

Belize in the Shrimp GVC

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I Executive Summary

This report uses the Global Value Chain (GVC) framework to examine Belize's position in the global shrimp industry and identify opportunities for local businesses to improve their competitiveness. While the sector has been punished by an outbreak of Early Mortality Syndrome (EMS), there are reasons for optimism. The industry has demonstrated an ability to coalesce in times of crisis and take steps to attempt process upgrading. Stakeholders have identified appropriate measures to improve the country's bio-security protocols and its resiliency to disease; however, to ensure those solutions are permanent, local actors must strengthen institutions while adopting a proactive approach to evaluating global trends that may alter the country's competitive landscape.

The Shrimp Global Value Chain

Shrimp is the second-leading seafood species as measured by world trade, trailing only salmon. There has been a strong increase in recent production, with global output increasing from 6.5 million MT in 2006 to 8.3 million MT in 2015, a jump of nearly 30%. The surge in production as well as some reshuffling of the global supply chain has led to some price fluctuations that have influenced total exports as measured by value. After shrimp diseases reduced supply in important production centers and pushed prices higher from 2010-2013, prices dropped by 15-20% in 2015 as large producers came back online. In more recent years, export values have recovered as prices have stabilized amidst record supply and demand.

The value chain itself can be divided into five categories: production, processing, trade/distribution, secondary processing, and retail. Inputs also play a critical role in aquaculture production. While the broad features of the global industry have supported growth, there has been important structural evolution in recent years. Some of the more tangible include the following:

- **Aquaculture is responsible for increasing share of global shrimp supply:** Fish farms account for a higher share of global shrimp supply than the broader seafood industry. Aquaculture's share of overall global fish consumption has jumped from 7% in 1974 to 44% in 2014 (FAO, 2016b). In shrimp, aquaculture's share first exceeded 50% in 2007 and accounted for 59% in 2015. Developing countries play a central role in aquaculture, accounting for 95% of total production.
- **Southeast Asia is still a major production hub, but recent growth has concentrated in other markets.** The world's leading producers traditionally have been in Southeast Asia. Measured by value across the value chain, the world's leading exporters in 2015 were India, Vietnam, Ecuador, China and Thailand (UN Comtrade, 2018). In recent years, one of the more pronounced trends has been emerging countries such as India and Ecuador gaining export share at the expense of Thailand and others.
- **Economic and environmental considerations increasingly favor intensive production systems found in Southeast Asia.** Shrimp production systems can be classified on a continuum from extensive to semi-intensive to intensive systems. *Intensive* farms feature the most aggressive use of inputs and management practices, including stocking densities, feeding and aeration rates, and human oversight. Recent advances in feed and aeration technologies provide benefits for intensive systems. Southeast Asia is notable for its reliance on intensive farms, with intensive systems demonstrating clear economic

benefits in Vietnam and Thailand (Engle et al., 2017). Moreover, environmental groups have advocated for intensive systems, citing the benefits of its reduced use of land, water and energy resources (World Wildlife Fund, 2017).

- **Early Mortality Syndrome has decimated stocks in Thailand and other countries.** Thailand's decline in exports is the result of a dramatic decrease in supply due to EMS. The disease, which impairs shrimp's digestive systems and results in mortality rates of 70% in afflicted ponds, has led to annual losses of close to US\$1 billion in the global industry (Global Aquaculture Alliance, 2015). Thailand was hit particularly hard, with EMS cutting overall production by 51% in two years and exports 57% in three years.

Belize in the Shrimp GVC

Aquaculture in Belize is an important generator of revenue and foreign exchange. The industry accounted for 3% of GDP in 2015, which put it above the regional average of 2% and just behind the country's sugar sector in terms of economic importance (FAO 2016a; FAO 2005). While small in overall size compared to the global industry, Belize's shrimp industry has distinguished itself through its country-wide pursuit of sustainability and environmental certifications. However, a recent outbreak of EMS has decimated production and threatened the survival of multiple smaller and medium-sized businesses. Recent trends and overall characteristics that are worth accentuating include:

- **Producers earning widespread ASC certification.** Eight Belizean shrimp producers completed ASC certification in 2015 through a program initiated by the Belize Shrimp Growers Association (BSGA) and funded by the Compete Caribbean initiative. As a result, Belize became the first country to have at least 90% of its national production system verified by the organization that evaluates environmental sustainability and protections as well as social responsibility in aquaculture (WWF, 2015).
- **EMS devastating shrimp production and exports.** Shrimp producers first started seeing signs of EMS in 2014 before widespread dispersion the following year. Whereas country-wide pre-EMS survival rates frequently approached 80-85%, many farms reported survival rates of 0-10% in 2015 as the country's production and exports plummeted. In 2014, the country's total production volume was 7,163 metric tons and the value of its exports was US\$44 million; by 2016, aggregate production had fallen to 1,089 metric tons and the value of shrimp exports was US\$6.1 million.
- **Belize's ongoing EMS recovery will be predicated on process upgrades.** In the wake of the EMS outbreak, the Belize Shrimp Growers Association (BSGA) has organized widespread outreach to educate farmers about improved bio-security measures as well as other mitigation strategies, including the use of amendments in the aquatic environment and feed (Field Research, 2018). Additional support is forthcoming through a \$400,000 grant from Compete Caribbean that was announced in February 2018 to further enhance bio-security.

The industry itself is a small network of businesses, with roughly 20 companies active in the upstream segments of the shrimp GVC. It is somewhat top-heavy, with the five largest companies accounting for 96% of total output as recently as 2013. Most of the big producers have capabilities in multiple segments of the chain, although some of the country's recent expansion of hatchery

operations has been a survival strategy. The relatively few numbers of actors as well as the geographic clustering promotes a relatively friendly, informal atmosphere that is also nurtured by the BSGA and its proactive information sharing among firms.

While there are some formal relationships between Belizean companies and downstream businesses, market dynamics govern most relationships. Although the local industry is not defined by power asymmetries between those buyers and sellers—in periods of regular production, Belizean farmers benefit from relatively strong and consistent international demand as well as easy access to a variety of markets—foreign actors give Belize’s shrimp value chain much of its shape, specifying production characteristics as well as processing considerations for domestic actors.

Aggregated, these characteristics lead to strengths for Belize as it pursues upgrading trajectories in the shrimp GVC. These advantages include:

- 1. Engaged stakeholders buoy institutional environment.** If governance is mostly dominated by foreign buyers and certification standards, the local landscape is characterized by casual relations between actors who often prize individual agency. While this attribute has at times impeded the development of a consistent structure within the sector, the bottoms-up approach to institutionalization has had successes in recent years, with engaged stakeholders either leading or assisting significant process upgrades.
- 2. Recent history of country-wide ASC certification.** The most prominent example of institutions and actors within the sector producing tangible results is the country-wide push for ASC certification achieved in 2015. Significantly, that effort—which involved financial support from the Compete Caribbean program—signaled to outside actors that Belizean production adheres to environmental and social best practices, thereby providing access to European and North American markets that pay higher prices for shrimp.
- 3. Favorable incentives for producers through EPZ regime.** All of Belize’s shrimp farms are located in EPZs throughout the country. The Ministry of Investment, Trade and Commerce manages the EPZ regime, which began in the 1980s to help nurture the aquaculture sector by exempting companies from import duties and taxes on export sales.
- 4. Access to Mexican, Caricom markets.** Before EMS, close to 75-80% of the volume of recent shrimp exports went either to Mexico or Caricom. Both are in relatively close geographic proximity to Belize and have duty-free agreements, providing producers with relatively easy access to those markets.
- 5. Geographic clustering and environmental conditions around Big Creek area.** Most of Belize’s shrimp farms and processing facilities are located near the coast in the south and central portions of the country. The close geographic proximity alleviates some of the logistical challenges associated with moving shrimp from production to processing sites in a country where road infrastructure is underdeveloped. It also facilitates informal information-sharing among neighboring sites.
- 6. Extensive hatchery operations.** Whereas regional peers have limited hatchery operations, Belize has growing capacity in this segment of the chain—of the US\$30 million

spent on aquaculture investments from 2014 to 2016, the second largest category of expenditures was for hatcheries (Field Research, 2018).

At the same time, there are multiple challenges, some of which have become particularly pronounced in recent years. The most prominent include:

- 1. Bio-security protocols and system resilience to diseases.** The EMS outbreak has highlighted the shrimp industry's vulnerability to disease. EMS and other afflictions often spread through seawater and pond conditions that cannot be completely inoculated; building system resilience across the country is the most effective strategy for recovery.
- 2. Non-scientific approach to semi-intensive production systems.** While the global industry has moved toward a science-based, input-heavy method of shrimp farming, Belize's production system remains somewhat informal. Leading firms have adapted more rigorous methods, with corresponding investments in intensive systems. But many smaller actors still rely on trial-and-error and previous experience to a significant degree.
- 3. Uncapitalized farmers and insufficient financing mechanisms.** With EMS wiping out production for much of the 2015-2017 period, producers have had limited inflows of revenue in recent years. Many farms are facing difficulties securing financing to help bridge the gap. Local banks reportedly will not extend loans to shrimp farms, and government organizations are risk averse.
- 4. Informal, reactive institutional environment.** While the EMS outbreak has demonstrated the cohesion and strength of the institutional environment, the lack of a rigid structure and limited resources sometimes limits the effectiveness of key supporting actors. Interviews highlighted the country's overall complacency with respect to bio-security measures before the emergence of EMS, a characteristic that might have contributed to the disease's spread. Adherence to bio-security standards is still mostly voluntary.
- 5. Limited pool of skilled human capital with knowledge of industry best practices.** The industry benefits from the availability of lower-skilled workers who lived in the rural area in the Stann Creek and Toledo districts. However, there are shortages of higher-skilled candidates who have knowledge of industry best practices.
- 6. Underdeveloped supporting features such as infrastructure and construction capacity.** From construction to logistics, supporting services are generally underdeveloped in Belize. While not specific to the shrimp industry, infrastructure shortcomings are among the most pronounced.

Chile and Ecuador are examples of two other countries that have faced similar obstacles in aquaculture value chains. As part of its disease-prevention strategies, Chile's government paid more attention to the nuances of the aquaculture compared to wild fisheries. Collaborative and coordinating bodies were created or more representative industry associations formed. These organizations helped create new regulations that aimed to improve environmental or bio-security standards while also providing for comprehensive enforcement. Laws were changed to provide financial support to farmers, implement aggressive bio-security measures, facilitate collective action to shared problems, and strengthen the authority of the National Fisheries Service.

Ecuador learned valuable lessons after disease difficulties in the late 1990s and early 2000s, helping it avoid large-scale EMS outbreaks and increase its global market share of shrimp exports. The government did this partially by providing the National Fisheries Institute with increased power. Additionally, the industry association for aquaculture was proactive against emerging threats, creating ad hoc committees, reviewing existing protocols and performing extension services to educate farmers. It even enlisted neighboring countries to adopt preventive laws that strengthened the resiliency of the region.

Belize's upgrading path in the shrimp GVC can replicate elements of both Chile's and Ecuador's experiences. To set such a course, Belize can employ broad-based strategies that address the following characteristics:

- *Institutionalization*: The industry has impressive individual agency but lacks a consistent overall structure to facilitate growth. The Chilean and Ecuadorean case studies detailed how institutions in both countries helped chart recovery efforts to disease outbreaks. Belize can replicate the aggressive monitoring of the aquaculture sector.
- *Human Capital*: Historically, human capital has not been a major constraint in the shrimp industry. However, with the onset of EMS and the advance of more scientifically rigorous shrimp farming, there is need for more skilled human capital that are conversant with bio-security protocols and best aquatic practices.

At the same time the country pursues these transversal trajectories, more narrow upgrading paths should also be pursued. These include the following:

1. **Process upgrading to improve bio-security.** Multiple stakeholders indicated that Belize's passivity to adopting stringent, systematic bio-security measures increased its vulnerability to disease. Both the BSGA and the Belize Agricultural Health Authority (BAHA) have taken steps to boost system resilience since EMS' emergence; however, further actions are required. Care must be taken to ensure there are credible enforcement mechanisms as well as an outreach effort to educate producers about the benefits.
2. **Process upgrading by moving toward intensive or extensive production systems.** Belize is somewhere in the middle on the extensive/intensive continuum, with mostly semi-intensive farms. Some producers have made investments in intensive systems, although others have been deterred by the financial costs and the need for more sophisticated human capital. In light of the undercurrents in the global industry, Belize stakeholders would benefit from understanding the value associated with shifting further toward intensive models and evaluate appropriate strategies.
3. **Functional upgrading through expansion of hatchery operations.** The second largest category of investments since 2014 in Belize has been associated with hatchery operations (Field Research, 2018). Some of the investments have been from new companies, while others have been made by businesses looking to develop shrimp that are either more dynamic. While these activities are initially focused on bolstering local supply, the recent investments as well as the global emphasis on improved genetics provides opportunity for future functional upgrading.

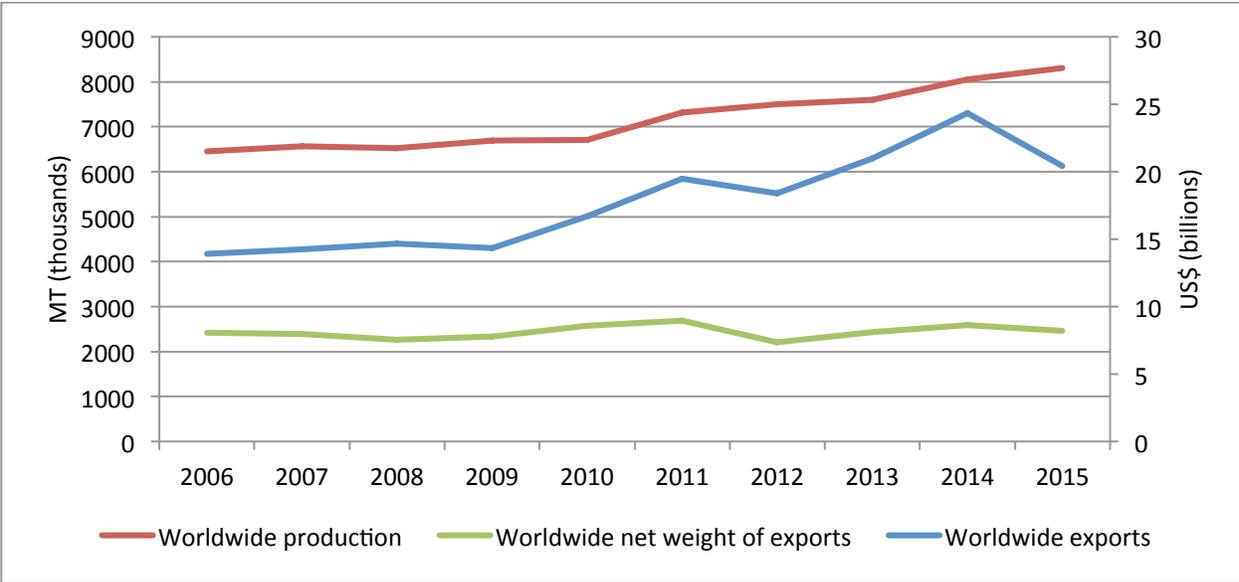
2 Global Shrimp Industry

Shrimp is the second-leading seafood species as measured by world trade, outpacing the likes of tuna and whitefish while trailing only salmon (FAO, 2016b).¹ There has been a strong increase in recent production, with global output in the last 10 years increasing from 6.5 million MT in 2006 to 8.3 million MT in 2015, a jump of nearly 30%. While there is a time lag associated with publication of FAO data, other sources have reported that global production has maintained its ascent, with 2017 setting a record and 2018 forecasted to do the same (Harkell, 2018a; Seaman, 2018).

The surge in production as well as some reshuffling of the global supply chain has led to some price fluctuations that have influenced total exports as measured by value. After shrimp diseases reduced supply in important production centers and pushed global prices higher from 2010-2013, the worldwide price of shrimp dropped by 15-20% in 2015 as large producers came back online and supply surpluses persisted in important markets such as the US, Japan and Europe (FAO, 2017). As a result, the value of global shrimp exports was US\$13.9 billion in 2006 and climbed to US\$24.3 billion in 2014 before dropping precipitously to US\$20.4 billion in 2015, despite overall volume sticking close to historical norms (between 2.2-2.7 million MT from 2006 to 2015) (see Figure 1).

In more recent years, export values have recovered as prices have stabilized amidst record supply and demand. Important export markets reported double-digit percentage increases in both volume and value terms in 2017 (Harkell, 2018b; Seaman, 2018). At the same time, imports into the US and the EU increased 10% and 6% over 2016, respectively, according to preliminary data (Harkell, 2018b; Seaman, 2018).

Figure 1: Value of Worldwide Shrimp Exports, 2006-2015



Source: UN Comtrade, 2018; FAO Fisheries Database. **Note:** Includes all product categories across value chain.²

¹ The term “shrimp” in this report captures all varieties and includes prawns. Table A-1 in the Appendix compares export shares of seafood products.

² The HS codes that capture trade of shrimp products include the following: 30613, 30616, 30617, 30623, 30626, 30627, 30635, 30636, 30695, 160520, 160521 and 160529. The 30617 HS code accounts for 66% of the value of all shrimp exports.

Beyond the recent supply and demand considerations, there are other characteristics that have helped shaped the global industry in recent years. The most significant of these include the following:

- 1. Aquaculture is responsible for increasing share of shrimp supply.** While all categories of seafood are increasingly reliant on aquaculture,³ fish farms account for a higher share of global shrimp supply than the broader industry. Aquaculture’s share of overall global fish consumption has jumped from 7% in 1974 to 26% in 1994 to 39% in 2004 to 44% in 2014 (FAO, 2016b).⁴ In shrimp, aquaculture’s share first exceeded 50% in 2007 and accounted for 59% in 2015.

Developing countries play a central role in aquaculture, accounting for 95% of total production. Moreover, 96% of the growth in worldwide aquaculture projected to occur before 2025 is forecasted in emerging nations (FAO, 2016b). China, the world’s leading producer, has been especially important in the growth of shrimp aquaculture. In 2000, 18% of the country’s total production volume came from shrimp farms (192,339 MT of 1.07 million total). By 2015, roughly 60% of the country’s total production came from farms (1.8 million MT of 3.2 total).

Table 1: Worldwide Exports of Shrimp and Shrimp Products, 2006-2015

Country	Export Value (US\$, millions)					World Share				
	2006	2008	2011	2013	2015	2006	2008	2011	2013	2015
World	13,905	14,683	19,472	21,004	20,441					
India	1,025	849	1,619	2,624	3,198	7.4%	5.8%	8.3%	12.5%	15.6%
Vietnam	1,381	1,571	2,412	2,998	2,852	9.9%	10.7%	12.4%	14.3%	14.0%
Ecuador	596	721	1,183	1,806	2,315	4.3%	4.9%	6.1%	8.6%	11.3%
China	1,339	1,380	2,189	2,538	1,921	9.6%	9.4%	11.2%	12.1%	9.4%
Thailand	2,287	2,535	3,668	2,286	1,667	16.5%	17.3%	18.8%	10.9%	8.2%
Indonesia	1,086	1,084	1,285	1,582	1,574	7.8%	7.4%	6.6%	7.5%	7.7%
Argentina	—	—	515	616	763	—	—	2.6%	2.9%	3.7%
Denmark	599	765	626	714	687	4.3%	5.2%	3.2%	3.4%	3.4%
Netherlands	451	554	660	656	635	3.2%	3.8%	3.4%	3.1%	3.1%
Canada	411	—	—	—	447	3.0%	—	—	—	2.2%
Bangladesh	478	457	494	445	—	3.4%	3.1%	2.5%	2.1%	—
Belgium	—	467	—	—	—	—	3.2%	—	—	—

Source: UN Comtrade, 2018. Based on 30613, 30616, 30617, 30623, 30626, 30627, 30635, 30636, 30695, 160520, 160521 and 160529 HS codes.

