



**Un Estudio de la Viabilidad de Acuicultura de Moluscas en La
Region Bío Bío
Estudio de Caso: Bahía de Coliumo, Dichato, Chile**

**Feasibility of Shellfish Aquaculture in the Bío Bío Region
Case Study: Coliumo Bay, Dichato, Chile**

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Executive Summary

Shellfish aquaculture presents a number of opportunities for Dichato and the Bío Bío Region, helping to address a number of economic needs exacerbated by the 2010 27F earthquake and tsunami, meeting a rising demand for seafood from a booming tourism industry and alleviate the impact of the declining fishing industry. The purpose of this report is to identify the challenges to expanding shellfish aquaculture in Coliumo Bay and to recommend solutions for stakeholders. While previous Universidad de Concepción (UdeC) studies determined that shellfish aquaculture is environmentally feasible in Coliumo Bay and there is regional demand for shellfish, challenges exist in the regulations, funding, and implementation of aquaculture. These obstacles make it challenging for potential entrepreneurs to begin an aquaculture enterprise.

Regulations: The main regulatory obstacle is the length of time necessary to receive a permit. To begin an aquaculture farm, potential aquaculture farmers need to either apply to the Servicio Nacional de Pesca (Sernapesca) for a concession area, or work with one of the local fishing syndicates to farm in their management area. After obtaining a concession or management area, potential aquaculture farmers must conduct an environmental impact assessment. To shorten the process, the fishing syndicates should identify sections of the management area well suited for shellfish aquaculture. Potential aquaculture farmers should work with existing concession holders to rent space. These two actions will incentivize aquaculture farming. In the long term, Sernapesca should work to shorten and simplify the permitting process.

Funding: Aquaculture has high start-up costs, yet it is difficult to receive government funding and nearly impossible to receive a bank loan. On the other hand, discussions with funding agency officials revealed that they were not receiving applications for aquaculture projects. To bridge this gap, the funding agencies should reach out to fishing communities to promote awareness of their programs. Additionally, the municipality should take the lead in helping potential aquaculture farmers navigate both the funding and regulatory process.

Implementation: Aquaculture farmers must understand and, when possible, mitigate the risks of building and maintaining an aquaculture farm. These risks include weather, theft, and high operating costs. Potential aquaculture farmers must understand these risks and develop business plans accordingly. UdeC should partner with aquaculture farmers to establish and fund a hatchery. UdeC should also create a practical aquaculture course program for knowledge transfer and information exchange.

In addition to these recommendations, Dichato can support its tourist and aquaculture industry with a targeted branding campaign. As one of the few towns in the region growing shellfish, Dichato should promote this fact at local restaurants. By linking tourism and aquaculture, the town can increase the number of tourists as well as the local demand for shellfish.

In summary, shellfish aquaculture presents new opportunities for Dichato, but the issues outlined in the following report must be addressed. This paper describes both short and long term recommendations that stakeholders can implement. If the town mitigates these barriers to success, aquaculture can help Dichato diversify and grow its economy.

Introduction

The following is a feasibility study of implementing small-scale shellfish aquaculture projects in the town of Dichato on Coliumo Bay in the Bío Bío Region of Chile. This report presents an analysis of the opportunities that the industry offers for the region as well as an analysis of the challenges and gaps in regulatory, financial and other relevant systems that affect entrepreneurs' ability to enter into and succeed in the market.

Artisanal shellfish aquaculture presents an opportunity to diversify Dichato's economy beyond tourism and wild-harvest fishing, the two industries on which it currently relies. A growing tourist industry is increasing demand for seafood, which the traditional fishing industry is unable to meet due to overfishing of wild stocks. Beyond filling the demand for local fresh seafood, there are numerous opportunities for developing integrated aquaculture and tourism enterprises to provide an additional boost to the current tourism base. This will establish a unique brand for the town and draw more tourists throughout the year. Fishermen recognize the need to diversify their income; entrepreneurs see the potential to integrate tourism and aquaculture in the future. Local government officials showed an increasing recognition of the potential benefits of aquaculture, and many are beginning to think about how they can support the industry.

At present, there is one successful aquaculture project underway in Coliumo bay. Others have had some success in the past, though due to mismanagement or natural disasters, they are no longer in operation. These experiences prove that aquaculture is feasible in the region. However, despite some small successes in the past and the many potential benefits of a successful project, few people are currently entering the market.

Complex marine and fishing regulations and the lengthy process of identifying suitable available space and getting permits are often cited as major hurdles by people who might otherwise consider establishing aquaculture projects. Lack of funding, or awareness about funding that meets the needs of aquaculture projects, is a common concern. In addition, disconnects between the timelines of permitting and funding agencies, and the long time horizon for return on investments in aquaculture present high barriers to entry. Limited technical knowledge and business skills were also commonly cited limitations.

This report includes recommendations for key stakeholders to address these challenges in order to reduce the barriers to entry and promote success in aquaculture (For a full SWOT Analysis, see Appendix I). The scope of this study is limited to artisanal¹ shellfish aquaculture in Dichato and the Bío Bío Region because artisanal fishing is the historic backbone of the community, and there is limited space for larger scale projects. Community members noted that efforts to promote the industry should include an eye toward protecting small-scale farmers from the threat of competition from conglomerates, which is something that has given commercial aquaculture (e.g. salmon aquaculture) a bad reputation in Chile.

Methods

We relied heavily on primary research for this project and worked to collect as much information from as many perspectives as possible in the course of two weeks. The town of Dichato was used as a case study for aquaculture in the region. Research included fieldwork, formal

¹ In Chile, "artisanal" simply means "small-scale".

meetings, informal conversations and interviews, and a final community meeting where key findings and recommendations were presented and discussed.

The team lived in Dichato to be fully immersed in the community. Travel to nearby towns and ports helped the team gain an understanding of the greater Coliumo Bay and Bío Bío Region. See Appendix II for full list of meetings and interviews.

This work was directed by Recupera Chile, a program addressing “a range of issues including technical assistance, livelihood restoration, capacity building, community mental health, early childhood education, cultural heritage restoration, and infrastructure reconstruction based in the three communities of Cobquecura, Dichato and Perales, near the epicenter of the 2010 earthquake and tsunami in southern Chile.”²

1. Field visits included:

- a. Visits to a number of regional fishing ports, beaches, towns, and fish markets.
- b. Visits to two existing aquaculture projects:
 - i. Jessica Cabrera Torres’ project in the Coliumo Bay across from Dichato is a 2-longline project cultivating mussels and oysters. See Appendix III for more information on Jessica’s project.
 - ii. The second project, run by a group of 40 fishermen with the help of Jessica, is located approximately 90km south of Dichato in the town of Laraquete. See Appendix IV for more information on the Laraquete project.

2. Meetings, Presentations and Interviews conducted:

- a. Researchers from Universidad de Concepción (UdeC), a partner of Recupera Chile, educated us on the local marine environment, the suitability of cultivating a variety of shellfish, and the advantages and disadvantages of aquaculture.
- b. Representatives from the Municipalidad de Tomé, Regional office of Sernapesca, and a number of other offices gave an overview of the national fisheries service and some of the regulations and avenues for technical and financial support related to aquaculture.
- c. Representatives from local fishing syndicates, neighborhood groups, the chamber of commerce, tourism promotion board, women in restaurants and markets, and fishermen landing at the port and selling at the fish market.

3. Final Presentation and Discussion:

- a. A presentation of key findings and recommendations was followed by a lively and productive discussion with stakeholders, which yielded additional information that has been incorporated into this report.

In addition to primary research, we consulted secondary sources to learn about aquaculture and fisheries on a national and global scale, and to further understand the technical and regulatory aspects of aquaculture. We relied more on qualitative information than quantitative data, as hard economic or demographic data about the region were generally not available.

With limited time, we were unable to identify and interview all potential stakeholders within the community. Although we made every effort to verify the information we gained in interviews, some information was difficult to confirm. In these instances, the information is presented as an opinion or estimation in this report.

²Recupera Chile: <http://www.recuperachile.cl/>

Dichato Economic Overview

Dichato is a small coastal town in the Bío Bío Region of Chile with a population of approximately 4,000. Located in the municipality of Tomé, Dichato is one of 18 communities that was hardest hit by the earthquake and tsunami on February 27, 2010 (known as “27F”). Reconstruction costs after the earthquake and tsunami in the country were approximately USD 30 billion which is 18% of Chile’s gross national product.³

Almost four years after the tsunami, more than USD 85 million has been spent on public infrastructure projects in Dichato. Although most homes have been rebuilt and the major public infrastructure projects are nearing completion, many small construction projects and renovations are still underway throughout the town.

