

Report on the Shrimp Sector

Asian Shrimp Trade and Sustainability



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EXECUTIVE SUMMARY

This study, undertaken by Sustainable Fisheries Partnership (SFP), aims to better understand market dynamics and sustainability concerns with respect to Asian shrimp, endeavoring to fill in gaps in publicly available information at both national and provincial scales. For 10 shrimp producing countries in Asia (Thailand, China, Indonesia, Vietnam, India, Bangladesh, Malaysia, Philippines, Myanmar, and Cambodia), experts on the ground gathered production, trade, and sustainability information from fishery managers, aquaculture experts, processing plants, and other sources. Simple regression analyses were applied to determine recent trends and compare between countries and provinces.

In conducting this study, we particularly hoped to answer the following questions:

- Where is Asian shrimp produced at the national and provincial scales, and how much of it stays on the domestic market? How much is exported abroad, and to what destinations?
- What proportion of Asian shrimp exports is of farmed origin, and what proportion of wild origin?
- What are the prevalent sustainability concerns facing the Asian shrimp industry today?

In addition to data gathered from local sources, SFP also pulled information for this report from its own Metrics database, into which participating retailers and suppliers of seafood log information about their seafood purchases. The 4,631 purchases of shrimp from these countries that have been logged into Metrics in 2009–2015 were assessed individually with an overall goal of identifying provinces that export shrimp to western supply chains and cross-checking the trade information provided by the local experts. While individual transaction details from Metrics are confidential and therefore are not included in this report, aggregate analyses are included.

Key findings of our study follow below:

- Aquaculture comprises a growing proportion of Asian shrimp production, currently accounting for 58% of the cumulative production of these 10 countries.
- Approximately half (49%) of these countries' shrimp production remains on domestic markets.
- Despite the growth of local demand for shrimp, western markets (the United States and the European Union) are still leading destinations for these countries' shrimp, as is Japan.
- Of the 34% of shrimp production exported by these countries, 87% of the exported volume is supplied by farms.
- Thailand, previously the world's leading shrimp exporter, has particularly suffered from production losses due to Early Mortality Syndrome (EMS), and its export volume has been surpassed by Vietnam, China, and India.
- While EMS affected its production as well, Vietnam currently appears to be the world leader in shrimp exports and farmed exports, although it no longer reports export volumes and only reports export value; thus, volume figures are only estimates.
- Four nations that have made large-scale investments in intensive whiteleg shrimp (*Penaeus vannamei*) farming (Vietnam, Thailand, India, and Indonesia) all export more than half of their shrimp production and have shrimp export values of over \$1 billion each.
- Nations that have not made large-scale investments in intensive whiteleg shrimp aquaculture (Bangladesh, Malaysia, Cambodia, the Philippines, and Myanmar) have struggled to compete for the international market with those that have, and these countries each export \$500 million or less of shrimp annually and keep more than half of their shrimp in-country for domestic consumption.
- China is an exceptional country in that it both has invested heavily in whiteleg shrimp culture and keeps 88% of its shrimp production for domestic consumption. This is indicative of the high demand for shrimp in the Chinese market.
- Sixteen provinces in six of the countries were identified as particularly large producers and exporters of shrimp, accounting for approximately 35% of global warm-water shrimp exports. Intensive whiteleg shrimp farming accounts for much of the shrimp production in these provinces, whose main sustainability concerns are disease proliferation, water pollution, and feed sustainability.

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A data annex accompanies the report as a separate Excel document.

SOUTHEAST ASIAN SHRIMP TRADE AND SUSTAINABILITY

INTRODUCTION

The importance of Asia's contribution to global shrimp production is indisputable: in 2013, the continent accounted for 85% of shrimp aquaculture production and 74% of wild shrimp capture, including 86% of warm-water shrimp harvest. Furthermore, in 2011 Asia accounted for 62% of global shrimp exports (FAO 2015). In light of Asia's predominance in the shrimp sector, the sustainable seafood movement must pay attention first and foremost to Asian farms and fisheries when endeavoring to improve global sustainability of shrimp production using leverage of the global supply chain.

