For this intervention to work, several enabling conditions must be present. Currently the laws in Chile: do not allow quota transfers between regions, do not allow individuals not involved in the fishery to buy quota, and do not allow an individual to hold onto quota unused for more than three years. For this intervention to work, exemptions to the law must permit quota transactions to occur across regions and individual or organizations not involved in the fishing industry must be able to buy quota and be able to hold onto it for more than three years to allow stocks to recover and quota to increase in value. Enforcement also must be stringent enough to address IUU and consequently make the leasing of quota an attractive alternative to fishers engaged in IUU. The investors can recapitalize in enforcement initiatives to assist with this.

The legislative changes needed to facilitate the Buyback and Quota Leasing intervention would need to include safeguards that would prevent the quota from accumulating with one buyer when the quota is sold back into the fishery after retirement.

Financial mechanism

Quota value is connected to the biomass because the quota is a percentage of the total allowable catch. The quota becomes an asset in an investor's portfolio, incentivizing the investor to ensure the biomass grows, thus appreciating their quota holdings value. Once the stock recovers, the investor can exit the market and sell of their holdings at a higher price. The precise exit strategy would be up to the discretion of the investor and would be determined as part of the investment deal structuring. However, the exit strategy could provide an opportunity for blended capital. If the investor wanted to sell the quota back to the fishers directly, one option could be to allow fishers to purchase the quota at the original selling price, where a philanthropic organization (for example) could provide the difference between the market price of the initial quota price to the investor.

Possible investors for this intervention could include impact investment firms (such as Althelia Ecosphere), corporations, or collectives of fishers.

Sustainability of the Intervention

After the quota leaves retirement and the investor leaves the fishery, what ensures IUU will remain under control and stock levels will remain high?

During the duration of the investment period, fishing effort will have been removed from the fishery. Enforcement may have increased, either due to full implementation of the SERNAPESCA Modernization law, or due to investment in other means of enforcement as part of the intervention strategy. During the intervention, increased enforcement could create an increased expectation of enforcement, which could make IUU seem riskier and could encourage some fishers to participate less in IUU. Fishers who were participating in IUU may also shift to alternative livelihoods themselves if they observe an increase in enforcement and since the costs of being enforced no longer outweigh the benefit garnered through IUU.

While the reduction in excess fishing capacity through the retiring of quota would be temporary, the idea would be that the quota would not be sold back to the fishers or the government until the stock had recovered to a level that would be robust enough that selling the quota back would not damage the stock. At the end of the intervention period, as before, the amount of quota allocated to fishers would still be determined by SUBPESCA at sustainable levels as fishers re-entered the fishery

This intervention stimulates near term and long-term growth of fishers' income. After the investor leaves the fishery, the stock will be in a recovered state allowing for higher levels of sustainable harvest than before. In the near term, the intervention would provide some financial assistance that would allow the fishers to transition to other ways of sustaining their income. Fishes that left could have invested their quota purchase funds to transitioning to an alternative livelihood. For the fishers that remained in the fishery during the course of the intervention, their profits would increase as the stock recovered, so the benefits to their income would remain after the investor left the fishery.

5.2.2 Caleta Certification

Compliance with the management regulations is necessary for the stock to recover. At present, it is unclear when the enforcement measures needed to bring compliance to the required level will be implemented in Chile. A certification program is a market-based approach that could provide an incentive for fishers to comply with the regulations. It may also give a clear signal for differentiating products on the market, thus getting consumers involved in the compliance monitoring. However, existing certification programs such as the Marine Stewardship Council (MSC) certification program are not applicable to the Chilean hake fishery, mainly due to stringent certification standards related to the stock status. Therefore, we developed a Caleta Certification intervention customized to the circumstances and goals of the fishery.

Explanation of the intervention

The Caleta Certification intervention seeks to reduce IUU fishing by rewarding caletas that properly comply with the law. The idea of this intervention is to have a set of standards that coincide with the behaviors of legal fishing. Caletas that meet these standards become

certified, which would grant them access to opportunities and rewards unavailable to non-certified caletas. Because caletas—not individual fishers—would be the certified units, members of the caletas who want access to the rewards would have an incentive to encourage other fishers in the caleta to comply with the standards. As more fishers within the caletas comply with the standards, IUU fishing would decrease, and as the certification program becomes more widespread, the collective decrease in IUU fishing could result in an eventual recovery of biomass.

In addition, the certification program would be designed to address supply chain inefficiencies and consumer concerns about fish freshness. Consumers and their demand for fresh fish would additionally trigger compliance with certification standards. Existing fishery certification programs such as the MSC program have demonstrated that consumers are willing to pay a price premium for a higher quality product and for supporting the environmental goals of the certification program. For example, a study on MSC-certified Alaska pollock products revealed that consumers in the UK market were willing to pay a price premium of 14.2% (Roheim et al., 2011). Certification programs provide consumers with the opportunity to become aware of the relevant issues at stake and this can influence their product choices.

However, this certification is different from a MSC certification in that the caletas are certified based on fisher behavior, not based on the status of the fishery. The standards actors must comply with in order to become certified incentive behavior propagating recovery. The certification is designed not just to reward good actors, but to also encourage better behavior from actors that have historically been involved in illegal fishing activities.

The standards for the Caleta Certification intervention are designed to encourage the recovery of the biomass, to reduce the loss of value in the middle of the supply chain and to meet consumer demand for fresh fish. To ensure compliance with the standards, an auditing agency would organize and train auditors responsible for verifying that standards are met and would certify compliant caletas. The minimum standards for certification would need to include:

<u>Qualification for Certification</u>

1. Compliance with all fishing gear regulations (e. g. net size and hook size)
2. Traceability and legality. Hake must have documentation verifying landing amounts are being counted as part of a legal quota, and that the quota has not been exceeded.
3. Cold storage to ensure freshness and quality. The time for the fish to travel from the caleta to the selling location must be below a maximum number of days from boat to market, and cold chain conditions must be proved.
4. Up to date documentation (fishing licenses, vessel inscription)

<u>Rewards</u>

Presently, most artisanal-caught hake is sold at the Terminal Pesquero Metropolitano (TPM), which is the central fish market in Chile. The TPM is known for being outdated, poorly run, lacking basic hygienic and health infrastructure and practices, and lacking transparency. Certified caletas would gain the opportunity to circumvent the TPM and sell their fish in an

alternative fish market, for example, a new TPM from which non-certifed caletas would be excluded, as described in the New Clean Fish Market Intervention in **Section 5.2.3**. Caletas selling at the alternative fish market would also gain access to a transportation service provided by the fish market and would have the opportunity to sell directly to distributors at the fish market. This service would help the caletas meet the cold storage standard as demanded in the qualification Standard 3 and guarantee fresh fish on the market. Further, the service would circumvent the present network of intermediates in the supply chain, counteract the value loss of the fish within this network, and prevent fishers from being extorted.

Additionally, certified caletas would receive a price supplement to further incentivize adoption of the certification program. The price supplement would be a per ton increase on the beach price of the fish and would be paid to the fisher by the investor as an additional reward for participating in the certification program. While the other rewards alone (i.e. access to selling at an alternative fish market and naturally receiving higher beach prices because intermediaries will no longer be exploiting the fishers) may create enough of an incentive to encourage compliant caletas to join the certification program, caletas benefitting from IUU fishing may not find that the non-monetary rewards alone outweigh the benefit they are receiving from IUU fishing. The goal of the investor-provided price supplement is to provide the additional incentive needed to tip the caletas engaged in IUU fishing towards joining the certification program. The price supplement would remain in place until the fishery recovered to the biological maximum sustainable yield, at which point the price supplement provided by the investor would be eliminated.

Lastly, the economic market forces will likely result in an increase in the certified fish sale price, as compared to the price of uncertified fish. The consumer desire for fresher, higher quality fish will increase the demand for certified fish and enhance the willingness to pay higher prices for certified hake, resulting in increased revenues to fishers. The passage of the SERNAPESCA Modernization law could also increase demand for certified fish by increasing the consumer understanding of the importance of purchasing legal fish. One provision of the law criminalizes the possession of illegally caught fish even to end distributors and consumers. These final steps are so far removed from the initial landing that a system that assures the legality of catch can meet this new demand.

Enforcement and Monitoring

The investor would start an auditing agency through which third-party auditors would monitor the caleta's activity and verify whether standards are met. If auditors determine the four standards are met, the caleta would be certified and would gain access to the benefits associated with certification. If at any point an auditor finds a certified caleta is not complying with any one of the four standards and exceeds a maximum number of violations, the caleta would lose their certification status. The auditing agency would also have an information-sharing agreement with the government, so that if the government does choose to enforce, it will have increased information on violations.

To ensure compliance, the auditing agency would verify certification standards are being met at two locations. First, an auditor in the caleta would check landings as fishers come to shore to ensure Standards 1 and 4 are being met. If these standards are met, the auditor will label the box of hake noting that Standards 1 and 4 were met, documenting landing size, and the day the fish was caught and packaged. Non-profits such as Future of Fish are developing technology designed to create new traceability measures that are easy to employ in small-scale fisheries like the artisanal fishers of Chile. These tools will include app-based technologies to verify reporting and matching with prescribed legal quota. These tools could be used by the auditing agency and could help reduce the time and associated costs of verifying traceability and could prove to be a valuable tool if this intervention were utilized. The information on the label about landing size and the date on the label will provide information to a second auditor at the market and will help the auditor determine whether Standards 2 and 3 have been met. The final certification would be granted at the end of the supply chain when an auditor at the new market verifies that the fish arrived within the established time period and that the fish is traceable and was transported using cold storage.

Figure 5.4 illustrates an overview of the impact of the Caleta Certification Intervention on the fishery in comparison to the status quo as described by **Figure 5.2**.

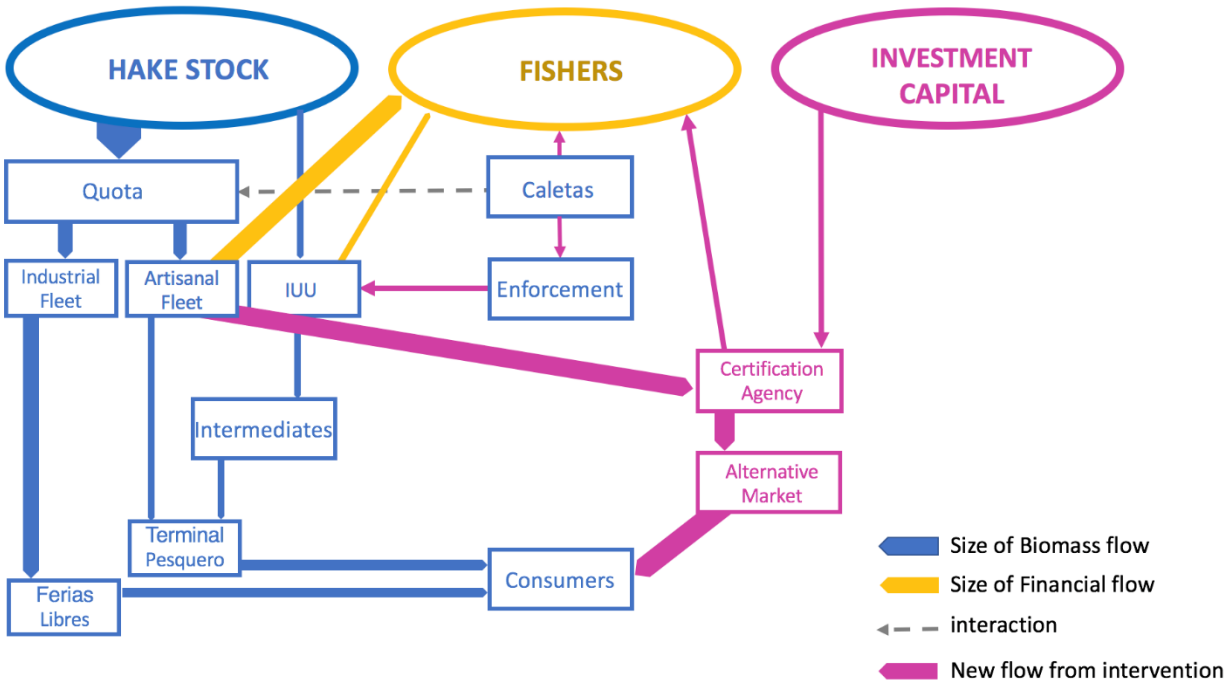

Figure 5.4: Caleta Certification Conceptual Model. Flow and interaction system of the hake fishery in Chile based on a Caleta Certification intervention. Investment capital is used to enable fishers to fulfill certification standards and establish alternative markets. Flows and interactions introduced by the intervention are indicated in purple. The certification program implements incentives for complying with fishery regulations and self-enforcement within the fishing community. Investment capital establishes a certification agency that introduces certification and documentation measures needed to comply with the qualification standards as mentioned above. Furthermore, the investment capital allows access to alternative market places for certified products that bypass intermediaries. The majority of the landings of certified caletas should be transferred to the consumer

via the certification process and the alternative market as indicated by the new pink flows. The rewards for fishers participating in the certification program will provide an incentive to decrease the share of illegal landings and create a culture of self-enforcement in the fishing community, wherein the fishers observe the compliance of their peers. Simultaneously, tightened enforcement actions should further reduce the amount of illegal fishing as shown by the thinner blue flow.

Problems Addressed by the Intervention

Reduce IUU: Because the Caleta Certification provides access to rewards on a caleta, not an individual, basis, fishers who want the rewards will be invested in the activities of their fellow fishers within the caleta resulting in self-enforcement within the fishing community without the involvement of government authorities. Caletas that meet the standards for certification must be engaging in legal fishing practices. Therefore, caletas that are certified will be fishing legally. As more caletas participate in the certification program, the amount of IUU fishing being done would decrease. The goal of this intervention would be to incentivize caletas that are currently engaging in IUU fishing to join the certification program and give up their illegal fishing practices, which would eventually result in biomass recovery.

Reduction of excess fishing capacity: The self-enforcement encouraged by this intervention would decrease effort in the fishery by reducing IUU fishing and consequently reducing fishing capacity.

Sustaining Fishers' Incomes: First, the price supplement provided through the certification program would bolster fishers' income. The price supplement would provide financial support to compensate for a decrease in income due to lowered IUU fishing. Second, an eventual recovery in biomass would serve to benefit the fishers by reducing cost per unit effort and leading to a higher legal quota allocation. Third, after some period of time the certification program will become well established in the market and consumers will be willing to pay a market price premium. Consumer will appreciate the opportunity to purchase high quality certified fish. As consumer become familiar with the certification program and the stock recovers over time, the price premium may replace the price supplement, which could then be reduced or even ceased. Ideally, the price premium could be reinvested in the program to cover the costs of the certification agency. Finally, once the caletas begin to comply with current regulations, philanthropic or government sources will prefer to work and fund projects within certified caletas.

Lack of traceability: The certification process would provide a mechanism for traceability. Traceability originating from the landing site to market assure legality of catch throughout the supply chain. The proliferation of the certification program will increase traceability in the fishery.

Enabling Conditions

In order for this intervention to be successful, there must be enough participation, enforcement, and subsequent reduction in IUU fishing to make a difference in the stock. The rewards of the certification program need to be appealing enough to encourage participation from the caletas. Ideally, the benefits of joining the program are attractive enough that not only the caletas that are currently fishing legally want to join, but also the caletas that are doing IUU fishing want to join. This is necessary in order for the certification program to achieve its primary goal of reducing IUU.