Like many coastal towns, Dichato’s economy is heavily reliant on fishing and seasonal tourism. After the tsunami, Dichato’s tourism industry has expanded, with tourists now coming from farther away and more often in the non-peak season, attributed in part to the paving of the road from Tomé and Concepción. The earthquake and tsunami brought greater notoriety to the area and Servicio Nacional de Turismo (Sernatur) has made a concerted effort to build the reputation of Dichato as a tourist destination. Businesses have sprung up quickly during the recovery, partly due to increased funding in the area.

The population in the city swells from 4,000 to as many as 12,000 in the summer months from December to March, due to the influx of tourists. As a result, businesses hire workers from neighboring cities, such as Tomé, to meet the demand. The winter months between June and August are low tourist seasons. Most residents rely on their income from the summer for the remainder of the year. Numeric data on the size of the economy and market are difficult to obtain, but Chamber of Commerce staff estimated consumption in the summer months between Chilean Pesos (CLP) 1.4 - 2 billion per month; consumption level falls by 50% during winter months.

The seasonality in consumption and employment levels is similar for the fishing economy. However, over-fishing has led to a significant decrease in fish stocks local and nationally; over the course of two decades jack mackerel catch in the country has fallen by 94%.⁴ According to reports, major fisheries in Chile could not even reach the quotas set for them by the government in 2013.⁵ All of the fishermen we interviewed in Coliumo Bay area spoke of the crisis of over-fishing, noting that they now need to travel farther to find fish and work longer months to make ends meet. This generation of fishermen in the bay area has seen fish stocks decline by 70-80%.

Some fishing occurs in the off-season, but many fishermen migrate to other cities to look for other employment. Fishermen supplement their earnings from fishing by working in tourism, construction and other service sectors. Pre-tax wage levels in the town are estimated to be in the range of CLP 220,000 to CLP 450,000 per month.⁶

³ Ministry of Housing and Urban Development, Government of Chile. Aug 2010. MINVU Reconstruction Plan: p.7

⁴“Fishing in Chile: Net profits.” *The Economist* 11 Aug 2012. Web. 16 Jan 2014.

⁵ Interview with Dr. Eduardo Tarifeño Silva from Universidad de Concepción

“Camanchaca: Capturas pesqueras del año pasado fueron un 4,4% inferior a las cuotas anunciadas para 2014” *Aqua* 13 Jan 2014. Web. 16 Jan 2014

⁶ Estimates from Chamber of Commerce interview with one representative – they do not have actual economic data.

Given that Dichato's seafood is an important part of the tourist experience, any growth in tourism will see demand in seafood rise as well. Implementation of aquaculture projects will not only help meet this increasing demand but it will also provide job opportunities and help diversify the tourism industry. Additionally, it will help address the severe impact overfishing has had on the region.

Dichato Community Overview

There are a number of community groups in the Coliumo Bay area that form the basis of organization for economic and social activities. Given the span of the area and the time constraint for this project, we do not consider this a comprehensive list. That said, the stakeholders in these groups are a natural starting point for identifying stakeholders for potential aquaculture projects. However, it is important that individuals and groups self-select for aquaculture projects to increase buy-in and ensure motivation.

Many of our interviews pointed to a disconnect between community members who feel that they do not get enough support from the government, or would be more entrepreneurial if they had access to financial resources, and community leaders and the government who believe that financial resources are under-utilized. There was also a division between men and women in the community, with groups being organized by gender. It is clear that gender dynamics play a significant role in the community. However, an in-depth analysis is beyond the scope of this project. Despite women being under-represented in fishing, there are a number of informal women's groups that appear motivated to find economic development opportunities, which many include aquaculture projects (For additional information obtained through interviews, see Appendix VI).

Universidad de Concepción

A key player in supporting the development of aquaculture in Dichato and the region is La Universidad de Concepción (UdeC), one of the leading universities in the country. UdeC has been involved in many aspects of the region's redevelopment post-tsunami, providing support in healthcare, education, tourism, fishing, and other areas. The University is also a leading partner of Recupera Chile. UdeC had a shellfish hatchery (for more information, see section on Aquaculture Operations) in Dichato for ten years that was destroyed by the tsunami. They have an established presence in the community and advocate aquaculture as a sustainable solution to over-fishing.

Fishing Syndicates

Fishing syndicates operate in many Chilean fishing towns and function as both social and professional support groups. Through a syndicate, fishermen can more easily navigate fishing regulations and licensing requirements, obtain necessary gear, and receive rights to certain fishing areas (see section on Regulatory Landscape for more information), among other things.

Syndicates are the most obvious candidates for implementing aquaculture in Coliumo Bay. They offer a number of advantages, including access to boats and knowledge of the marine environment in the region. Syndicates have the potential to regulate robbery, overfishing, and unfair use of resources by individual members. On a broader scale, a well-organized syndicate could provide an opportunity for joint-funding, advertising, processing, and mobilizing public and

institutional support for farmers, among other benefits⁷. For more information on the syndicates, see Appendix VI.

Neighborhood Association

Another main community group in Dichato is the Neighborhood Association (Juntas de Vecinos), which is comprised of mostly women. None of the fishing families participate in the general neighborhood association, in part because the fishing syndicates function as an important community group. Also, fishermen are less interested in joining a female-dominated neighborhood group. Some women algae-collectors within the group approached the association's president to discuss their idea to formalize and apply for funding or a permit to expand their work. These women are not a part of the main fishing syndicate, reportedly in part because they do not feel welcome in the male-dominated group, but are another group that might be interested in aquaculture.

Local Officials

Officials from a variety of local government offices and business associations like the tourism board and chamber of commerce, as well as community leaders like the school principal, and other neighborhood associations were well aware of the overfishing crisis and saw aquaculture as a way to provide high-quality local seafood, develop unique tourism activities and increase income for fishermen. However, many were not well versed on the specifics of the industry, and those who were mentioned that aquaculture would require a different mindset for fishermen who are less accustomed to making long-term investments. (See appendix VII for additional notes on community interviews).

Shellfish Demand

The Bío Bío region represents a major market for shellfish aquaculture. According to the 2012 census, over 1.9 million people live in the region, half of whom live in Concepción. Aquaculture farmers in Coliumo Bay have several options to sell their products: to fish markets in Talcahuano, Tomé, and Concepción; to restaurants; or directly to consumers. While current aquaculture farmers have considered shipping their product to Santiago by air, this would greatly increase transportation costs. In the short term, most of the farmed shellfish produced in Coliumo Bay will most likely be sold and consumed regionally.

Current aquaculture farmers and researchers from Universidad de Concepción state that the types of shellfish most likely to succeed in local environment are mussels, oysters, and scallops. Thus, this analysis focuses on regional demand for these shellfish. The below chart shows national consumption and regional production of the three species:

	Consumption in Chile (MT)	Production in Bío Bío (MT)
Mussels	208,089	155
Oysters	222	-
Scallops	4,895	-

Exhibit I: Data from Sernapesca's 2012 Annual Report comparing national consumption of shellfish to regional production levels.

⁷ FAO Fisheries and Aquaculture Technical Paper: Aquaculture Farmer Organizations and Cluster Management: Concepts and Experiences, Rome, 2011. Laila Kassam, Rohana Subasinghe, Michael Phillips. <http://www.fao.org/docrep/014/i2275e/i2275e.pdf>

Based on average national per capita consumption figures, current shellfish production in Bío Bío is not enough to meet even regional demand. Without data for shellfish trade within Chile, Bío Bío, it is reasonable to assume the region imports mussels, oysters, and scallops from other regions. The vast majority of scallops are farmed in Northern Chile, and the Los Lagos region produces 99.76% of Chile’s mussels and 89.27% of its oysters.⁸ Los Lagos is home to only 4.7% of Chileans, whereas 11.9% of the population lives in Bío Bío.⁹ Additionally, many high-end restaurants in Concepción serve scallops and oysters, which are not produced locally.¹⁰ Shellfish produced in Coliumo Bay would have an advantage in the Bío Bío market because of its proximity to consumers. This closeness saves on transportation and ensures that buyers receive fresh produce.

Determining the feasibility of aquaculture production requires estimating how the volume of shellfish that could be produced in Coliumo Bay compares to existing or projected demand. The existing aquaculture farm in Coliumo estimated their maximum production potential to be 20 longlines, producing 200 metric tons (MT) of mussels or 20 MT of oysters.¹¹ Scallops are not currently farmed in the bay, but experts estimate that scallop production levels would be similar to that of oysters. These figures are order of magnitude estimates as it is very difficult to predict future production. The below chart displays the maximum production estimates for that farm in metric tons and the portion of the national market they would represent:

	Coliumo Bay Production Estimates (MT)	Portion of National Market
Mussels	200	0.10%
Oysters	20	9.01%
Scallops	20	0.41%

Exhibit II: Projected feasible production (in metric tons) for 20 lines of cultivation dedicated to each species

Comparing the maximum local production estimates to current national production demonstrates that production in Coliumo Bay would have little impact on market prices for mussels and scallops. While oyster production could potentially reach a significant portion of national production, this should not affect market prices because there is high demand for oysters in international markets.¹²

Another consideration is that increased oyster and scallop supply could increase demand. According to interviews with local restaurant owners and fishermen, when Dichato’s aquaculture facility produced oysters, local restaurants sold oysters. When the aquaculture facility ceased production, local restaurants stopped selling oysters. Because Dichato receives visitors from the wealthy Pingueral community, there is a demand for higher-end shellfish such as oysters and scallops. Though these products are not currently sold en masse in Dichato, local production could influence local demand. The chamber of commerce could look into this possibility to start up this virtuous circle.