- 2. Although Southeast Asia is a major shrimp production hub, recent growth has concentrated in other markets.** The world’s leading producers traditionally have been in Southeast Asia. Measured by value across the value chain (both raw shrimp and shrimp

³ The FAO defines aquaculture as the “farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated (FAO, 1997).”

⁴ Unless otherwise specified, all global aquaculture production statistics cited in this section of the report come from the FAO, either through its aquaculture database or (FAO, 2016b).

preparations and other products), the world's leading exporters in 2015 were India, Vietnam, Ecuador, China and Thailand (UN Comtrade, 2018). While China is the world's leading shrimp producer, between 80-90% of its production is consumed by domestic consumers (Anderson et al., 2016).⁵ Table 1 above lists the leading exporters from 2006-2015. Overall, the total global value increased almost 47% in the decade.

In recent years, one of the more pronounced trends has been emerging countries such as India and Ecuador gaining export share at the expense of Thailand and others. India's exports have grown from 7.2% of the world market in 2006 to 15.6% in 2015 while Ecuador's has jumped from 4.2% to 11.3%. Thailand, meanwhile, has lost its position as the leading source of shrimp, falling 18.8% of worldwide exports in 2011 to 8.2% in 2015.

- 3. Economic and environmental considerations increasingly favor intensive production systems.** Shrimp production systems can be classified on a continuum from extensive to semi-intensive to intensive systems. *Intensive* farms feature the most aggressive use of inputs and management practices, including stocking densities, feeding and aeration rates, and human oversight. Significantly, pond sizes for intensive production systems are smaller (often smaller than one hectare) and usually feature lined bottoms; *extensive* systems, meanwhile, require minimal water pumping and allow shrimp to live in conditions close to their natural state (Kongkeo, 2005).

Historically, there have been divergent opinions about which end of the production spectrum provide the most benefits. There is evidence that low-input extensive production systems generate higher returns through minimal input costs, lower disease rates and improved feed conversion ratios (FCRs) (Engle et al., 2017). However, recent advances in feed and aeration technologies provide additional benefits for intensive systems. Southeast Asia is notable for its reliance on intensive farms; analysis of farm-level data in Vietnam and Thailand show clear economic benefits for intensive production systems (Engle et al., 2017). Moreover, environmental groups have advocated for intensive systems, citing the benefits of its reduced use of land, water and energy resources (World Wildlife Fund, 2017).

- 4. Early Mortality Syndrome has decimated stocks in Thailand and other countries.** Thailand's decline in exports is the result of a dramatic decrease in supply after its shrimp were decimated by Early Mortality Syndrome (EMS). The disease, which impairs shrimp's digestive systems and results in mortality rates of 70% in affected ponds, has led to annual losses of close to US\$1 billion in the global industry (Global Aquaculture Alliance, 2015). It first appeared in Southeast Asia, emerging in China before spreading to Vietnam and other regions. Thailand was hit particularly hard, with EMS cutting overall production by 51% in two years and exports 57% in three years (Figure A-1 in the Appendix charts Thailand's production volume and exports in the period of 2000 to 2015).⁶ The country has employed a number of strategies to cope with EMS, including selecting species that are not impaired by the disease and instituting farm-level process upgrades to improve sanitation (Jittapong, 2014). However, with India and Ecuador gaining and maintaining market share at Thailand's

⁵ Chinese shrimp consumption increased 123% in the period from 2005 to 2015 (Anderson et al., 2016).

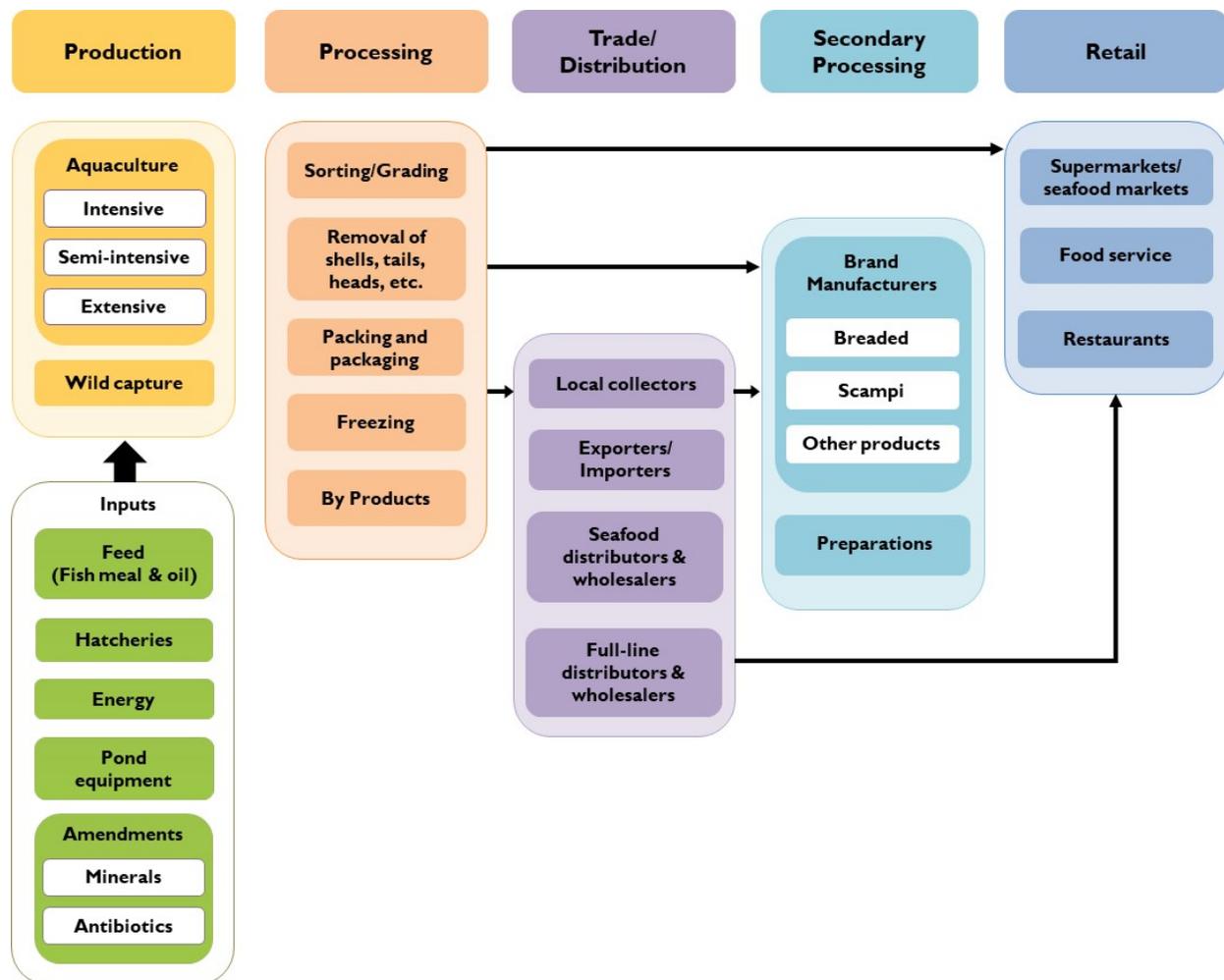
⁶ Production fell from 653,470 MT in 2012 to 318,443 MT in 2014 while the value of the country's shrimp exports—excluding shrimp preparations—fell from US\$17.5 million to US\$7.3 million.

expense (Rabobank, 2015), it remains to be seen if Thailand can regain its position as the world's leading exporter.

2.1 Shrimp Global Value Chain

The shrimp value chain includes several stages of transformation. Inputs and production take a different form depending on whether aquaculture is involved; since the shrimp industry in emerging markets is tilted toward aquaculture, this sub-section focuses mostly on activities associated with farms and only discusses wild shrimp or fishermen where appropriate. Figure 2 provides a visual representation of the various stages of value-addition in the shrimp GVC and highlights the firm-level actors or activity typically associated with each segment. The following section offers a brief introduction to each category.

Figure 2: Shrimp Global Value Chain



Source: Authors.

Inputs

The most significant input in the shrimp GVC is feed. Across all forms of aquaculture, fish feed accounts for between 40-50% of total production costs (M&A International, 2013). Shrimp largely

conforms to larger aquaculture trends, with some minor variance (Field Research, 2018; World Wildlife Fund, 2017). Fish meal and fish oil are the most common ingredients of food; fish meal is the term to describe the flour that is generated through the milling and drying of fish parts, while fish oil is the liquid that is produced by pressing fish remains or cooked fish (FAO, 2016b).⁷

FCRs, the feed-to-output conversion ratios, are important predictors of economic success for shrimp producers. Targets vary depending on production systems; however, a general rule is that 80 tons of feed generates 50 tons of output for FCRs in the range of 1.5-1.6 (IBIS World, 2016; Kongkeo, 2005). With the general shift toward aquaculture in seafood value chains, there has been increased demand for fish feed, which has put upward pressure on prices. In general, there is a measure of price volatility, with governance features and regulatory considerations influencing costs.⁸

While feed is the largest input cost, there are others, including capital requirements such as tanks, cages, pumps and feeding systems. Energy and power requirements are also significant costs. Hatcheries provide access to broodstock and shrimp post-larvae (PLs);⁹ breeding technology can drive productivity gains by providing access to genetic modifications that allow for increased growing rates or reduced disease risks (IBIS World, 2016; Ponte et al., 2014)¹⁰ Finally, shrimp producers use a variety of amendments for farming and pond environments, with common categories including lime, minerals, disinfectants, antibiotics and probiotics (Engle et al., 2017). There is, however, a growing emphasis on antibiotic-free aquaculture practices, with a number of countries limiting their use.

Production

Production is generally concentrated in Southeast Asia, although India and Ecuador are also major suppliers of shrimp for the global markets.¹¹ Most leading producers as well as emerging actors generate most of their shrimp on farms—aquaculture is responsible for 98% of shrimp production in Ecuador, 89% of all production in Thailand, and 76% in Vietnam (FAO Fisheries Database). Across all forms of aquaculture, the overall numbers of people involved at the production level has trended down in recent years to 18.75 million people in 2014 after peaking at 18.86 million in 2012 (FAO, 2016b).

Market prices for all varieties of shrimp are highly integrated and do not appear to distinguish between wild-caught and farmed shrimp in the long run (Asche et al., 2012). Instead, shrimp's sized-based model is its most prominent long-run determinant of prices and distinguishes it from other seafood species; in the US market, for instance, jumbo shrimp (15 count or less) can receive nearly

⁷ Fish meal can also be supplemented by soy meal, wheat gluten, corn meal, stabilized vitamin C and other materials (IBIS World, 2016).

⁸ For example, the Environmental Protection Agency in the US changed its ethanol policy in 2013, which allowed increased amounts of corn to be used in the manufacture of fish feed. This had the result of boosting the global supply of fish feed, which drove the price down in 2015, 2016 and 2017 (IBIS World, 2017).

⁹ The term “broodstock” refers to mature female shrimp that are used for breeding purposes. PLs are the baby shrimp. Belize allows imports of broodstock but does not permit importation of PLs for bio-security purposes.

¹⁰ The number of hatcheries in significant shrimp producing countries has dramatically increased in recent decades. In Vietnam, for instance, there were roughly 500 shrimp hatcheries in 1990; by 2005, that number had increased to 2005 (Tran et al., 2013).

¹¹ Of the more than 18 million people engaged in fish farming worldwide, 94% were located in Asia, followed by Latin America and the Caribbean (1.9%) and Africa (1.4%) (FAO, 2016).

10 times the price of smaller shrimp (Roheim et al., 2016; Smith et al., 2017). With farmed shrimp, there are two species that account for roughly 80% of global supply: *Penaeus vannamei* (Pacific white shrimp) and *Penaeus monodon* (giant tiger prawn) (Anderson et al., 2016). The variety of shrimp grown often depends on the production system used: *Penaeus monodon* prefer the conditions found in extensive ponds.

As highlighted in the Introduction to this section, production systems can be divided into extensive, semi-intensive and intensive systems. Broadly, intensive systems use higher levels of inputs across the board. Key variables that differentiate the production regimes include the following:¹²

- **Pond sizes:** The average size of ponds range from 0.5-1 hectare (intensive) to 5-10 hectares (semi-intensive) to as many 20 hectares.¹³
- **Stocking densities:** Extensive farms stock shrimp PLs at a rate of 10-15 per square meter while intensive operations target as many as 100.
- **Aeration:** Water circulation is minimal in extensive ponds, with tractors and paddlewheels serving as common strategies; intensive ponds, meanwhile, require capital investments in pumps or electric motors to keep water moving.
- **Feeding rates:** There is daily or twice-daily feeding for extensive systems, while shrimp in intensive ponds receive food as many as five times per day.
- **Bottom of ponds:** Extensive and semi-intensive often feature earthen bottoms, while intensive ponds are lined.
- **Human capital:** While extensive ponds require minimal daily oversight, intensive sites require higher numbers of workers as well as more sophisticated trainings to monitor scientific data and pond conditions.

The costs associated with intensive systems are anywhere from 100-500% higher than semi-intensive and extensive varieties (Engle et al., 2017; Field Research, 2018; Kongkeo, 2005). However, costs per metric ton of shrimp produced are often lowest in intensive farms,¹⁴ with intensive farms also generating consistently higher net returns (Boyd et al., 2017; Engle et al., 2017). Table 2 below provides a summary of key economic results observed in shrimp farms in Thailand and Vietnam. While extensive regimes in Vietnam lost money, intensive farms had returns of \$25,622 per hectare per year. High fixed costs for items such as land in the Thai cluster ensured that all farms sampled had negative net returns; however, intensive producers suffered less loss.

¹² The variables and ratios outlined are based on literature reviews (Engle et al., 2017; Kongkeo, 2005). Field research was also used to supplement where appropriate.

¹³ A study of 83 shrimp farms in Vietnam and Thailand reported variance in both average farm size (7.7 hectares in Thailand and 2.2 hectares in Vietnam) and average pond size (9.9 hectares for *P. monodon* and 0.4 hectares for *P. vannamei* in Thailand) depending on these factors (Engle et al., 2017).

¹⁴ In the analysis of shrimp farms in Thailand and Vietnam, the costs per pound of the lowest intensity farming in Vietnam were US\$10,245 compared to US\$3,484 at the highest; in Thailand, the same spread was US\$8,184-\$3,817.

Table 2: Key Economic Results for Shrimp Farms in Vietnam and Thailand

Factor	Extensive	Semi-Intensive	Intensive	
	LP	MP	HP	VHP
Vietnam				
Costs (US\$ per hectare per year)				
Feed	\$3,502	\$12,805	\$25,615	\$43,521
PLs	\$2,162	\$2,577	\$5,487	\$6,069
Amendments	\$986	\$4,106	\$21,556	\$48,033
Energy	\$526	\$924	\$2,182	\$2,336
Labor	0	0	\$5,186	\$7,588
Other	\$5,703	\$8,182	\$12,751	\$18,526
Total Costs	\$12,879	\$28,594	\$72,777	\$126,073
Gross Receipts	\$3,435	\$44,969	\$90,405	\$151,695
Net Returns	—\$9,444	\$16,375	\$17,629	\$25,622
Thailand				
Costs (US\$ per hectare per year)				
Feed	\$3,736	\$10,660	\$24,347	\$41,480
PLs	\$4,167	\$4,167	\$5,467	\$6,600
Amendments	\$1,389	\$992	\$1,924	\$5,301
Energy	\$2,315	\$5,343	\$5,850	\$6,384
Labor	\$0	\$313	\$1,639	\$7,763
Other (fixed costs such as land)	\$13,956	\$21,375	\$24,467	\$35,980
Total Costs	\$25,563	\$42,850	\$63,694	\$103,508
Gross Receipts	\$8,673	\$23,220	\$46,547	\$90,400
Net Returns	—\$16,889	—\$19,630	—\$17,149	—\$13,108

Source: Engle et al., 2017. **Key:** PL = postlarvae. LP = low productivity. MP = medium productivity. HP = high productivity. VHP = very high productivity.

Processing

In the processing stage of the chain, shrimp are sorted by size before they are frozen, packaged and prepared for shipment. The sorting is especially time-consuming and has been historically been described as the most labor-intensive processing activity (Karnicki, 1984). Depending on the final product, the shrimp may be peeled to remove heads, tails and shells. Most shrimp purchased undergoes some sort of processing: in terms of the final product form of farmed shrimp, only 29% are raw with heads and shells on; 19% are raw with heads off; 21% are peeled; 16% are pre-cooked, 7% are breaded and 9% are in other forms (Anderson et al., 2016).

Heads, tails and shells account for 50% of the weight of the animal (Heu et al., 2003), which means there is incentive to re-use the by-products of processing, either for human or animal consumption. Shrimp by-products can be further processed into fish meal or fish oil—across all aquaculture, these outputs are important sources of revenue for many countries active in the production and processing segments of the chain (FAO, 2016b). However, the overall trend line is more fish by-products to be used for human consumption, with increasing demand for stocks and soups as well as heads in some markets (FAO, 2016b).

While there are different models depending on the country and its position in the shrimp GVC, processing facilities are most often located near ports to improve logistics (Dubay et al., 2010). Additionally, processing facilities' quality control, hygiene practices, packing and packaging protocols and cold-chain infrastructure often determines their competitiveness (Field Research, 2018; Ponte et al., 2014). In nations with smaller catches, there may or may not be significant processing;

instead, shrimp are sold directly to traders without any processing or value addition activities (Oddone & Padilla-Pérez, 2016). Secondary processing then regularly occurs in the importing country.

Trade/Distribution

There are a large number of traders involved between multiple stages of the shrimp value chain. Depending on the location, production and processing may be integrated, or there may be extensive networks of collectors and intermediaries who move shrimp in preparation for export to final markets. In countries with fragmented production networks (Vietnam, for example), processors and exporters are usually far removed from farmers, which increases the importance of the traders, since they provide access to markets, help set prices and define modes of payment (Oddone & Padilla-Pérez, 2016; Tran et al., 2013). In countries where larger-scale or streamlined production systems (Thailand, for example), exporters can influence production standards and requirements to a higher degree, accentuating their power (Goss et al., 2000). Prominent importers may have internal capabilities inside production countries to facilitate trade; however, segmented approaches can also be observed (see Governance section).

Once importers receive the shrimp, there are two primary types of distributors and wholesalers: 1) *Specialty seafood distributors*, who feature a shrimp product line as part of their seafood focus (Pacific Seafood, Eastern Fish, Inland Seafood and Central Seaway are example in the US market, although it has a national presence); and 2) *Full-line distributors*; who sell a range of products and have national networks (Sysco and United Natural Foods Inc. are examples in the US market) (Dubay et al., 2010; White, 2017).¹⁵ In the US, fish and seafood wholesalers' most common customers are other wholesalers (46%) followed by restaurants, hotels and food service companies (24%), retailers (20%) and other markets (10%) (IBIS World, 2017a).¹⁶

The primary value addition of these wholesalers and other distributors is the ability and convenience associated with connecting retailers with imported products, often at significant volume or with characteristics that align with marketing considerations (Engle et al., 2016). Red Chamber, for instance, serves as a supplier for high-volume retailers such as Long John Silver's and can meet that company's need for bulk.