To get those caletas engaged in high levels of IUU fishing to join the certification program, government enforcement in the Southern Regions VIIth and VIIIth should be high to incentivize participation. Additionally, the implementation of the SERNAPESCA Modernization Law would facilitate the success of this intervention. The SERNAPESCA Modernization Law seeks to punish retailers and industries that benefit from illegal fishing, which would create a demand for traceable fish. This would increase the appeal of certification for caletas, as it would help them to more easily find for their catch.

Other enabling conditions include the existence of the aforementioned alternative market willing to exclusively sell certified fish. We discuss a possible strategy for the implementation of such an alternative market in **Section 5.2.3** as one of our proposed interventions. The presence of such a market plays a key role for the Caleta Certification intervention and the associated incentivization for behavior change. Lastly, were this intervention coupled with the Buyback and Quota Leasing intervention (see *Financial Mechanisms* section below), all Buyback and Quota Leasing enabling conditions would be required as well.

Financial Mechanisms

Blended capital should invest in the certification program. For example, philanthropic capital can help caletas build the necessary infrastructure to become certified, while private capital provides the price supplement and initial capital for the certifying agency. The exact funding needed for the auditing agency would depend on the frequency auditors monitor the caletas. An investor might be willing to provide a higher level of funding to enable the auditing agency to check landings on a more frequent basis, knowing that the stricter enforcement would increase the likelihood of the intervention's success.

The investors would be responsible for paying the price supplement to the fishers. While the investors provide the price supplement, over time market forces would eventually lead to a price premium on certified fish developing based on a higher consumer demand for fresher, legal fish. While the price supplement would be paid by the investor directly to the caletas, the price premium would develop at the alternative legal market at the end of the supply chain. During the investment period, any price premium that develops and is paid at the alternative market could be collected by the investors to assist them in paying the price supplement to the fishers. This price premium could also be collected by the investors to help finance the auditing agency.

After the investment period ends, for example after five years, the investors would stop paying for the price supplement and the auditing agency. The price premium could start going straight to the caletas to cover the costs for the certification programs. The cost of certification encompasses the amount of money needed to pay for the auditors and administration. If the caletas believe that the value gained from being certified is greater than the cost of certification then they will have a reason to pay for their continued status as a certified caleta. The certification costs could be covered by a fee paid by the caletas to the auditing agency. The fee could either be a flat rate paid annually or a percentage of the price premium.

The Caleta Certification intervention could yield a return in investment in case the price premium would exceed the total of the cost of the certification program and the price supplement for the fishers. The surplus to this total or a percentage thereof could be payed to the investors until the expected return is covered. Once the investors are paid out, the caletas are free to keep the price premium for themselves and the fishers, respectively.

However, the intervention is not necessarily guaranteed to provide a return on investment on its own. It does create incentives for self-enforcement, which is crucial for the recovery of the fishery. This intervention could indirectly generate returns by providing a means of enforcement, which could enable other fishery recovery strategies to generate value. Similarly, certification could add value by making caletas more attractive for tourism. To create a return on investment more directly, this intervention could be coupled with the Buyback and Quota Leasing intervention. Were the Caleta Certification coupled with the Buyback and Quota Leasing intervention, the investor would purchase quota at the start of the intervention time period, would proceed with the Caleta Certification intervention as described above, and after the biomass had recovered and has reached a maximum sustainable yield (B_{msy}), would sell the quota back, generating a return. The investor could also use funds generated by leasing quota to pay for the auditing agency or the price supplement during the course of the investment period.

Sustainability of the Intervention

The goal of this intervention is to encourage fishers to comply with the management plan for the fishery, i.e. to incentivize legal fishing through the provision of an investor-provided price supplement. Were a critical mass of caletas to join the certification program, this could greatly reduce IUU fishing and contribute to the recovery of the biomass. During the investment period, the price supplement should be designed to be at a level to encourage the joining of this necessary critical mass of caletas. By the time the investor is ready to exit, the biomass should be recovering due to the reduction of IUU fishing. Ideally, the investor would agree to remain in the fishery until the hake biomass has recovered to a sustainable level.

Once the investor leaves and the investor-provided price supplement is eliminated, the certification program can still continue to run. The only cost that will need to be covered will

be the operating costs of the auditing agency. Though this will no longer be paid for by the investor, the caletas can choose to pay for the costs and remain certified, which would allow the certification program to be self-sustaining, even in the investor's absence. The caletas will likely take over these costs because even after the price supplement has been eliminated, the caletas will still be receiving the other benefits of the certification program. They will continue to be able to sell at alternative market places like the TPM, they will still be able to avoid the loss of value via the supply chain, and they will begin to receive the market-generated price premium. Additionally, the caletas will have already put in the effort needed to switch to legal fishing practices. This should encourage the caletas to remain certified, and to continue to abide by the certification standard, even after the investor exits the fishery and stops compensating the loss of fishers' income.

Lastly, if the SERNAPESCA Modernization Law passes, the demand for traceable fish will increase and the certification program could provide an easy way for restaurants and other suppliers to identify caletas with whom they can do business. This would further create a demand for certified fish in the future, leading to a greater income for the fishers.

5.2.3 New Clean Fish Market

Explanation of the intervention

The New Clean Fish Market Intervention would consist of the construction of a new, high-quality building for centralizing and trading seafood in the Metropolitan Region that would be able to provide incentives for a better hake market.

The current existence of a single and centralized terminal in Chile has either perpetuated or generated a series of deficiencies in the value chain for the hake fishery. Currently, more than 70% of the locally consumed fish and seafood in Chile is estimated to pass through the existent Terminal Pesquero Metropolitano. Long transportation times, several “changes of hands”, and low accountability for sanitary conditions through the chain before the terminal (due to low traceability), reduces the quality of the fish, and generates an unnecessary addition in price. Several stakeholders have identified the terminal as a point in the valued chain that encourages these practices, where even *last mile* intermediaries exist (actors in the chain whose role is exclusively to bring the fish inside the terminal).

Additionally, a single point of sale and distribution of seafood provides monopoly power to its administration, increasing inefficiency. Even more, the current terminal does not provide an incentive for legally reported or traceable seafood, where no differentiation or public communication of traceability is displayed (at least for the hake), and no price premium is offered. The existing Terminal Pesquero Metropolitano in Santiago has gained a bad reputation for incompliance and lack of adequate sanitary conditions in managing the fish. In addition, there seems to be considerable tax reporting violations and a lack of fair and open trading conditions between suppliers (intermediaries) and sellers, where the suppliers seem to hold an excess of power.

By funding the construction of a New Clean Fish Market, hake within the supply chain can circumvent the current inefficient and degraded TPM (**Figure 5.5**). Fishers and the investor will capture more value from the streamlined sale of hake.

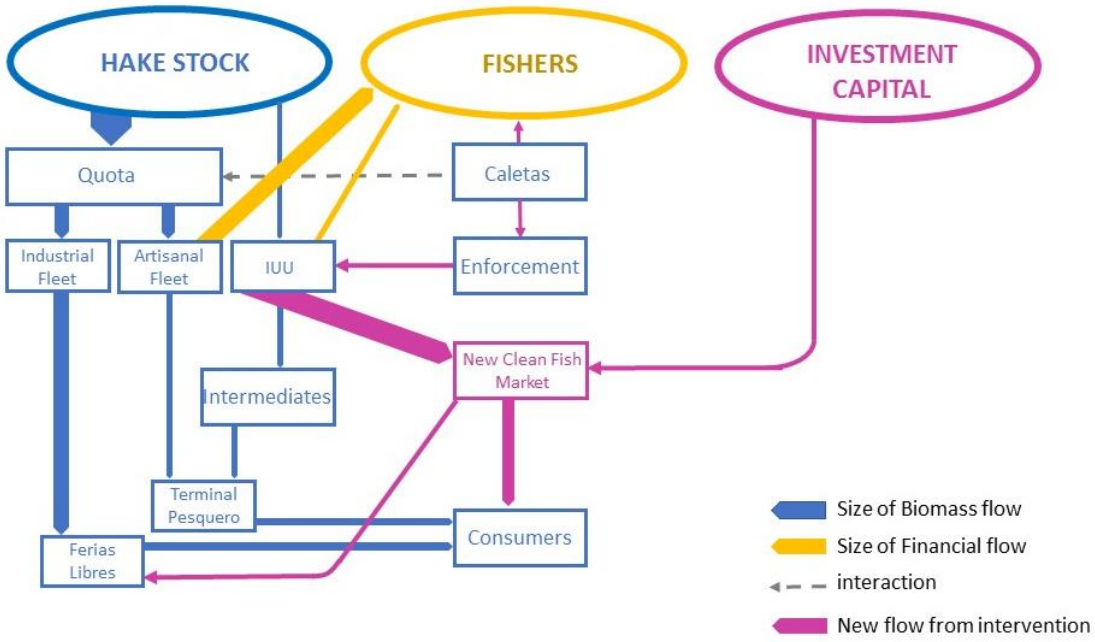

Figure 5.5: New Clean Fish Market Conceptual Model: Flow and interaction system of the hake fishery in Chile based on a New Clean Fish Market Intervention. A new fish market is developed beside the existing terminal funded by investment capital. The New Clean Fish Market improves marketing conditions for the product and strengthens the interest of artisanal fishers, which in turn results in reduced IUU fishing.

Problems addressed by the intervention

Sustaining Fishers' income: There is a need to increase and stabilize the beach prices for reported, traceable, healthy, and bigger fish. As mentioned earlier, there is currently no market for "better performing fishers". Increased enforcement, and the consequent reduction in supply, should go hand in hand with the possibility of increasing beach prices for hake and mitigating the impact on fishers impact on the short term (during the time it takes to the stock to recover, and the value of the fishery to increase as a whole).

Inefficient Supply Chain: While assessing the supply chain, Future of Fish identified large variability in the amount of business interactions or intermediaries from the beach to the terminal. It was even mentioned in one of our interviews with stakeholders in Chile that there is a whole link of the supply chain for just the last kilometer before entering the terminal, a

seemingly inefficient part of the chain that has risen due to the monopolistic nature of the single terminal. The intermediate part of the supply chain adds little to no value and there are no proper incentives in place for making the chain more efficient.

While establishing the New Clean Fish Market, binding legal contracts with clear obligations between the vendors in this new terminal and fishers will provide greater certainty on the transportation procedure for caught fish eliminating excessive exchanges..

Lack of Traceability: A New Clean Fish Market could provide an efficient and properly designed platform for increasing and facilitating traceability at this point of the chain. SERNAPESCA Modernization Law once passed will expose retailers, restaurants, and final consumers to stronger penalties for purchasing unreported fish. Providing a proper platform for adequate traceability will minimize this risk to buyers, facilitating a better and more transparent market. Finally, this will also translate into higher quality products, with the display of proper origin and sanitary information for the consumer.

IUU: In addition to the above-mentioned expected benefits, such a centralized platform as a new terminal could provide the opportunity for improved communication with the public about the legality of their fish purchases and the harm caused by IUU fishing, through information campaigns and education. Additionally, as a central location enforcement can be more easily concentrated as opposed to the expansive coastline.

Enabling conditions

The passing of the SERNAPESCA Modernization Law, and the expected increase in enforcement is significant enabling condition. This would incentivize the generation of a better market for hake, for which the New Clean Fish Market would very likely become a key player.
Additionally, the commitment of the Open Markets (Ferias Libres, all under the umbrella of the same organization: ASOF) and their strong market power would strongly incentivize compliance with the regulations throughout the supply chain. Association or formal agreements between the New Clean Fish Market and the ASOF would generate powerful incentives for compliance and increase the chances for the success of the intervention. In other words, if the main buyer is increasing the standards, a higher standard service (as the one provided by the New Clean Fish Market) will have highest chances of becoming successful.

Finally, the availability of adequate technological tools that can facilitate traceability would also be a relevant condition for the success of the intervention.

Financial mechanisms

Private investors would fund the majority of the New Clean Fish Market. Investors could either issue a loan to the new company in charge of the New Market or receive equity in exchange for initial capital. Equity would perhaps be the preferred option as the construction of the terminal results in real estate assets bolstering the company's value. That will hedge

risk against an inability for the new company to become the chosen alternative for the consumers. AS the company earns revenue and market value, the investor could choose during the deal inception to either receive dividends or simply hold onto their stake while the company's value accrues. At a strategic date for the investor, or when the returns are sufficient enough to meet their goals, they could sell their equity stakes.

Government participation in the funding would be encouraged but has not been considered a necessary condition. Government support could come in the form of a tax reduction (at least for the initial period of construction and operation), training, and educational campaigns. When this intervention was discussed during the workshop in Valparaiso in December 2017, some government officials did express the belief that the government should take part in the funding of a new terminal.

Sustainability of the Intervention

This intervention would likely be able to sustain itself, even after the investment period has ended. As long as the regulations are kept, enforcement is effective, and the high standard service provided by the New Clean Fish Market remains unchanged, consumers should continue to be willing to pay –at least a slightly- higher price for better product at an improved market.

6. Results: Intervention Evaluation

6.1 *Methods*

Interventions need to be evaluated against clearly defined goals to ensure they have the potential to achieve the objectives of our project. Investment models incorporating the biological and socioeconomic dynamics of the fishery can serve as robust tools to understand the benefits of using impact investing in the Chilean Hake fishery. We designed a bioeconomic model that outputs indicators to compare against evaluation metrics for two of the approved interventions: Buyback and Quota Lease and Caleta Certification. The New Clean Fish Market remains a strong potential investment opportunity; we excluded it from model evaluation only because the intervention requires the development of a significant business plan that was outside the scope of this project.

The first step in the evaluation process was to solidify quantitative impact metrics to measure projected progress towards our projects goals. Effectiveness of intervention designs are evaluated in alignment with common impact investing measures supported by the Global Impact Investment Network IRIS system as well as the unique objectives of this project (IRIS, 2016). Metrics allow an investor to design interventions that improve specific goals and to quickly monitor the impact deployed capital has on the targeted system. Therefore, we chose one metric for each of our three goals of environmental recovery, socioeconomic support, and investor return.

Metric 1: Environmental

Recovery of the stock is the key environmental outcome our interventions address. In fisheries management, biomass recovery relative to biomass at maximum sustainable yield is a widespread indicator of the health of a stock (Sparre and Venema, 1998). Stocks at a $\frac{B}{B_{msy}}$ level of 1 are theoretically able to produce the maximum catch in perpetuity. Current levels of $\frac{B}{B_{msy}}$ for Chilean Hake are approximately 0.4 (IFOP, 2015), so their stocks would have to be more than doubled in order to return maximum catch. Our interventions thus aim to restore Chilean Hake $\frac{B}{B_{msy}}$ to 1 over the investment horizon.

Environmental Metric (1):

$$\frac{B}{B_{msy}} = 1$$

Metric 2: Socioeconomics

All interventions attempt to alleviate the impact of enforcement on artisanal fishers. Thus, measuring net present value (NPV) of the artisanal fleet relative to changes in enforcement will capture the benefits accrued by our social demographic of concern. Net present value adjusts fishers' income by accounting for time preferences. For example, if fishers value more money in the short run, money earned in later in the investment is worth less. Percent change further supports the use of intervention compared to a status quo scenario, as it is not subject to magnitude nor time biases.