⁸Servicio Nacional de Pesca y Acuicultura, “Anuario 2012,” 20 November 2013, http://www.sernapesca.cl/index.php?option=com_repository&Itemid=246&func=startdown&id=7684.

⁹Instituto Nacional de Estadísticas, “Diagnostico de Censo 2012,” December 2013, <http://www.ine.cl/filenews/files/2013/diciembre/plan-de-accion-censo2012.pdf>.

¹⁰ Adam Roberts, “Shucking Oysters,” *The Amateur Gourmet*, 18 November 2013, <http://www.amateurgourmet.com/2013/11/how-to-shuck-an-oyster.html>.

¹¹ Interview with Jessica Cabrera Torres.

¹² Unattributed, “European Investors Eye Chilean Oysters,” *This is Chile*, 02 May 2012, <http://www.thisischile.cl/7723/2/european-investors-eye-chilean-oysters/News.aspx>

This analysis concludes that expanding Coliumo Bay aquaculture will not flood the market in mussels and scallops. Given that the local oyster market is currently smaller, farmers interested in oysters will need to do a more careful analysis and consider their ability to access international markets or stimulate local demand.

Regulatory Landscape

There are three areas in which government regulation poses challenges for new entrepreneurs seeking to start aquaculture projects: physical space, regulations and permitting process, and government support.

Physical space

The first challenge to potential aquaculture farmers is obtaining the physical marine space for a farm. According to interviews, there are two ways in which one can obtain an area on which to carry out aquaculture. The first is what is called an “area de manejo” or management area, which is an offshore area allocated to a syndicate of fishermen for conservation and harvesting purposes. These cannot be given to individuals. Management areas have specific regulations, such as how much space can be used for aquaculture and the types of species that are allowed to be raised within the area. For example, exotic species such as scallops and oysters are not allowed to be raised in management areas.

The second way in which aquaculture is allocated is through concessions, or permits, which can be awarded to individuals or groups. These concessions are obtained through a complex permitting process (outlined below) and allow most types of aquaculture, given that the environmental and technical reviews are approved.

According to Sernapesca, Chile’s National Fisheries and Aquaculture Service, Coliumo Bay currently contains two management areas and three concessions, with two more concessions requested but unauthorized. Exhibit III shows management areas (outlined in green), along with requested (dark teal) and granted (bright teal) aquaculture concession areas.

There were conflicting reports of whether there is more space available for concession areas. Some experts said that there were no more areas available, while others mentioned that any offshore space was available for a concession, as long as a permit was requested.¹³ Fishing groups and community members consistently cited lack of space or the inability to obtain rights to space as significant barriers to starting aquaculture projects. At the moment, however, there is not an integrated coastal development plan in the area for efficient and sustainable use of offshore space.

Regulations and Permitting Process

In order to request new parcels of space on which an individual can conduct an aquaculture project, farmers must navigate a complex application process that can take from two to ten years. Many interviewees mentioned that the lengthy process discourages them from applying. Appendix X outlines the complicated concession application process.

In addition to the amount of time taken to complete the application, farmers also face other challenges. Interviewees mentioned that defining specific coordinates in the application is challenging, given that applicants have limited resources to identify specific space that has not

¹³ According to interviews with Fishermen, the Municipalidad de Tomé, and Sernapesca

already been requested. This results in a drawn-out back-and-forth process between Sernapesca and the requestor about available and desired space.



Exhibit III: Map of concessions and management areas in Coliumo Bay¹⁴

Another challenge faced by potential applicants is the requirement of an environmental and technical review called a Preliminary Characterization of Site (CPS), as mentioned above. According to most, these studies need to be conducted by an outside expert and funded by the requestor, which is a cost barrier for many applicants. Furthermore, the technical and environmental requirements are currently unclear to applicants.

Finally, once a concession area is granted, it can be taken away if it sits idle. In general, the concession holder should commence the aquaculture activity within a year from the official delivery of the title after the permitting request has been approved. The authorization holder may interrupt operations for a period of two consecutive years, with a possible extension of up to four years.¹⁵

It is recommended that Dichato fishing syndicates, in consultation with Sernapesca and marine biologists at the University of Concepción, identify sections of the management area that are relatively well-suited for shellfish aquaculture. Individual community members looking to start an aquaculture project could potentially work with existing concession-holders to rent or share space to begin farming and bypass the lengthy concession process.

¹⁴Courtesy of Sernapesca Bío Bío Regional Office.

¹⁵Food and Agriculture Organization, Fisheries and Aquaculture Department. "National Aquaculture Legislation Overview: Chile". Accessed January 15, 2014. http://www.fao.org/fishery/legalframework/nalo_chile/en

In order to clarify the application process in the short term, Sernapesca or other regional or local government agencies should create an easy-to-understand outline of the permitting process. In the long term, they should seek to improve the efficiency of the permitting process and shorten the time-span for awarding concessions.

For improving the application process, a program should be created to pre-identify suitable areas for aquaculture (in conjunction with a coastal development plan) to avoid inefficiencies in area identification. In addition, this program can pre-allot the authorization for aquaculture in order to avoid lengthy application processes (including necessary technical assessments) and can provide technical assistance in the application process to fishermen looking to begin small-scale aquaculture farms.

In addition, the application for concessions and authorization could be integrated with the application for startup funds for aquaculture. In this way, the government would remove a main barrier by reducing the amount of paperwork required for the actual startup of an aquaculture operation. This also assures the authorities providing funding that the funding will be well-used.

Government Support

The Municipalidad de Tomé has had an office of fisheries and aquaculture (Oficina Borde Costero) for 5 years that expressed an interest in supporting aquaculture in the area. This office should continue to develop relationships in the community in order to become a key player in helping people understand and navigate the complex regulatory environment.

Funding

Aquaculture farming is a capital-intensive venture that requires high start-up costs, which may pose a challenge for potential farmers in Dichato. As demonstrated by the absence of a bank, there is virtually no private funding source available for potential farmers in Dichato. Currently, the only viable source of funding is public funding from government agencies or NGOs.

Even though there are several public funding sources available, there is a huge gap in the accessibility of funding between representatives of public funding agencies and community members. Government representatives mentioned that funding resources are under-utilized, and that there have been several efforts to provide technical training regarding business management and financial literacy skills, but with limited uptake. Some fishermen interviewed, on the other hand, did not seem aware of potential opportunities, felt that these opportunities were not accessible to them, or felt that the opportunities were inappropriate for their needs. According to one interviewee, “the government doesn’t care about us because we don’t pay taxes.” Many seemed skeptical of any opportunities mentioned for government support.

A cause for this gap in perception could be a misalignment in the interests of the government and the need for capital required to start an aquaculture farm. For example, the seed money program (capital semilla) of SERCOTEC is generally given for the implementation of innovative projects, such as new refrigeration techniques, rather than for start-ups in conventional industries.

Available public funds

In Chile, several government agencies provide funding sources for those who are considering a new business. Among them, the programs Fondo de Solidaridad e Inversión Social (FOSIS), Servicio de Cooperación Técnica (SERCOTEC), Corporación de Fomento de la Promoción (CORFO) and Fondo Fomento para la Pesca Artesina (FFPA) could be considered as potential sources of funding for aquaculture (detailed in Exhibit V).

Exhibit V: Funding Agencies and Available Sources of Funding for Aquaculture

AGENCY	PROGRAMS	LEVEL OF GRANT (CLP)	TARGET GROUP	ELIGIBILITY
FOSIS (Fondo de Solidaridad e Inversión Social)	Fondo concursable I.D.E.A.	Up to 300,000	A person of family (within poverty group)	Social protection index - less than 8500 score
SERCOTEC (Servicio de Cooperación Técnica)	Capital Semilla Emprendimiento OR Capital Semilla Empresa	L1: 0 – 2 million (new projects) or L2: 2 – 6 million (ongoing projects)	Entrepreneurs with innovative ideas or Small enterprises	20% minimum co-financing
CORFO (Corporación de Fomento de la Promoción)	Providing various programs	Amount varies Up to 75% of total cost of a project (maximum CLP 40 million) 40% of total cost for feasibility study	Micro, small and medium enterprises Feasibility studies	Period of project not exceeding 2 years. Total sales not exceeding CLP 100 million
FFPA (Fondo Fomento para la Pesca Artesanal)	*programs are designed for fishing industry; not clear if aquaculture is eligible	N/A Significant amount	Artisanal fishing organization	More than 1 year of founding history

FOSIS is only available to individuals, while SERCOTEC and CORFO accept applications from both individuals and enterprises. FOSIS is also only available to the lowest income group, i.e., those that score less than 8500 on the Social Protection Index.