Secondary Processing

Brand manufacturers may perform secondary processing once receiving shrimp. This category of businesses includes companies that sell peeled, ready-to-cook, breaded or other value-added products in supermarkets or online. With shrimp production and processing companies investing in pre-prepared product lines, there could be future opportunities in this segment (Harkell, 2018a). There is also market for shrimp preparations, although sauces and other such products only comprised 20% of the total global export market for all shrimp products in 2016, down from 26% in 2012.¹⁷ SeaPak is a notable example of a company with a shrimp-focused product line. The US

¹⁵ A third, less prominent, category includes *environmentally sustainable distributors*, which includes actors who are most interested in environmental standards and certifications (Dubay et al., 2010).

¹⁶ Other wholesalers were defined as grocery wholesalers, frozen food wholesalers or smaller fish and seafood wholesalers. The other category included exports, manufacturers that use fish and seafood as inputs, businesses for end use in their operations as well as households and individuals (IBIS World, 2017a).

¹⁷ Table A-2 in the Appendix provides a breakdown of the share of shrimp products in the period from 2012 to 2016 based on HS codes from the UN Comtrade database.

company bills itself as the country’s top-selling frozen shrimp brand; it had annual sales of \$200 million with a diverse line of products sold in supermarkets (Sea Pak; White, 2017).

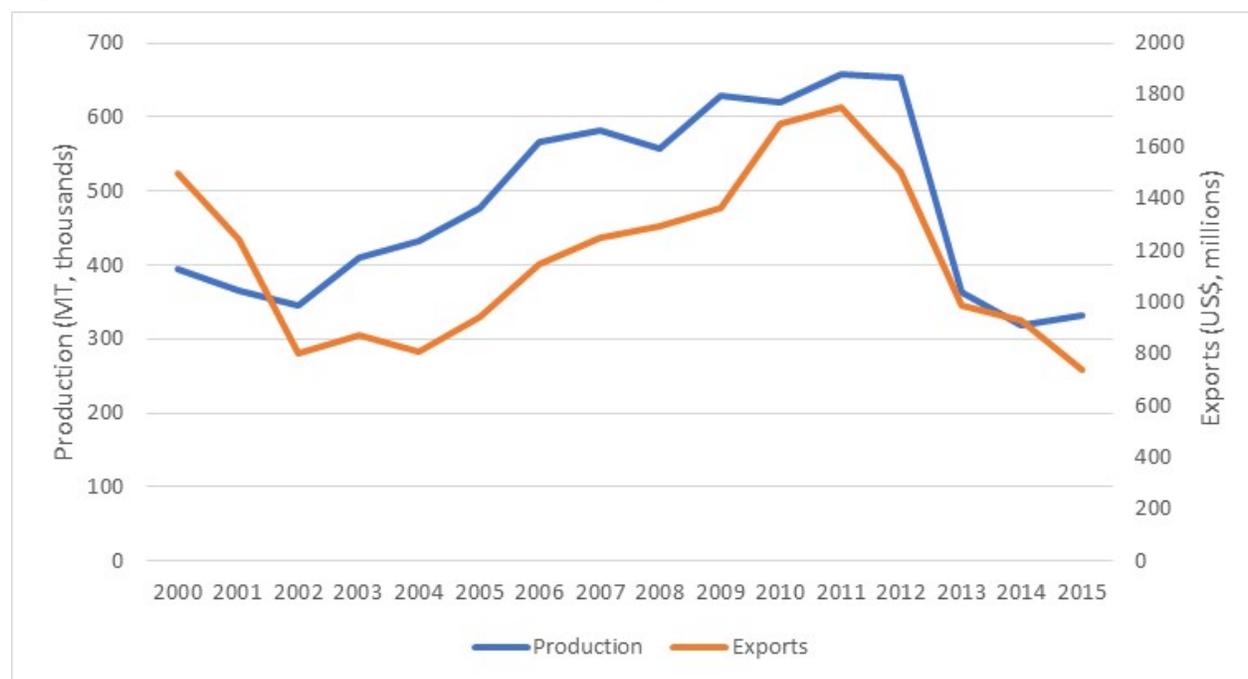
Retail

The final value chain category describes the businesses that sell shrimp to final consumers. There are three primary outlets: 1) general supermarkets or specialty seafood markets; 2) restaurants; and 3) food service or hospitality companies. Retail markets with specific concentrations on shrimp are not common; however, there are chain restaurants such as Red Lobster and Long John Silver’s in the US (owned by Darden Restaurants Group) with significant demand. Retailers and restaurants in developed markets in Europe and the US are noted for their demand for higher quality, certified products—these preferences are communicated upstream through the chain, most often through lead firms’ requirements for third-party standards (Ponte et al., 2014).

2.2 The Geography of Global Supply and Demand

Historically, global trade in farmed shrimp has been characterized by two dominant features: 1) Southeast Asian supply; and 2) American, European and Japanese demand. In recent years, there has been some disruption to this equilibrium, with countries such as India and Ecuador taking advantage of production downturns associated with diseases in Thailand and other places (Figure 3 below charts Thailand’s decline). Demand in important markets has fluctuated at points, with domestic production capacity, currency fluctuations and improvements in cold storage all moving global prices. However, the overall trend line points toward increasing production and consumption, with leading export and import markets reporting double-digit growth in 2017 (Harkell, 2018a, 2018b; Seaman, 2018). The following section analyzes global supply and demand. Unless otherwise stated, the source for all trade data is the UN Comtrade database.

Figure 3: Thailand Shrimp Production and Exports, 2000-2015



Source: FAO Fisheries Database and UN Comtrade, 2018. **Note:** Exports include only HS codes for raw or semi-processed shrimp and not shrimp preparations.

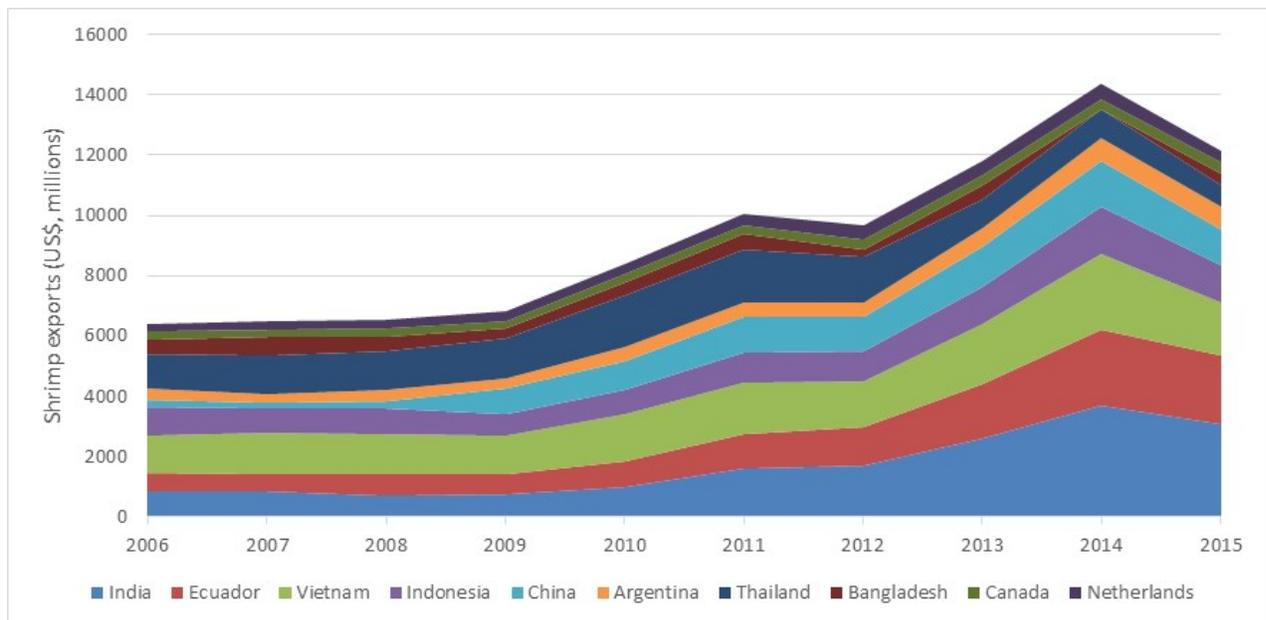
2.2.1 Supply

China's share of total global production has increased in recent years. In 2000, it generated 26% of the world's shrimp; by 2015, that figure had jumped to 38% (FAO Fisheries Database). Figure A-1 in the Appendix charts the trend over the 15 years from 2000 to 2015. Beyond China, the leading shrimp producers are India (11% of total production), Vietnam (9%), Ecuador (5%) and Thailand (4%). Ecuador's growth over that span has been marked—it only produced 1% of the world's supply as recently as 2003. Ecuador's ascension is a characteristic of the global industry, which has seen diversification in both demand and supply markets in the last decades (Ponte et al., 2014).

A precise estimate of the percentage of total shrimp production that is exported each year is complicated by weight disparities between shrimp in the production and processing segments.¹⁸ However, FAO literature as well as its aquaculture database suggests that roughly 65-75% of globally farmed shrimp is exported each year. While many countries export most of their production, China, the world's leading producer, only exports between 10-20% of its catch each year.

Beyond China, all the leading producers are also major exporters. Thailand had long been the top exporter of shrimp worldwide, posting a 14% share of all exports of shrimp (value) as recently as 2010. However, the country experienced a downturn in both production and exports beginning in 2012 due to an outbreak in EMS (see trend #4 in Introduction to this section). Figure 4 charts the drop, which has stabilized, although neither production nor exports have regained prior levels.

Figure 4: Annual Value of Leading Shrimp Exporters, 2006-2015



Source: UN Comtrade based on 30613, 30616, 30617, 30623, 30626, 30627, 30635, 30636 and 30695 HS codes.

¹⁸ Heads, tails and shells account for 50% of the weight of the animal (Heu et al, 2003).

Relative newcomers India and Ecuador have taken advantage of Thailand's troubles, growing their export market share to 20% and 14% in 2015 to be the leading two suppliers of shrimp on the global market. Both countries rely almost exclusively on aquaculture to generate supply and have taken advantage of geographical proximity to ship shrimp that have undergone only initial processing to European and US markets with increasing volume (Rabobank, 2015; UN Comtrade, 2018).¹⁹ Figure 4 charts the value of 2015's leading 10 shrimp exporters. It excludes shrimp sauces and preparations; therefore, some of the totals may differ from figures in Table 1 on page 2.²⁰

The interplay between Thailand, India and Ecuador and other leading exporters provide context for the fall in shrimp prices that was seen in 2015. That drop, which was highlighted in the Introduction, was associated with supply surpluses in leading markets. As the world's leading importer of shrimp, the US influences global prices to a significant degree. US wholesalers paid higher prices from 2010-2012 as Thailand first began to feel the effects of EMS. American prices then spiked in 2013 as Thai production plummeted (Anderson et al., 2016). The US compensated in 2014 and 2015 by sourcing from countries such as Ecuador and India, and a surge in domestic supply further reduced import demand in 2015, driving down prices (FAO, 2015, 2017). Box 1 presents more detail about EMS' causes and environmental factors that help spread the disease.

Box 1: EMS Disease Linked to Bacterial Agent Present in Ponds

EMS or Acute Hepatopancreatic Necrosis Syndrome (AHPNS) is a shrimp disease that was first reported in China in 2009 before spreading to other Southeast Asian countries and then to other locations throughout the world. Thailand was particularly hard hit by the disease, with production and exports plummeting in 2013.

The disease is caused by a bacterial agent that is transmitted orally and persists in the aquatic environment, even after treatment. The bacteria lives in the shrimp's gastrointestinal tract and generates a toxin that compromises digestive organs. EMS outbreaks usually emerge within the first 30 days after shrimp are stocked in ponds. It does not affect humans.

A variety of environmental factors have been identified as helping to spread of the disease. These include high salinity in ponds (higher than 7 ppt salinity), high water temperatures, blue-green algae blooms, organic material that builds up in ponds or shrimp PLs that are already infected with the disease or live in a stressful environment.

Source: Global Aquaculture Alliance, 2013; Kawahigashi & Carrias, 2016.

2.2.2 Demand

The major importers of shrimp have traditionally been the US, the EU, Japan and China (see Table 3 below). There are, however, varying growth trajectories in these leading markets. The US is the world's leading importer. Both the volume and the value of its imports dropped from 2011-2013, partially due to falling trade with Thailand because of EMS. Import volume then posted a strong recovery in 2014 and 2015 in volume terms, increasing by close to 16% in the two years, with the

¹⁹ Neither India nor Ecuador have undergone extensive functional upgrading to include substantial exports of shrimp that have undergone secondary processing (Rabobank, 2015).

²⁰ The total global export value of shrimp preparations and other sauces was US\$4.6 billion in 2015, which was down from US\$5.4 billion in 2011. Four countries (Vietnam, Thailand, China and Indonesia) accounted for roughly 70% of the exports of shrimp preparations (UN Comtrade).

US shifting its sourcing toward India, Indonesia and Ecuador.²¹ Together with the stabilization of its import supply, American domestic production from the Gulf of Mexico dramatically increased in 2015 (FAO, 2015), pushing down the prices its wholesalers paid for common shrimp varieties from US\$7-8 per pound in 2013 to US\$4-5 in 2015 (Anderson et al., 2016). Prices then pushed higher in 2016 as domestic production waned.

Major European importers such as Spain and France have followed a similar fluctuating pattern as the US in terms of total volume trends in the last five years, although both rely on emerging shrimp exporters such as India, Ecuador and Argentina for supply than the US (Anderson et al., 2016). After posting declines in the period from 2011 to 2013, European imports from outside the EU have steadily increased in the last four years, with 2017 imports up 6% over the previous year in volume terms (Harkell, 2018a, 2018b). Spain and France are the leading importers in the continent.

Import trends in Japan and China are moving in different directions. While Japan was the second-leading importer of shrimp in 2015 as measured by value, both the value and volume of its imports have dropped dramatically in recent years (volume was down 26% in the period from 2010 to 2015), a dip that has been tied to Thailand's challenges as well as Japan's currency depreciation in 2015 (Anderson et al., 2016; FAO, 2015). Japanese wholesalers also have substantial cold-storage capacity, which can limit the country's demand (FAO, 2015). On the other hand, China's voracious appetite has also translated to the imports, with the value increasing 194% from 2011 to 2016 and the volume jumping 94%. See Figure A-2 in the Appendix for charts of the leading global importers.

Table 3: Worldwide Imports of Shrimp, 2006-2015

Country	Import Value (US\$, millions)					World Share				
	2006	2008	2011	2013	2015	2006	2008	2011	2013	2015
World	10,866	11,551	14,049	15,040	15,022					
USA	3,151	3,314	4,027	4,270	4,325	29.0%	28.7%	28.7%	28.4%	28.8%
Japan	1,974	1,776	2,223	2,190	1,631	18.2%	15.4%	15.8%	14.6%	10.9%
Spain	1,278	1,234	1,211	1,068	1,138	11.8%	10.7%	8.6%	7.1%	7.6%
China	—	—	—	434	749	—	—	—	2.9%	5.0%
France	612	678	775	811	744	5.6%	5.9%	5.5%	5.4%	5.0%
Italy	475	474	488	482	469	4.4%	4.1%	3.5%	3.2%	3.1%
UK	322	313	444	440	422	3.0%	2.7%	3.2%	2.9%	2.8%
Belgium	426	525	513	481	414	3.9%	4.6%	3.7%	3.2%	2.8%
Germany	—	—	322	385	413	—	—	2.3%	2.6%	2.8%
Vietnam	—	—	—	—	404	—	—	—	—	2.7%
Canada	241	246	344	360	—	2.2%	2.1%	2.5%	2.4%	—
S. Korea	232	—	327	—	—	2.1%	—	2.3%	—	—
Netherlands	—	272	—	—	—	—	2.4%	—	—	—
Denmark	220	247	—	—	—	2.0%	2.1%	—	—	—

Source: UN Comtrade based on 30613, 30616, 30617, 30623, 30626, 30627, 30635, 30636, 30695 HS codes.

Two additional characteristics are worth accentuating:

- I. **Demand has diversified more broadly than supply.** The leading 10 importers has dropped over time—in 1994, they imported 80% of all shrimp traded internationally; by

²¹ The value of US shrimp imports fell in 2015, from US\$5.4 billion in 2014 to US\$4.3 billion, but this decline was due to the price pressures discussed earlier.

2015, that percentage was down to 63% (Ponte et al., 2014). By comparison, the share of the top 10 exporters by value has increased from 61% in 2000 to 75% in 2015.

- 2. Geographic regions have varying preferences in terms of shrimp products.** While trade data does not differentiate for final forms, survey data indicates that North America skews heavily toward peeled or head-off products (78% of all imports), while Asian countries have higher demand for whole, head-on shrimp (Anderson et al., 2016).

2.3 Governance

Companies in the retail segment of the shrimp GVC have significant degrees of control over other actors in the chain, regularly dictating product specifications and processing requirements. Within retail, there are diverse categories of businesses subject to varying industry currents: supermarkets are responsive to customer concerns about environmental and social factors and most likely to prioritize third-party certifications; restaurants and food service companies often prioritize volume considerations. Brand manufacturers play a role in chain governance; however, that segment of the chain is relatively diffuse. This sub-section explores the most topical governance considerations, including the following:

- 1. There is growing concentration and increasing power in the retail segment of chain.** Retail outlets such as supermarkets as well as food service companies and large-scale restaurants have consolidated around fewer numbers of high-volume buyers. The increasing importance of supermarkets and food retailers has been noted in many agribusiness value chain studies.²² The dynamics associated with seafood are similar: supermarkets, food service companies and high-volume buyers such as restaurants such as Red Lobster, Long John Silver's and Applebee's dictate shrimp product specifications and processing specifications, oftentimes placing an emphasis on logistical considerations to take advantage of economies of scale and scope (Lee & Chang, 2014; Ponte et al., 2014; Roheim et al., 2016).
- 2. Shrimp brand manufacturers are relatively weak with unconcentrated market share.** While there are well-known brands in some seafood segments—tuna, with companies such as Starkist and Bumble Bee is an example—shrimp is characterized by low sales concentration of leading companies. In the US, for instance, the largest brands selling shrimp only have market shares of 1-2%, a trait that has also been observed in other leading markets such as China (IBIS World, 2017b; Lee & Chang, 2014) Table 4 below lists sales for the leading companies in the US. Beaver Street, which had the second-leading share in 2012, had sales of US\$500 million in 2016, while Thai Union International had sales of US\$1.32 billion across multiple product lines (both companies sell non-shrimp goods) (White, 2017).

²² Duke GVCC has published a number of reports that have explored this issue (Fernandez-Stark et al., 2011).

Table 4: Shares of Leading Shrimp Brands in the US, 2009-12

Company Name	Market Share			
	2009	2010	2011	2012
Aqua Star	1.09	1.62	1.30	2.22
Beaver Street Fisheries	1.47	1.74	1.92	1.83
Thai Union International	0.76	0.69	1.25	1.06
The Mazzeta Company	0.82	0.65	0.52	0.57
Eastern Fish Co.	0.79	0.53	0.39	0.29

Source: Lee & Chang, 2014.

- 3. There has been a move toward integrated supply chains.** Shrimp brand manufacturers have experienced some of the same move toward integration that has characterized the broader seafood industry. Recent merger-and-acquisition activity between different segments of the seafood value chain has been robust. In one active stretch between 2010 and 2013, there were at least 212 acquisitions in the global industry (M&A International, 2013). Asian actors such as Thai Union—which has a broad seafood portfolio in addition to shrimp—and others have been particularly notable in their attempts to pursue companies in other regions to expand their markets.