Socioeconomic Metric (2):

$$\%\Delta\ Artisanal\ NPV > 0\%$$

Metric 3: Investor

Impact invests are willing to forego some, but not all potential earnings. Thus, we need to ensure the investment will still be profitable to the investor. There are many methods for measuring return on investment. Each is contingent on the investment vehicle or classification. The simplest measures for return are positive net present values or internal rates of return (IRR). Internal rate of return is equivalent to the effective compounded interest rate needed to generate a specific return. It allows for easier comparison across investment vehicles. Unless it is inappropriate or incompatible to use IRR due to the investment vehicle, we will evaluate investor return as the means to achieve 5-10% IRR.

Investor Metric (3):

$$5\% < IRR \leq 10\%$$

A Gordon-Schaefer Surplus Production model is an ideal assessment tool to evaluate the metrics. Its simple and robust design will allow us to record the biomass change over time (Metric 1), profit by fleet (Metric 2), and integrate investor profit (Metric 3). The simplicity also offers us the ability to manipulate inputs more easily as response functions and change the model form to include the impacts of illegal fishing and enforcement, often-neglected influences in other models (Agnew et al., 2009). The extensive scientific literature surrounding Chilean Hake provides us with parameters and the ability to compare results across other models (IFOP, 2015; Wiff et al., 2016). Our model follows the traditional logistic growth of biomass (X_t) with different sources of extraction (Eq. 1).

$$X_{t+1} = X_t + rX_t\left(1 - \frac{X_t}{K}\right) - H(Q_t)_{t,f} - IUU(E_t)_{t,f} \quad (1)$$

Growth of the stock is controlled by the intrinsic growth rate (r) and the carrying capacity (K). Extraction is divided into legal harvest ($H_{t,f}$) and illegal or underreported harvest ($IUU_{t,f}$) indexed by year (t) and fleet (f). Fleet is split between the artisanal sector and the industrial sector. Harvest is a function of quota allocation (Q_t) where quota allowance is calculated in each time step. With no changes, harvest between the fleets is split under the current legal proportions ($H_{t,1} = Q_t * 0.4,\ H_{t,2} = Q_t * 0.6$). Legal fishing mortality is constant at the initial proportion extracted in 2017 until the biomass reaches B_{msy} then it switches to removal of surplus production, which ensures the quota will extract exactly to B_{msy} (Eq. 2).

$$Q_t = \begin{cases} \frac{Q_0}{X_0}X_t, & X_t < \frac{K}{2} = B_{msy} \\ X_t + rX_t\left(1 - \frac{X_t}{K}\right) - \frac{K}{2}, & X_t \geq \frac{K}{2} = B_{msy} \end{cases} \quad (2)$$

Thus, if $X_t = B_{msy},\ Q_t = r\frac{K}{4}$ or Fmsy. The amount of unreported fishing is a function of the amount of enforcement, or proportional reduction in illegal catch, in this system. Enforcement would include greater observation and/or more stringent fines from SERNAPESCA. We assume that IUU fishing will continue at constant initial proportional levels with changes in biomass, IUU responds linearly to enforcement, and enforcement is an exogenous factor determined outside the system (Eq. 3). For example, the imposition of the Modernization law is exogenous to the deployment of capital, though the investor may be able to find ways to directly improve

$$IUU(E_t)_{t,f} = \frac{IUU_{0,f}}{X_0}X_t(1 - E_t) \quad (3)$$

enforcement through supporting SERNAPESCA budget expenses or indirectly through lobbying powers. Additionally, deterrence may affect the response of underreported fishing to enforcement levels, as some fishers may be more risk averse and cease IUU fishing more readily. Currently, IUU changes by 10% with a 10% change in enforcement. These

assumptions may be relaxed to test their robustness and influence on model performance later by having IUU change exponentially or any other functional form that mimics artisanal fishers' responsiveness. This could be done by taking the natural log of enforcement probability and adding scaling parameters to acquire the appropriate shape of the curve (see McDonald et al., 2016 for a demonstration).

Profit must be separated from legal ($\pi_{t,f}$) and illegal ($IUU\pi_{t,f}$) activities (Eq. 4, and 5).

$$\pi_{t,f} = pH(Q_t)_{t,f} - c_f H(Q_t)_{t,f} \tag{4}$$

$$IUU\pi_{t,f} = pIUU(E_t)_{t,f} - c_f IUU(E_t)_{t,f} \tag{5}$$

Price (p) is the beach price received by artisanal fishers. The price received by industrials is assumed to be the same, though value-added processing in their production facilities masks the immediate value they receive per ton of harvest. Costs are dependent on fleet with industrials experiencing a lower cost per harvest. Summing discounted total artisanal profit, which includes the monetary benefits of illegal fishing, compared to the discounted legal profit will assist measuring Metric 2 as change between these two outcomes are affected by strategy effects and discount rates (ρ) (Eq. 6 and 7).

$$Legal\ Artisanal\ NPV = \sum_{t=0}^{T} \frac{\pi_{t,1}}{(1+\rho)^t} \tag{6}$$

$$Total\ Artisanal\ NPV = \sum_{t=0}^{T} \frac{\pi_{t,1}}{(1+\rho)^t} + \sum_{t=0}^{T} \frac{IUU\pi_{t,1}}{(1+\rho)^t} \tag{7}$$

Measuring the return to investor (Metric 3) varies between each intervention strategy and will be clarified during the incorporation of each strategy. In general, investors provide some amount of capital injection into the system. The capital changes variables based on the investment design of the intervention. Specific adjustments are discussed in more detail before the evaluation results.

Parameterization

The Instituto de Fomento Pesquero (IFOP) has the most comprehensive information available on *Merluccius gayi gayi* for both biological and economic parameters (**Table 6.1**). Most of their data sources are compiled reports from SERNAPESCA. They employed methods from Martell and Froese (2013) to obtain r, K, and initial population values from historical catch data. Initial population numbers also align closely to the official stock size estimate in the stock assessment (IFOP, 2015). Intrinsic growth rate followed a log normal distribution with a geometric mean of 0.346 ($\pm$ 2 s.d [0.2 - 0.597]) (IFOP, 2015). Though lower than the FishBase reported intrinsic growth rate of 0.62, this more conservative estimate still provides a medium resiliency level and reflects inputs from fishery data (Froese and Pauly, 2018). Beach price is $750 per ton after conversion from Chilean pesos to USD at

a current exchange rate of 0.0015 USD per Chilean peso (Future of Fish, 2017). Artisanal costs fluctuate among regions. Independent interviews obtained cost structures per region by vessel classification (Muñoz and Goldeman, 2016). We condensed costs by taking the weighted average of relative proportion of harvest by boat size and region (Muñoz and Goldeman, 2016; OECD, 2018). Industrial fishers report the cost of their operations to SERNAPESCA for daily use of a trawler (SERNAPESCA, 2014). Discount rates reflect the possible ranges for stakeholders in the system. Managers and impact investors may have lower discount rates, such as 0% to 5%, then fishers, which could range to 20%. Our baseline scenario uses a discount rate of 5%, but a robustness check for sensitivity will be needed. Total initial quota is the quota allocation given by SUBPESCA in 2017 at 25,000 tons with 60% to the industrials (15,000 tons) and 40% to the artisanals (10,000 tons). To estimate IUU, we multiplied current levels of artisanal legal fishing by illegal fishing multipliers of 3 and 4 (WWF, 2017).

Table 6.1: Model Parameters. Model parameters employed to evaluate effectiveness of impact investing interventions on the recovery of the Chilean Hake (*Merluccius gayi gayi*).

Parameter	**Value**	**Source**
r (Intrinsic growth rate)	0.346 $\pm$ 2 s.d [0.2 - 0.597]	IFOP (2015)
K (Carrying capacity)	906,789 tons $\pm$ 2 s.d. [592,019 - 1,388,919]	IFOP (2015)
P (Beach price)	$750/ton	Future of Fish (2017)
C_1 (Cost of artisanal harvest)	$577.40/ton	CEDEPESCA (2014)
C_2 (Cost of industrial harvest)	$400/ton	SERNAPESCA (2014)
ρ (Discount rate)	$\in$ [0,0.2]	Assumed
E (Enforcement)	$\in$ [0,1]	Selected
X_0 (Initial population)	226,697 $\frac{K}{4}$	IFOP (2015)
Q_0 (Initial Quota)	25,000	SUBPESCA (2017)
$IUU_{0,1}$ (Initial IUU)	30,000 – 40,000 tons	WWF Chile (2017)

6.2 *Buyback and Quota Lease*

Evaluation methods and results:

Incorporating the Buyback and Quota Leasing intervention into the evaluation model required adjusting the quota variable. In principle, the investor essentially becomes another fleet in possession of quota. Since the intervention focuses solely on purchasing quota from

the artisanal fleet, we restricted investor interaction to only the artisanal sector. As there is still uncertainty on the future buyers for the exit strategy, we simplify the ability for the investor to earn money solely through leasing a proportion of their purchased quota at a set price to artisanal fishers. Thus, quota allocation becomes a function of investor capital (how much the investor puts in), the purchase price (how much quota is the investor able to buy given their capital), retired proportion (how much does the investor hold in reserve), and lease price (how much will they charge willing artisanal fishers to use a portion of their quota). Purchase price is the current value of a quota permit for artisanal fishers over the investment time horizon (Eq. 8).

$$P_q = \frac{\sum_{t=0}^{T} \frac{\pi_{t,1}}{(1+\rho)^t}}{Q_0 * 0.4} \tag{8}$$

Integrating all these factors together yields a new function of harvest that adjusts the biological system and fisher income dynamics from equations 1 and 3. The managers of the fishery still determine the total amount of quota as in equation 2, but now each fleet receives a different proportion for extraction (Eq. 9 and 10).

$$H(Q_t, C, R, P_q)_{t,1} = 0.4Q_t\left(1 - \frac{C}{0.4P_qQ_0}\right) + R(Q_t\frac{C}{P_qQ_0}) \tag{9}$$

$$H(Q_t)_{t,2} = 0.6Q_t \tag{10}$$

Where C is the investor capital, R is the proportion of quota owned by the investor they retire, and P_q is the quota purchase price. In addition to changes in harvest, there are now additional costs that affect artisanal income (Eq. 11). Artisanals must pay to use the quota at the price the

$$\pi_{t,1} = pH(Q_t)_{t,1} - c_1H(Q_t)_{t,1} - \mathrm{L}^* R(Q_t\frac{C}{P_qQ_0}) \tag{11}$$

investor chooses (L) based on how much quota was leased out ($R(Q_t\frac{C}{P_qQ_0})$). All quota offered for lease was assumed to be bought by the artisanal fleet so long as the fishers were able to achieve additional profit.

Evaluation of Metric 1

First, we analyzed how the Buyback and Quota Leasing intervention would be able to assist the recovery of the fishery. From our problem identification, illegal fishing must be addressed to restore the fish stock. With the SERNAPESCA Modernization Law passage, we expect reductions in unreported fishing though at what level is not clear. Therefore, we simulated recovery by increasing the impact of enforcement under stochastic environmental influence. Random draws of the intrinsic growth rate r represented the sensitivity of recovery

to the environment. Monte Carlo simulations with 10,000 iterations created 95% confidence intervals for the biomass over time with enforcement at status quo levels, 68% reduction of IUU, and 100% reduction in IUU ($E_t = \in (0,0.68,1)$) and with complete buyback of the artisanal fishery. All investor quota was retired to accelerate the potential for recovery. At all levels of enforcement, the complete Buyback had a greater probability of recovery than just enforcement and recovered the fishery sooner with high levels of enforcement. Status quo in enforcement has only a 2.3% probability of recovery in 20 years with the fishery on average losing biomass (**Figure 6.1**). Buyback of quota increased the probability of recovery to 2.4% and on average saw an increase in biomass. If there was recovery of the stock, there was little difference in the average time to achieve recovery between only enforcement and Buyback (10 years vs. 10.2 years).

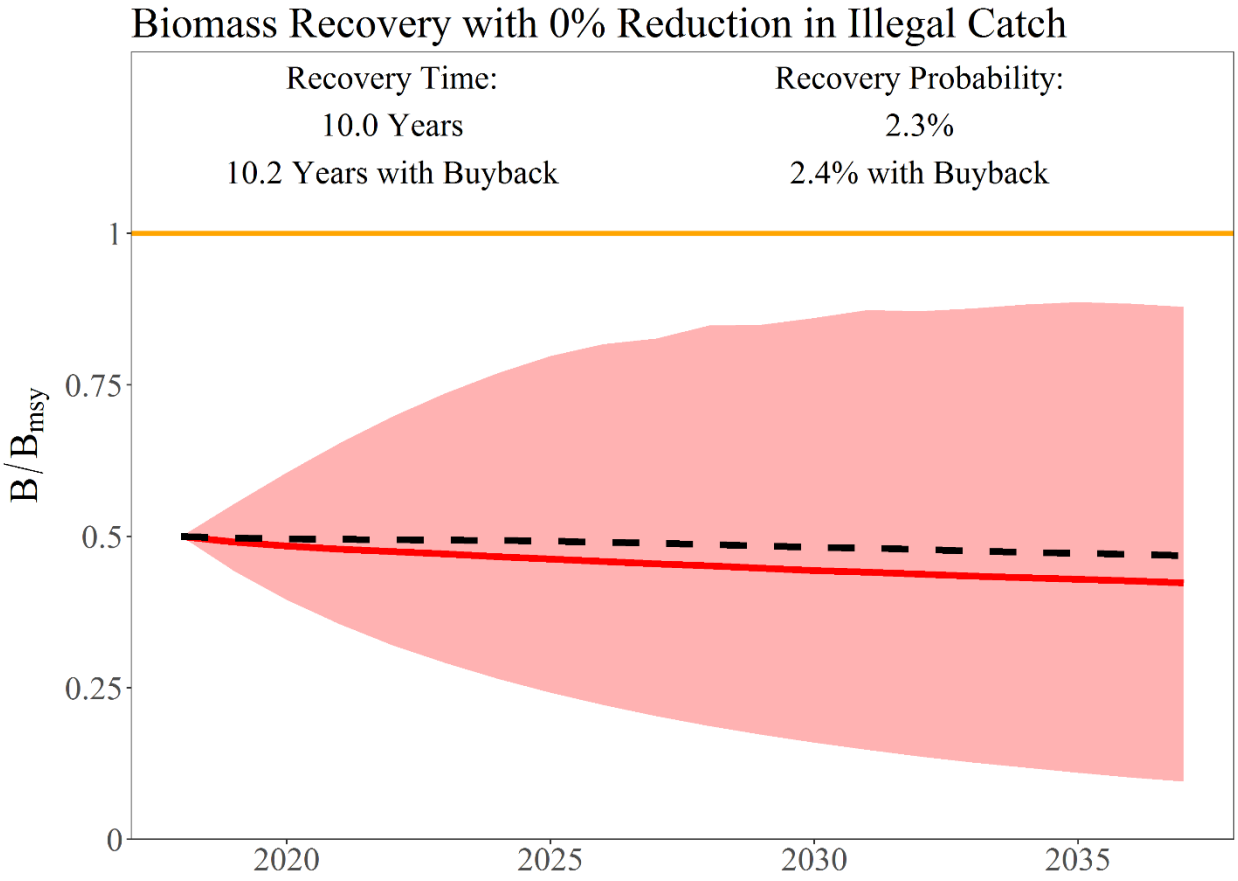

Figure 6.1: **Biomass Recovery with 0% Reduction in Illegal Catch**. Hake biomass recovery with no change in illegal catch proportion in red with 95% confidence interval bans over 20 years. Average biomass recovery with the Buyback strategy retiring 30% of artisanal quota shown as the dotted black line. Target B_{msy} shown as horizontal orange line.