While FOSIS is directed towards supporting vulnerable populations, SERCOTEC is directed towards individuals and groups of entrepreneurs, providing direct lump-sum cash transfers to successful applicants. In 2013, 450 individual entrepreneurs, selected from 14,000 applicants, were awarded a total of CLP 1.5 billion.¹⁶ For the group grant, which is relatively less competitive than the lump-sum cash transfer program, 5 winners out of 20 applicants received CLP 30 million last year. Most of the business proposals in Dichato are related to tourism; representatives of the regional SERCOTEC office could not remember any SERCOTEC applicant proposing aquaculture in the past three years. Accordingly, the organization is conducting outreach information sessions to advertise available funding. It also provides technical and capacity-building service to educate people on how to apply for funds and draft a simple business plan.

CORFO has various programs. Iniciativa de Desarrollo Territorial has the greatest potential for creating social impact. A group of people, which does not have to be a legal entity, can apply for this funding to start a project that will benefit the community. In general, CORFO provides the largest amount of funding, but also requires a fully developed business plan with cash flow estimates, which could prove particularly difficult for aspiring aquaculture farmers.

Unlike the previous three agencies, funds from FFPA are designed exclusively to promote the fishing industry. However, there is no previous record of solicitation to this fund for support of an aquaculture project.

¹⁶ Based on interviews with SERCOTEC Bío Bío regional director Macarena Vera Messer

Challenges and recommendations

In spite of the fact that there are several funding sources and agencies willing to provide funding, barriers also exist that discourage potential aquaculture farmers.

Misalignment: The funding sources that are available are not uniquely targeted to aquaculture. Applicants for FOSIS must be considered economically vulnerable to be eligible, which makes potential aquaculture entrepreneurs an unlikely match for this fund, given the high startup costs and capital investments required for operation. Funding by SERCOTEC requires 20% co-financing. However, due to limited availability of capital including loans, this requirement could be difficult to meet. Although it is a known fact that FFPA provides funds for the fishing industry, it is unclear whether or not they are providing the same opportunity for aquaculture.

An alternative option would be to meet the 20% equity requirement of SERCOTEC through co-financing with another institution, such as an NGO, private company, or micro-finance institution. In addition, funding agencies should develop tailored aquaculture funds, or specifically target aquaculture entrepreneurs for certain rounds of funding.

Time-span: The grant period and use of available funds does not align with the time-span of beginning an aquaculture projects. The existing sources disburse funds to support one year of business development, whereas shellfish aquaculture projects require up to two years for an initial harvest, and two to five years to become profitable.¹⁷ Without any follow-up after the disbursement of the grant, it is only likely that the probability of failure during start-up phase will increase. Funding agencies should be aware of this for best use of their limited resources.

Furthermore, agencies should take into account the fact that aquaculture is unique: it is akin to farming than to fishing. Having considered this, funding agencies may consider multi-year grant plans for new aquaculture farms. Alternatively, agencies could support recipients to set-up multi-year business plan with the funds received.

Accessibility: The majority of potential applicants do not have the capacity to access funding information. Some funding agencies accept applications only via the Internet, which many potential aquaculture farmers do not have access to. Tailored off-season outreach and information sessions on government funding for aquaculture would be beneficial to potential farmers. The Municipalidad de Tomé could take a role in diffusing information about funding opportunities, being more aware of local people's successes, timeline, and specific needs. For example, the Municipalidad could act as one-stop shop for aquaculture entrepreneurs, encompassing information on creating a business plan, technical support opportunities for concession applications, and funding.

Aquaculture Operations

Based on our conversations with researchers and community members, aquaculture in Coliumo Bay is logistically feasible. Coliumo Bay is a shallow, semi-closed bay approximately 5 km² in total area. The Bay reaches a maximum depth of 25m near the mouth and decreases to 10m in most of the bay, towards the rocky inter-tidal and sub-tidal zones¹⁸. Coliumo Bay is open to the North. Weather is an issue, especially in the winter months when prevailing winds are from the

¹⁷Based on interviews with Jessica Cabrera Torres.

¹⁸Hernández-Miranda, E., Cisterna, J., Díaz-Cabrera, E., Veas, R., Quiñones, R. 2013. Epibenthic macrofaunal community response after a mega-earthquake and tsunami in a shallow bay off central-south Chile. *Marine Biology*. P 1-16

north. There are some areas that are better suited for aquaculture than others, which is mainly dependent on exposure to strong winds and currents.

Currently, the Bay is a regional spawning ground for many marine species, making it a viable spot for aquaculture projects. However, proposed projects, such as a paper pulp plant have the potential to impact the viability of aquaculture in the area. These projects could affect the temperature and pollution levels of the water, impacting spawning success.

These natural and anthropogenic factors are not prohibitive, but should be taken into consideration when implementing an aquaculture project. For example, aquaculture has been successful in other challenging climates such as Northern Canada.¹⁹

Shellfish Aquaculture

Currently mussels make up the majority of attempted, active, and proposed aquaculture projects in Coliumo Bay. Mussels are naturally found in the Bío Bío Region and are therefore most suited for shellfish aquaculture in the bay. However, other shellfish species whose seeds need to be imported, such as oysters and scallops, are logistically feasible. For each crop, there is a unique set of challenges and opportunities.

Mussels: While mussels propagate and can be harvested in the wild, they do not demand as high of a price in the market as oysters and scallops. Farmed mussels must also compete with wild-caught mussels, which can be sold for cheaper because they do not require the same costs of production. Conversely, a mussel farmer has exclusive rights to their farmed product and does not have to compete with other wild-harvest fishermen for limited resources. Farmed mussels offer the opportunity to create a more-reliable, high-quality product that can command a higher price, which may offset the cost of additional inputs.

Oysters: Native Chilean Oysters are slow-growing and notoriously difficult to cultivate, making them infeasible for local oyster aquaculture. However, the methods for cultivating Japanese Oysters have been well established (i.e. hanging lanterns; see Exhibit VI) and the local waters are suitable for their cultivation. Oyster seed is not currently available in the central region of Chile, and therefore must be purchased from hatcheries in the North or South. The price of seed is expensive: fully grown oysters can only be sold for a markup of approximately three times the purchasing price of seed. Importing seed of any species also introduces the risk of importing diseases, parasites, or other harmful organisms to the area. For example, Central Chile is not currently affected by Red Tide, which produces a toxin that is harmful to humans if ingested through shellfish. Red Tide has affected both Northern and Southern Chile, causing aquaculture farms to cease operations for extended periods of time. Seed supplied from hatcheries requires certification that they do not contain any of these potentially harmful organisms. However, shellfish farmers and other fishermen are still wary of imported seed and would prefer a local option. Because Japanese Oysters are a non-native species, they require additional regulation (e.g. they cannot be farmed in Management Areas).

Scallops: While there presently appears to be a high regional demand for scallops, scallop farming is the most challenging to implement. Scallop seeds are fragile and face high mortality rates in transit, as well as during farming because of the lower water temperature in the Coliumo Bay compared to the water temperature in Northern Chile where the seeds are grown.

Algae: While there are larger scale industrialized algae farms in other regions in Chile, algae is currently wild-harvested in the region and sold at low prices to stock-pilers, who then sell to

¹⁹Deep Water Mussel Farming In Newfoundland and Labrador. Terry Mills – President, Norlantic Processors Limited. Powerpoint. Accessed on: http://hermes.mbl.edu/mrc/research/pdf/deep_water_aquaculture.pdf

large exporters. Analyzing the feasibility of algae farming is beyond the scope of this project. For more information on algae, see Appendix VIII.

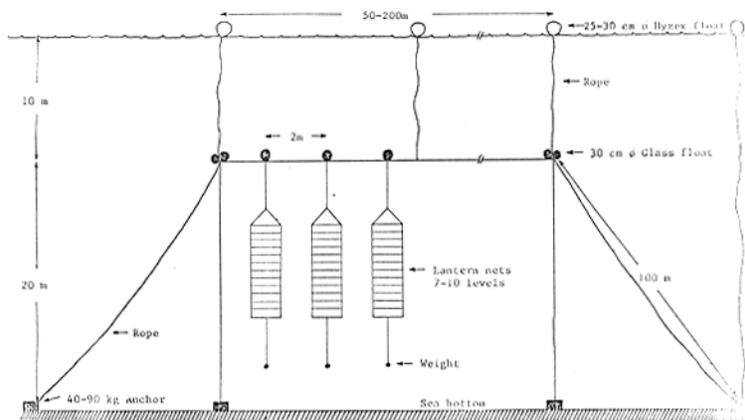


Exhibit VI. Hanging Lantern system for cultivating oysters.²⁰

Abalone: The cultivation of Abalone has been successful in other regions of Chile. However it does not appear that environmental conditions – especially temperature – are suitable for farming abalone in Coliumo Bay.