The motivating factors for the acquisitions have depended on segments of the value chain involved (M&A International, 2013). Producers have most often sought more effective access to inputs such as feed to reduce costs and generate increased revenue or to processing activities to expand value-addition activities. Downstream actors and brand manufacturers have pursued production opportunities to gain greater control over their supply. Other significant reasons for increased integration include improving distribution networks and responding more immediately to changing consumer preferences (M&A International, 2013). Activity amongst shrimp companies featured prominently in the trend—Table 5 provides representative examples.

Table 5: Representative Examples of Shrimp M&As

Date	Buyer	Target	Description	Value
March 2012	Nutreco (Netherlands)	RaçSes Fri-Ribe S.A. (Brazil)	RaçSes Fri-Ribe was a fish feed company that Nutreco targeted to strengthen its position in Brazil. Nutreco Fri-Ribe is a market leader in shrimp feed in Brazil with over 20% market share.	US\$39.1m
November 2011	Cargill Vietnam Ltd.	Higashimaru Vietnam Co., (Vietnam)	The deal helped Cargill Vietnam enter the shrimp feed manufacturing market in Vietnam with significant capacity.	N/A
July 2010	Nutreco (Netherlands)	Tomboy Aquafeed (Vietnam)	Nutreco targeted Tomboy Aquafeed, a Vietnamese fish and shrimp feed company with country-wide distribution networks for fish and shrimp feed.	US\$13.5m

Source: M&A International, 2013.

- 4. Traceability and sustainability increasingly key considerations for lead firms.** Another driver of the integration and consolidation described above is the increasing emphasis on traceability and sustainability, especially in major markets such as the US and the UK. NGOs and other certification agencies are key actors that influence the governance of the chain through their ability to force retailers and restaurants to adopt third-party

standards related to environmental, sustainability or labor concerns (Jespersen et al., 2014). The volume of certified sustainable seafood increased by an average of 35% per year in the years between 2003 and 2015, from 500,000 metric tons in 2003 (0.5% of overall production) to 23 million metric tons in 2015 (14% of overall production) (Potts et al., 2016).

From the Marine Stewardship Council (MSC) and Aquaculture Stewardship Council (ASC) to Global Aquaculture Alliance Best Aquaculture Practices (GAA BAP), there are a number of different certifications. The GAA BAP has the largest corporate buy-in from shrimp businesses that rely on aquaculture for production; large companies such as Red Chamber (the supplier for Long John Silver's), H&N Foods International, Eastern Fish and SeaPack Shrimp helped develop the BAP standards (Potts et al., 2016). Table 6 below lists shrimp production by the various certifications—in total, an estimated 7.6% of all shrimp production in 2015 was certified by one of the regimes.

The section that follows explores certifications in further detail, including characteristics of each system and examples of how they have caused producers in countries such as Vietnam to evolve.

Table 6: Certified Shrimp Production by Classification, 2015

Standard	Wild shrimp production	Aquaculture production	ALL
Marine Stewardship Council/Aquaculture Stewardship Council	310,200	41,092	351,292
Global Aquaculture Alliance Best Aquaculture Practices	—	134,529	134,529
Global Good Agricultural Practice	—	94,504	94,504
Friends of the Sea	40,319	5,687	46,006
Organic	—	8,779	8,779
Total certified shrimp production	350,519	284,591	635,110
Total global shrimp production	3,439,902	4,875,792	8,315,694
Certified share of total global production	10.2%	5.8%	7.6%

Source: Potts et al., 2016; FAO Fisheries database.

2.4 Workforce

The shrimp industry is characterized by high numbers of unskilled workers in jobs that often offer low wages and poor working conditions, especially in the upstream segments of the chain. Production is especially precarious and informal. It is regularly includes male migrants who only have part-time employment. Globally, there are 58.3 million people who work as aquaculture farmers; only 37% of them had full-time status with 23% engaged part time and 40% working only occasionally or have ambiguous status (ILO, 2016). The reliance on seasonal or temporary employees has led NGOs and third parties to raise widespread concerns about exploitative labor practices, especially among aquaculture farmers or feed providers in Southeast Asia (Hodal et al., 2014; Urbina, 2015). Male youth are frequently targeted and trafficked for illegal practices (ILO, 2016).

Women's participation in aquaculture GVCs is most often concentrated in processing and marketing activities. Whereas women only account for 15-20% of the workforce in production and input provision, they go as high as 90% in processing activities (ILO, 2016). Marketing is another

area where there is strong female representation—a study of shrimp farmers in Indonesia indicated that women’s participation in processing and marketing activities was 1.5-1.7 times higher than men (ILO, 2016; Sari & McDougall, 2017). Defining characteristics of women’s participation in shrimp GVCs is that they routinely receive lower wages than men and that their job placement is mostly predicated on social and gender norms (Sari & McDougall, 2017). Common categories of jobs that feature women workers based on observations from the Indonesian shrimp industry are presented in Table 7.

Table 7: Gender Distribution in Jobs in Indonesian Shrimp Industry

Job	Gender Profile	Skill	Factors Limiting or Encouraging Women Participation
Production			
Pond preparation	Male	Low	Women traditionally not involved in physical labor
Water gate operator	Male	Low	Perceived security risks for women at night
Purchase of inputs	Male or female	Medium/High	Depends on access to management
Feeding	Generally male	Low/Medium	Social or gender norms
Harvesting shrimp	Male	Low	Physical strength
Processing			
Grading and sorting	Female	Low/Medium	No need for physical strength
All			
Financial management	Mostly female	Medium/High	Social norm is that women manage household finances. Belief women are more trustworthy.

Sources: Sari & McDougall, 2017; Authors.

The move toward intensive production systems provides opportunity for higher-skilled jobs that pay higher wages. While extensive ponds require minimal daily oversight, intensive sites depend on greater numbers of workers who must understand and monitor scientific data associated with pond and shrimp conditions. Table 2 on page 7 presents the expenditures associated with shrimp farming in Vietnam and Thailand. Labor costs increase substantially with the intensive systems.

2.5 Certifications

Certifications help shape the institutional framework of governance in the shrimp GVC (Jespersen et al., 2014). The standards that are most prominent began to emerge in the late 1990s. These include GAA BAP, Global BAP and ASC. The criterion associated with each varies, with the ASC generally being the most aggressive in its environmental standards, while the GAA BAP has had the most industry support. There are then broad processing standards and considerations that apply to the shrimp industry but are not necessarily unique to aquaculture; however, this section focuses mostly on shrimp- or seafood-focused schemes. Each of the major ones is outlined below.

- **ASC:** The ASC is an independent NGO based in Europe. It worked in partnership with the Worldwide Wildlife Fund (WWF) to establish the ASC certification in 2010, which uses third-party certifiers to evaluate shrimp producers based on standards for farms (monitoring both environmental footprints and conditions for workers), feed and inputs, and traceability.²³ The standard covers a variety of seafood species in addition to shrimp, with salmon being most common. Its expansive scope distinguishes it from other

²³ Descriptions of the ASC program can be found on the organization’s website: <https://www.asc-aqua.org/>. There is also a MSC that follows similar protocols for wild-caught shrimp.

certifications, with producers having to comply with a variety of FAO or ISO standards while also ensuring proximate flora and fauna is not degraded, with mangrove protection a particular concern (Vandergeest et al., 2015). Although the ASC only began certifying shrimp farms in 2014, its stringent standards have limited its spread with Kroger and Ahold, a Dutch business, among the few private companies to commit to it (Gunther, 2012).

- **GAA BAP:** In contrast to the ASC, the GAA BAP is a private-company-led effort that focuses on food safety as much as environmental considerations (Potts et al., 2016). It was established in 2004 and used the Global GAP as its foundation. While its standards have been noted as being less rigorous with respect to fish meal while also providing loop-holes for processors to buy from non-certified producers (Gunther, 2012), GAA BAP's adoption has been widespread (see Table 6 above for total production volume).²⁴ The total volume of GAA GAP certified seafood grew at an annual rate of 35% from 2008 to 2013, from 159,316 metric tons at the beginning of that period to 711,827 at the end (Potts et al., 2016). Salmon is also its most common species.
- **Global GAP:** Global GAP began in 1997 in Europe and was the model for the GAA GAP in the US. Most of its requirements are similar to the GAA BAP—like the GAA GAP, two of its most prominent characteristics are its emphasis on food safety and its ties to private businesses. The standard also set criteria for legal compliance, workers' occupational health & safety, animal welfare and environmental care as well as inputs such feed and hatcheries. Overall, Global GAP is the leader in terms of volume in terms of certified aquaculture production (Potts et al., 2016).

With uncertainty about whether certification for aquaculture producers provides environmental benefits (Jonell et al., 2013) or financial advantages (Marschke & Wilkings, 2014), the evidence that it has reshaped the value chain and become part of the governance paradigm is more concrete (Jespersen et al., 2014; Marschke & Wilkings, 2014; Vandergeest et al., 2015). In effect, receiving third-party documentation has become a pre-requisite to value chain participation, especially for those who wish to sell to developed markets. Most often, that is North America or Europe; however, there are exceptions. For instance, after Japanese buyers expressed concern about Vietnamese aquaculture's food safety standards, Vietnam's government required its producers to be GAA BAP or ASC compliant. The public and private-sector prodding helped significant numbers of producers to pursue the more arduous ASC standards (Marschke & Wilkings, 2014).

²⁴ In addition to Red Chamber (the supplier for Long John Silver's), H&N Foods International, Eastern Fish and SeaPack Shrimp, other companies that follow GAA GAP include Walmart, Target, Food Lion and Harris Teeter.

3 Belize and the Shrimp Global Value Chain

Aquaculture in Belize is an important generator of revenue and foreign exchange. The industry—which is almost exclusively oriented toward farmed shrimp in export processing zones in Stann Creek and Toledo area²⁵—accounted for 3% of GDP in 2015, which put it above the regional average of 2% and just behind the sugar sector in terms of economic importance to Belize (FAO, 2016a).²⁶ There are additional measures of aquaculture’s significance: there were US\$13.2 million of new investments in 2014 and US\$9.5 million in 2015, while the sector employed 1,185 people in a country with a workforce of 185,100 people (Belize Ministry of Trade, 2018). Table 8 lists aquaculture’s quantifiable contributions to Belize’s economy from 2014 to 2016.

Table 8: Economic Indicators for Aquaculture in Belize, 2014-16

	2014	2015	2016
Employment	1,189	1,185	772
Income tax paid by businesses (BZ\$)	123,132	190,435	140,076
Imports (US\$)	8,184,436	10,742,376	4,965,007
Exports (US\$)	32,824,776	31,956,732	8,041,012
Local sales (BZ\$)	956,032	1,474,256	1,720,848
Investments (US\$)	13,223,127	9,556,471	7,115,936
Wages (BZ\$)	6,593,804	8,106,042	4,152,616

Source: Belize Ministry of Investment, Trade and Commerce.

While small in overall size compared to the global industry,²⁷ Belize’s shrimp industry has historically been a player in the regional market, distinguishing itself through its country-wide pursuit of sustainability and environmental certifications. However, a recent outbreak of EMS has decimated production and threatened the survival of multiple smaller and medium-sized businesses. While domestic stakeholders are optimistic about the prospects for a recovery, further steps to reinforce recent process improvements are required. The recent trends and overall characteristics that are worth accentuating include the following:

- I. **Producers earn widespread ASC certification.** Eight Belizean shrimp producers completed ASC certification in 2015 through a program initiated by the Belize Shrimp Growers Association (BSGA) and funded by the Compete Caribbean initiative (Belize Shrimp Growers Association; Beltraide, 2015).²⁸ As a result, Belize became the first country to have at least 90% of its national production system verified by the organization that evaluates environmental sustainability and protections as well as social responsibility in aquaculture (WWF, 2015). At the same time third-party standards have become increasingly prominent components of the governance regime of the global industry (see Global section), Belize’s country-wide certification has positioned it to integrate more completely into the value chain of significant markets such as the US and Europe.

²⁵ Data provided by Belize’s Belize Ministry of Investment, Trade and Commerce for the aquaculture sector included 17 shrimp producers and processors and one tilapia farm.

²⁶ Aquaculture’s contribution to Belize’s GDP was as high as 5% as recently as 2014 (BSGA, 2018).

²⁷ Belize’s recent apex in production was 11,187 metric tons in 2004 (FAO Fisheries Database). For sake of comparison, China, the world’s leading shrimp producer, generated 3.1 million tons of shrimp in 2015.

²⁸ The Compete Caribbean Partnership Facility (CCPF) is a private sector development program funded by the Inter-American Development Bank (IDB), the UK Department for International Development (DFID) and the Caribbean Development Bank.

2. EMS devastated shrimp production and exports. Shrimp producers first started seeing signs of EMS in 2014 before widespread dispersion of the disease the following year. Whereas country-wide pre-EMS survival rates frequently approached 80-85%, many farms reported survival rates of 0-10% in 2015 as the country's production and exports plummeted. Figure 5 charts the trend—in 2014, the country's total production volume was 7,163 metric tons and the value of its exports was US\$44 million; by 2016, aggregate production had fallen to 1,089 metric tons and the value of shrimp exports was US\$6.1 million.²⁹

Figure 5: Belize Shrimp Production and Exports, 2003-16



Source: FAO Fisheries Database; UN Comtrade, 2018; Belize Ministry of Investment, Trade and Commerce.

3. Belize's ongoing EMS recovery will be predicated on process upgrades. In the wake of EMS outbreak, the BSGA has organized widespread outreach to educate farmers about improved bio-security measures as well as other mitigation strategies, including the use of amendments such as probiotics, rice bran and soy in the aquatic environment and feed (Field Research, 2018). Additional support is forthcoming through a \$400,000 grant from Compete Caribbean that was announced in February 2018 to further enhance bio-security. While compliance with bio-security best practices has been voluntary, and most

²⁹ There are minor discrepancies in the data presented for exports in Table 8 and Figure 5. This can be attributed to two factors: 1. The data included in Table 8 includes numbers from all aquaculture producers in Belize, which includes at least one tilapia producer; 2. Historical exports and production figures were accessed through both the UN Comtrade and FAO databases while Table 8 and 2016 were provided by Belize's Ministry of Investment, Trade and Commerce. However, the larger trend of the precipitous drop in both production and exports in 2015 and 2016 after increasing production in previous years was confirmed by field research. Furthermore, while 2017 data was not yet available, interviews with producers indicated that there had not yet been a significant rebound in production or exports.

producers are still only experimenting with limited production arrangements as they attempt to chart paths forward, there has been an uptick in survival rates in ponds, with multiple farms exceeding 70% in trials (Field Research, 2018).³⁰

The following section analyzes Belize's participation in the shrimp GVC and examines how it is attempting to surmount significant challenges. Its goal is to provide a foundation for the potential upgrading trajectories and recommendations that follow in subsequent sections. Its organization is as follows: first, the country's current participation is examined before the structure of the industry is then outlined as well as key firms active in the country at each stage of the value chain. After assessing important upgrading steps that have been taken by stakeholders, the section concludes with advantages and constraints that will shape future participation.

Qualitative and quantitative data presented in this section is based on field research conducted in Belize in January of February of 2018. Individual citations are included when supplemental material was used to support the analysis.

3.1 Belize's Current Participation in Shrimp GVC

With production and exports a fraction of what they were before the 2014 onset of EMS,³¹ Belize's shrimp industry is in the midst of a recalibration as it attempts to reintegrate into global value chains. Figure 5 above charts the precipitous decline. Country-wide production dropped 84% from 2014 while exports fell 86% (Belize Ministry of Trade, 2018; FAO Fisheries Database). The scale of the downturn was among the highest by any country that has experience an EMS downturn; by way of comparison, Thailand, previously the leading shrimp exporter in the world, experienced drops of 51% in production and 57% in exports in three years.

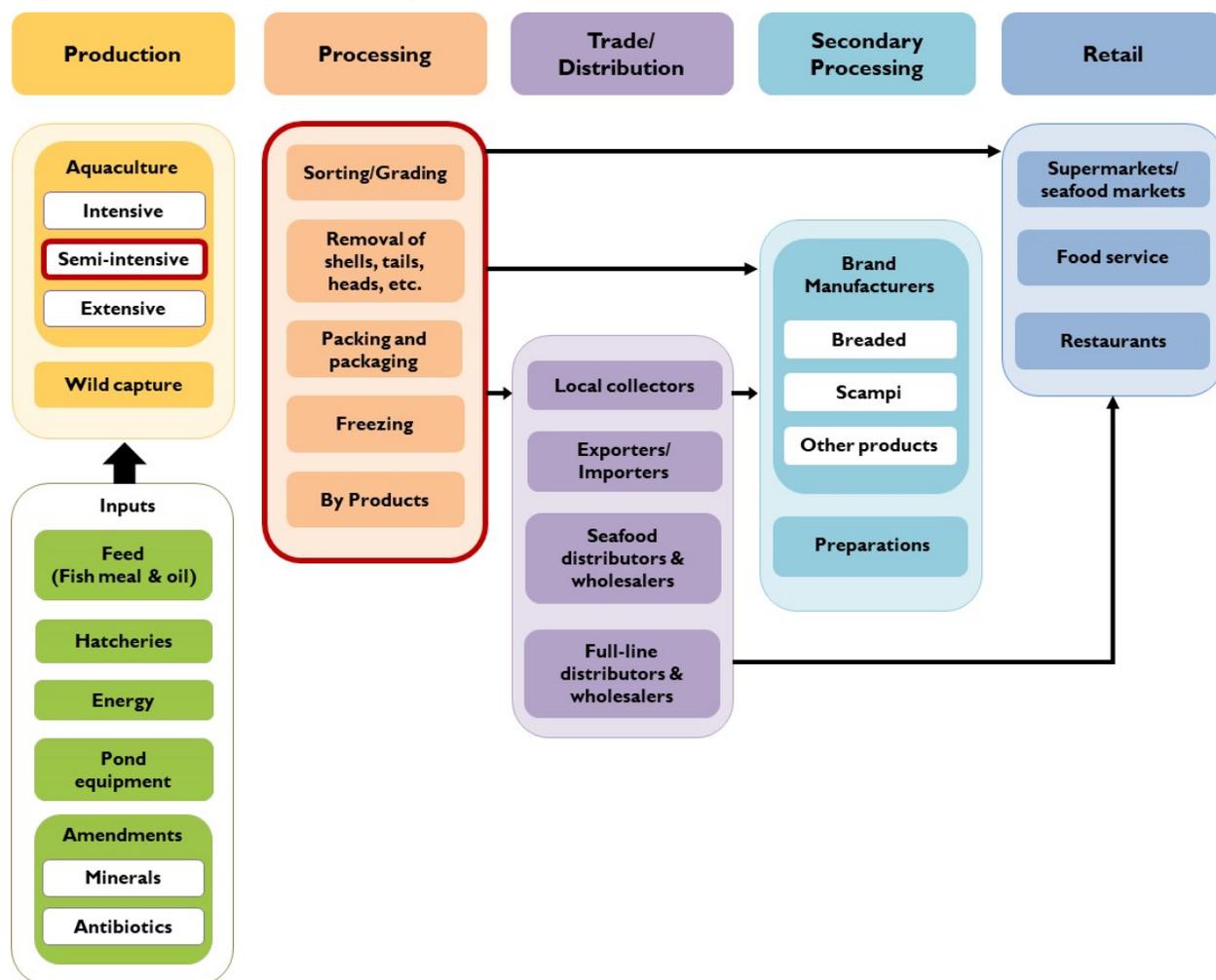
Belize's activity was concentrated in the production and initial processing segments prior to the EMS outbreak.³² Figure 6 below highlights the country's position, primarily taking into account where the country was in 2014. The following section outlines the contours of the local industry. With minimal available shrimp, Belize processors have been largely dormant over the last three years; however, capacity remains comparable to pre-EMS. While there has been an expansion in the country's hatchery operations, partially in response to the disease, these companies are only selling to the domestic market and thus are not included in Figure 6. Finally, there is no significant secondary processing for foreign consumers nor marketing and retail activities for international buyers.