Increasing enforcement increases the biomass as expected. However, the minimum level of enforcement (E=68%) needed at the geometric mean of intrinsic growth rate (r=0.346) to reach B_{msy} in twenty years only results in successful recovery approximately 50.4%. in all simulations. If recovery was achieved, on average it took 10.4 years. Integrating the Buyback increased the probability of recovery by 15% and the average level of biomass, though there

was little improvement in recovery time (10.4 years with no buyback and 10.3 years with buyback) (**Figure 6.2**).

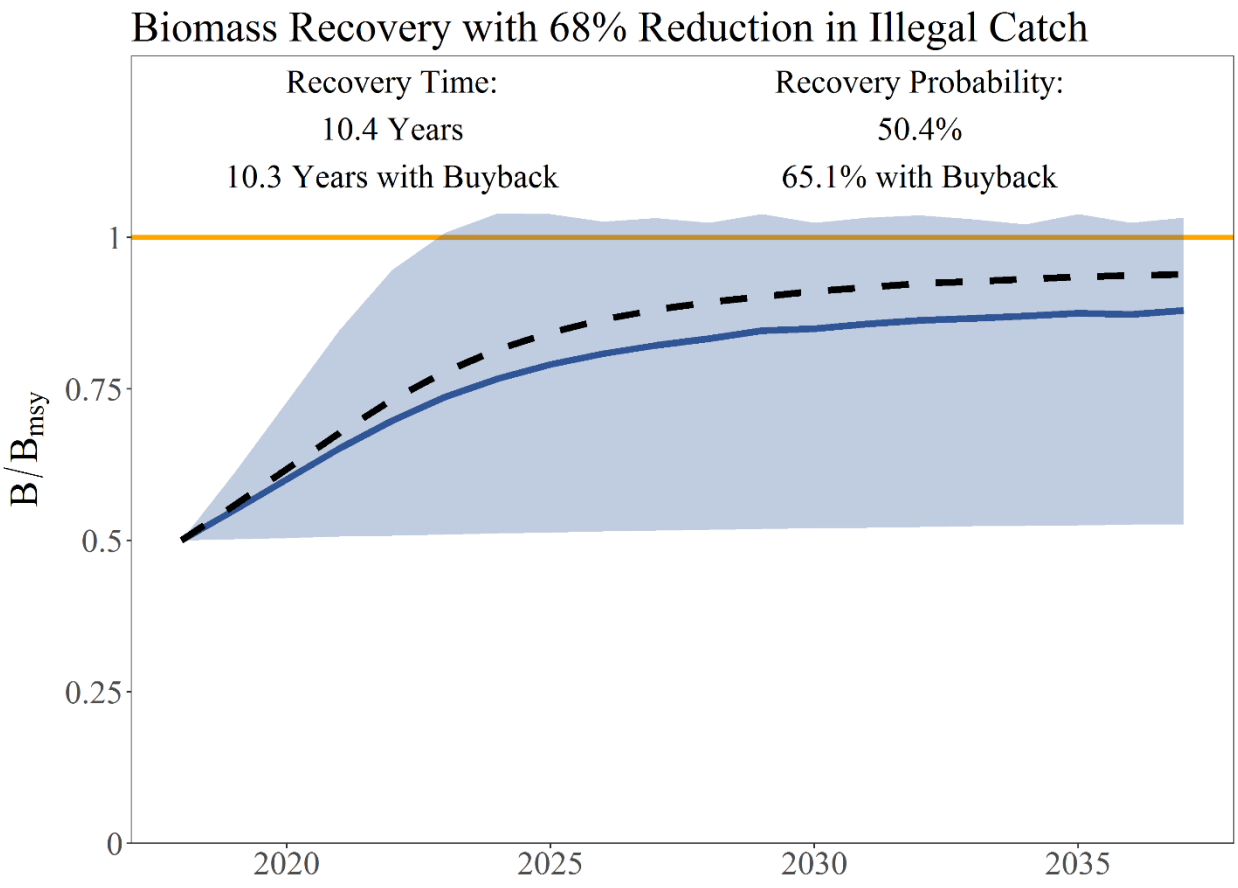

Figure 6.2: Biomass Recovery with 68% Reduction in Illegal Catch. Biomass recovery with 68% change in illegal catch proportion in blue with 95% confidence interval bans over 20 years. Average biomass recovery with the Buyback strategy retiring 30% of artisanal quota shown as the dotted black line. Target B_{msy} shown as horizontal orange line.

Eliminating illegal fishing restores the biomass with the greatest probability and shortest recovery time. Increasing enforcement by itself on average recovered the fishery in 8.6 years with 92.3% of projections achieving B_{msy}. Integrating the Buyback rose the probability of recovery to 98.0% and lowered the average time to recovery to 8.1 years (**Figure 6.3**).

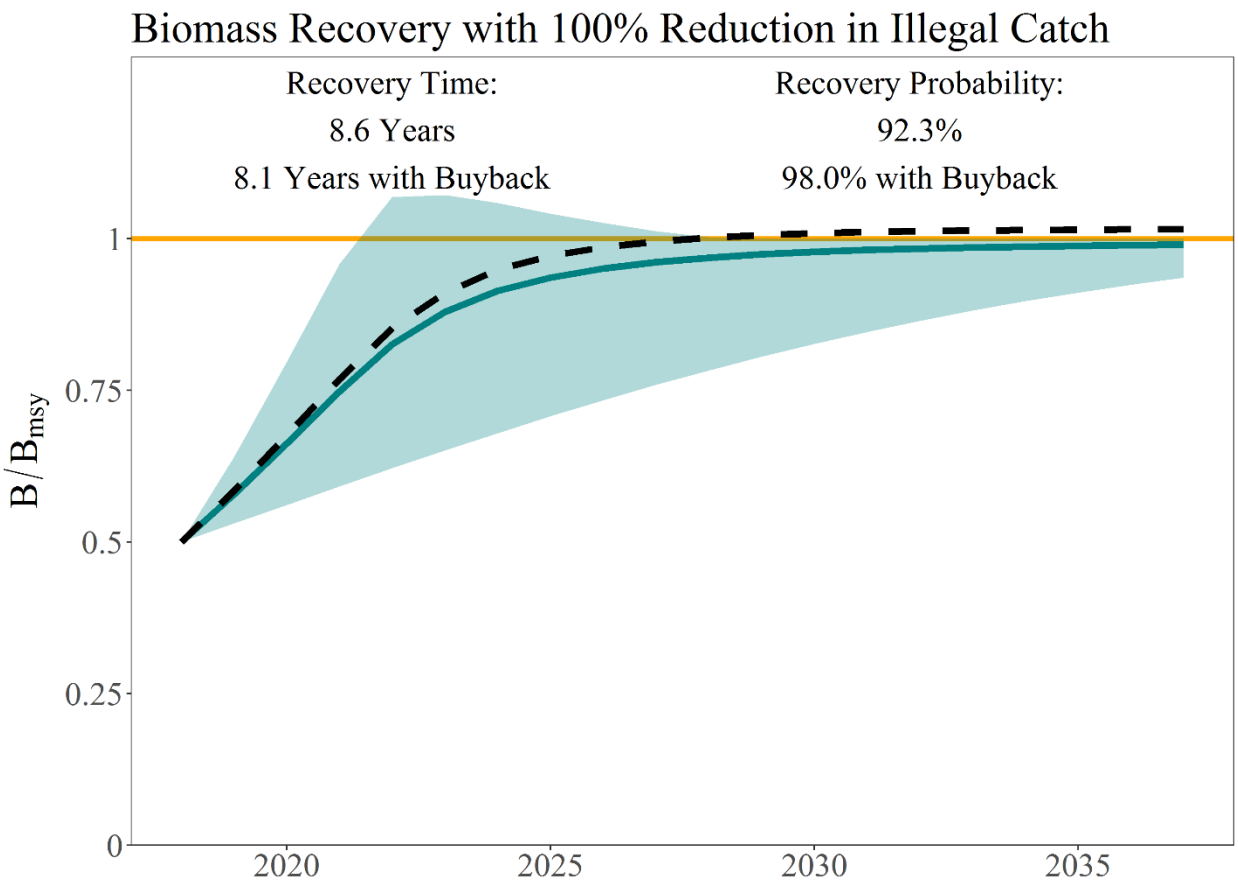

Figure 6.3: Biomass Recovery with 100% Reduction in Illegal Catch. Hake biomass recovery with 100% reduction in illegal catch proportion in green with 95% confidence interval bans over 20 years. Average biomass recovery with the Buyback strategy retiring 30% of artisanal quota shown as the dotted black line. Target B_{msy} shown as horizontal orange line.

In regard to the first metric of biomass recovery, the Buyback strategy can achieve B_{msy} so long as there is an increased enforcement presence. Without enforcement, the intervention cannot alter the dynamics of the fishery enough to grow the stock under high pressure provided the fishing mortality regime remains the same. Though with small increases in enforcement, the Buyback can increase the likelihood of reaching B_{msy} assisting the goals of the Management Plan. In conjunction with perfect enforcement, the Buyback provides the strong assurance of biomass recovery as well as reducing the time to recovery by six months. The Hake Management Plan aims to recover the stock within in 7 years. This is possible, but perfect enforcement and a large proportion of the quota must be bought from artisanal fishers. Though this would provide immediate capital injection to the fishers, it would exclude them from the fishery as it recovers. This may lead to unequitable distribution. The tradeoff of biomass recovery against fisher income is the primary reason for inclusion of the second metric.

Evaluation of Metric 2:

Illegal fishing remains a significant source of income for a small proportion of artisanal fishers. Clamping down on illegal behavior will detract from the total revenues of these fishers. Though it may be questionable to consider loss of illegal income as a concern for managers, the ignitable political tension of the fishery limits imposition of new plans. To make the interventions palatable for artisanal fishers and the government, we must find ways to mitigate the loss of income from all means. First, we examined how much the fishers' incomes change with enforcement. Increasing levels of enforcement create a loss of illegal income for artisanal fishers (**Figure 6.4**). Higher levels of enforcement lead to higher loses foregone rents of illegal fishing.

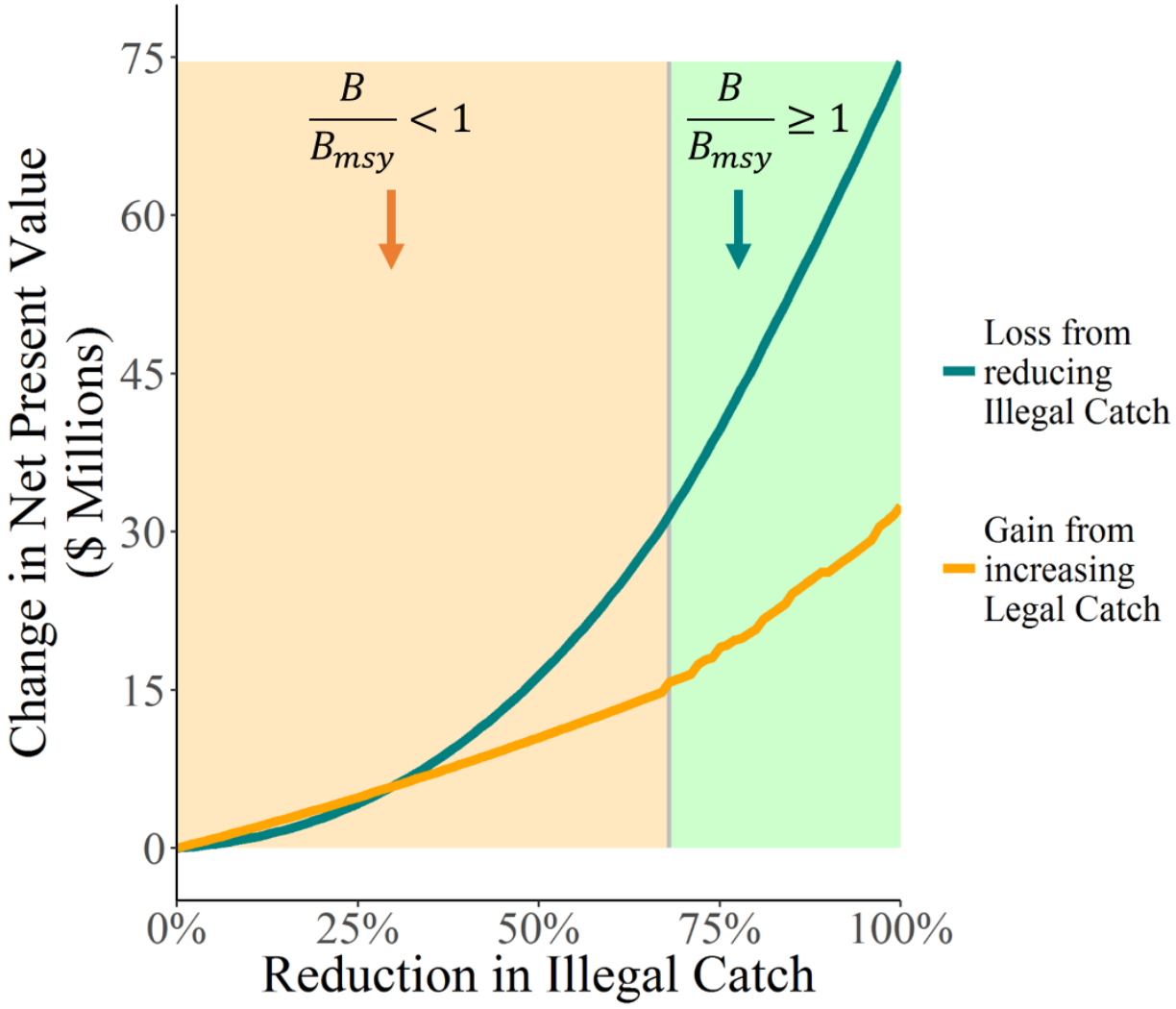

Figure 6.4: Artisanal Income Loss from Enforcement. Artisanal fishers lose income with increasing levels of enforcement (green line). Legal income improves with a healthier stock (orange line). Income over twenty years is discounted and summed to create the net present value to the artisanal fleet as a whole (discount rate =5%). Relative levels of biomass recovery at average biological parameters where 50% of simulations reach sustainable levels is shown as the shaded regions of the graph. No recovery in orange ($\frac{B}{B_{msy}}$<1) and full recovery in green ($\frac{B}{B_{msy}}$>1).

Reduction in illegal fishing will recover the stock and allow more fish to be legally harvest, but the rate of gain cannot fully compensate the loss of illegal revenue. To recover the stock, the fisher have to reduce their income by more than what they would earn in benefits. This result reinforces the race to fish mentality currently at play and is clear when catches under the status quo are compared to a fully recovered stock. The greatest sustainable harvest extraction rate with perfect enforcement (F_{msy}) for the artisanal fleet under the current legal structure at B_{msy} is lower than total catch levels under the status quo with no enforcement. A recovered stock allows the artisanal fleet to legally extract 31,374 tons of hake. High range estimates of illegal fishing are at 40,000 tons. When combined with allowed legal catch, total artisanal catch currently stands at almost 50,000 tons. Thus, we need the intervention to raise legal income to mitigate income loss as fully possible.