Different species also require unique inputs, such as equipment, and marine conditions. They also have different growth and harvesting timelines. Only native species, such as mussels, abalone, and algae, can be farmed in management areas, whereas any species approved by the relevant regulatory authorities can be farmed in a concession area. Some community members, such as Dichato's fishing Syndicate #1, have considered in-land trout farming as a possible supplement to fishing. However, an analysis of this opportunity is beyond the scope of this report.

Inputs

Aquaculture requires a large initial investment in capital. For example, mussels are farmed on a longline system, one unit of which is 100m and is composed of anchors, buoys, and looped rope (see Exhibit VII). Other species require unique equipment. However, traditional fishermen may already have much of the equipment and knowledge necessary for aquaculture (e.g. boats, access to the water, diving equipment, and access to the markets). This makes aquaculture conducive to supplementing wild-harvest efforts, but this does not imply that aquaculture is inaccessible to other entrepreneurs and groups.

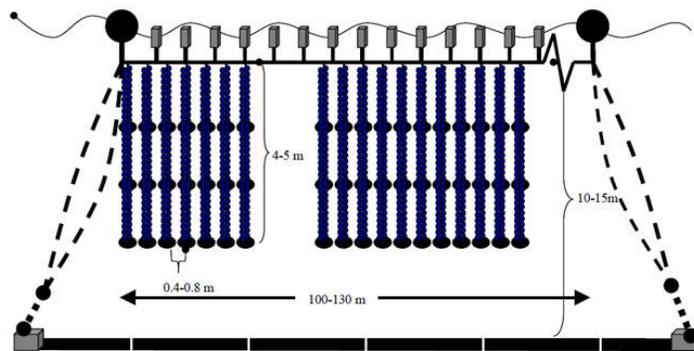


Exhibit VII: Mussel longline system²¹

²⁰ <http://www.fao.org/docrep/field/003/ab714e/AB714E03.htm>

Exhibit VIII below presents a rough estimate of startup costs for a 2 hectare, 20 longline mixed-species system based on a current aquaculture project in the region.

Exhibit VIII: 20 longline aquaculture project start-up cost estimates

Item	Cost (In Chilean Pesos)
Boat and motor	7,000,000
Buoys	18,000,000
Longlines	6,000,000
Lanterns	3,500,000
Anchor blocks	1,500,000 – 15,000,000
Total	36,000,000 – 49,500,000

Other technology can be viable for reducing startup costs. For example, bottom culture is not capital intensive and is protected from weather and theft. Given that the majority of Dichato fishermen are divers, this method may be easier to introduce than other aquaculture methods. Additionally, bottom culture does not require surface equipment, avoiding user conflict and complaints about the aesthetics of the bay, especially from the wealthy Pingeral community. However, this may increase risks or present new challenges. For example, bottom cultured shellfish are more susceptible to predators, may have slower growth rates, and require greater labor to harvest. All of these are tradeoffs that require assessment at the individual farm level.

Aquaculture projects also have significant annual operating costs, as roughly outlined in Exhibit IX. Note that a significant portion of this budget is associated with the cost of purchasing seeds, particularly for non-native species such as oysters and scallops. Alternative technologies such as Floating Upweller Systems (FLUPSY) could be employed to reduce the cost of purchased seed by allowing farms to purchase much smaller (i.e. cheaper) seed and at much greater quantities. Any technology that allows smaller seed to be purchased should be considered as an opportunity to reduce annual operating costs.

Exhibit IX: 20 longline aquaculture project operating cost estimates

Item	Cost (In Chilean Pesos)
Seeds	3,000,000
Tools	900,000
Annual Permitting Fees	890,000
Marketing/Promotion	500,000
Labor	470,000
Maintenance/Repairs	250,000
Transportation	200,000
Internet	35,000
Total	6,245,000

Seed Availability

Even for naturally-occurring species such as mussels, a hatchery is necessary for aquaculture. Currently, there is not a hatchery in central Chile. Costs, mortality rates, availability of seeds, and other risks need to be considered when a farmer purchases seeds from the North or South. A local hatchery would be advantageous to mitigate these risks for local shellfish aquaculture.

The University of Concepción (UdeC) had an experimental hatchery in Dichato for ten years until it was destroyed by the tsunami. A small amount of mussel seeds were given to two

²¹<http://www.depi.vic.gov.au/fishing-and-hunting/fisheries/fisheries-management-plans/portland-aquaculture-fisheries-reserve-management-plan/environmental-monitoring-of-marine-aquaculture>

farmers in the area; unfortunately, their projects were destroyed by the tsunami one month before their first harvest. UdeC is currently considering building a new hatchery in Concepción bay. The old hatchery in Dichato is being converted into a research and teaching laboratory for UdeC, which does not include a hatchery.

A local hatchery would be a valuable resource for people beginning artisanal aquaculture. Parties interested in aquaculture should support the development and funding of this hatchery. UdeC should also support the development of local aquaculture through the transfer of seeds from their new hatchery to farmers. In this way, a mutually-beneficial relationship can be formed through which farmers receive seeds and UdeC can use their projects for research purposes. Furthermore this relationship can be extended to the general community where the hatchery can be used to host educational field trips for the local school children and parents to spark their interest in aquaculture. If necessary, the Oficina Borde Costero Municipalidad de Tomé can serve as the facilitator of this relationship-building process. UdeC should also consider commercializing their hatchery in order to sell seeds within the region. It is important to note that development of both a hatchery and new shellfish aquaculture projects can take 5-10 years.

Technical Support

Access to technical knowledge is key to the success of new aquaculture ventures. Aquaculture projects exist all over the world, providing enormous potential for information transfer. In this sense, setting up a new framework for information exchange between the community and universities is recommended. In addition to technology transfer, capacity building through diverse channels should be established. This should include vocational classes, apprenticeship opportunities, business courses, extension services, and continued guidance from a coalition of university members, existing aquaculture farmers, and government representatives. There are several successful models for such programs, which are typically implemented through universities and funded by government grants.²²²³

In order to not interfere with fishing and harvesting in the Coliumo Bay, UdeC should hold classes during the winter low season, possibly at their new lab. This lab is in an ideal location for the UdeC to work within and support the community at large. To succeed in developing and sustaining this kind of community-level mutual capacity-building activities, external funding is imperative. Additionally, aquaculture farmers actively engaged in knowledge in the Bío Bío region, such as Jessica, should receive funding for additional training and to support an apprenticeship model.

Security

Theft of equipment and crops was identified as a major issue by virtually all interviewees. This problem extends beyond the region and is an issue throughout Chile and the world. Therefore, it is recommended that any new aquaculture project include a comprehensive security plan. Options to deter theft include installing surveillance cameras and hiring security personnel.

Security equipment is expensive, reliant on consistent internet access, and vulnerable to theft and weather damage. For example, it is estimated that installing two solar-powered security cameras would cost CLP700,000 plus a monthly internet fee. Alternatively, hiring a security guard would provide an opportunity for local employment. It is also possible that key groups within the community could pool their resources to pay for a security guard for the Coliumo Bay. If this is met with social resistance, it may be easier for the Municipalidad de Tomé to hire a warden to monitor the activity in the region.

²²<http://www.who.edu/seagrant/page.do?pid=52096>

²³<http://www.barnstablecounty.org/wp-content/uploads/2011/09/Extension.pdf>

Natural Disaster Risk

Coliumo Bay's orientation makes it susceptible to strong winter currents and geologic impacts, notably tsunamis. In many nations, government agencies offer vulnerable industries insurance to help protect against the impact of severe weather. Chile is the second largest salmon exporting country behind Norway and aquaculture insurance for salmon is well developed in Chile. However, insurance for artisanal farming is a niche for insurance companies, but has great potential for development²⁴. However, we are unsure of who should be responsible for developing an insurance program, but it is an important component in reducing the risks of entering into aquaculture.

Marketing

This section outlines general ideas for marketing and value addition for Coliumo Bay shellfish. This is not a comprehensive analysis of every marketing strategy.

As discussed in the demand section, the Bío Bío region does not produce many oysters or scallops. Dichato can differentiate itself from other fishing communities in the region by promoting locally harvested aquaculture to tourists in Dichato. Additionally, Dichato has a unique story: a fishing community rebuilding itself after a natural disaster by embracing new methods of harvesting shellfish. Promoting this story to tourists will have a two-fold effect. It would increase tourism as well as increase demand for aquaculture shellfish at local restaurants.

Local officials and aquaculture farmers should market Coliumo Bay shellfish as part of the Festivo Viva Dichato. This annual music festival brings thousands of tourists to Dichato and presents an excellent opportunity to promote local industry. At the festival, the town and aquaculture farmers should consider having a stand to raise awareness of Coliumo Bay aquaculture.