³⁰ At least one producer reported survival rates of 90-92% in trials (Field Research, 2018).

³¹ Country-wide production dropped 84% from 2014 to 2016 while exports fell 86% (Belize Ministry of Trade, 2018; FAO Fisheries Database).

³² As highlighted in Section 2.1, there are five stages of the chain: production; processing; trade; distribution; and retail & marketing.

Figure 6: Belize in the Shrimp GVC



Source: Authors.

INPUTS: The largest unit costs for inputs for Belize shrimp farmers are feed, fuel or power and labor. The precise share of each will vary on the production system used, with power and labor absorbing higher percentages for intensive farms, while feed is often the highest input cost for farms that are closer to the extensive end of the spectrum. Feed is the area where the backward linkages with the local economy are the weakest; companies report that they generally buy pelletized feed or other inputs from companies such as Cargill, Areca and Biomar that are primarily located in Honduras, Guatemala or Costa Rica. Table 9 below breaks out the costs for Belize’s shrimp producers in period from 2014 to 2016. Feed is the highest category for inputs.

There has been significant activity in recent years in the hatchery segment of the chain. *Penaeus Vannamei* (Pacific white shrimp) is the only shrimp variety used in Belize. Traditionally, there have been three companies that have internal capabilities to breed shrimp and produce post-larvae (PLs) both for themselves and the local market.³³ Post recovery, there could be as many as five hatcheries

³³ Belize allows imports of broodstock but does not permit importation of PLs for bio-security purposes.

in the country. Recent investments provide opportunity for expansion in this area, with the potential for production and possible export of genetically advanced broodstock.

Table 9: Input Costs for Belize’s Shrimp Industry, 2014-2016

Category	2014		2015		2016	
	US\$	%	US\$	%	US\$	%
Feed (total)	13,778,512	50.3%	8,805,961	35.9%	3,189,725	32.5%
Imported	13,244,333	48.3%	8,254,174	33.7%	2,883,939	29.4%
Local	534,180	2.0%	551,787	2.3%	305,786	3.1%
Fertilizer (total)	1,245,691	4.5%	1,147,882	4.7%	497,278	5.1%
Imported	768,549	2.8%	635,552	2.6%	276,594	2.8%
Local	477,142	1.7%	512,330	2.1%	220,684	2.2%
Labor	4,708,630	17.2%	8,102,964	33.1%	3,884,845	39.6%
Fuel	2,423,038	8.8%	2,231,452	9.1%	732,291	7.5%
Utilities	1,903,610	6.9%	1,878,209	7.7%	824,022	8.4%
Larvae	1,820,282	6.6%	693,606	2.8%	189,509	1.9%
Packaging	440,641	1.6%	881,997	3.6%	137,825	1.4%
Pond preparations	1,073,090	3.9%	758,412	3.1%	354,545	3.6%
Other (fees, works, supplies)	3,200,546	11.7%	6,022,743	24.6%	1,845,162	18.8%
TOTAL	27,393,494	—	24,500,484	—	9,810,040	—

Source: Belize Ministry of Investment, Trade and Commerce.

PRODUCTION: Shrimp farms have been responsible for virtually all of Belize’s shrimp production since 2001 (FAO Fisheries Database). There are approximately 15 shrimp farms in the country, although closer to 10-12 were active as of early 2018. Five of those have historically accounted for 90% of the country’s total production, generating more than 2 million pounds each year. Those farms are generally located close to the coast in the central and southern regions of the country where savannah plains are a dominant geographic feature. Most shrimp production sites have been classified as Export Processing Zones (EPZs) by the Ministry of Investment, Trade and Commerce, which allows businesses to import inputs duty-free while also providing benefits on taxes on export sales. Aquaculture is the only industry in Belize that has production sites as part of the EPZ regime.

Table 10: Production Systems and Pond Sizes of Belize Shrimp Farms

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Primary Production System	Intensive	Semi-intensive	Semi-intensive	Semi-intensive	Extensive
Pond Capacity	68	87	45	24	6
Active Ponds*	10	7	10	1	0
High Intensity Ponds	68	5	10	5	0
Pond Sizes	68 0.5-3 acre	57 10-acre 22 20-acre 3 5-acre 5 0.6-acre	35 6-8 acre 10 0.6 acre	24 2-5 acre	6 25-acre

Source: Authors. * = Active ponds were as of January or February, 2018. Some companies had plans to expand capacity in March and later months if trials proceeded without outbreaks of EMS.

Most farms rely primarily on semi-intensive systems. Since EMS’ emergence, there has been a shift toward intensive production systems and the input-heavy, smaller ponds that that method entails.

Table 10 above lists production systems and pond distribution of five shrimp producers in Belize, highlighting the prominence of semi-intensive regimes; it is, however, worth noting that the high-intensity ponds of Farms 2, 3 and 4 have been added since 2014. Even still, most ponds are semi-intensive—there is only one producer employing a large-scale intensive program. While earthen ponds and limited aeration are a dominant feature of the industry, there is only sporadic use of extensive ponds. Other farms not included comparable to the semi-intensive farms listed.

PROCESSING: There are four processing sites in Belize, all of which perform initial activities such as sorting and grading as well as deveining and removing heads or shells. All four processing plants have ties to production companies, either through direct ownership or partnership arrangements. Most will process shrimp for other domestic producers on a contract basis depending on the preferences and demands of the buyer. There were no prominent processing bottlenecks reported by producers, and the geographic clustering of shrimp actors in the central and southern areas allows for relatively easy access.

The degree of processing depends on final markets. Mexican buyers prefer head-on, shell-on shrimp and rarely demand formal processing; instead, importers will send their trucks pond-side where the shrimp is sorted and frozen before traveling back to Mexico. On the other hand, European, North American and Caribbean buyers require a variety of preparations, from head-on, shell-on (primarily continental Europe) to headless or peeled and deveined shrimp in the UK and the US.

Table 11 below lists the composition of sales in 2015-16 for one Belizean producer/processor selling mostly into North America and Europe. Peeled and deveined shrimp consistently accounted for the majority of sales before the EMS outbreak (peeled and deveined is captured by the other category). While 2015 replicated historical trends with sales heavily skewed toward peeled and deveined shrimp, 2016 saw a sizeable shift away from Europe toward Asian and local markets, which consume head-on, shell-on shrimp in higher volume. Headless, shell-on shrimp (also referred to as shrimp tails) is a popular preparation in European markets where they receive secondary value-added processing.

Peeling and deveining is the most labor-intensive processing activity. There is only limited mechanization in Belize, and the global industry has struggled to automate peeling and deveining on a large scale. Finally, packaging is generally the final processing step before the shrimp moves to deep-water ports in Belize City and Big Creek, although some product is shipped using large containers.

Table 11: Shrimp Sales by Product Category of Belizean Processor, 2015-16

Product Category	Unit Value (US\$/lbs)		Share of Year-End Total			
			Volume		Sales	
	2015	2016	2015	2016	2015	2016
Head-on, shell-on	\$3.67	\$5.32	15.5%	42.0%	10.6%	44.7%
Headless, shell on	\$3.11	\$5.03	3.8%	53.2%	2.2%	53.6%
Other (peeled and deveined, etc.)	\$5.79	\$1.80	80.7%	4.8%	87.2%	1.7%
TOTAL	\$5.36	\$5.00	—	42.0%	—	44.7%

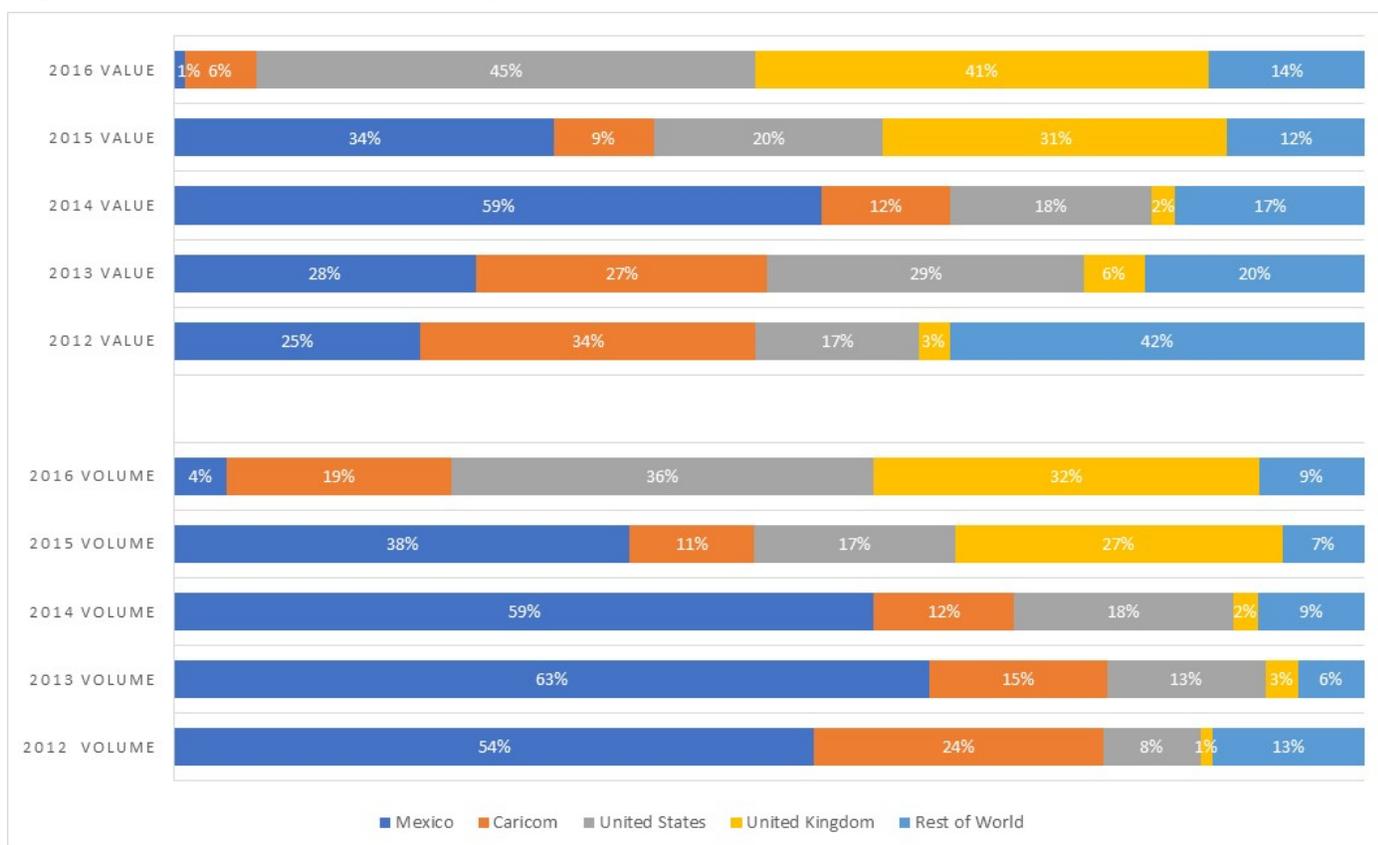
Source: Belize Ministry of Investment, Trade and Commerce.

TRADE/DISTRIBUTION: While there have been recent fluctuations in trade destinations with the outbreak of EMS, the export market is concentrated on Mexico, Caricom countries—Jamaica

and Trinidad & Tobago—and the United States, with between 86-92% of the volume of the country’s shrimp exports heading to one of those countries each year from 2012-2014. Of those, Mexico has historically been the largest single buyer of Belizean shrimp, accounting for 54-63% of exports during that period. The EMS outbreak has reduced Mexican demand, with the United Kingdom and the US being the largest single buyers in the last two years. However, those fluctuations can largely be attributed to the fact that farms who sold to Mexican importers have been hit particularly hard by EMS—stakeholders believe that buyers from Mexico will return once production recovers.

The dynamics are slightly different if one focuses on value considerations. Mexico is one of the largest market as measured by export value; however, its position is impaired by the relatively low unit-value associated with its imports. Instead, Caricom, the United States and the United Kingdom have all had the highest value of exports in individual years in the period from 2012 to 2016, owing to the higher unit values associated with their purchases. Figure 7 charts this trend—volume is depicted in the bottom half, highlighting Mexico’s importance (see blue bars); value is shown in the top half, with a greater distribution of countries. The section on Upgrading that follows explores this matter in further detail, including Table 13, which lists unit value by year for Belize’s major export markets.

Figure 7: Belize Shrimp Exports by Volume and Value, 2012-2016



Source: Authors based on Statistical Institute of Belize data.

SECONDARY PROCESSING AND RETAIL: Belize generally does not participate directly in downstream segments of the chain. After production and initial processing, most shrimp exits the

country on trucks bound for Mexico or on ships from the deep-water ports in Belize City or Big Creek. Mexican distribution is marked by a degree of informality, with importers taking control of the shrimp pond-side, often without processing. There are a small handful of Mexican importers that were active in Belize before the EMS outbreak; wholesalers who prefer smaller shrimp for ceviche, these actors generally brought the shrimp to Mexico City before selling to retail markets.

Jamaica and Trinidad & Tobago serve as access points for the Caribbean market, where Belizean shrimp often are purchased by resorts for use in their restaurants. Some Belizean producers are integrated companies that sell branded shrimp products in significant volume through affiliated companies in Europe and the US, often through retail stores such as Marks and Spencer and Wegmans. Shrimp sold in these outlets regularly receive secondary processing, usually at facilities in the importing country.

3.2 Governance and Industry Organization

Belize's shrimp industry is a small network of businesses, with roughly 20 companies active in the upstream segments of the shrimp GVC.³⁴ The industry is somewhat top-heavy, with the five largest companies accounting for 96% of total output as recently as 2013.³⁵ Most of the big producers have capabilities in multiple segments of the chain, although some of the country's recent expansion of hatchery operations has been a survival strategy for businesses to ensure healthy PLs that are less susceptible to EMS. The relatively few numbers of actors as well as the geographic clustering promotes a relatively friendly, informal atmosphere that is also nurtured by the BSGA and its proactive information sharing among firms. Table 12 lists the most prominent producers. It uses 2013 production data since that was the final year at full capacity; when possible, the other columns feature more current information collected during field research in 2018.

There are some formal relationships with downstream businesses. The two most prominent examples involve integrated companies with production and processing operations in Belize that ultimately sell branded seafood products to retailers in international locations. Belize Aquaculture Limited (BAL) is the first. It is a subsidiary of Sea Fresh Group, which operates under different names depending on the location (Sea Farms in the UK; Sea Farms Inc. in the US; Sea Fresh in Thailand). The second involves Bel-Euro (production) and Rainforest Seafoods (processing), which are both part of the broader Rainforest Seafoods umbrella. Rainforest Seafoods is a Jamaican-based company that acts both as a brand manufacturer in the Caribbean as well as a wholesaler to resorts in the region. Otherwise, market dynamics govern most relationships.

While the local industry is not defined by power asymmetries between those buyers and sellers—in periods of regular production, Belizean farmers benefit from relatively strong and consistent international demand as well as easy access to a variety of markets—foreign actors give Belize's shrimp value chain much of its shape, specifying production characteristics as well as processing considerations for domestic actors. The features that most define the competitive landscape for local firms include the following:

³⁴ As of early 2018, there were five hatcheries, roughly 15 shrimp farms and four processing facilities in Belize. However, not all were operational at that time—at least one hatchery was preparing to open in 2018, while a number of shrimp farms had temporarily ceased operations with the EMS outbreak.

³⁵ The five largest producers generated 14.9 million of the country's 15.4 million pounds in 2013 (Beltraide, 2015).

Table 12: Belizean Companies Active in Shrimp Value Chain

Company	ACS Certification	2013 Production Capacity	Primary Markets	Processing Facility	Hatchery
Belize Aquaculture Limited	Yes	5,292,270	UK, USA	Yes	Yes
Aqua Mar Belize	Suspended	2,252,831	Mexico	Yes	Yes
Paradise Shrimp Farm	Cancelled	2,332,400	Mexico	Yes	Yes
Royal Mayan Shrimp Farms	Suspended	2,657,469	Europe, Caribbean	No	No
Tex Mar	Cancelled	2,433,063	Mexico	No	No
Cardelli Farms	Yes	99,026	Caribbean	No	No
Tropical Aquaculture	Cancelled	192,528	Unknown	No	No
Destiny Aquaculture	No	—	Unknown	No	No
Caribbean Shrimp Farm	No	—	Unknown	No	No
Melinda Mari culture	No	220,000	Unknown	No	No
Bel-Euro Aquaculture	Cancelled	—	Unknown	Yes*	Yes
Haney's Shrimp Farm	No	—	Unknown	No	No
4Hands Shrimp Farm	No	—	Unknown	No	No
Golden Crown Shrimp Farm	No	—	Unknown	No	No

Source: Beltraide, 2015; ASC; Field Research, 2018. * = Bel-Euro is affiliated with Rainforest Alliance, which has a processing facility in Belize.

- 1. ASC certification allows entry to lucrative markets.** Belize's widespread adoption of ASC standards provides businesses with opportunities to integrate into the supply chains of European and North American retailers and wholesalers, who often require compliance to third-party standards.³⁶ While some producers have let the certification lapse as they focus on EMS recovery, all maintain the capacity to re-earn the designation when production resumes.
- 2. BAL associate grower program provides access to leading retailers.** As the largest shrimp producer and processor, BAL has sizeable influence in the market. The company, which sells to Marks & Spencer in the UK and Wegman's in the US, is a local leader in terms of good aquaculture practices, following rigorous bio-security protocols and achieving ASC and GAA BAP certifications. It also augments its internal supply by buying shrimp from local producers through an associate grower program. That allows participating firms to access the higher price points shown in Table 13, although it also requires maintenance of ASC certification.
- 3. Mexican importers demand smaller shrimp but do not prioritize certifications.** Mexican demand for Belizean shrimp has been a defining characteristic of the industry, with importers preferring smaller shrimp that can be used in dishes such as ceviche. Although Mexico traditionally does not pay the same prices as other markets, the relative informality of the relationships provides advantages for producers, including cash transactions, minimal processing requirements or emphasis on ASC compliance, and shorter lifecycles for the

³⁶ The "Governance" and "Certifications" sections of the global portion of the report provide further details on how third-party standards have become important governance features of the worldwide industry.

shrimp, which reduces the risks of mortality and potentially extends production cycles.

4. **Foreign buyers determine where shrimp is processed in Belize.** Where and how shrimp is processed in Belize depends on the preferences of the importer or the retailer selling the product. That decision is predicated on multiple factors, from each site's adherence to quality and cleanliness protocols as well as packing considerations. Wegman's, for instance, might have precise packaging instructions that they would expect BAL to follow. On the other hand, shrimp ultimately destined for the Caribbean generally will go through the Rainforest Seafoods processing plant because of that company's strong presence in the region. HACCP is key certification that all processing facilities must have to export. Depending on the final market, other noteworthy standards include the British Retailer Consortium (BRC).