When the investor leases quota back to the fishers, they expand their opportunities to increase their legal catch and income. The investor must choose what price to lease back to the fishers (**Figure 6.5**)

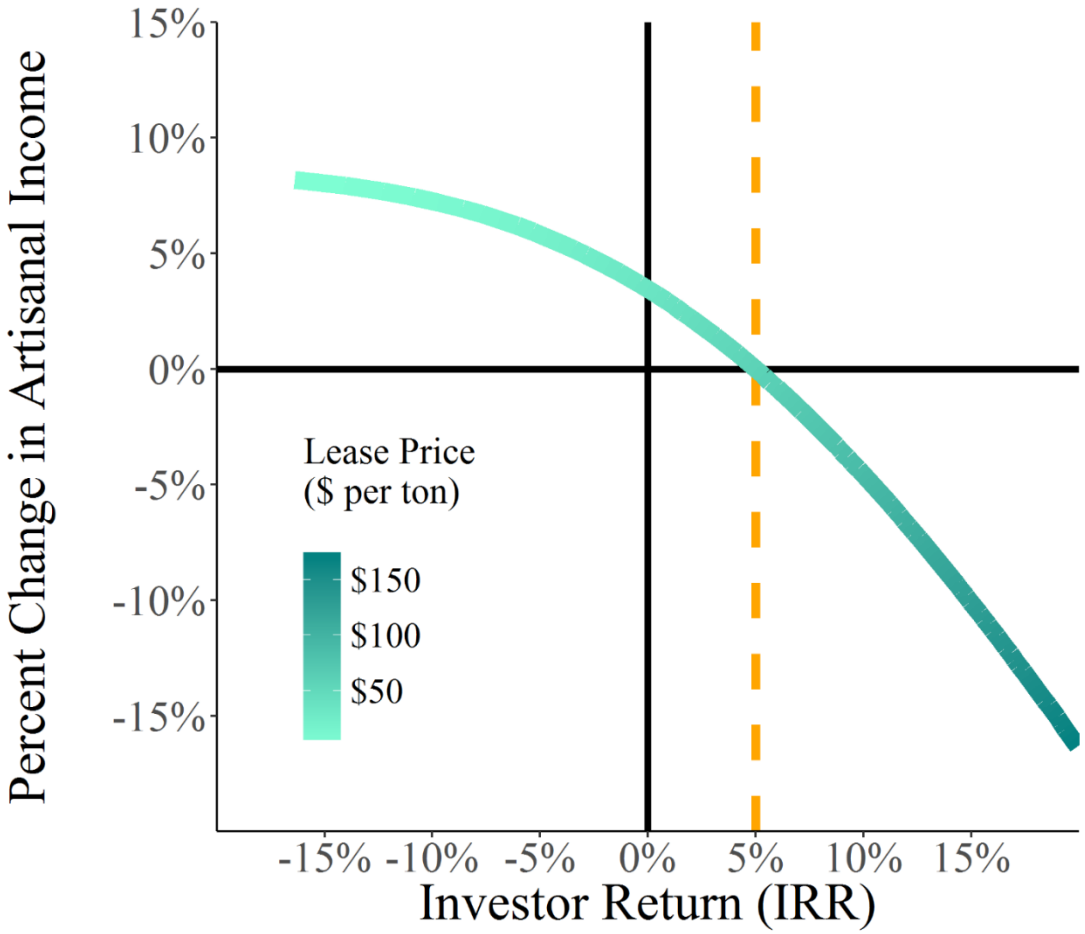

Figure 6.5: Artisanal Income vs. Investor Return. Changes in artisanal fisher's income in the y-axis against the return to the investor in the x-axis over a simulated 20 year intervention horizon. Investors purchased 30% of the initial artisanal quota and leased 100% of holdings back to the artisanal fleet as part of the Buyback and Quota Lease Intervention. Changes in lease price is the color of the line with light turquoise showing low prices and dark turquoise showing high prices.

Investor target return of 5% shown with vertical dashed orange line. Discount rate was 5% with r = 0.346, K = 906,789 tons, and an initial biomass of 226,000 tons.

6.3 *Caleta Certification*

Evaluating the performance of the Caleta certification required additional modifications to the core bioeconomic model. First, choosing to become certified needs a behavioral component lacking in the current configuration of the bioeconomic model. Fundamentally, fishers choose to exceed quota limitations based on expected profit. Enforcement level controls expected profits from illegal fishing by increasing the likelihood of getting caught or changing fine amounts (Arnason, 2013; McDonald et al., 2016). Rather than making illegal fishing proportional to enforcement level, integrating the expected benefits into fisher's behavior allows them to select the appropriate levels of illegal catch (Eq. 12). Fishers maximize profit in each period. They also

$$\max_{H_{t,f}} \pi_{t,f} = \begin{cases} pH_{t,f} - \dfrac{c_f H_{t,f}^2}{\beta_f X_t^{\alpha}}, & H_{t,f} \le Q_{t,f} \\ pH_{t,f} - \dfrac{c_f H_{t,f}^2}{\beta_f X_{t,f}^{\alpha}} - \varphi f(H_{t,f} - Q_{t,f}), & H_{t,f} > Q_{t,f} \end{cases} \tag{12}$$

behave myopically in the model, only concerned about the immediate level of biomass in their region (X_t), quota allocated to them ($Q_{t,f}$), and current levels of fines (f) and enforcement probability (φ). In this model the fishers are responsive to changes in biomass given by the α parameter; if α is equal to one, then they respond perfectly to changes in biomass. Profits in this model take on a quadratic form in order to assure convergence during optimization. Each subsequent time step takes on the equation of motion found in Eq. 1 and Eq. 2 as the logistic growth function grows the stock and a new quota for the period is allocated.

Second, aggregation of the entire artisanal fleet limits our ability to determine which caletas would choose to become certified. In its current structure, the model would have a binary selection of either the entire artisanal fleet choosing to be certified or none of it. Caletas face different incentive structures leading some to underreport more than others. The Caleta Certification model disaggregates the artisanal fleet into distinct caleta fleets split between the north and south in proportion to quota distribution. The fleet subscript f in equation 12 demonstrates this separation with each cove as specific index of f. Additionally, to account for variation in spatial distributions of the stock between the north and south, a biomass weight parameter β_t was added to proportionally change the level of biomass observed by the fleet.

Now with the fleets deconstructed to caletas, we simulate how the fishery would change with the Caleta Certification. Reported cost data are not broken down by caleta. Therefore, we created nine hypothetical caletas, three in the North and six in the South, and estimated their costs (c_f) by substituting known harvest, price, quota, and biomass data into equation 12.

Harvest data divided 2015 quota allocations evenly between the nine coves and then added illegal catch by each caleta. We distributed relative proportions between all caletas to indicate various levels of illegal fishing occur in different caletas. Total proportions equaled one to ensure all initial estimates of illegal fishing are included. Initial levels of enforcement probability were set to zero ($\varphi = 0$) for all caletas to as there no estimates of current enforcement probability in Chile though SERNAPESCA does actively enforce. This simplifies the calculation of cost parameters. In the end, all nine caletas possessed different profit functions, which respond to the inclusion of the price supplement differently.

The price supplement (p^s) raises the price paid to the fishers at the beach if they are certified and thus legally fishing, otherwise fishers receive the standard beach price (Eq. 13). Thus given the

$$\max_{H_{t,f}} \pi_{t,f} = \begin{cases} p^s H_{t,f} - \frac{c_f H_{t,f}^2}{\beta_f X_t^\alpha}, & H_{t,f} \leq Q_{t,f} \\ pH_{t,f} - \frac{c_f H_{t,f}^2}{\beta_f X_{t,f}^\alpha} - \varphi f(H_{t,f} - Q_{t,f}), & H_{t,f} > Q_{t,f} \end{cases} \quad (13)$$

stock dynamics and available biomass, each caleta chooses whether it is more profitable to become certified or fish illegally.

For this model, the investor pays the price supplement for the first five years as part of the initial level of capital needed to run the certification program. Additional capital is set aside to build the certifying agency so that it can operate during the initial investor supported timeframe. After this period, the investor withdraws paying the price supplement and the certifying agency begins charging a nominal fee (C_{cert}) to the caletas in order to maintain the certification status (Eq. 14).

$$\max_{H_{t,f}} \pi_{t,f} = \begin{cases} p^m H_{t,f} - \frac{c_f H_{t,f}^2}{\beta_f X_t^\alpha} - C_{cert} H_{t,f}, & H_{t,f} \leq Q_{t,f} \\ pH_{t,f} - \frac{c_f H_{t,f}^2}{\beta_f X_{t,f}^\alpha} - \varphi f(H_{t,f} - Q_{t,f}), & H_{t,f} > Q_{t,f} \end{cases} \quad (14)$$

A price premium (p^m) will arise in the domestic market as the imposition of the SERNAPESCA Modernization Law shifts the burden of verifying legal catch to end consumers. Knowing where the fish come from will increase demand for certified catch, though not necessarily at a level equivalent to what the investor paid in the first five year period. Investors therefore, take a loss in the first five years as they deploy the initial capital. Over time as the certifying agency makes a profit from the revenue generated by its fees and siphons off a proportion (γ) of its profits to the investor as dividends (Eq. 15). Certified legal harvest is summed for all caletas ($1,2,..F$).

$$Investor\ Return = \gamma C_{cert} \sum_{1}^{F} H_{t>5,f} - Capital - p^s \sum_{1}^{F} H_{t\leq 5,f} \quad (14)$$

Evaluation Results of Metric 1:

A single model run of the Caleta Certification intervention was run to provide a snapshot of potential performance on the metrics (**Table 6.2**). Initial input capital was $2,550,000.

Table 6.2: Input parameters for snapshot Caleta Certification Model Run.

Parameter	**Value**
r (Intrinsic growth rate)	0.346
K (Carrying capacity)	906,789 tons
P (Beach price)	$750/ton
p^s (Price Supplement)	50%
p^m (Market Price Premium)	20%
ρ (Discount rate)	$\in$ [0,0.2]
φ (Probability of receiving fine)	0.8
τ (Fine amount)	$750/ton
X_0 (Initial population)	226,697
Q_0 (Initial Quota)	25,000
$IUU_{0,1}$ (Initial IUU)	40,000 tons
Capital	$2,550,000
γ (Dividend payment)	10%
C_{cert} (Certification cost)	$375/ton
α (Fishers responsiveness)	1

Certification of all the caletas ought to have nine certifying agents and two administrative managers. If each are paid $50,000 dollars over the course of the first five years the total cost will be $2,550,000. With these inputs, the Caleta Certification improved fishery biomass (**Figure 6.6**).

Though as before with the Buyback, this may be driven more so by increasing enforcement. Regardless, the biomass reaches$\frac{B}{B_{msy}} = 1$ a year sooner with the certification process than only enforcing providing a boost to biomass recovery. Caleta Certification can achieve an improved fishery stock.

Evaluation of Metric 2:

Fishers gain significantly more legal income under the Caleta Certification intervention (**Figure 6.7**). Though the legal income is significantly more, it still does not fully recoup the loss in total income under a business as usual scenario with no enforcement and fishing illegally shown by the negative total income bar. Overall though, the certification mitigates the loss to income and would increase fishers' income by 34% more than simply enforcing thus achieving our second metric.

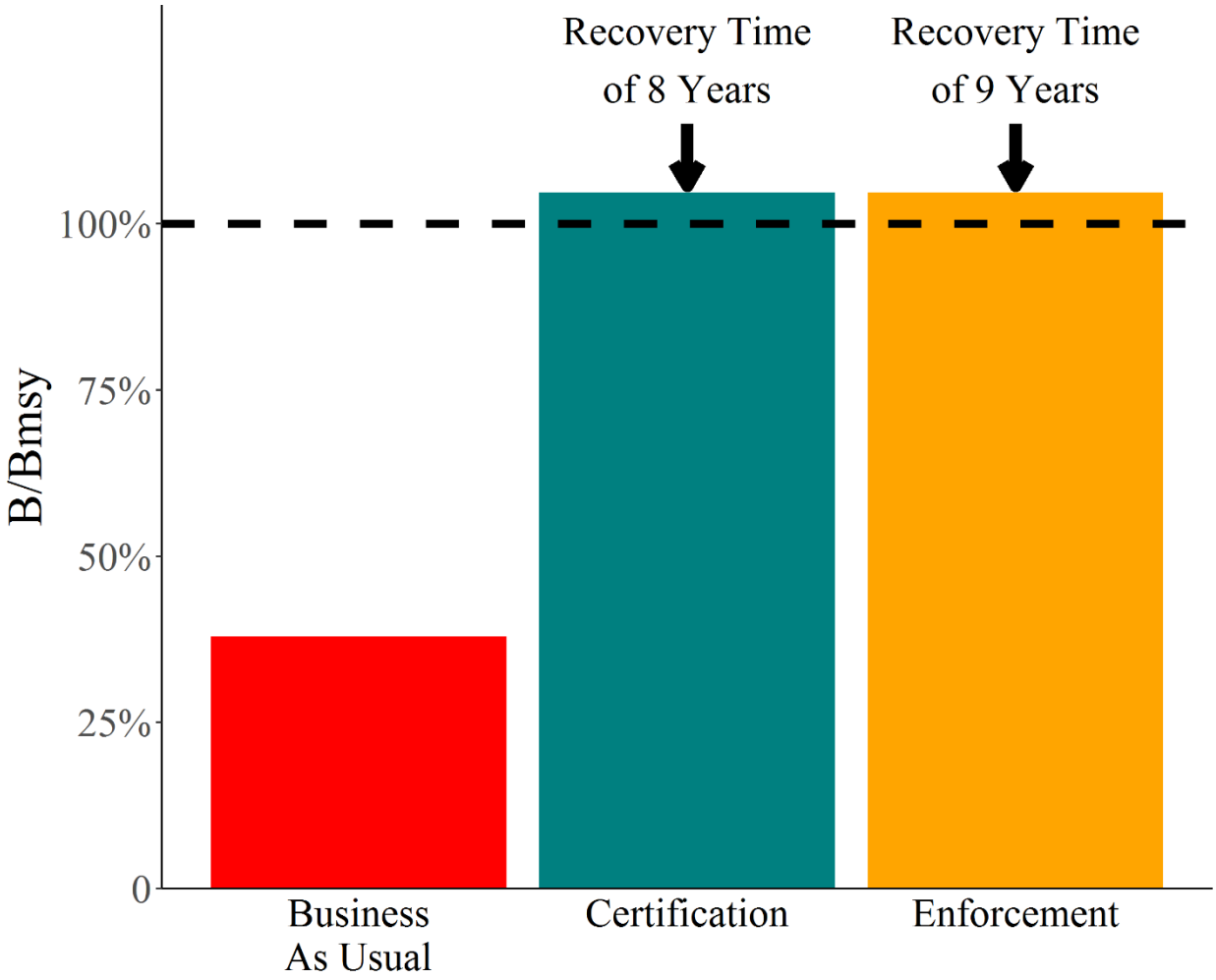

Figure 6.6: Evaluation of Biological Metric for Caleta Certification. Evaluation of the biological impact metric from the Caleta Certification model with snapshot parameters from **Table 6.1**. Output is $\frac{B}{B_{msy}}$ in the last period of the simulation for a Business as Usual scenario with no intervention (red), developing a certification program (green), and only raising enforcement levels (orange). The first year the fishery reaches $\frac{B}{B_{msy}}$ is recovery time shown above each scenario if obtained.

Though as before with the Buyback, this may be driven more so by increasing enforcement. Regardless, the biomass reaches $\frac{B}{B_{msy}} = 1$ a year sooner with the certification process than

only enforcing providing a boost to biomass recovery. Caleta Certification can achieve an improved fishery stock.