Aquaculture farmers and the tourist industry should also consider partnering with local restaurants to promote locally grown shellfish. Current aquaculture farmers plan sell some of their produce to local restaurants. Restaurants should make an effort to let their customers know that they sell locally caught shellfish as tourists will likely prefer the locally grown shellfish. These two inexpensive efforts will not dramatically increase tourism, but they will plant the seeds for Dichato to gain publicity for its aquaculture industry. There were a number of proposals from various members of the community for innovative ways to integrate restaurants and local seafood with tours and information sessions about the aquaculture projects that would add unique appeal to the restaurants and increase awareness of and appreciation for the local seafood.

Value Addition

After harvesting shellfish, farmers can add value by sorting, cleaning, and packaging. One recommendation is to sort the shellfish by size so that they can be packaged and sold as small, medium, and large units. The packaging requirements will depend on the buyer's needs.

The chairman of the Dichato Chamber of Commerce suggested that a freezing and processing plant would benefit the fishermen in Dichato. Local processing facilities should reduce costs, but a study of their viability and profitability is beyond the scope of this paper.

²⁴ World Bank. Agricultural Insurance in Latin America – Developing the Market, Dec 2010.

Local aquaculture farmers expressed interest in government-sponsored quality assurance standards. Because of the risks of eating contaminated shellfish, these standards would have two functions. First, they would protect consumers from purchasing contaminated shellfish. Second, they could increase demand if consumers are confident that they are eating a safe product. However, these changes would require national government support.

Conclusion and Summary of Recommendations

There are many risks and challenges that aquaculture entrepreneurs can face, from the loss of seeds during the initial operation, to management and obtainment of capital, to navigating a complex regulatory system. This report recommends both short and long-term steps that can be taken to mitigate barriers to starting a viable enterprise.

The following are short-term recommendations for stakeholders at the local level to support shellfish aquaculture in Coliumo Bay. These recommendations should be implemented immediately. For a diagram outlining the stakeholders that should take responsibility for these recommendations, see Appendix IX.

Regulatory

1. Dichato fishing syndicates, in consultation with Sernapesca and marine biologists at the University of Concepción, should identify sections of the management area well-suited for shellfish aquaculture.
2. Community members looking to start an aquaculture project should work with existing concession-holders to rent or share space, to begin farming and bypass the lengthy concession process.
3. Sernapesca and other relevant government agencies should create a one-page outline of the permitting process. In the long term, Sernapesca should amend the permitting process to shorten the time-span for awarding concessions.

Funding

4. Relevant funding agencies should distribute pamphlets and employ other offline advertising methods in fishing communities to promote awareness of their programs to potential aquaculture entrepreneurs who lack internet access.

Logistics

5. Aquaculture farmers should explore different aquaculture technologies such as bottom culture and the Upweller System
6. UdeC should partner with local aquaculture farmers to establish and fund a hatchery.
7. A “Bío Bío Region Aquaculture Promotion Project” should be established by UdeC to provide business, technical, and market classes for aquaculture farmers. UdeC should work with municipal governments, fishermen, and aquaculture farmers to develop a practical curriculum.
8. Aquaculture farmers should create a security plan incorporating cameras and/or security guards. Aquaculture farmers should hire security guards to protect their produce. This will also provide an opportunity for local employment. Key groups within the community could pool their resources to pay for security guards for the Coliumo Bay. If this is met with social resistance, it may be easiest for the Municipalidad de Tomé to hire a warden to monitor the activity in the region.

Marketing

9. Aquaculture farmers, members of the tourist industry, and local officials should link shellfish aquaculture and tourism. They should promote Coliumo Bay shellfish at the Festivo Viva Dichato. They should also raise awareness to tourists about Coliumo Bay shellfish served at local restaurants.
10. Aquaculture farmers and the tourism industry should work with the Municipalidad de Tomé to fund these marketing opportunities.
11. Aquaculture farmers should clean, sort, and process the shellfish to market Coliumo Bay shellfish as a high-quality, gourmet product.

The following are longer term recommendations for stakeholders at the local and regional level. These recommendations can take effect within the next three years.

1. UdeC, Sernapesca, and the Municipalidad de Tomé should work with other maritime agencies to create a program to identify suitable areas for aquaculture.
2. The Municipalidad de Tomé Office of Fisheries and Aquaculture should take the lead in helping potential aquaculture entrepreneurs navigate both the funding and regulatory process.

In addition to these area-specific recommendations, community members noted that they are interested in intersections between the aquaculture and tourism industries that could create mutually beneficial opportunities for growth. Some ideas that were suggested by different community members included:

- Cooperation with ceviche or oyster stands to sell fresh products on the waterfront
- A wine and oyster tour that brings tourists out to view oyster farms, help to harvest oysters, and dine on their catch
- An oyster, mussel, or scallop festival during the winter months to extend tourism to include the full year

Aside from promoting both tourism and aquaculture, partnerships between restaurants and aquaculture farms can produce co-benefits, such as facilitating access to loans and startup capital. We encourage any potential aquaculture farmer to explore these networking opportunities.

Finally, community members noted that efforts to promote the industry should include an eye toward protecting small-scale farmers from the threat of competition from conglomerates, which is something that has given commercial aquaculture (e.g. salmon aquaculture) a bad reputation in Chile. While a deeper analysis of this problem was outside the scope of this report, implementers of these recommendations should ensure that any restructuring of regulations or facilitation of aquaculture takes these concerns into account.

Appendices

Appendix I: SWOT Analysis of Aquaculture in Dichato

Internal	Strengths	Weaknesses
	<ul style="list-style-type: none"> • Sustainable; addresses overexploitation of wild-harvest fish stocks • High quality product • More reliable than wild-harvest 	<ul style="list-style-type: none"> • High start-up costs • Long time-frame for investment • Extensive technical knowledge required • Previous attempts failed
External	Opportunities	Threats
	<ul style="list-style-type: none"> • Favorable conditions <ul style="list-style-type: none"> ○ Warmer waters than Southern Chile ○ Coliumo Bay as multi-species spawning ground ○ wild mussel seeds available • Access to UdeC research lab in Dichato for technical support • Local branding • Large local and regional markets • Government funds availability 	<ul style="list-style-type: none"> • Unfavorable conditions <ul style="list-style-type: none"> ○ harsh winter weather, winter storms ○ open to outer seas, susceptible to tsunamis and storm surge • Theft of gears and crops • Predators (star fish, crabs) • Long permit processing time • Expensive seeds costs • Government funds complicated and inaccessible • Lack of risk mitigation measures (ex. insurance)

Appendix II: List of People Interviewed

Universidad de Concepción

- Dr. Pedro Moisés Arriagada Pulgar Faculty of Biological Sciences, Universidad de Concepción
- Dr. Eduardo Hernandez, Marine Biologist, Universidad de Concepción
- Dr. Rudi Radrigán, Director del Centro de Desarrollo Tecnológico Agroindustrial, Universidad de Concepción
- Dr. Eduardo Tarifeño Silva, Professor, Department of zoology, Universidad de Concepción,
- Dr. Jean Simon, Director and Professor, Masters in Politics and Government, Department of Public Administration and Political Science, Universidad de Concepción

Community Leadership

- Martin Zilic, former Chile Minister of Education, former Governor of Bío Bío Region
- Jessica Cabrera Torres, aquaculture farmer in Coliumo Bay
- Pablo Cofre, President of the fishermen Syndicate No. #1
- Jaime Eris, Dichato Chamber of Commerce

Other community members

- Emiline, student of Dr. Eduardo Tarifeño Silva, attempting aquaculture project
- Don Mino, restaurant owner in Dichato
- Laraquete Aquaculture Syndicate members
- Claudia, representative from Tomé recycling group
- Daniela, Dichato Tourism Kiosk representative
- Restaurant owner in Pingueral, manager of community association
- Fishermen at regional fish markets
- Ximena, community member
- Pedro, Dichato representative of Tomé Mayor's Office
- Dichato elementary school principal

Government Officials

- Katherine Castillo, Oficina Borde Costero, Municipalidad de Tomé
- Mabel Gomez Castro, President of Neighborhood Association
- Macarena Vera Messer, Bío Bío Regional Director SERCOTEC
- Lilian Troncoso, Marine Biologist, Chief of Aquaculture and Environment, Sernapesca, Bío Bío
- Juan Carlos Navarro Quital, Fomento Productivo

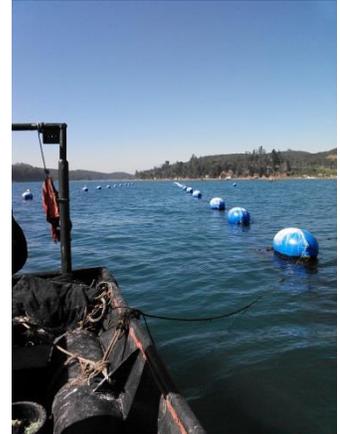
Recupera Chile

- Dr. Judith Palfrey, MD., Professor of Pediatrics at Harvard Medical School
- Dr. Ivan Cartes, Professor of Urban Design at Universidad del Bío Bío, Chile
- Pilar Del Canto Cortés
- Dr. Elizabeth Peacock-Chambers, pediatrician and public health researcher

Appendix III: Jessica Cabrera Torres

Jessica, the daughter of a fisherman from Coliumo, was a wild shellfish diver for many years before she began noticing the scarcity of fish in the region in the 1980s. Fishermen in the area were forced to travel further and further offshore to match their jack mackerel and sardines catches from previous years. This convinced Jessica to take up aquaculture, seeing it as a sustainable way to remain successful in the fishing industry. With her knowledge of shellfish through diving, she decided that she could farm shellfish and traveled to Northern Chile to study industrial-scale farmers.