The local institutional environment provides services that collectively have helped Belizean businesses better align with some of the governance characteristics. As a rule, the industry skews toward an ethos of individual agency; however, various actors provide structure through three important sources. The first is the Ministry of Investment, Trade and Commerce, which played a role in the establishment of the sector in the 1980s through the provision of an EPZ regime that provided incentives to businesses. The second is the BSGA, which includes every shrimp producer in its membership. The organization's primary focus is promotion and advocacy. It has also served as a valuable resource during the EMS crisis, researching and connecting producers with best practices, strategies and consultants to fight the disease. Finally, the Belize Agricultural Health Authority (BAHA) plays an important regulatory role, monitoring the health of the country's aquaculture system.

3.3 Industry Upgrading

Belize's shrimp industry has been attempted various upgrading strategies in recent years. Some have been proactive attempts to position the country to sell into markets that pay a higher premium for shrimp or make the production systems more efficient. Others have been more reactive efforts to improve resilience to threats such as EMS. The most prominent are outlined in the section below. Because the US\$400,000 grant associated with the Belize Shrimp Biosecurity Aquaculture Zone Management plan to improve the country's bio-security standards is so recent, awarded in February, 2018, it is not included here since its implementation had not begun at the time of publication.

1. **Process upgrading through the country-wide ASC certification program.** Belize producers pursued widespread adoption of the ASC standard through a program initiated by the Belize Shrimp Growers Association (BSGA) and funded by the Compete Caribbean initiative (BSGA). The benefits of the certification and selling into Europe and North American markets can be detected by analyzing the unit value of Belizean shrimp exports. While Mexico has historically been Belize's largest market in terms of volume, American, English and French consumers pay a higher price premium as the shrimp can be marketed as adhering to environmental and social standards. Moreover, the widespread ASC certification achieved in 2015 corresponded with a general increase in the unit price for all shrimp exports—US\$3.21 per pound in 2015 compared to US\$1.38 per pound in 2012. Table 13 is sorted alphabetically and lists the unit value for each country in the period from

2012 to 2016; countries shaded in yellow are destinations where buyers emphasize third-party standards (whether ASC or GAA BAP) to higher degrees.

Table 13: Unit Value for Belizean Shrimp Exports, 2012-16

Country	Unit Value (US\$ per pound paid for exports)				
	2012	2013	2014	2015	2016
Canada	\$2.73	\$5.49	—	—	—
France	\$2.90	\$10.99	—	—	—
Germany	—	—	\$3.69	\$2.80	—
Guatemala	—	—	\$2.92	\$2.98	—
Jamaica	\$0.95	\$3.92	\$3.08	\$2.56	\$1.40
Mexico	\$0.64	\$1.26	\$3.09	\$2.84	\$0.47
Spain	\$1.94	\$4.47	\$2.74	—	—
Thailand	\$3.14	\$5.95	\$3.22	\$2.35	\$3.44
T. & Tobago	\$2.37	\$5.65	\$3.04	\$2.74	\$2.27
United Kingdom	\$4.22	\$5.90	\$3.19	\$3.58	\$5.49
United States	\$2.82	\$6.35	\$3.06	\$3.90	\$5.52
Vietnam	\$2.75	\$5.29	\$2.95	—	—
TOTAL	\$1.38	\$2.87	\$3.07	\$3.21	\$4.34

Source: Statistical Institute of Belize.

- 2. Process upgrading through investments into intensive production systems.** Firms active in Belize aquaculture have spent almost US\$30 million spent on capital investments since 2014 (see Table 8) (Belize Ministry of Trade, 2018). A sizeable percentage of those expenditures have been directed toward a move to intensive production systems that has been shown to generate higher economic returns on shrimp farms in Vietnam and Thailand (Engle et al., 2017). Aqua Mar, Bel Euro and Paradise Shrimp Farm have all experimented with intensive systems, purchasing aeration pumps and converting some of their larger earthen ponds into smaller, lined ones. Farms in Belize that have experience with intensive and semi-intensive systems estimated it cost roughly US\$60,000 per acre to convert semi-intensive ponds into intensive ones, while it cost roughly US\$6,000 per acre to build semi-intensive systems. There is also discrepancy in human labor requirements, with Belizean producers reporting that three to four individuals must monitor each individual pond compared to one in semi-intensive systems (see Workforce section that follows).

3.4 Workforce

At full production capacity, the Belizean shrimp industry generates roughly 2,000 jobs directly, although this number has fluctuated in recent years because of EMS, with fewer than 750 employed in 2016 because of reduced operations at all production sites. The industry broadly benefits from an available supply of lower-skilled Belizeans who live in rural communities close to the coast. There are regular swings in the precise number of workers depending on the season, with producers hiring seasonal help to assist with harvesting and processing. There is only limited automation in the processing segment of the chain, with producers reporting only limited success in having machine perform key tasks such as peeling and deveining.

Belizean businesses that have invested in intensive ponds report that labor costs are three to four times higher. The work is both labor and skills intensive. Three or four operators must perform regular maintenance on each pond, checking oxygen levels, monitoring algae levels, and water

salinity. Despite the aeration pumps, bio-material must regularly be cleaned out, often requiring workers to wear scuba gear and clean the lining. Producers report that finding skilled human capital with scientific training can be a challenge. Consistent with general global trends, extensive and semi-intensive farming require far less attention.

Belize’s labor profile in the shrimp GVC can be quantifiably analyzed across three variables: gender, nationality and skill level. Table 14 below presents the data associated with each across a three-year period: 2014-2016. In any given years, between 67-69% of the workers in the shrimp industry are male and 91-97% are Belizean. The number of unskilled workers plummeted in 2015 because of the decline in production associated with EMS; otherwise, roughly 60% of workers in the shrimp industry are unskilled, one-third are skilled and around 5% are management. The global section of the report presented data for the overall number of temporary vs. full-time workers in aquaculture value chains;³⁷ if one uses temporary as a proxy for unskilled (and full-time as a proxy for skilled or management), then Belize is in line with global averages.

Table 14: Labor Profile for Belize’s Shrimp Industry, 2014-2016

Category	2014		2015		2016	
	Number	%	Number	%	Number	%
Gender						
Male	861	68%	592	67%	516	69%
Female	402	32%	294	33%	227	31%
Nationality						
Foreign	117	9%	75	8%	25	3%
Belizean	1146	91%	811	92%	718	97%
Skill						
Unskilled	782	61%	269	30%	445	61%
Skilled	435	34%	561	63%	233	32%
Management	56	4%	56	6%	46	6%
TOTAL	1263	—	886	—	724	—

Source: Belize Ministry of Investment, Trade and Commerce. Note: Because of minor discrepancies data submitted to Duke GVCC, numbers might not add up across categories.

Drilling further into each variable, most of the micro-data (ie, the number of female Belizeans or skilled male workers) conforms to the broader trends. One area where there are some discrepancies is the number of foreign individuals in management. While the share of foreign-born workers is between 3-9% in the years surveyed, the percentage of internationally born management officials is 13-20% each year. While not definitive, this supports the qualitative observation collected in field research that there is sometimes difficulty identifying higher-skilled workers for the shrimp GVC.

3.5 Advantages and Constraints

Belize’s shrimp industry is characterized by its tight cluster of actors with strong environmental credentials who are trying to manage a shock to production capacity through the onset of EMS. Because of the country’s geographic location and access to strong markets, there are opportunities for economic upgrading. For this to happen, actors must address systematic shortcomings, both to

³⁷ As stated earlier, only 37% of aquaculture workers had full-time status with 23% engaged part time and 40% working only occasionally or have ambiguous status (ILO, 2016).

mitigate EMS concerns as well as to alleviate other challenges. Table 15 summarizes both the strengths and weaknesses of Belize’s shrimp industry. The most prominent advantages and constraints are outlined in the section that follows. The potential upgrading section then expounds on possible opportunities.

Table 15: SWOT of Belize’s Shrimp Industry

Strengths	Weaknesses
<ul style="list-style-type: none"> • Engaged stakeholders buoy institutional environment • Recent history of country-wide ASC certification • Favorable incentives for producers through EPZ regime • Access to Mexican, Caricom markets • Geographic clustering and environmental conditions around Big Creek area • Extensive hatchery operations 	<ul style="list-style-type: none"> • Bio-security protocols and system resilience to diseases • Non-scientific approach to semi-intensive production systems • Undercapitalized farmers and insufficient financing mechanisms • Informal, reactive institutional environment • Limited pool of skilled human capital with knowledge of industry best practices • Underdeveloped supporting features such as infrastructure and construction capacity
Opportunities	Threats
<ul style="list-style-type: none"> • Increased global emphasis on sustainably farmed shrimp • Advancements in shrimp genetics and breeding • Global move toward intensive production systems in many leading exporting countries 	<ul style="list-style-type: none"> • Diseases in the shrimp GVC • Tropical storms • Climate change

Source: Authors.

3.5.1 Advantages

Belize’s advantages in the shrimp sector revolve around its cluster of engaged businesses and industry stakeholders that have marshalled support for key initiatives that have strengthened the country’s competitive position. Duty-free access to nearby markets such as Mexico and Caricom are also important considerations. The following sub-section expounds upon Belize’s strengths.

1. **Engaged stakeholders buoy institutional environment.** If governance is mostly dominated by foreign buyers and certification standards, the local landscape is characterized by casual relations between actors who often prize individual agency. While this attribute has at times impeded the development of a consistent structure within the sector (see Challenges below), the bottoms-up approach to institutionalization has had successes in recent years, with engaged stakeholders such as BSGA or BAHA either leading or assisting significant process upgrades. The ASC certification drive (see below) and the Belize Shrimp Biosecurity Aquaculture Zone Management project that was approved in February 2018 through the Inter-American Development Bank’s Compete Caribbean initiative are two examples. In one sense, these efforts are reflective of an industry in crisis. Yet the ability of the BSGA and other leading actors to marshal financial support and connect producers with best practices speaks to the overall strength of the network.
2. **Recent history of country-wide ASC certification.** The most prominent example of institutions and actors within the sector producing tangible results is the country-wide push

for ASC certification achieved in 2015. Significantly, that effort—which involved financial support from the Compete Caribbean program—signaled to outside actors that Belizean production adheres to environmental and social best practices, thereby providing access to markets that pay higher prices for shrimp.

- 3. Favorable incentives for producers through EPZ regime.** All of Belize’s shrimp farms are located in EPZs throughout the country. The Ministry of Investment, Trade and Commerce manages the EPZ regime, which began in the 1980s as a way to help nurture the aquaculture sector by exempting companies from import duties and taxes on export sales (local sales are still taxed). For shrimp farms, this provides benefits for businesses that must import pumps and accessories for ponds as well as shrimp feed. While there are other incentive programs available in the country (traditional fiscal incentives and free zones for in transit trade are two others), the EPZs provide the most direct benefits for shrimp producers.
- 4. Access to Mexican, Caricom markets.** Before EMS, close to 75-80% of the volume of recent shrimp exports went either to Mexico or Caricom (see Figure 7). Both are in relatively close geographic proximity to Belize and have duty-free agreements, providing producers with relatively easy access to those markets.
- 5. Geographic clustering and environmental conditions around Big Creek area.** Most of Belize’s shrimp farms and processing facilities are located near the coast in the south and central portions of the country—the Stann Creek and Toledo districts and surrounding areas. The close geographic proximity alleviates some of the logistical challenges associated with moving shrimp from production to processing sites in a country where road infrastructure is underdeveloped while also facilitating informal information-sharing among neighboring sites. Furthermore, the savannah plains, rivers and access to seawater in the Stann Creek and Toledo districts offer environmental advantages and provide a point of contrast to other nations where shrimp aquaculture threatens mangroves and other natural resources. There is, however, a downside to the clustering in that disease epidemics can spread faster because of shared ecosystems.
- 6. Extensive hatchery operations.** Whereas regional peers have limited hatchery operations, Belize has growing capacity in this segment of the chain—of the US\$30 million spent on aquaculture investments from 2014 to 2016, the second largest category of expenditures was for hatcheries (Field Research, 2018). Belize’s relatively robust breeding capability is partially the result of governance features—BAHA only allows the importation of broodstock and not PLs because of bio-security concerns. Additionally, most of the expansion has been existing actors bolstering internal capabilities as a strategy to have access to shrimp that are more resistant to EMS or mature more quickly. However, there has been new investment from companies that plan to concentrate exclusively on breeding programs, providing the country’s producers with animals that can grow at faster rates in addition to being less susceptible to disease.

3.5.2 Challenges

Despite the country’s strengths, Belize faces multiple challenges in the shrimp industry, some of which have become particularly pronounced in recent years. While the EMS outbreak has been an

obvious source of concern in recent years, highlighting some of the country's bio-security gaps, there are others, including inefficiencies in the production system and access to critical supporting features. The following sub-section expounds upon these challenges.

- 1. Bio-security protocols and system resilience to diseases.** The EMS outbreak has highlighted the shrimp industry's vulnerability to disease. EMS and other afflictions often spread through seawater and pond conditions that cannot be completely inoculated; building system resilience across the country is the most effective strategy for recovery. While BAHA has advanced bio-security guidelines and standards, compliance is not mandatory. As a result, most farms throughout the country only have had limited implementation of best practices for bio-security.³⁸
- 2. Non-scientific approach to semi-intensive production systems.** While the global industry has moved toward a science-based, input-heavy method of shrimp farming, Belize's production system remains somewhat informal. Leading firms have adapted more rigorous methods, with corresponding investments in intensive systems. But many smaller actors still rely on trial-and-error and previous experience to a significant degree.

The reliance on semi-intensive production systems is not necessarily a weakness. Ecuador, the leading South American producer and exporter, had traditionally used semi-intensive farming before producers recently moved even more toward extensive production as a strategy for avoiding EMS (see Ecuador case study).³⁹ But Belize's model appears to be in the middle, standing in contrast to the strategies of both producers in Southeast Asia, where empirical data shows clear economic benefits for intensive production systems (Engle et al., 2017), and the aforementioned Ecuador, where a variety of actors moved toward a more scientifically rigorous system after widespread diseases in the 1990s (Massaut & Camposano, 2015). While there are significant differences between shrimp farming in Thailand and Belize—the costs and availability of land being one of the most immediate (see Table 2 for high fixed costs associated with Thailand and Vietnamese shrimp farming)—the orientation of the global industry toward intensive farms threatens to put Belize at a competitive disadvantage, especially since less-intensive South American players are not in the midst of recovery from disease.

- 3. Undercapitalized farmers and insufficient financing mechanisms.** With EMS wiping out production for much of the 2015-2017 period, producers have had limited inflows of revenue in recent years. Many farms are facing difficulties securing financing to help bridge the gap. Local banks reportedly will not extend loans to shrimp farms, and government organizations are risk averse. There are regional opportunities, with institutions such as the Latin American Agricultural Development bank out of Coral Gables, Florida, providing help. However, the interest rates offered by such private actors are generally high, threatening the economic position of many producers.

³⁸ To cite one example, only one producer subjected visiting vehicles to screening and disinfectant sprays upon entry into production sites during the field research phase of this project. Best aquaculture and bio-security practice includes use of disinfectant sprays, along with many other strategies.

³⁹ Although Ecuador farmers are quick to credit extensive farms for avoiding EMS (see case study), it should be accentuated that the disease can strike both extensive and intensive farmers (Kawahigashi & Carrias, 2016).

- 4. Informal, reactive institutional environment.** While the EMS outbreak has demonstrated the cohesion and strength of the institutional environment (see Advantages), the lack of a rigid structure and limited resources sometimes limits the effectiveness of key supporting actors. Multiple interviews highlighted the country's overall complacency with respect to bio-security measures before the emergence of EMS, a characteristic that might have contributed to the disease's spread. Heretofore, the BSGA has focused primarily on promotion and advocacy instead of enforcement. The organization's membership fees are modest, and it does not attempt to conduct extension services or set a formal strategic agenda. Such an orientation would be natural with the presence of a strong regulatory or scientific body, but BAHA does not necessarily have the financial wherewithal to monitor the sector in a comprehensive manner. Somewhat understaffed, the agency is sometimes prone to bureaucratic inefficiencies that limit its effectiveness.⁴⁰ It is further hamstrung by laboratories that cannot provide comprehensive testing and diagnostic services.
- 5. Limited pool of skilled human capital with knowledge of industry best practices.** The industry benefits from the availability of lower-skilled workers who lived in the rural area in the Stann Creek and Toledo districts. However, there are shortages of higher-skilled candidates who have knowledge of industry best practices. Aquaculture experts are also in short supply at the University of Belize and other places. Any potential move toward intensive production systems would exacerbate the issue—Belizean producers estimated that intensive systems require triple or quadruple the labor of semi-intensive ponds, with training requirements being similarly more pronounced.
- 6. Underdeveloped supporting features such as infrastructure and construction capacity.** From construction to logistics, supporting services are generally underdeveloped in Belize. While not specific to the shrimp industry, infrastructure shortcomings are among the most pronounced.⁴¹ The geographic clustering of shrimp businesses in Stann Creek and Toledo alleviates some of the concern. Yet most shrimp farms are not connected to the electricity grid and do not have access to paved roads. Additionally, direct road access to the deep-water port in Belize City involves a circuitous route that includes travel through Belmopan. Although infrastructure is not considered a major liability by existing actors, some of the shortcomings could limit further expansion and upgrading within the sector.

⁴⁰ Examples cited during field research ranged from the establishment and enforcement of bio-security measures to the importation of hatchery feed. With its mission to safeguard agriculture and aquaculture health, BAHA controls the imports of broodstock and feed for the sector.

⁴¹ While the World Economic Forum's *Global Competitiveness Report* includes rankings on infrastructure metrics for countries around the world, Belize has not been included in recent editions because of insufficient data. In older rankings, Belize ranked in the bottom third globally for road and power infrastructure.

4 Lessons in Upgrading in Shrimp GVC

Belize will need to improve its bio-security regulations and enforcement capacity to maintain its position in the shrimp GVC. Once output recovers, producers can evaluate the suitability of further upgrades. By adopting improved technologies and agricultural practices or by engaging in new activities, upgrading can also allow actors to capture greater value from their participation in GVCs (Humphrey & Schmitz, 2002). There are many possible options, such as: 1) Product and process upgrading through improvements in volume and/or varieties through changes in technology or management; or 2) Functional upgrading by changing or adding new capabilities; and 3) Market upgrading that means moving to more sophisticated markets that require compliance with new, more rigorous standards or into larger markets that call for production on a larger scale and price accessibility (Gereffi & Fernandez-Stark, 2016). Table 16 summarizes the key upgrading trajectories that have been pursued by countries in the shrimp GVC.