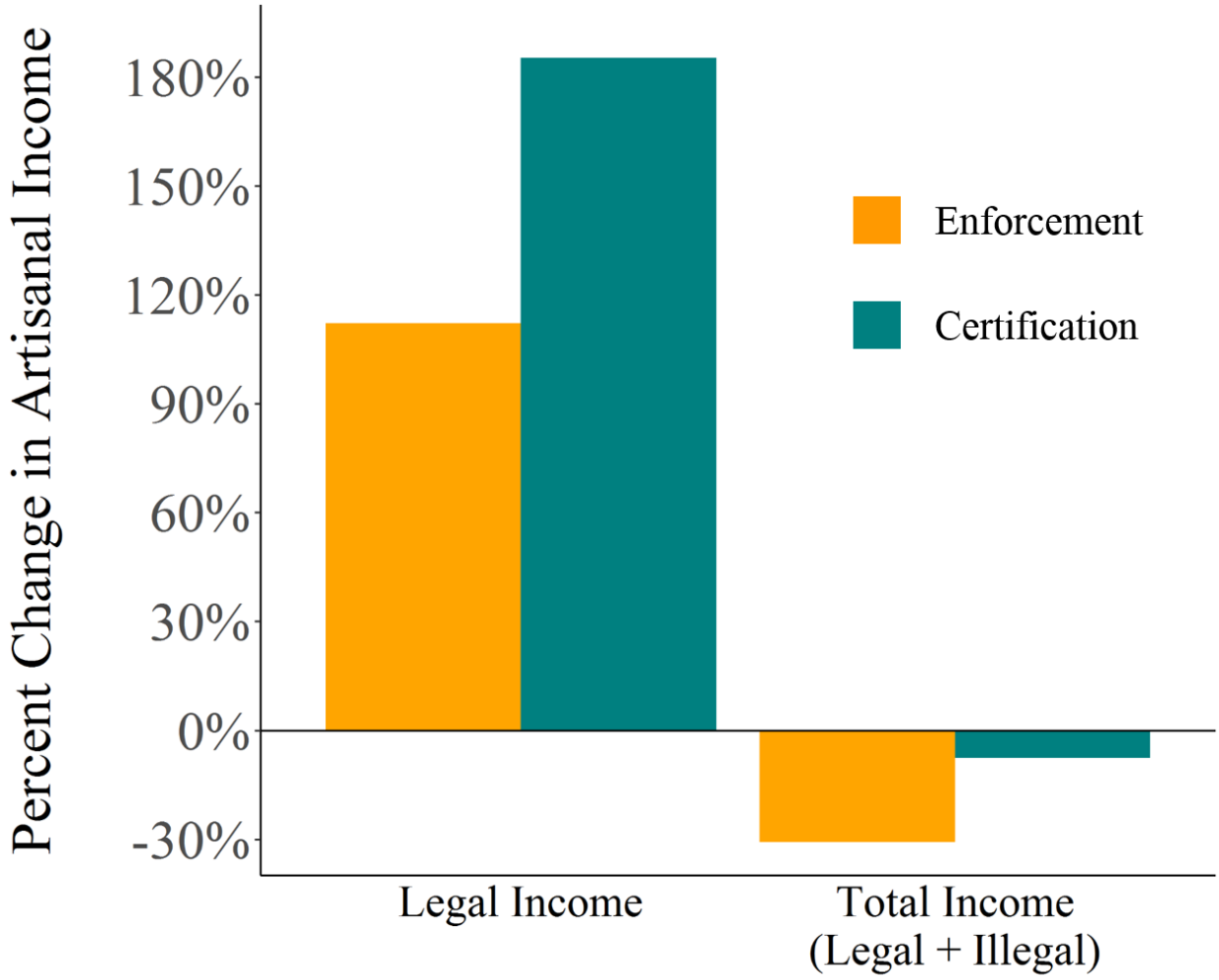

Figure 6.7: Evaluation of Socioeconomic Metric for Caleta Certification. Caleta Certification snapshot model evaluation of socioeconomic metric. Model parameters shown in **Table 6.2**. Percent Change in artisanal income relative to Business as Usual legal income and total income for certification (green) and enforcement (orange) scenarios.

Evaluation of Metric 3:

The payouts in the initial investor supplementary price drives the benefit to the fishers. Similar to the Buyback, a tradeoff arises between the investors return and fishers' income. Offering high price supplements forces the investor to earn negative returns. Internal Rate of Return for the investor in the snapshot model is -18.8%. By itself, the amount of profit the certifying agency earns is insufficient to pay a dividend that provides enough return to the investor. The overall level of cost and benefits to the investor is low when compared to the Buyback model. Both of these interventions contain elements that are not mutually excludable. For example, an investor can still buy quota from fishers who are willing to retire or do not believe the fishery will improve even if a new certification program starts. The

investor can then sell the quota to earn orders of magnitude more money they receive from the certifying agency in twenty years' time as more fishers want to enter the market at a recovered state with a healthy price premium for legally caught fish. A new model that integrates these two strategies together needs to be developed in order to validate these hypotheses.

6.4 *Sensitivity and Risk Analysis*

Model outputs are sensitive to input parameter changes. In the evaluation of the Buyback intervention, we presented preliminary analysis of the sensitivity of the biomass to changes in the intrinsic growth rate and enforcement. These same parameters also affect the income of artisanal fishers and the investor. The analysis needs to be extended to all three metrics and to other key parameters in both interventions. Discounting has significant effects on IRR and NPV. The interventions must be comprehensively tested to inform investors of potential vulnerabilities, risk, and uncertainty in the interventions before their release on the market. After gaining support from investors for the conceptual application and theoretical framework of the interventions, we will conduct a full sensitivity analysis with suitable robustness checks. Time limitations prevented a more detailed assessment.

7. Assumptions and Limitations

To develop a set of viable interventions and quantitatively evaluate their consequences, required many assumptions and contains limitations. These do not necessarily undermine the conclusions of our analysis, but they help qualify our results and point to future required research. The main limitations include the following:

1. For the recovery of the fishery as a whole, we are assuming that the stocks would be ecologically able to recover (this is, that their ecological niche has not been occupied by another species).

2. There is not a precise estimation for the amount of IUU in the fishery. Some studies have been performed (CEDEPESCA, 2016; WWF, 2017) that consider different approaches, and they do significantly overlap in the estimated ranges (from 26,000 to 45,000 tons of unreported, not including illegal). Having an accurate magnitude would change some of our results on the response of the stocks to the levels of enforcement.

3. IUU reduction for our models was considered as the percentage increase of enforcement, which is a simplification, and not necessarily a linearly direct relation.

4. As stated earlier in the report, we think that the approval of the new SERNAPESCA Modernization Law could play a very significant role in the increase of enforcement and therefore the improvement of the whole fishery. Although we believe the new law would make enforcement more viable for government officials, the sole approval of the law will not necessarily translate into an enforcement increase.

5. Although the biological parameters used for the models were based on information provided by IFOP, the information that the Institute uses each year is assessed for the specific year to come, and not for forecasting on the long term (20 years) as we have done. In other words, some of those biological parameters might have considerable errors. Sensitivity analysis would assist in pinpointing potential outcomes should parameter estimates be inaccurate.

6. For the Buyback and Quota Leasing Intervention, we conducted our analysis based on the current distribution of the stock (higher hake concentration in the VIIth and VIIIth regions). This results in a higher cost per unit catch in the north, which allows us to assume a quota trade between regions would increase efficiency. Current distribution of the hake could change during the following years (as it already did in the past, shifting from central Chile to central-southern Chile), introducing new challenges to this approach.

7. The Caleta Certification Intervention and the New Clean Fish Market Intervention rely on the development of a differentiated better market, which we think is very likely to happen if the new SERNAPESCA Modernization Law is approved and enforced (especially considering the higher risks that intermediaries, retailers, and final sellers would be facing). However, even with the passage of the SERNAPESCA Modernization Law, it is possible that the final consumer doesn't really value this differentiated market.

8. Together with an increase in enforcement, we consider that an improvement of the traceability system for the supply chain is needed for the successful creation of a differentiated better market. The current system does not seem enough for the easiness and time efficiency that we think is necessary for a) successful and easy reporting for fishers, and b) easy control and access to information through the supply chain (for enforcers).

8. Recommendation

Our analyses show that no one intervention by itself can provide positive outcomes across all metrics. This is consistent with similar findings within the ESG investment literature, that illustrate that tradeoffs exists between environmental performance and investment performance, and can be addressed if they are acknowledged via transparent metrics (Delmas and Blass, 2010).

We suggest that a combined intervention is the safest option if we are to achieve economic, social, and environmental outcomes in the hake fishery. A packaged strategy would include investment into all or components of the analyzed interventions: New Clean Fish Market, Caleta Certification, and Buyback and Quota Lease. These interventions can support and leverage each other. For example, once the New Clean Fish Market is established, it will require a steady and safe supply of legal catch. Certified caletas can meet the new fish

market's demand as buying from these caletas assures higher standards of legality and sanitary conditions. A more efficient supply chain will incentivize more fishers and caletas to achieve a certification status. Furthermore, caletas in the south that are interested in achieving better markets, can do so via the certification and if interested in increasing their catches they can do so by leasing additional quota from Northern caletas.

For all the interventions to work in Chile, there need to be significant legal changes. Currently the regulation allows only parties that have fishing activities to hold quota. If the intervention aims to create a quota holding and potentially retire some of the quota, it is important that such regulation is revised. Therefore, we recommend changes to the existing national fishing law to allow quota holding time without fishing activities, conditional upon proof of safeguards to prevent unequitable, concentrated distribution of quota.

The quota lease also requires a change in regulation that allows inter-regional trade of quota. Currently the system restricts trade within each region, allowing the quota trade between regions will help to make the fishery more responsive to future stock spatial changes. The inter-regional trade will also benefit from market transparency. Currently there is no information about quota trade within regions. There is information about the quota transactions in terms of tonnage but the transaction price is not publicly available. We recommend that this information is made publicly available to make the market more efficient.

Finally, we recommend developing a financial education system with a focus on fisher communities and the financial value of their quota. From our interactions with the fishers, it is our understanding that fishers do not see the quota as an asset that can be traded and that has a value of its own that can fluctuate according to stock dynamics. Because this very feature is essential to the functioning of the interventions, making this knowledge more widely understood should be a priority.

8.1 *Safeguards*

We are pleased to report that as of March 2018, and following our recommendations, the Industrial Association is exploring, together with EDF, the possibility to develop a New Clean Fish Market. The plan includes the development of preferential agreements with fishing communities that have in place mechanisms that ensure the legality and origin of the catch.

Although it is not the focus of this work, we recommend the future development of a minimum set of social safeguards against which to check impact investment outcomes in fisheries in Chile. Seafood social safeguards have been identified as a priority for a safe and sustainable global seafood supply (Kittinger et al., 2017). As the industry moves into developing and adopting this type of standards, it will also benefit the impact investment sector. In particular, it will benefit investors interested in fisheries recovery who are looking for more and better indicators of ESG performance

We recommend that safeguards address the following topics:

Equity: Do the investment, implementation, and, exit strategies exacerbate inequality across the fishers' communities?
Gender: Is the intervention taking account of the impact on other actors besides (mostly male) fishers? Is the intervention accounting for gender equal opportunities?
Institutions: Is the intervention helping to establish or strengthening solid institutions that can improve fisheries management? Is there a mechanism to measure or document the improvement or changes in governance?
Leadership: Is the intervention helping to cement a particular brand of leadership, is it eroding or helping to maintain local/traditional leadership roles in the communities?
Market power: Is the intervention exacerbating or helping to address inefficient market structures like oligopolies?
Labor and income: Is the intervention accounting for the potential job losses in the productive cluster e.g. processing plants, supply chain, open markets?
Final price to consumers: Is the intervention accounting for the impact in food security, particularly if the intervention leads to an abrupt cut in supply and increase in market prices.
Transparency: Is the intervention helping to create transparent mechanism across the supply chain? Are monitoring and verification carried in an efficient and timely manner? Is the intervention actively engaging in making its information publicly available?
Data for fisheries management: Does the intervention help to increase the state of knowledge about the state of the resource and provides that information to the government agencies, researchers and general public in an efficient and timely fashion?
Conflict resolution: Does the intervention considers mechanism that can help to deal and deescalate conflicts that may arise during the implementation stages? Is the intervention considering alternative resolution methods besides the judiciary?

8.2 Application to other fisheries

Impact investment has the ability to help restore the hake fishery, it can help managers and stakeholders to address funding gaps and blend with public capital to address institutional and market shortcomings. However, it and the interventions we designed will not necessarily work for all fisheries. Holmes et. al (2014) described some of the minimum requirements for investment in fisheries. Based on those, we would like to differentiate between those fisheries that are ready for private investment and others that need reform in management, institutional structure, or data collection before becoming viable investment recipients.

Fishers in fisheries with secure property rights either individually or collectively have ownership over the marine resource. The tenure can be in the form of Territorial Rights or Quota Rights, and these should be considered assets. These assets can increase if stocks recover and harvest becomes sustainable. The value of the stocks and the associated rights needs to be validated via robust monitoring and enforcement, such practices will then give assurance to external investors that the stock is healthy and increasing in value.

It is also important to highlight that these fisheries will be object of interest from private investors only if there is a business case for the transition. A solid business case for the transition from overexploited to healthy stocks is key to sustain the change in practices, but also to generate added value for the catches. For example, markets in Chile are willing to pay more for catches with solid health standards and traceability and make a good business case

for investment. Market interest should incentivize fishers to change practices, and invest in better equipment or capacitation.

Finally, fisheries that are ready to receive private capital should have investable entities. In the case of fisheries, there should be individuals or organizations that are legally established and have the capacity to conduct formal financial transactions.

These requirements disqualify most the open access fisheries from being suitable for impact investment, particularly those in developing countries where there is little governance on the fisheries, and data is almost nonexistent. For those cases, it has been proposed that government or philanthropic capital can invest in the reforms needed to attract private capital (EDF and Nicholas Institute for Environmental Policy Solutions at Duke University, 2018). Finally, stocks are biological entities and have diverse dynamics. Stocks that are intrinsically more productive will be more attractive for investment.

In conclusion, our work shows that there is strong potential for the use of impact investments to restore the hake fishery in Chile. Our models show that it is possible to generate attractive return rates and achieve environmental and social goals. Our results, also show that there are potential tradeoffs in the investment performances, but we believe that a combination of interventions can help to achieve a triple bottom line. Finally, we are confident that our findings contribute to the growing literature in the use of private capital to support fisheries restoration, a powerful tool that can help to fisheries restoration across the globe.

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A. Appendix A

A.1 Financial Landscape in Chile

Multiple institutions create favorable enabling conditions within Chile for fishery reform through finance. Chilean government bonds have been rated investment grade across all three major credit rating agencies with Moody's giving Chile an Aa3 high grade with a stable outlook (Moody's Investor Services, 2016; Trading Economics 2017). Although Chile just had its first fall in risk classification after 25 years, due to prolonged low economic growth, their assessment remains the highest rating for the region. Furthermore, the Heritage Foundation Economic Freedom Index ranked Chile as the 10th freest nation in the world particularly due to high scores in its investment freedom, trade freedom, and fiscal health measures. Economic Freedom Index scores can serve as proxy measurements for the strength of formal institutions in a nation (Nystrom 2008).