She returned to Coliumo eager to apply what she learned, modified for the central, Bío Bío Region. Instead, she faced a daunting ten year wait to secure the proper permitting to establish her own farm. But she was persistent, finally receiving an 11-hectare concession on the western side of Coliumo Bay. Originally established with a group to support the initial investment, Jessica currently farms two longlines – covering only a small fraction of her concession space – with a small crew. The longline system allows for a combination of rope for mussel cultivation and hanging lanterns for oysters.



When the tsunami devastated Coliumo Bay in February 2010 and destroyed her farm, Jessica was one month away from her first harvest. She has since rebuilt with help from government grants, but funding has always been a challenge for her. While mussels reproduce naturally in Coliumo Bay, the water temperature is too cold for oysters to spawn. Without a local hatchery, Jessica is forced to buy expensive seeds from Northern Chile 3-4 times per year. Purchasing seeds from the North impacts her profit margin, mortality rates, and reliable availability of seeds. She also risks bringing contaminated or infected oysters into Coliumo Bay.



Jessica has begun selling mussels informally to individuals and restaurants throughout the Concepción region, but she has not yet harvested her estimated 70,000 oysters. Even though Jessica believes that she could expand her business and still find a market for 10,000 oysters per month in Concepción and 20,000 per month in Santiago, she will need continued support from all sides in order to grow her business. She is currently working other jobs in order to support her aquaculture project, partially due to a deficiency in private loan availability. Her farm is on the verge of success, and when it is successful it is likely that her project will serve as model in the region.

Jessica is clearly an entrepreneur. She has been working with the government to develop a quality assurance method, which could then be used for marketing her shellfish as a gourmet, artisanal product. She also envisions a large tank in the fish market to display and sell live oysters and mussels, a Community Supported Agriculture (CSA) model to deliver cleaned and packaged shellfish to people's doors, and a high-end wine and oysters boat tour of her farm.

Appendix IV: Laraquete Aquaculture Project

Laraquete is a town of 6,000 people located in the Bío Bío region 50 kilometers south of Concepción. Like most towns in the region, the 27F tsunami greatly affected the fishing community. In addition to destroying equipment, the tsunami changed the seabed, sweeping away algae roots. Before the tsunami, algae collection made up a large part of the fishing community. The algae is just now started to grow again, but the changes caused by the tsunami reduces algae growth. The fishermen needed a new revenue stream.

To help the fishermen, the Japanese Red Cross began funding an aquaculture project in Laraquete in 2011. Laraquete had started aquaculture 2005, but the industry was destroyed by the tsunami. The Red Cross has allocated CLP50 million thusfar to the fishermen for aquaculture equipment. This funding enabled the town to buy 7 lines for to grow mussels. The fishermen would not have been able to start aquaculture without this funding as the fishermen do not have access to bank loans. They have also received technical support from the University of Concepción as well as extensive advice from Jessica.

The aquaculture fishermen solely farm mussels. Their farm is located about 200 meters off the coast, not far from the fishing docks. The farmers are organized into a 40-member syndicate, including both men and women. The men clean the mussels and the women make the nets. Everyone helps harvest the mussels. They buy mussel seeds from Southern Chile. On our visit, there appeared to be a high level of cooperation and enthusiasm for aquaculture. The syndicate pays CLP80,000 per hectare per year licensing fee.

A possible advantage for Laraquete's mussel growers is the town's special dish "torillas con mariscos." This dish consists of a specially made tortilla stuffed with shellfish. Because the town is known regionally for this special dish, the aquaculture farmers could use this dish to market their mussels. It is unclear whether or not they currently do this.

Several factors threaten aquaculture in Laraquete. The town has a coal plant and lumber yards. Runoff from these industries affects the water quality. Additionally, there are plans to build a cellulose plant in Laraquete, which will likely worsen the water quality. It is unclear whether or not the water quality will adversely affect aquaculture. The government is also considering moving the main highway into town. This is significant because the townspeople typically sell their mussels along the highway.

According to the townspeople, the Red Cross will terminate funding in five months. The fishermen complained that they did not have the funds to move two 2.5 MT blocks into place to increase the number of lines from 7 to 20. They estimate the cost of this project at CLP1.5 million and argue that this additional funding is necessary to make aquaculture in Laraquete profitable.

However, theft appears to be the most significant problem. The townspeople explained that armed fishermen from a neighboring town sail to Laraquete and steal their product. They know exactly who is stealing from them, but cannot go to the police because the police are headquartered in the neighboring fishing community. The fishermen have considered installing cameras. This would cost CLP700,000 for two cameras connected to the internet as well as a monthly internet fee. However, we fear that the cameras would not stop armed thugs who could easily mask themselves and destroy the cameras.

Appendix V: Summary of Aquaculture in the Area

In addition to the case studies in Appendix III and IV, a number of other aquaculture projects have been attempted with various degrees of success.

In one instance a syndicate had a one-year government grant to start a loco aquaculture project but was unable to sustain the project without further funding (got these seeds from Puerto Vales). The syndicate also had a promising mussel and oyster project underway in 2009, but the products were wiped out by the 27F earthquake and tsunami in Feb 2010 just before they were ready to harvest (also mentioned bad and expensive technical support for this one). The group set up an additional project after that tsunami, in which they received government funding to support their capital goods, but those were also wiped out by a wave from the Japanese Tsunami in 2011.

Accounts from municipal offices indicate that another pilot project for mussel cultivation in Dichato failed because the seed used was actually older mussels, which did not grow properly and that starfish predation on the lines was an issue.

On the more positive side, restaurant owners and community members told us of at least one successful project that was supplying mussels and oysters to local restaurants for a number of years. It seems it was closed due to mismanagement, but was an example of the type of collaboration that could work in the area.

Appendix VI: Fishing Syndicates and Community Groups

Dichato has two fishing syndicates. The first syndicate consists of 150 fishermen, primarily men. The second has about 60 members, predominantly women, some of whom are involved in fishing and algae collection and others who focus on selling and distributing seafood.

Dichato Syndicate #1 was formed as a community group to support the local artisanal fishermen.²⁵ Many of the members are divers, involved in collecting congrio, shellfish, algae and other fish depending on the season. The group has tried a number of aquaculture projects in the past without success. Interviews with the president of Syndicate #1 and other members indicated that because of previous aquaculture failures – in some cases because of poor project execution and in other cases due to natural disasters – they are not actively planning another aquaculture project. They recognize that the wild fish stocks are declining and know that they need to diversify their income and business models, but they also recognize that aquaculture is challenging. Currently, the group is focused on securing funding and completing plans for a fish market and restaurants to be run by the wives of fishermen in the Syndicate.

The town of Coliumo – across the bay from Dichato – has three syndicates. The first, Coliumo Syndicate #1, has 140 members and is one of the oldest in the country. The group mainly fishes far off-shore for sardines and jack mackerel, but they diversify throughout the seasons. They have not tried aquaculture. However, they understand that they needed to consider other sources of revenue in the face of declining wild fish stocks and are open to the idea of aquaculture, provided they can acquire the necessary technical knowledge. There are also two women's syndicates in Coliumo, each with 30-40 members. They separated from Syndicate #1 when their algae collection activities were threatened by theft from other communities and the men were too busy fishing to prevent the thefts.²⁶

²⁵ In Chile, “artisanal” simply means small-scale as opposed to industrial-scale.

²⁶ We were unable to get in touch with this group during this study.

Appendix VII: Community Characteristics: Education, Rebuilding, Health Services

The following provides additional notes on the community of Dichato, the post-tsunami rebuilding initiatives and basic public services and needs that came up in conversation with community members and provide important context for any development program or future research in the community.