Table 16: Selected Upgrading Trajectories in the Shrimp GVC

Upgrading Trajectories	Description
PROCESS UPGRADING	<ul style="list-style-type: none"> • Introduction of new technologies into production system or restructuring the existing system to improve efficiency • Pursuit of chain-of-custody certification is a process upgrade that yields product upgrades (shrimp that receives higher prices) • Improving logistics are important process upgrades for processors, with many countries seeking to bolster cold chain storage and reduce time between harvesting and processing • Other examples include implementing quality control measures for pond or animal health, instituting strict bio-security protocols or shifting to more economically valuable production systems <p><i>Example:</i> Vietnam has engaged in a wide range of process upgrades across its value chain to improve financial gains in the short term and mitigate risk in the long term (Ponte et al., 2014). Increasing yields at farms has been a prominent strategy, with producers attempting to manage water quality, feed and inputs more efficiently. After initially resisting widespread pursuit of third-party environmental standards (Tran et al., 2013), Vietnam’s government shifted tack and prodded all shrimp producers to pursue ASC, GAA BAP or other standards in order to alleviate concerns from Japanese buyers about the country’s food-safety protocols (Marschke & Wilkins, 2013). Finally, many producers have pursued intensive production systems to increase economic efficiency.</p> <p>Process upgrading in Thailand has taken similar forms, although there has also been significant investment by both the government and the private and sector in technology and R&D to fight against the EMS outbreak (Ponte et al., 2014). Partially as a result, Thailand is a global leader in bio-security and genetic innovations. Additionally, the country’s processors have enhanced their quality control mechanisms and cold chain capacity to reduce time between harvest and processing by providing labor at harvest time to ensure shrimp are quickly packed on ice (Ponte et al., 2014).</p>
PRODUCT UPGRADING	<ul style="list-style-type: none"> • Product upgrading involves the production of a higher value product, such as certified or jumbo shrimp • Requires knowledge of market preferences, costs and prices • Entry into certified markets is example of product upgrading; however, these usually require process upgrading first (see above)

	<p><i>Example:</i> Prior to EMS, Belize itself provided a clear example of product upgrading by pursuing country-wide ASC certification. Compete Caribbean helped finance the certification drive with the BSGA playing a critical coordinating role. The certifications provide access to European markets that pay higher price premiums.</p>
FUNCTIONAL UPGRADING	<ul style="list-style-type: none"> • Involves assuming new capabilities at different segments of the value chain and trying to harness economies of scope through investments • Requires technology and knowledge investments • Hatcheries or genetic investments have been common functional upgrade • Moving from aquaculture to processing. Adding value-added products such as breaded or prepared shrimp meals usually requires functional upgrading secondary into secondary processing <p><i>Example:</i> After the emergence of white spot syndrome virus, Ecuador improved genetics and broodstock in the shrimp industry (see case study below). Thailand also offers product upgrading examples. Companies have invested in R&D to create new products, and processing plants have invested in value-added research and the development of ready-to-cook and ready-to-eat products (Ponte et al., 2014).</p>
END-MARKET UPGRADING	<ul style="list-style-type: none"> • Moving into markets that pay higher unit prices for shrimp or demand high volumes of shrimp <p><i>Example:</i> Belize provides another example, with the country shifting toward European markets that pay higher price premiums before the EMS outbreak. Mexico has also historically been an important market for the country, providing easy access to buyers who do not require processing activities or third-party certifications.</p>

Source: Authors.

4.1 Case Studies

In analyzing different prospective paths for upgrading in the Belizean shrimp industry, it is useful to look more in depth at specific examples from countries that have strengthened both domestic institutions and regulatory capacity to assist disease prevention. Two cases were selected for further examination:

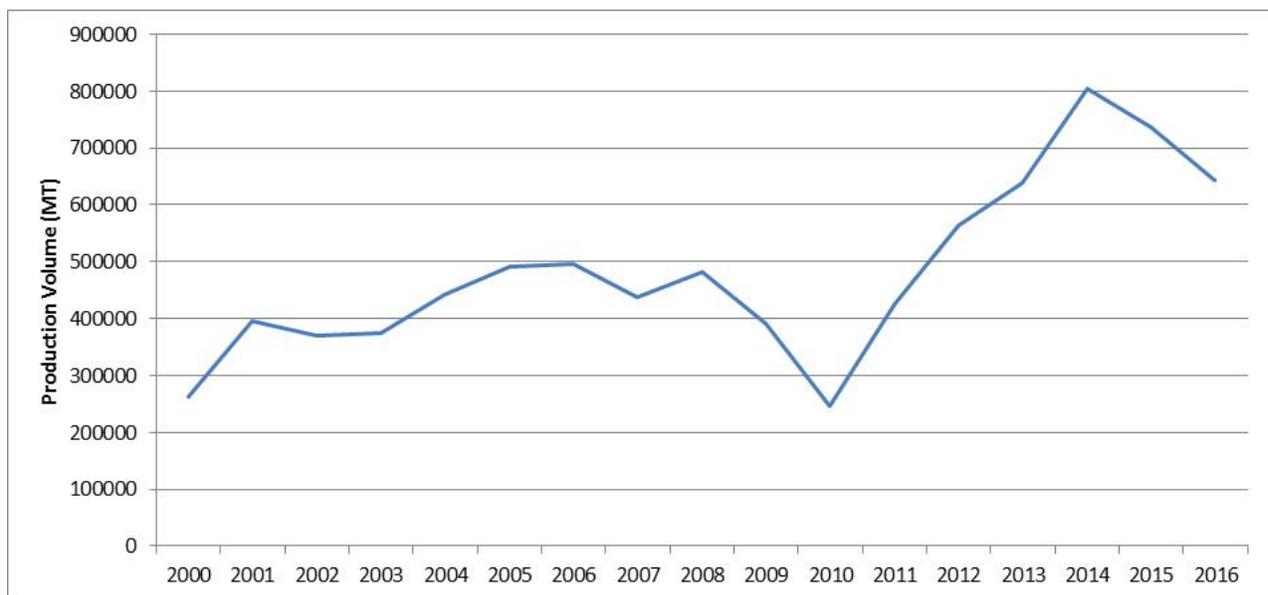
- **Chile** offers an example of a country that has attempted to strengthen institutions with a goal of improving bio-security and environmental standards in reaction to a disease outbreak in an aquaculture GVC. The country has long been one of the world's largest producers and exporters of salmon before the emergence of ISA and SRS threatened the competitiveness of the sector.
- **Ecuador** has not been afflicted by EMS to a significant degree. Instead, the country was proactive in its response to diseases in the late 1990s, instituting both process and functional upgrades that allowed it benefit from Southeast Asia's struggles with EMS. By strengthening the country's institutions and enforcement capacity ahead of EMS, Ecuador has become the world's second-leading exporter of shrimp and the fourth-leading producer.

4.1.1 Chile

Chile's salmon industry has a significant economic footprint. The sector is the country's second-leading source of exports behind copper—it generated 6% of total exports and 36% of general food exports in 2015 (SalmonChile, 2015). As salmon aquaculture production has expanded throughout much of the last three decades, the country has become the world's second-leading source of the fish behind Norway, accounting for close to one-third of global supply (SalmonChile, 2015). The industry also supports a high number of workers, with as many as 71,000 people and 4,000 small or medium-sized businesses either directly or indirectly supported by the sector (SalmonChile, 2015).

The favorable profile is a testament to the industry's expansive growth since the late 1970s. The sector's roots can be traced to cooperative projects between the Chilean government and Japan International Cooperation Agency (JICA) to explore the viability of salmon farms in the country (Hosono et al., 2016). Development accelerated after the establishment of the Fisheries Department and the National Fisheries Service (Sernapesca) in 1978 and public-private initiatives such as Fundación Chile in the early 1980s provided critical public goods such as R&D services as well as technical foundation (Katz, 2016).⁴² The spread of farms persisted throughout the 1980s, many of which had ties to the Japanese market, and the formation of an industry association, SalmonChile, helped give the industry shape.

Figure 8: Chile Salmon Production, 2000-2016



Source: FAO Fisheries Database. **Note:** Includes all salmon varieties.

A defining characteristic of the industry for much of its first three decades was the lack of regulation and enforcement by public sector agencies (Katz, 2016). As a result, poor environmental standards at production sites throughout the country allowed for circumstances that contributed to the 2007 emergence of the infectious salmon anaemia (ISA) virus. The disease, which spread

⁴² Fundación Chile was started by the government and the ITT Corporation as a non-profit organization focused on technological advancements. One of its first projects involved development of salmon farming technologies in Chile (Katz, 2016).

through overcrowding and other sub-standard sanitary conditions, led to more than US\$2 billion in losses as production of Atlantic salmon fell by nearly half and as many as 26,000 workers lost their jobs (Barrionuevo, 2011) Figure 8 charts Chile's production volume from 2000 to 2016 for all varieties of salmon; ISA's effects can be seen in 2009 and 2010.

Chile's missteps and the public sector's response to it can provide an example for countries such as Belize that are attempting to recovery for similar diseases in their aquatic sectors. A series of changes allowed the country to regain its footing to a degree from 2011 to 2015. The strength and resilience of those process upgrades has been tested by a second country-wide infection, this time from Salmon Rickettsial Septicaemia (SRS), a disease that causes hemorrhaging, lesions and death. Recovery from SRS is still ongoing, yet some of the institutional changes provide reasons for optimism in Chile's ultimately ability to maintain its global competitiveness.

ISA Outbreak

While the initial trigger for ISA is believed to be infected eggs that originated in Norway (Barrionuevo, 2011), the spread of the disease exposed systematic shortcomings that were rooted inside the domestic industry. These failures can be examined at both the farm-level and the country as a whole (Iizuka & Zanlungo, 2016). For production sites, there were three prominent shortcomings that weakened resiliency of the system and compromised Chile's sanitary standards. These included the following:⁴³

- 1. Geographic clustering:** Almost three-quarters of Chile's salmon farms were located within 300 square kilometers of each other. By comparison, most production sites in Norway were spread in a 1700-square kilometer area. The tight concentration of farms in Chile was further complicated by the fact that space between production sites was 2.2 kilometers (Iizuka & Zanlungo, 2016).
- 2. Stocking density:** As Chile's salmon production increased in the early 2000s, farmers faced increasing pressure to pack more fish into existing ponds to keep pace. The result was stocking densities that far surpassed peer countries—a survey of major production sites in Chile indicated an average stocking density of 1,021 tons per farm while Norway has an average of 474 tons per farm (Iizuka & Zanlungo, 2016).
- 3. High disease rate and use of antibiotics:** Even before ISA and SRS outbreaks, there were high mortality rates on Chile's salmon farms, prompting extensive antibiotic use to try to limit the spread of disease. While there is limited available data, the antibiotics are believed to have contributed to the degradation in sanitary conditions (Iizuka & Zanlungo, 2016).

Considered more broadly, these farm-level shortcomings persisted because of at least two systematic features associated with Chile's salmon industry: 1) The competitive pressures of the global industry encouraged firms to pursue profit-drive strategies, with SalmonChile—the industry association—more effectively representing the interests of large producers instead of serving all actors in the value chain; 2) The underdeveloped regulatory side lacked capacity to enforce best aquaculture practices or effectively marshal support for sustainability standards in the face of resistance from SalmonChile and others in the private sector. Both of these characteristics have

⁴³ The discussion below is based on analysis conducted by Iizuka & Zanlungo (2016).

been the focus of reform efforts that have attempted to improve the resiliency of the industry through the formation of more vibrant institutions.

Strengthening of Chile's Institutions

There were a series of institutional changes in Chile after the emergence of ISA that were intended to improve the salmon industry's ability to collaborate against shared threats. Fundamentally, these alterations pushed the sector away from its export-oriented, *laissez-faire* model toward one that included more direct regulation. Among other items, this manifested itself in the creation of coordination bodies that enhanced communication across the value chain, the passing of a new Aquaculture Law that governed the sector, the empowerment of Sernapesca and the Undersecretariat of Fisheries (Subpesca). Each of these developments is outlined below:⁴⁴

- **The creation of the salmon roundtable (*Mesa de Salmon*):** One of the first responses was the formation of the salmon roundtable, which brought together officials from the Ministry of the Economy, the National Commission of Environment, Sernapesca and Subpesca, the Chilean Economic Development Agency and others in a crucial coordinating role. Initially, its mission included reviewing existing legal regulations, proposing new standards to strengthen bio-security, analyzing institutional capacity, and creating a research program for the sector with incentive mechanisms. Over time, however, the roundtable's scope expanded, and it provided crucial collaborative services for emergent challenges.
- **Major changes in sanitary standards:** Through modifications to the country's General Law of Fishery and Aquaculture (LGPA), the government established new regulations that strengthened the country's sanitation standards. There were four components of the changes: 1) **Increased financial support to farmers** through changes to distribution of concession rights that allowed for more expansive use of collateral in loan programs to alleviate financial stress incurred by producers by the death of fish; 2) **More aggressive bio-security measures**, which included stricter regulation surrounding the importation of eggs and broodstock as well as limitations on chemicals and antibiotic with punishments for non-compliance; 3) **Facilitation of collective action** through the creation of neighborhoods of salmon farms (*barros*) in same geographic areas; and 4) **Strengthening of the authority of the National Fisheries Service** to inspect production sites and meaningfully enforce all regulations.
- **Organizational modifications within government:** Although a National Commission on Aquaculture had been established in 2001, there was a further shift in priorities in response to ISA within the public sector from wild-caught fisheries to aquaculture, with more resources (personnel and budget) conferred to aquaculture. The National Fisheries Service gained an aquaculture unit to investigate sanitary issues. Critically, it had its own laboratory and added capacity to enforce regulations.

In the midst of the public-sector restructuring, the private sector also evolved. Specifically, SalmonChile lost some of its preeminence. Before ISA, SalmonChile's membership accounted for roughly 90% of exports (Iizuka, 2016). Yet the organization most often accommodated the wishes of its most powerful companies and failed to respond to the concerns of all its stakeholders. In

⁴⁴ The analysis in this section is based on Iizuka (2016).

2009, some Coho salmon producers formed the Association for Producers of Coho Salmon and Trout of Chile (Acotruch) to advocate for the interests of non-Atlantic salmon producers. Input suppliers also came together to form their own association around this time to give voice to their concerns.

SRS Outbreak

Even though Chilean salmon production stabilized in 2010 after the industry upgrades, there were still environmental vulnerabilities that threatened the country's salmon supply. These shortcomings have contributed in more recent years to persistent occurrences of SRS, a bacterium that is found in coastal waters and causes lesions and other symptoms that kill the fish. The 20% drop in production between 2014 and 2016 that can be seen in Figure 8 can largely be traced to the disease.

In light of the institutional changes that characterized Chile's response to ISA, the public sector and regulatory agencies have managed to develop regulations that are targeted to aquaculture instead of wild fisheries. Specifically, the National Commission on Aquaculture—which is housed within Subpesca—identified multiple areas for intervention, including smaller distance between broodstocks, more restrictive rules on stocking density, mandatory reporting of algae blooms (Mereghetti, 2017). Moreover, the various stakeholders and coordination bodies have identified the need for an industry master plan to further strengthen the country's ability to withstand crisis.

4.1.2 Ecuador

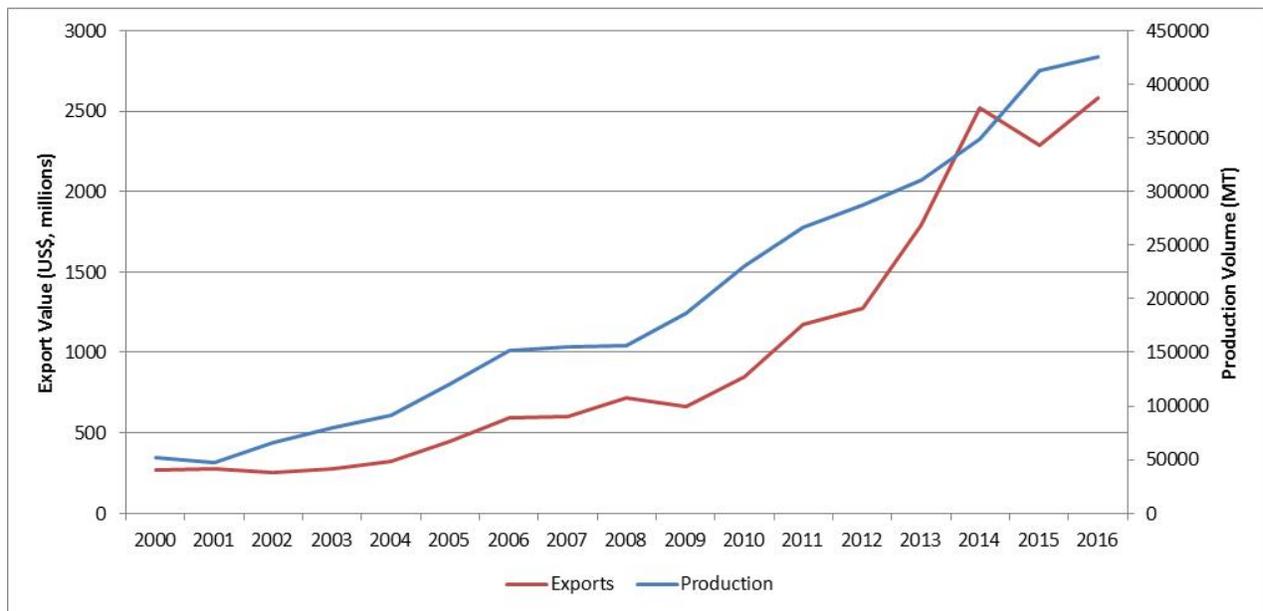
Perhaps no country benefitted more from EMS than Ecuador. At the same time Southeast Asian countries endured supply shocks, Ecuador producers managed to avoid widespread infection. With Vietnam, Thailand and others demanding shrimp for their processing facilities, Ecuador stepped into the breach, sending increasing volumes of shrimp to Southeast Asia and China.⁴⁵ As a result, the country increased its share of world shrimp production from 2% in 2008 to 5% in 2015 and its share of world exports from 6% in 2008 to 14% in 2015 (as measured by value) (FAO Fisheries Database; UN Comtrade, 2018). Figure 9 charts Ecuador's increasing production and export value from the period between 2000 and 2015. By 2015, Ecuador was the world's second-leading exporter of shrimp (Table 1 on page 2 includes shrimp and shrimp products).

Ecuador has a history of shrimp farming dating to 1967 and has been an important regional and global supplier for much of the last 30 years.⁴⁶ The late 1980s and 1990s were a critical inflection point for the industry, with three separate disease outbreaks jeopardizing the competitiveness of the sector: seagull syndrome (1989); Taura syndrome (1993-94); and white spot syndrome virus (WSSV) (1999). The WSSV outbreak was particularly debilitating, with survival rates in ponds plunging to 0-20%, and exports falling by 55% in 2000 alone (Massaut & Camposano, 2015; UN Comtrade, 2018).

⁴⁵ Whereas Asia historically only represented for 2-3% of Ecuadorean exports, it accounted for roughly 40% in 2015. At the same time, US exports also increased during the period that Thailand's and Vietnam's supply was hit (UN Comtrade, 2018). More recently, exports to the US have tapered off slightly as China has been an important growth market (Rabobank, 2017).

⁴⁶ Buoyed by the exports, the sector is an important employment generator, directly or indirectly providing jobs for 5% of Ecuador's workforce (Massaut & Camposano, 2015).

Figure 9: Shrimp Production and Exports in Ecuador, 2000-2015



Source: UN Comtrade, 2018; FAO Fisheries Database.

In the midst of fighting WSSV, Ecuador instituted regulatory changes that facilitated more active monitoring of the sector. Moreover, producers and the industry association have embraced distinct geographic features and moved even more toward an extensive production system that mitigates stress—and potentially disease-risk factors—on shrimp. These upgrades have provided a foundation for the country’s resilience to EMS, allowing it to reemerge as one of the world’s largest shrimp exporters.

This section charts Ecuador’s response to WSSV before analyzing key characteristics of the current industry that may have contributed to its EMS prevention. Those features include: 1) Its active implementation of bio-security measures and its encouragement of neighboring countries to adopt similar measures through the industry association’s vigilance (process upgrading); 2) Investments in hatchery programs that provide genetically advanced broodstock and PLs (functional upgrading); and 3) Shift toward extensive production systems, which helped maintain sanitation levels at production sites.