Strong, stable institutional structures make Chile a favorable recipient of foreign direct investment. In 2016, Chile attracted the third most FDI in Latin America behind Colombia and Brazil. Previously, Chile consistently ranked second in Latin America; however, the decrease of metal prices on the world market discouraged investment inflows into mining, the largest industry in Chile that receives Foreign Direct Investment (FDI) (Barcena et al. 2017). The Chilean Ministry of Finance continues to facilitate the growth of FDI through passage of a new framework for investors in 2015 and non-discriminatory treatment of multinational corporations. Foreign investments are eligible for tax breaks if they specifically support the development of local Chilean economies by sourcing materials and labor in underprivileged communities (Bureau of Economic and Business Affairs, 2016). Foreign Direct Investment has been successful both for investors and for spurring growth in Chile. Most notably within the late 1990s and early 2000s, FDI into salmon aquaculture boosted production capacity while reducing poverty levels in Region X (Floysand and Barton, 2014). Mature, robust financial markets allow the transfer of funds needed for impact investments to occur smoothly.

Financial instruments within Chile are compliant with UN Sustainable Investment Principles. According to the Equator Principles, Chile is classified as a "Designated" country. Countries on this list are "deemed to have robust environmental and social governance, legislation systems and institutional capacity designed to protect their people and the natural environment" (Equator Principles, 2017). These characteristics are indicative of a financial environment that supports impact investing.

Other encouraging signs within the fishery include the fishing syndicates, as potential investable entities who have secure tenure on the resources, as well as a system in place that administers the monitoring and catch reporting system for all fisheries. In hake, industrial fishers undergo thorough evaluations of compliance. As described above, artisanal fishers are more difficult to monitor and enforce due to the less concentrated landing points and remoteness of coves. However, the recent 2014 Management Plan, establishes the goal to increase monitoring efforts to 80% of all landings by the artisanal sector (SUBPESCA, 2016b).

A.2 Existing Public Funds

In the early stages of fisheries reform, it is possible to use public and philanthropic capital to accelerate the transition and minimize risks, thus, facilitating the access to private capital. Chile has already in place a system of public funding focused on fisheries that could be used for the previously proposed blended capital approach. These available public funds are each briefly describe below.

Fondo de Fomento para la Pesca Artesanal (FFPA) (Fund for the Development of Artisanal Fisheries)

Dependence: SERNAPESCA (Ministry of Economics, Development, and Reconstruction)
Approximate Total Annual Budget: $5,000 million CLP (Approximately $8 million USD)
Objective: The FFPA is a public body created in 1992 by the General Law on Fisheries and Aquaculture, under the Ministry of Economy, Development and Reconstruction. The Council of Development for Artisanal Fishing is a public entity responsible for administering the FFPA. The Council bases its actions on the principles of equity, transparency, and participation.
The mission of the FFPA is to "promote the sustainable development of the Chilean artisanal fishing sector and to support the efforts of legally established artisanal fisher's organizations through Chile. The Fund seeks to improve living and working conditions throughout the country. The fund co-finances projects managed by the organizations themselves" (Fondo Fomento, 2017).

The Council of the Development for Artisanal Fishing is chaired by the National Director of Fisheries and Aquaculture, and consists of up to three representatives of the artisanal fishers and their respective alternates, who personify the interests of the fishers of the country. These councilors are elected every four years by the members of legally recognized organizations of artisanal fishers. In addition, the council includes the National Director of Port Works, the Executive Director of the Fisheries Development Institute, a representative of the Ministry of Planning and Cooperation, and a representative of the Undersecretary of Fisheries.

The fund is available to all legally recognized organizations active in the artisanal fishery. Specific programs within the FFPA include infrastructure programs (pertaining to safety, sanitation, and concessions in the coves), training programs (including female entrepreneurship programs that provide working capital of $300,000 CLP, $450 USD, and training funds of $500,000 CLP, or $750 USD), and technical graduate programs in administration, business, and tourism (cost: $2.5 million CLP per individual), repopulation and cultivation programs, and programs focused on the commercialization of fishing products and administration of the production centers.

Fondo de Administración Pesquera (FAP) (Fund for Fisheries Administration)

Dependence: SUBPESCA (Ministry of Economics)
Approximate Total Annual Budget: $8,000 million CLP (approximately $13 million USD)

Objective: Promote and develop fishing activity in a sustainable way through promotional tools and social interventions that strengthen and improve the productivity and socioeconomic conditions of the fishing sector. To achieve this objective, SUBPESCA uses a territorial economic development approach (FAP, 2017). This is, an approach driven by the "interactions between the geophysical characteristics, the individual and collective initiatives of different actors, and the operation of the economic, technological, sociopolitical, cultural and environmental forces in the territory" (CEPAL).

The goal of FAP is to utilize a clear territorial development approach that allows an increase in the competitiveness and the self-sustainability of the artisanal fishing sector, while granting social and economic welfare to the fishers. The program also aims to support the industrial and processing sectors, in part by promoting the training of the workers in those sectors.

Within FAP, the Promotion and Development Unit for Artisanal Fisheries allocates resources to manage and implement development actions in the artisanal fishing sector. The Promotion and Development Unit seeks to transform the artisanal fishing sector into a focus of self-sustaining economic progress by promoting artisanal fisheries organizations and their members as central actors of growth.

The financing structure of the Fund for Fishing Administration is oriented towards territorial economic development, prioritizing a strategy of intervention that starts from the internal view towards the outside, from the organizational base in its territory towards the market. In addition to developing artisanal fisheries, FAP also has areas of development related to displaced workers, processing plant workers, crew and officials, and recreational fishing.

Programa Estratégico de Pesca Sustentable (Sustainable Fisheries Strategic Program)

Dependence: CORFO (The specific program is part of "Chile Transforms").
Approximate Total Annual Budget: Varies. See (CORFO, 2017), page 78 for details on fund for the coming years.
Objective: The Strategic Programs from CORFO seek to transform Chile through modernizing and increasing the competitiveness of key productive sectors of the national economy. Chile Transforms and its various programs aim to improve competitiveness through coordination between companies, public institutions, science, technology entities, and leaders of the community. The work focuses on identifying and proposing solutions to the problems that limit the growth and innovation of the sectors.

In particular, the Sustainable Fisheries Strategic Program aims to increase the sustainability of the value chain for the artisanal and industrial sectors, and to improve the decision-making process for the management of the resources on which they operate (PEPS, 2014). The goal is to ensure access to markets through the generation of conditions that favor the presence and quality of their products. By using better processes and products, the program aims to replace profitability from volume with profitability from added value (ChileTransforma, 2016).

The fund specifically aims to address reforms to recover overexploited or collapsed fisheries, help restore economic activities in fishing zones impacted by fishing and other human activities, address gaps in research and knowledge towards sustainability, institutional reforms, reduce the loss of external markets due to lack of sustainability innovations.

SERCOTEC (Servicio de Cooperación Técnica)

Dependence: Ministry of Economy, Development, and Tourism
Approximate Total Annual Projects Budget: 36,500 million CLP (SERCOTEC, 2016)
Objective: To improve the capabilities and opportunities of entrepreneurs and small companies to start and sustainably increase the value of their businesses while permanently assessing the impacts of the Service's actions (SERCOTEC, 2018).
Some of SERCOTEC's programs include (SERCOTEC, 2018):

- Funding for the development and/or strengthening of small businesses and entrepreneur initiatives
- Funding for promotion of products and businesses on international affairs

Fondo de Solidaridad e Inversión Social (FOSIS) (Solidarity and Social Investment Fund)

Dependence: Ministry of Social Development
Approximate Total Annual Budget for Projects: 40,000 million CLP.
Objective: Supports people in poverty or socially vulnerable conditions who seek to improve their quality of life. The Fund implements programs in three axes of action: capacity expansion, community welfare, and investment for opportunities (FOSIS, 2017).
Some referential programs are:

2. *Yo emprendo semilla.* The objective of this program is to develop business ideas, provide support through business improvement workshops, support and fund the creation of business plans, and support business plan implementation.

3. *Yo emprendo grupal autogestionado.* This program helps organizations develop a productive investment initiative in order to improve the conditions of development of their economic activity(s). It is also expected that by participating in the project, the organization and its members will strengthen their capacities, partnerships, and access to networks.

Servicio Nacional de Capacitación y Empleo (SENCE)
Dependence: Technical decentralized organism, related to government through the Ministry of Work and Social Prevision.
Approximate Total Annual Budget: No information available.
Objective: To improve the employment prospects of the most vulnerable and to contribute to the productivity of Chile by providing high quality orientation, training, and labor intermediation (SENCE, 2017).
The Service supervises the operation of the training system and disseminates information to the public and private agents that operate in the system. It also applies a tax incentive designed to encourage companies to develop training programs and administer social programs.

A.3 Future Public Funds

INDESPA: Instituto Nacional de Desarrollo Sustentable de la Pesca Artesanal y Acuicultura de Pequeña Escala (Institute for the Development of Artisanal and Small-Scale Aquaculture)
Estimated date of creation: 2019
Estimated annual budget: $25,000 million CLP (or approximately $40 million USD).

A broadly supported bill is currently being discussed in Chile for the creation of the **INDESPA**. Both FAP and FFPA would eventually belong to this institute, which will depend administratively on the Ministry of Economics. INDESPA would eventually have the tools to co-develop projects together with the private sector (something that currently neither FAP nor FFPA can do).
One of the objectives of the creation of this Institute is the coordination of resources that today depend on different administrative organisms (such as CORFO, SUBPESCA, and SERNAPESCA), the promotion of a more efficient use of resources, and the coordination of strategies.

A.4 International Development Funds

Development finance institutions, such as the World Bank, the Inter-American Development Bank (IDB), the Global Environment Facility (GEF), and Fishery Improvement Projects (FIPs) also represent potential funding sources for environmental projects. These sources of funding are often limited to governmental organizations and address climate change mitigation, biodiversity preservation, social justice, education, and community health. In Chile, GEF allocated $26 million in the 2014 STAR-6 fund raising (GEF 2017).

Eight million of the grant was part of a total package of $87.7 million with co-financing from the United Nations Development Program, International NGOs (WWF, TNC, CI, Walton Family Foundation, and Sustainable Fisheries Partnership), and the agency departments of both Chile and Peru including SUBPESCA, IFOP, and SERNAPESCA. These agencies partnered to establish a Strategic Action Plan aiming to improve management of Humboldt Current ecosystems in 2016 (Strategic Action Plan 2016). Other fisheries and biodiversity management plans have received funding in the past from these organizations, though none specifically to address Chilean Hake.

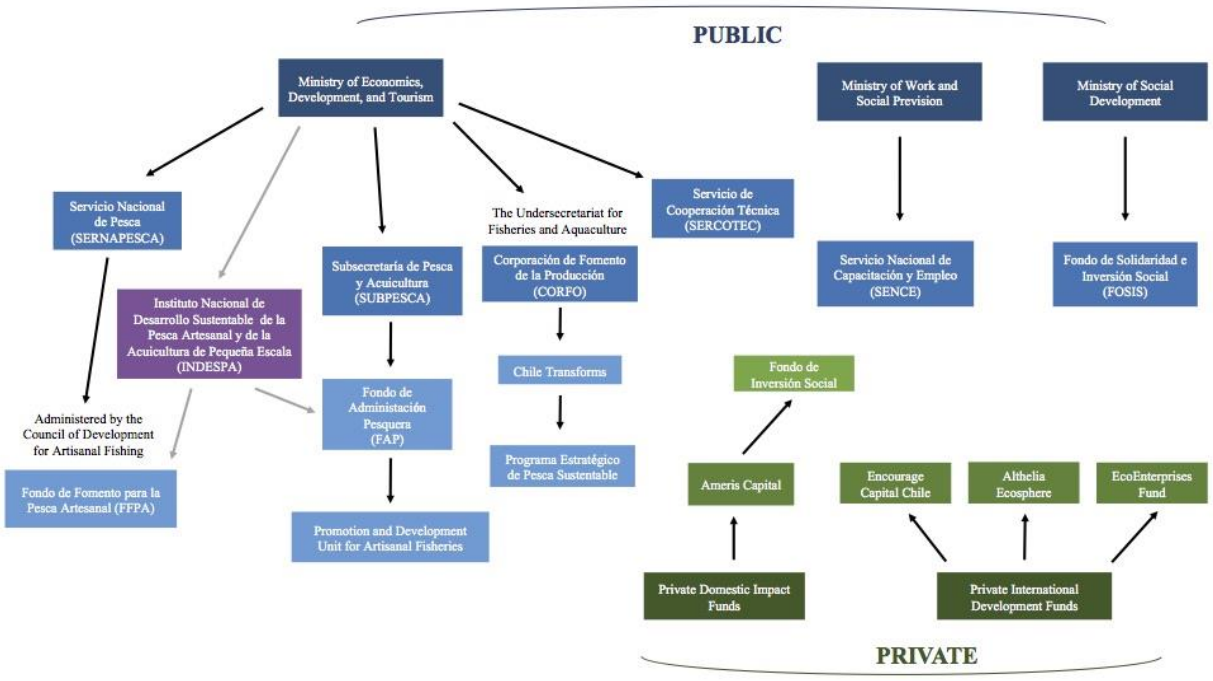

Figure A.1: **Map of Potential Investors in Chile**

B. Appendix B

Interventions Considered but Eliminated

B.1 Alternative Fishing Livelihoods

The Alternative Fisheries and Processing Intervention would assist the transition of artisanal fishers to other fisheries (i.e. jumbo squid, jaiba limon, and reineta). The funding from investors would fund the change in gear, equipment, and training necessary to facilitate a transition to a new fishery. Funding would also go towards expanding production facilities in caletas, building new processing plants near unloading zones, and supporting development of a new markets to expand demand. A summary of the intervention is outlined in **Figure B.1** below, including changes compared to the status quo indicated in pink.

This intervention would reduce IUU, address the excess of fishing capacity in the hake fishery, and would contribute to the goal of sustaining fisher income. It would reduce IUU by providing an additional means of generating income for fishers. The assumption is that some IUU occurs

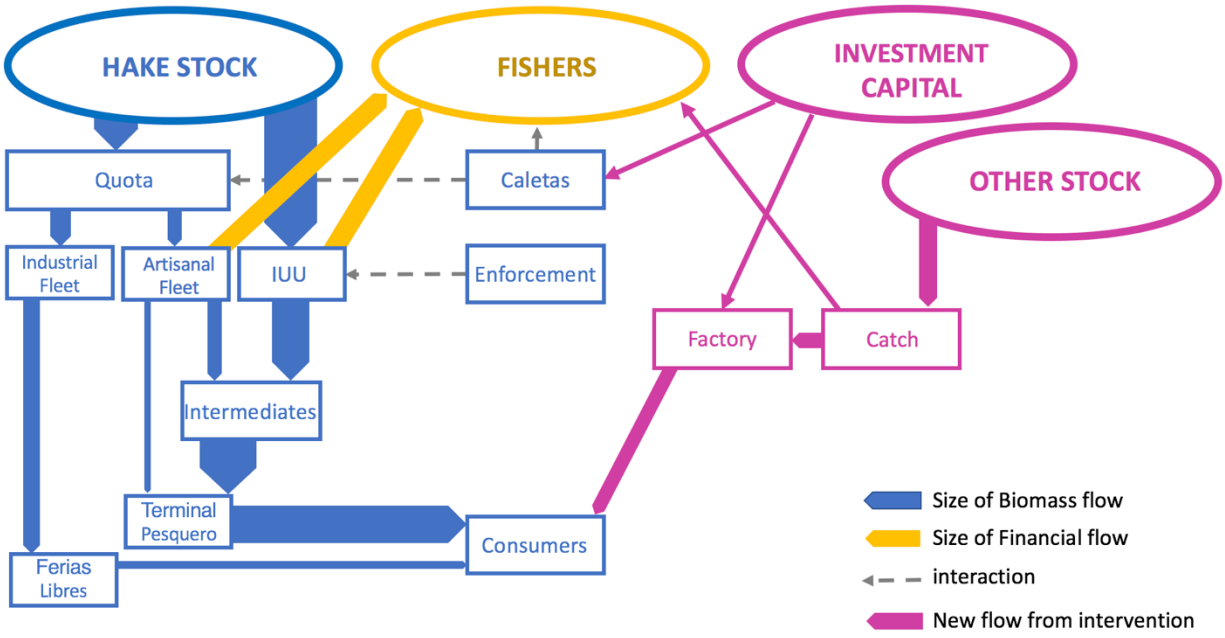

Figure B.1: Alternative Fisheries and Processing Conceptual Model. Flow and interaction system of the hake fishery in Chile based on an Alternative Fisheries and Processing Intervention. Investment capital could facilitate a change of the fishers to harvest other fisheries. The intervention received low acceptance within the local fishing communities.

because fishers cannot make ends meet by simply fishing the amount of hake allotted by the quota. Consequently, fishers fish over their quota amount in order to generate additional income and are not reporting the additional fish caught. This intervention seeks to transition fishers into a fishery that is not overexploited so that the fishers can fish the amount needed to meet their financial needs while also not negatively impacting the stock. A secondary assumption is that if fishers are provided with a means for fishing enough to sustain themselves, they will not participate in IUU.