Physical Rebuilding

Though many of the commercial shops, restaurants and even rental cabanas have been rebuilt in the valley near the beach, the pre-k through 4th grade students are in a new school building on top of the hill so they do not have to evacuate in case of another tsunami. The school building for older students (grade 5-8) is still located in the tsunami flood zone. Similarly, the government built most new houses in five villages atop hills overlooking the town. These examples represent the many ways in which the threat of another tsunami influences town planning. Seeking to balance people's desire to return home with the fact that it is riskier for businesses and people to rebuild in areas threatened by natural disasters, those who owned land in the valley were eligible for government grants to rebuild on the plots they owned, but most of the new housing, including homes built for people who were previously renters but were given their own homes after the disaster, were built at higher elevation.²⁷

Basic Services

Dichato has two small grocery stores, but no ATM or bank branch, so residents remain reliant on the nearby larger town of Tomé (approx 10 km away) for banking services and larger shopping needs beyond basic food and small household supplies. The town has a small rural health post with funding approved to build a larger family health center starting in the spring of 2014. For more advanced care, residents travel to the nearby larger cities of Tomé or Concepción, the second largest city in Chile. Healthcare is provided free at public facilities.

Community Health

Recupera Chile programs in Dichato have focused extensively on community health, especially children and mental health in the aftermath of the tsunami. They use a case management model and are working closely with the local school to develop an integrated community and social services program. While this is not the main topic of this analysis, it is important to keep the broad community context in mind in the development of any socioeconomic development proposal. Social challenges identified by staff in the area include teen pregnancy and a high prevalence of single mothers. Neighborhood dynamics were significantly disrupted by the destruction of the town. Moreover, villages that were rebuilt after the tsunami are in new locations where people were randomly assigned to new homes rather than kept in extended family or community groups that reflected the social dynamics of the neighborhoods before the storm. This may have led to a breakdown in community cohesion.

²⁷ Those who were not rebuilding on plots they owned were randomly assigned to temporary housing and again randomly assigned to permanent housing, which may have added a sense of fairness to the assignment of housing location, but also had adverse effects on community dynamics as people were resettled twice not with old neighbors and family, but instead had to rebuild communities with new people each time.

Education

Dichato has two schools in the public school system for grades pre-k through 8. Students go to high school in Tomé. There are about 650 children in school in Dichato. Most Dichatino children graduate from high school, but only 5-10% of students attend university.²⁸ There are about 640 students currently in both schools. For high school, students go daily to the town of Tomé. Most students complete high school, though only about 5-10%²⁹ of students attend University.

Education has changed somewhat since the tsunami. Because they built a second school all kids can go to school for the full day whereas before they only had half days to accommodate all the students. There has also been an increase in interest in University and it has been easier to get grants and loans, because the requirements for student loan applications have been loosened for students coming from the tsunami affected areas. In Chile there are quite a few scholarships available for students.³⁰

According to the Principal some students lack motivation and vision beyond a short-sighted sense of trying to make money off tourists in the summer and surviving the winter. Another concern, echoed by many others in the town, is that because of the large amounts of resources and attention given to Dichato after the tsunami, there is a sense of expectation that the government will provide for people, and therefore a lack of motivation and self-reliance that permeates the community.

The school has programs to help children overcome their fear of the sea, learn to swim and start to see the ocean as a resource for their community, not just a threat.

There are some initiatives in conjunction with the University of Concepción, one called 'explora' through which the kids learn marine science. Some in the community feel there is less of a connection with the University. Many of the scientists are here just doing science and don't necessarily think about the educational opportunities. However, the University could do more by opening its labs and hatcheries to for educational field trips where school children can enjoy and learn more about aquaculture.

²⁸ Estimates from Mayor's office staff and public school Principal

²⁹ estimates form Mayor's office staff (5%) and Principal (9%)

³⁰ Students with a high school grade average of 6 or above are eligible for President's scholarship. Those who score well enough on the National Exam and pursue education studies can get grants and there are grants for people with indigenous roots, among others.

Appendix VIII: Case Study on Algae Collecting

Dichato fishermen have established a co-op for algae production. This co-op helps local algae collectors organize and sell their harvest. Algae collection is a widespread industry in Chile because of increasing demand for algae from Asian countries. Domestic algae consumption is low because Chileans do not typically eat algae. Collecting algae is advantageous for fishermen in that it does not require complex technology, but algae collectors earn a mere USD 4 to 5 per day.

We interviewed six fishermen about the algae business as they packaged the algae. They collect five different types of algae, with each type selling for a similar price. These fishermen work six days a week using fishing boats to collect the algae. Each boat collects around 500kg of algae per day and then sells it to an intermediary collector for CLP180/kg. The intermediary buys the algae from the fishermen in Dichato and transports it to Coronel. In Coronel, the algae is processed and then exported.

When the fishing industry is doing well, fewer fishermen collect algae because of the low profits. For example, congrio, a fish found in the waters around Dichato, sells for CLP3,000 per kg, and a large congrio weighs 10kg. However, as mentioned throughout this report, fishing stocks have been declining. It appears that many local fishermen work in both fin-fishing and algae collecting depending on the perceived profitability of each activity.

In addition to low wages, algae collection endangers the environment because fishermen collect the algae from the seabed, which destroys the algae too quickly that it cannot re-grow. From interviews with various fishermen, this practice will risk elimination of a majority of the algae in one to two years. Hence algae collection is not a viable industry for Dichato fishermen.

Appendix IX: Stakeholder Recommendations Map

		Policy Recommendations									
		Potential stakeholders	Government agencies	Funding agencies	Technical support						
1	Business skills & analysis support	<ul style="list-style-type: none"> • Accessible training programs on aquaculture techniques and business strategies 	x	x	x			x	x	x	
2	Funding Support	<ul style="list-style-type: none"> • Tailored info outreach • Multi-year funding opportunities 	x	x	x		x	x	x	x	
3	Permits/Concessions	<ul style="list-style-type: none"> • One-stop shop to facilitate funding & permit process • Streamline permitting process 	x	x	x	x				x	
4	Implementation support	<ul style="list-style-type: none"> • Establishment of hatchery to provide low-cost seeds to aquaculture farmers • Partnership with UdeC for technical assistance 	x	x				x			
5	Marketing	<ul style="list-style-type: none"> • Link tourism and shellfish aquaculture to simultaneously promote both industries 	x	x	x					x	
6	Ongoing business development & funding support	<ul style="list-style-type: none"> • Ongoing classes and programs on farming techniques and business • Funding support for business expansion 	x	x	x		x	x	x	x	x

Aquaculture entrepreneurs	Fishermen Syndicate	Municipality of Tome	Subpesca/Serma pesca	Corfo	Sercotec	University of Concepcion	Chile Emprande Fomento Productivo

Appendix X: Application Process for Concession

There are two types of access rights available for aquaculture farmers:

- *Área de Manejo y Explotación de Recursos Bentónicos (AMERB)*
 - o Available only for groups of artisanal fishermen
- *Concesión de acuicultura*
 - o Available for individual people

Process for Submitting an Application for Concession:

1. A *Concesión de acuicultura* must be approved by both:
 - **The Secretary of the Armed Forces**, which authorizes concessions through the Sub-Secretary of the Armed Forces, in areas dedicated as “Appropriate Areas for Aquaculture”.
 - AND**
 - **The Sub-Secretary of Fishing**, which authorizes permits to allow aquaculture activities.
2. The full application must include:
 - o Application Form
 - o Technical Report
 - o Chart identifying the geographical location of the concession request.
 - o Certificate of Maritime Authorization
 - o Various other legal documents
3. Once the application is submitted, Sernapesca verifies the receipt of the application, that all documentation is in order, and then submits the application to Subpesca for verification.
4. Subpesca then verifies:
 - The absence of previous authorizations and concessions on the space according to a cartographic analysis
 - Compliance with the law subject to:
 - o Ministry of economy (for example, activities not exceeding the carrying capacity of the Bay)
 - o The limitation of the requested area (m²) according to types of species, systems of cultivation and number of structures to be installed
 - Environmental regulations for aquaculture (branch)
 - CPS (Preliminary Site Characterization)
 - Environmental information, which includes production details and projections about annual production.
 - Law on General Bases of the environment, if necessary
 - Admission to the evaluation system of environmental impact for resolution of environmental qualification obtaining.
 - Legal analysis of the application and documents submitted by the applicant.
 - Finally pronounce approving or rejecting the request by means of a resolution.
5. Subpesca then submits the application to the Secretary of the Armed Forces, who:
 - Receives record with resolution of Subpesca
 - Examines the record and analyzes the background provided by the other institutions involved in the process.
 - Issues a resolution that grants the concession.

- Forwards resolution and record to Comptroller General of the Republic with decision.
6. Once the applicant has received the resolution for a concession from the armed forces, the applicant must submit notice of the concession and its summary for publication in the official journal (45 days from notification deadline).
 7. During this time, the unique patent of aquaculture should be confirmed.
 8. Registration with the national register of aquaculture is automatic with publication in the official journal.
 9. Finally, within three months the applicant must request the actual delivery of the authorization/concession (entrega material) to the Maritime Authority. The official delivery of the authorization/concession is performed once the fee for the concession or authorization is paid.
 - Once the business begins to operate, it must report monthly to Sernapesca.