Responses to WSSV

Ecuador’s government implemented a series of changes in response to WSSV. Many of the initial ones were somewhat reactionary in nature, ranging from prohibiting the capture of wild shrimp larvae to supporting breeding programs as the private sector experimented with improved technologies (Massaut & Camposano, 2015).

After the worst of the crisis had passed, the government focused on structural concerns. It empowered the National Fisheries Institute to regulate all matters related to health and sanitary issues and improve standards at each segment of the value chain (Massaut & Camposano, 2015). Another step was the formulation of the National Control Plan and Residue Monitoring Plan, both of which provided aquaculture with a blueprint for a variety of disease-prevention measures, including routinely monitoring and diagnosing diseases in shrimp-production regions. A Technical

Committee for Import Risk Assessment was also formed in 2008 with aquaculture stakeholders to formulate scientifically sound strategies for the importation of inputs.

Resiliency in Current System

Ecuador has not experienced widespread EMS outbreaks in its production system, instead expanding share of global exports as Thailand, Vietnam and others have been afflicted. At least three factors may have played a role in the country's resilience. Each is outlined below:

- **Active EMS prevention through industry association's vigilance (process upgrading):** Originally founded in 1993, Ecuador's National Aquaculture Chamber functions as an industry association for shrimp and tilapia businesses in the country. The organization took a proactive approach to guard against EMS, forming an internal committee with a comprehensive group of stakeholders to review the latest scientific information about the disease and formulate strategies to reduce Ecuador's risk. In 2013, the government acted on recommendations from that group and prohibited the importation of live shrimp at any stage of their life cycle as well as amendment supplies for shrimp farms (prebiotics, probiotics, algae, etc.) (Massaut & Camposano, 2015). The National Fisheries Institute was also aggressive in using its laboratories to test for EMS and monitor adherence to bio-security standards (Undercurrent News, 2015).

Significantly, the National Aquaculture Chamber lobbied countries in close geographic proximity to adopt similar regulations. Colombia and Peru both prohibited the importation of shrimp or shrimp supplies from nations with EMS, thereby providing regional barriers for the disease (Massaut & Camposano, 2015). Lastly, the council also performed expansive extension services, regularly hosting workshops and conferences on EMS while publishing multiple articles in the industry association newsletter on best practices for prevention.

- **Investments in hatchery programs that provide access to advanced genetics (functional upgrading):** Improved genetics became a focus for actors in the Ecuadorean shrimp industry as part of the efforts to fight WSSV, with at least one of the country's prominent operators establishing itself in 1999 (Inve Aquaculture). Ecuador's shrimp producers demand 5.5 billion PLs per month, with the country's hatcheries expanding to meet supply—as of 2015, there were more than 300 laboratories producing PLs in the country (Suasnavas, 2018; USDA Foreign Agricultural Service, 2015). They have become more sophisticated over time, with leading companies adopting a variety of bio-security protocols and control measures both to prevent the introduction of diseased or infected animals into the ecosystem and increase overall production volumes.⁴⁷
- **Maintenance of extensive production systems:** Intensive production systems have been shown to yield greater economic gains in locations such as Southeast Asia (Engle et al., 2017). The constant monitoring of pond conditions and pumping of water in such an environment also provide benefits in the fight against EMS. However, a key feature of such places is the limited supply of available land. In Central and South American countries that do not have the same space pressures, there is sometimes resistance to adopting intensive

⁴⁷ Valuable lessons learned for Ecuador hatchery companies include the importance of bio-security screenings and access control for visitors, strict monitoring of water quality, cleaning procedures, management of waste, contingency plans for contaminations, and protocols for quarantining shrimp (Suasnavas, 2018).

production methods.

Ecuador has historically been a semi-intensive producer, with stocking densities of 8-12 PL per square meter and survival rates of 60-65% (Massaut & Camposano, 2015). More recently, its shrimp farmers have moved further toward the extensive end of the spectrum, citing their belief shrimp are healthier and less stressed living closer to their natural state—country-wide, survival rates recently improved to 75-80% when farmers opted for even lower stocking densities (Craze, 2016; Peel et al., 2013; Seaman et al., 2015).⁴⁸

As the country's recent growth plateaus, there is some pressure on the industry to consider moving toward intensive models (Craze, 2016). However, high electricity costs and limited human capital makes adoption of intensive systems unlikely. Furthermore, the recent success of avoiding large-scale EMS outbreaks after moving more toward the extensive pole on the intensive-extensive continuum provides a measure of confidence in the strategy.

4.2 Lessons Learned for Belize

Although there are important differences between Belize, Chile and Ecuador in terms of size, capacity and species, there are compelling lessons that can be learned by local stakeholders as they attempt to surmount challenges posed by EMS and maintain their position in both regional and global shrimp value chains. The most immediate takeaway is that **both countries nurtured or empowered institutions and expanded regulatory capacity to fight aquaculture diseases.**

As part of the efforts to combat both IRA and SRS, Chile's government paid more attention to the nuances of aquaculture (as compared to wild fisheries). Collaborative and coordinating bodies were created or more representative industry associations formed. These organizations helped created new regulations that aimed to improve environmental or bio-security standards while also providing for comprehensive enforcement. The modifications to Chile's regulatory environment should be accentuated. The law was changed to: 1) Provide financial support to farmers; 2) Implement stricter bio-security measures; 3) Facilitate collective action to shared problems; and 4) Strengthen the authority of the National Fisheries Service.

Meanwhile, Ecuador learned valuable lessons after difficulties with WSSV in the late 1990s and early 2000s, helping it avoid large-scale EMS outbreaks and increase its global market share of exports. The government did this partially by providing the National Fisheries Institute with increased power. Additionally, the National Aquaculture Chamber—the industry association for aquaculture—was proactive against emerging threats, creating ad hoc committees, reviewing existing protocols and performing extension services to educate farmers. It even enlisted neighboring countries to adopt preventive laws that strengthened the resiliency of the region. Ecuador further benefitted from functional upgrading into hatchery operations to provide genetically advanced broodstock and PLs as well as moving even closer to one of the two poles (extensive farming) in its production system.

⁴⁸ While EMS can inhibit both extensive and intensive producers, other diseases have been shown to be less virulent in open extensive systems compared to intensive systems (Hoa et al., 2011).

5 Proposed Upgrading Trajectories

Belize's upgrading path in the shrimp GVC can replicate elements of both Chile's and Ecuador's experiences. The most immediate priority is improving bio-security and enforcement capacity to allow a country-wide recovery to take root. Once production stabilizes, small and medium-sized businesses associated with the sector will have better opportunity to flourish.

To set such a course, Belize can focus on cross-cutting, transversal features that will provide a foundation for individual strategic aims. These broad-based efforts should include the following:

- *Institutionalization:* The industry has impressive individual agency but lacks a consistent overall structure to facilitate growth. Both the BSGA and BAHA have provided critical services during the EMS crisis, including valuable coordination and extension activities. Even so, a defining feature of Belize's aquaculture industry is that its institutions are somewhat informal and reactive rather than proactive. The Chilean and Ecuadorean case studies detailed how institutions in both countries helped chart recovery efforts to disease outbreaks. Belize can replicate the aggressive monitoring of the aquaculture sector. To this point, the BSGA has focused more on promotion as well as connecting actors to best practices, especially in times of crisis. With BAHA having limited resources to comprehensively fill this role, there is room for stakeholders to imagine how best the country can fill its institutional voids.
- *Human Capital:* Historically, human capital has not been a major constraint in the shrimp industry. Somewhere close to 60% of workers are usually lower-skilled employees, and there is available supply of such individuals who live in rural communities close to the coast. However, with the onset of EMS and the advance of more scientifically rigorous shrimp farming, there is need for more skilled human capital that are conversant with bio-security protocols and best aquatic practices. With relatively high representation of women workers in certain segments of the shrimp GVC, there might be opportunity for Belize to further boost the number of females in the sector, up from its current 31-33% range.

At the same time the country pursues these transversal trajectories, more narrow upgrading paths can also be pursued. These include the following:

1. **Process upgrading to improve bio-security.** Multiple stakeholders indicated that Belize's passivity to adopting stringent, systematic bio-security measures increased its vulnerability to disease. Both the BSGA and BAHA have taken steps to boost system resilience since EMS' emergence; however, further actions are required. The February 2018 award of a US\$400,000 Compete Caribbean grant to improve bio-security in the country's shrimp cluster was a significant step in this direction. As stakeholders further consider the contours of any regulatory overhaul, care must be taken to ensure there are credible enforcement mechanisms as well as an outreach effort to ensure producers understand the benefits associated with compliance.
2. **Process upgrading by moving toward intensive or extensive production systems.** There are benefits of being at either end of the intensive/extensive production spectrum. The global industry has generally moved toward intensive farming, with demonstrated economic benefits for producers in Southeast Asia. Ecuador, meanwhile, has moved in the

opposite direction, embracing extensive ponds as a strategy for avoiding EMS while also acknowledging embedded features of the domestic industry such as high-power costs and land availability. It should be stressed that EMS can strike both extensive and intensive farms. The solutions and prescriptions for fighting the disease vary depending on the system, with the recommendations for extensive farms generally requiring fewer resources (Kawahigashi & Carrias, 2016).

Belize, for its part, is somewhere between the two poles, with mostly semi-intensive farms; some producers have made investments in intensive systems, although others have been deterred by the financial costs and the need for more sophisticated human capital. In light of the undercurrents in the global industry, Belize stakeholders would benefit from understanding the value associated with shifting further toward intensive models and evaluate appropriate strategies.

It is possible the costs—both in terms of human and physical capital—would make a large-scale transition to intensive difficult. However, stakeholders should also consider benefits. Furthermore, if a country-wide shift to intensive is not possible, closer examination of Ecuador’s experience may be worthwhile. A corollary benefit of extensive systems is potential product upgrading; jumbo shrimp, which are grown in extensive ponds more frequently, command higher prices on global markets.

3. Functional upgrading through expansion of hatchery operations. The second largest category of investments since 2014 has been associated with hatchery operations (Field Research, 2018). Some of the investments have been from new companies, while others have been made by businesses looking to develop shrimp that are either more resistant to EMS or mature more rapidly, thereby boosting production. While these activities are in their nascent phase and initially concentrated on bolstering local supply, they might provide opportunity for future functional upgrading. The timeline for such a trajectory would be in the medium or long-term, as Belize would first have to bolster its reputation for bio-security; however, it is conceivable that genetically advanced shrimp could find regional markets.⁴⁹ Globally, bio-security concerns limit the trade of PLs in many locations, although countries such as Thailand and the US (Hawaii) regularly export various lines of advanced broodstock.⁵⁰ At the very least, sophisticated hatchery programs could offer Belize a competitive advantage as it seeks to regain market share for its shrimp.

⁴⁹ With respect to disease resistance, there are two primary types of genetically advanced shrimp: Specific Pathogen Free (SPF), which is shrimp broodstock that has never been exposed to disease; and Specific Pathogen Resistant (SPR), which is shrimp broodstock that is resistant to certain pathogens.

⁵⁰ Export data on shrimp broodstock is not easily retrievable; the FAO and UN Comtrade does not differentiate between the export of shrimp that is destined for human consumption and broodstock, which is larger and used for breeding purposes. By some estimates, Hawaii may account for as much as 60% of worldwide broodstock production (Gomes, 2015).

6 Appendix

Table A-1: Shares of Main Group of Species in World Trade, 2013

Species	Share by Value (%)	Share by Live Weight (%)
Fish	67.7	80.6
Salmons, trout, smelt	16.6	7.2
Tunas, bonitos, billfishes	10.2	8.3
Cods, hakes, haddocks	9.6	14.4
Other pelagic fish (sardines, etc.)	7.5	12.7
Freshwater fish	4.0	4.8
Flounders, halibuts, soles	1.6	2.1
Other fish	18.1	31.2
Crustaceans	21.7	8.2
Shrimps, prawns	15.3	6.0
Other crustaceans	6.4	2.1
Mollusks	9.8	10.4
Squids, cuttlefishes, octopuses	5.6	4.0
Bivalves	3.0	5.6
Other mollusks	1.1	0.7
Other aquatic invertebrates/animals	0.8	0.9

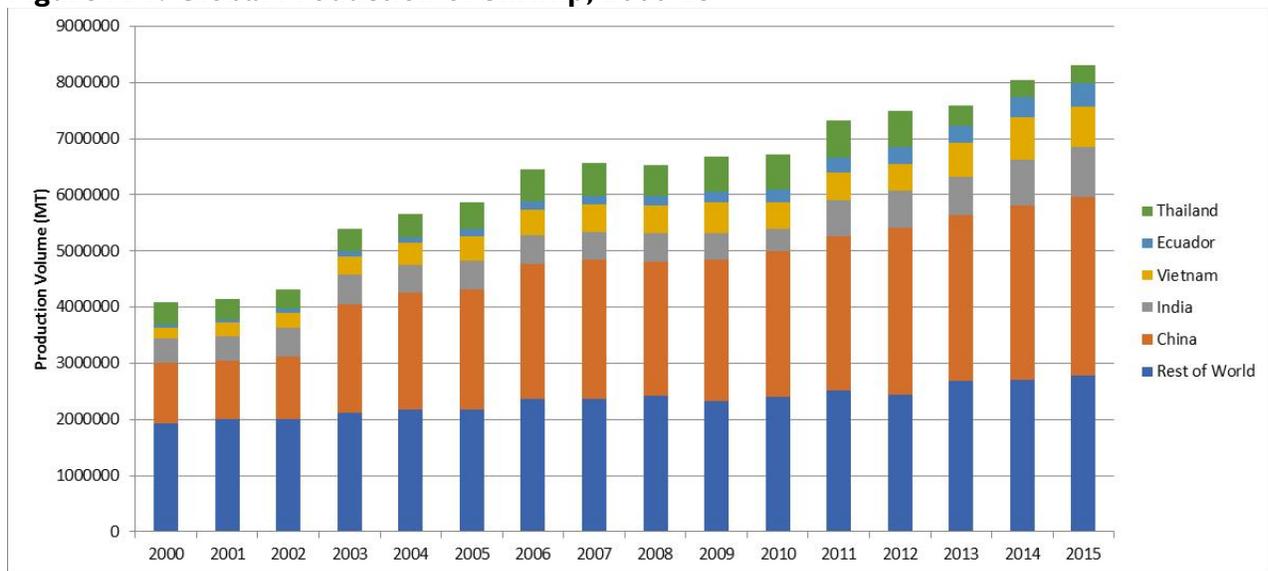
Source: FAO, 2016.

Table A-2: Global Export Share of Shrimp by Product Category, 2012-2016

Description	HS Code	2012	2013	2014	2015	2016
TOTAL (US\$ millions)	—	18,423	21,004	24,365	20,441	19,141
Whole or Ready-to-Cook Shrimp						
Frozen shrimp and prawns, excluding cold-water varieties, in shell or not	30617 & 30613	60.7%	61.4%	65.1%	64.3%	65.9%
Frozen shrimp and prawns, cold-water, in shell or not	30616	5.9%	8.3%	7.6%	7.9%	7.6%
Shrimp and prawns, not frozen, excluding cold-water varieties, in shell or not	30627	2.0%	1.8%	1.7%	2.0%	2.3%
Shrimp and prawns, not frozen, cold-water varieties, in shell or not	30626	2.1%	1.9%	1.6%	1.6%	2.1%
Shrimp and prawns, not frozen, general	30623	0.9%	0.5%	0.4%	0.0%	0.0%
Sub-total (%)	—	73.2%	75.6%	78.2%	77.4%	79.5%
Shrimp preparations						
Preparations, shrimps or prawns, not in airtight containers	160521	18.3%	16.4%	14.1%	14.3%	12.4%
Preparations, shrimps or prawns, in airtight containers	160529	7.6%	7.6%	7.2%	7.9%	7.0%
Preparations, shrimp and prawns, general	160520	0.5%	0.1%	0.1%	0.0%	0.8%
Sub-total (%)	—	26.8%	24.4%	21.8%	22.6%	20.5%

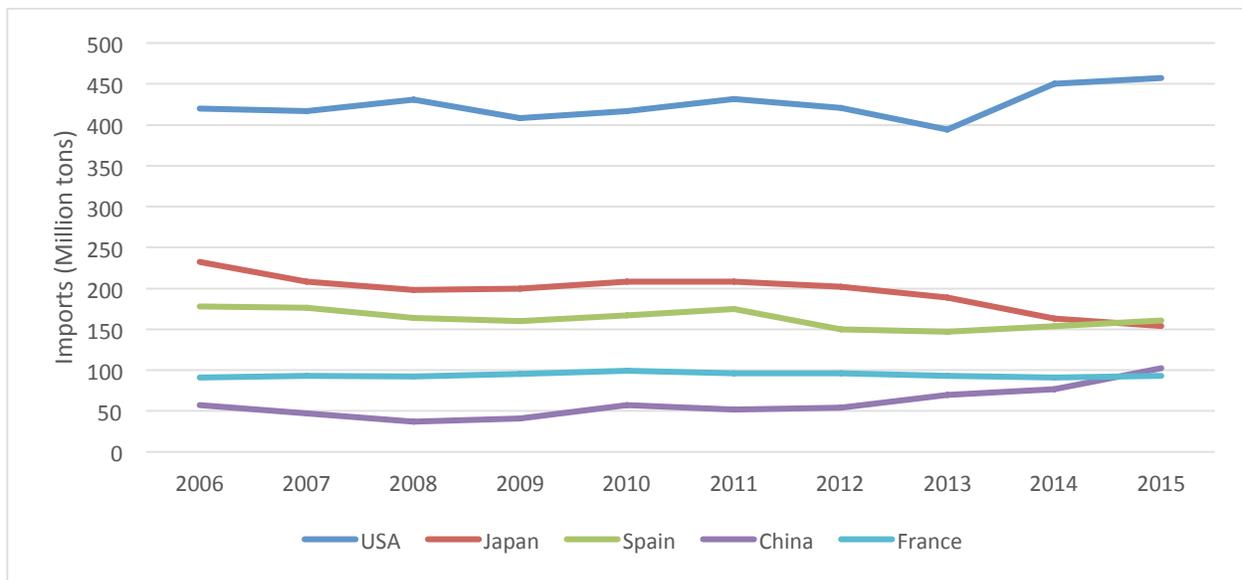
Source: UN Comtrade, 2018.

Figure A-1: Global Production of Shrimp, 2000-15



Source: FAO Fisheries Database.

Figure A-2: Leading Global Importers of Shrimp, by Volume, 2006-2015



Source: UN Comtrade based on 30613, 30616, 30617, 30623, 30626, 30627, 30635, 30636, 30695 HS codes.

Table A-X: Key Production Factors in Shrimp Farms in Vietnam and Thailand

Factor	Extensive	Semi-Intensive	Intensive	
	LP	MP	HP	VHP
Vietnam				
Stocking density (PL/m ²)	26	31	66	73
Feeding rate (kg/ha)	1246	4556	9114	15,485
Aeration rate (hp/ha)	4	12	28	50
Yield (kg/ha)	265	3,469	6,974	11,702
Survival (%)	23	75	81	81
Thailand				
Stocking density (PL/m ²)	62.5	62.5	82	99
Feeding rate (kg/ha)	1681	4,797	10,956	18,666
Aeration rate (hp/ha)	9	33	35	49
Yield (kg/ha)	1301	3,483	6,982	13,560
Survival (%)	75	67	73	80

Source: Engle et al., 2017. **Key:** PL = postlarvae. LP = low productivity. MP = medium productivity. HP = high productivity. VHP = very high productivity.

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