The intervention would reduce excess fishing capacity by transitioning some fishers to an alternative fishery. This would reduce effort in the hake fishery and would relieve pressure on the hake fishery for the fishers remaining in the hake fishery. This intervention would address the issue of sustaining fishers' income by transitioning fishers to fisheries that are thriving, which would enable fishers to fish enough to meet their financial needs.

For this intervention to work there would need to be external market demand for the fish in the alternative fishery, there would need to be a management plan in place for any of the fisheries selected for hake fishers to transition into, and there would need to be fisheries that are thriving enough that transitioning fishers from hake into the other fishery wouldn’t cause the new fishery to collapse.

The financial mechanisms for this intervention include funding gear switches through microfinance and encouraging private companies to expand factory production in caletas with the assistance of equity, quasi-equity, or debt structured capital.

When this intervention was discussed during the EDF workshop in Chile, it did not receive as much support as the previous ones, and there were a couple of strong opinions against it. Stakeholders from the fishing industry felt this intervention would be logistically difficult. Other stakeholders noted that no other attractive or realistic fisheries existed that hake fishers could transition to; all other fisheries were either overexploited or had closed their registries. Concerns also arose over the lack of management plans in other fisheries (EDF 2017). Due to these concerns, this intervention was eliminated from the range of alternatives.

B.2 Closure Fund

The Closure Fund Intervention would extend the current fishery closure period to cover additional months of the peak hake spawning period. Fishers would be able to access a fund during those additional months to help them meet their financial needs. Having access to the fund would theoretically decrease the incentive to participate in IUU fishing during closure months, and therefore would facilitate stock growth. An overview of the intervention is outlined in **Figure B.2** below, depicting additions compared to the status quo in pink.

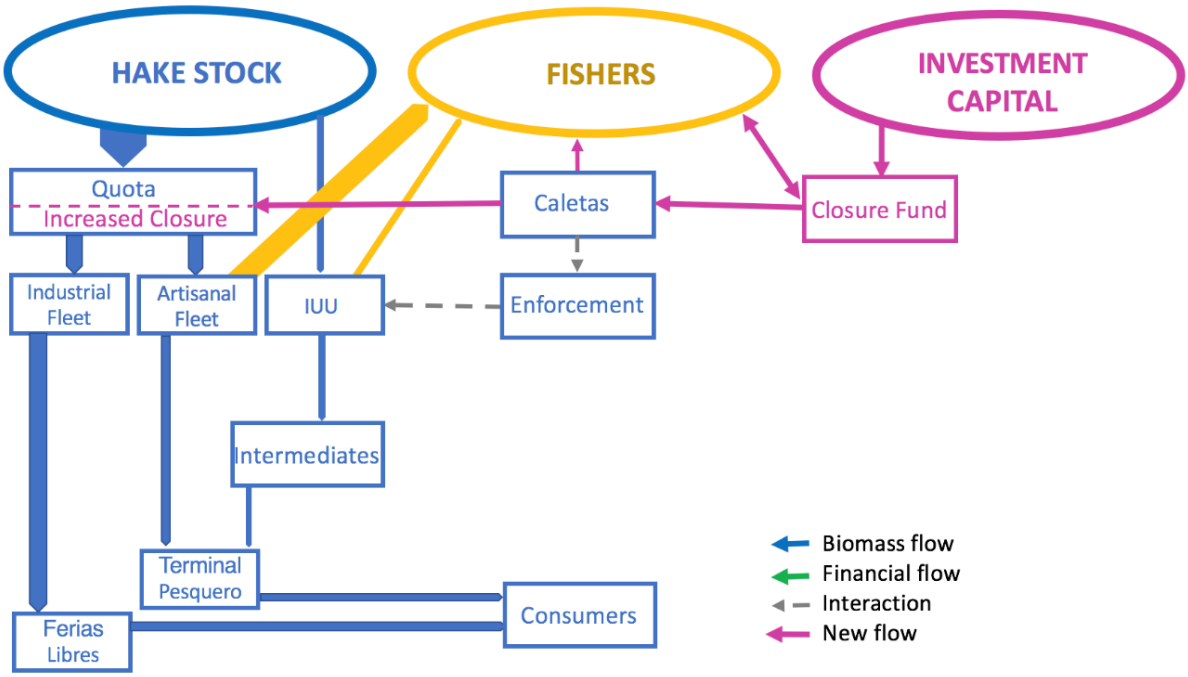

Figure B.2: Closure Fund Conceptual Model. Flow and interaction system of the hake fishery in Chile based on a Closure Fund Intervention. Investment capital could fund an extension of the closed fishing period, which results in decrease income. The intervention received low acceptance within the local fishing communities.

Extending the closure would reduce fishing effort, decrease demand during the extended closure, make targeting aggregating fish less feasible, and make IUU enforcement easier during the closure periods. By decreasing effort and demand, the intervention would contribute to an increase in biomass over time. By making enforcement easier, IUU would be decreased. By providing a financial support for fishers during the extended closure, the goal of sustaining fishers' incomes would be met.

For this intervention to be effective, many enabling conditions would need to be met. The government would need to be able to extend the closure and enforce effectively. The intervention would need to reduce rather than relocate effort. The fund would need to be seen as a replacement for the income that would have been made during fishing during the closure months, not as an additional source of income to supplement income from IUU. If this strategy were coupled with the Buyback invention so that the Buyback could be used as a financing mechanism, all the enabling conditions for the Buyback would also need to be met.

An investor interested in funding this intervention would put capital into the closure fund. A return on investment could be generated if this intervention were coupled with the Buyback. If this were to occur the investor would also use initial capital to purchase quota. As the biomass recovered, the value of the quota would grow, which would eventually enable the investor to sell the quota back at a higher price than that the price at which it was purchased. Additional funding could be used for enforcement to address IUU and increase the likelihood of closure success. If this intervention were not coupled with the Buyback, this intervention would not have a mechanism for generating a return over time.

This invention was eliminated for several reasons. First, there was a concern among stakeholders that providing a closure fund would create a perverse incentive or create subsidy dependence (EDF 2017). Stakeholders were also concerned that if funding were offered during closures in the hake fishery, other fishers would want funds for temporal closures in other fisheries, which would be undesirable.

Concerns also arose over the timeline for this intervention. Would fishers expect compensation indefinitely? How would this be financially sustainable? Additionally, the true impact of this intervention would come through better enforcement, which would be the main driver of behavior change and reduced IUU. The presence of the fund is secondary to increased enforcement and increased enforcement could be achieved independent of the fund. Lastly, stakeholders were concerned that this intervention would merely relocate and not reduce effort, and therefore would have no impact on biomass or incomes over time.

Due to the many concerns about the effectiveness of this intervention, this intervention was eliminated from the list of possible interventions.

B.3 Supporting Interventions

The following interventions were proposed and assessed during late 2017. Although these interventions could help mitigate some of the problems identified in the fishery, we have categorized these interventions as secondary, or supporting interventions due to the magnitude of the intervention's anticipated impact, the inability of the interventions to generate a return on investment and therefore be attractive for impact investors, or the inability of the intervention to stand on its own.

While these secondary interventions cannot stand alone, they could be coupled with the primary interventions to support the recovery of the fishery and mitigate the economic impact of an eventual increased enforcement scenario on the fishers.

Price Sharing Platform

For this intervention an investor or NGO would develop an easy-access, public information platform through which fishers could share information about fish sale price throughout the value chain. This could be done using a currently existing social platforms (such as Facebook), or a specific website/electronic platform created for this purpose.

Creating and popularizing a platform like this would improve and strengthen the fishers' negotiation power. As mentioned previously, fishers are price takers and there is little to no cooperation or information sharing between the caletas. This situation gives the intermediaries disproportionate control over the information and therefore negotiation power.

For this intervention to be successful, collaboration and consistency in providing information among the caletas would be necessary.

One of the advantages of this intervention is that it could be easily and cost-effectively implemented. It could be easily coupled with the Caleta Certification and New Clean Fish Market interventions to increase the ability of those interventions to sustain fishers' income.

Traceability

For this intervention an investor or NGO would devlop a high-end, easy-to-use technological tool that would provide traceability information that could create a differentiated market for hake.

SERNAPESCA currently has an existing web platform for reporting catch, but it relies heavily on the willingness of fishers to self-report online or through SERNAPESCA’s regional offices. Whether due to lack of will or lack of knowledge, this web platform does not seem to be broadly used by fishers in the country. Additionally, the current tool does not seem to provide information on dates of fishing, cold chain, or stage in the supply chain.

A new technological tool could, for example, generate a traceable QR code (bar code, or equivalent) easily traceable by enforcement officials during the different stages of the supply chain. Every box of hake coming from the beach could have its own bar code (provided on site either by SERNAPESCA officials or civil enforcers in a Certified Caleta) and as the box of hake moved through the supply chain it could accumulate information about traceability. This would allow individuals at the final point of sale, for example at the New Clean Fish Market, to have access to a complete record of traceability for the fish they were purchasing. Our group decided not to pursue this intervention because Future of Fish is working to develop such a tool and technology development is out of our area of expertise. However, were a traceability platform developed, such a platform could be coupled with either our Caleta Certification or New Clean Fish Market interventions to collect traceability information and increase efficiency.

Cold Storage

The intervention consists of an increase in cold storage infrastructure in some of the caletas. This would aim to increase the control fishers would have over setting the price of their fish and could be especially useful in cases in which the prices offered by intermediaries are too low (for example, down to $5,000 clp for a box of 27kg). In addition to increasing fisher negotiation power, building cold storage infrastructure could also provide better sanitary conditions.

During our field visits, we observed that this infrastructure already exists in some caletas, but does not seem to be extensively used. We were not able to determine why this was from our field visits and casual conversations with stakeholders. During our December workshop in Valaparais, we did not see strong stakeholder support for this intervention.

Enforcement Fund

During the early stages of our intervention development process, we considered the creation of a fund to finance additional enforcement. Increased enforcement would improve the state of the fishery, which would increase its value as a whole. Funding increased enforcement could be an opportunity to both improve the state of the fishery and to capture some of that increased value, and return it to investors.

The idea was discarded after we realized that the main reason for the existing lack of enforcement is the lack of political willingness to enforce, as opposed to a shortage of public resources to fund enforcement activities.

C. Appendix C

C.1 EDF Workshop in Chile for Scrutinizing the Interventions

After identifying the main underlying problems, we designed interventions to positively restructure the fishery by correcting the problems at the identified leverage points. The interventions were developed from July to November 2017. The Merluccius Group held a workshop specifically aimed towards this task on October 20 at the Bren School of Environmental Science & Management. External project advisors, EDF, and Future of Fish all participated in this meeting. During the course of the workshop, an agreement was reached among the parties on an initial proposal of five main intervention strategies and four supporting secondary strategies (Described in detail in **Section 5.2** and **Appendix B**).

As a final stage for this process, the initial set of strategies was presented in Valparaiso, Chile to stakeholders throughout the fishery on December 18, 2017. The goals of the workshop organized by EDF were to validate our assumptions, gauge stakeholder interest, and obtain feedback from the broad perspectives of the gathered representatives. Representatives from the following sectors and organizations participated in the workshop: SERNAPESCA (National Fishing Service), SUBPESCA (Undersecretary of Fishing), artisanal fishers (mainly from the Vth region), SONAPESCA (Industrial Fishing Association), fish processing sector (mainly from the VIIIth region), Future of Fish, OCEANA, WWF, the Walton Family Foundation, and the Federico Santa Maria University.

The Merluccius Project group members presented the five main intervention strategies, and four supporting strategies. The presentation of each intervention focused on explaining the strategy and the problems that each might be able to address. We also explained the necessary regulatory enabling conditions for each of them to take place, and the limitations and unknowns.
Following that presentation, the participants of the workshop were divided into different groups of similar stakeholders. In each of the groups, either a representatives of the Merluccius Group or EDF moderated the discussions, soliciting feedback on the strengths and weakness of each intervention. The Merluccius Group and EDF compared the strategies that received the most widespread support (**Figure C.1**). This process led to the final selection of three main intervention strategies.

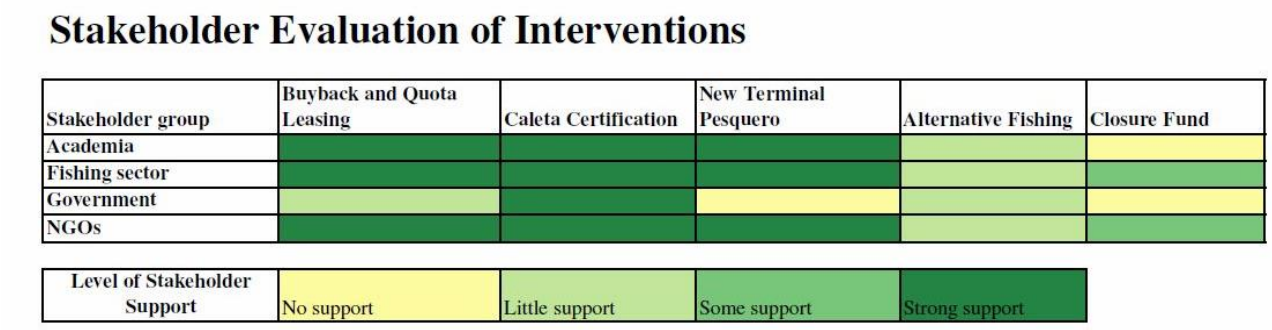

Figure C.1: Stakeholder evaluation of interventions from December 2017 workshop in Chile. The most positive feedback is indicated by dark green. Lighter colors represent increasingly less enthusiastic responses. Yellow represents the most negative feedback and indicates stakeholders felt the idea was both unrealistic and/or fundamentally flawed. Note that the New Clean Fish Market here is referred to as the New Terminal Pesquero.

The three strategies selected are examined in depth in **Section 5.2.**. The strategies that were considered but eliminated are described in **Appendix B**, Interventions Considered but Eliminated. Together these intervention designs demonstrate the first set of results of this project.