This study, undertaken by Sustainable Fisheries Partnership (SFP), aims to better understand market dynamics and sustainability concerns with respect to Asian shrimp, endeavoring to fill gaps in publicly available information at both national and provincial scales. We included 10 Asian, shrimp-producing countries, listed in descending order of production volume, in the scope of analysis:

1. China
2. Thailand
3. Indonesia
4. India
5. Vietnam
6. Malaysia
7. Philippines
8. Myanmar
9. Bangladesh
10. Cambodia

For each country, experts on the ground gathered production, trade, and sustainability information from fishery managers, aquaculture experts, processing plants, and other sources. On the basis of this information, we highlight provinces that produce and export large volumes of shrimp and also require sustainability improvements.

Why do we care? Significance of shrimp for the seafood industry

The shrimp sector is globally significant in economic, environmental, and social respects alike:

- Shrimp is the most highly traded seafood product by value globally.
- In the world's single biggest seafood importer, the United States, shrimp is the most consumed seafood per capita.
- Over half (123 countries) of the world's countries engage in shrimp production, with commercial wild shrimp fisheries existing in 110 countries, and shrimp farming occurring in 65 countries (including 52 nations that also have fisheries).
- Shrimp fisheries and farms are both prominently associated with environmental risk due to high bycatch rates in bottom trawl fisheries and various impacts of shrimp

aquaculture, including habitat destruction, disease outbreaks, and overfishing of low trophic wild stocks to produce feed.

- Shrimp farming is a rapidly expanding industry worth \$19.4 billion as of 2012.
- Shrimp fisheries employ over one million fishers, and shrimp farms are also an important source of jobs worldwide.

Brief overview of global shrimp trade data

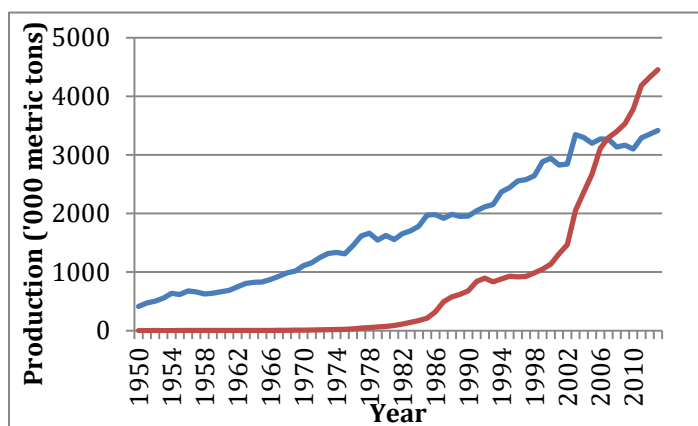


Figure 1: Wild and aquaculture global production of shrimp, 1950–2013. Aquaculture production (red) of shrimp surpassed wild-capture (blue) in 2007, and climbed to 56% of global shrimp production in 2013 (FAO 2015).

Aquaculture, which only began to make significant contributions to global shrimp production in the 1980s, overtook wild harvest in 2007 and has continued to claim a growing share of the market in each subsequent year. As of 2013, production from shrimp farms accounts for 56% of global shrimp production (FAO 2015) (Figure 1). In that year, farmed shrimp production amounted to a record 4.45 million metric tons, compared with 3.4 million metric tons of wild harvest (also a record).

According to FAO data (FishStat J) for 2010 and 2011, the countries analyzed in this report account for 77% of global

shrimp production and 60% of global shrimp exports (Table 1). Thailand, Vietnam, China, and India are the world's largest exporters of shrimp, with Indonesia ranking sixth and Malaysia ninth. While the developing world produces much of the world's shrimp, the developed world

Table 1: Shrimp production and trade information for the countries of analysis. All data is taken from FishStat J (FAO 2015) with the exception of information for Bangladesh (provided by the in-country analyst engaged in this project). FishStat J currently contains trade data up through 2011.

Country	Avg Annual Wild Harvest (metric tons, 2010-2011)	Avg Annual Aquaculture Production (metric tons, 2010-2011)	Avg % of Production from Aquaculture (metric tons, 2010-2011)	Avg Annual Total Production (metric tons, 2010-2011)	Avg % of Global Production on (2010-2011)	Avg Annual Exported Volume (metric tons of product, 2010-2011)	Running Total of Exported Volume (metric tons of product)	Running Percent of Global Shrimp Exports
Thailand	50,031	588,995	92%	639,026	8.9%	411,045	411,045	16%
Vietnam	152,900	325,500	68%	478,400	6.7%	340,968	752,013	28%
China	1,161,835	1,501,702	56%	2,663,536	37.1%	290,140	1,042,152	39%
India	344,752	178,457	34%	523,209	7.3%	225,370	1,267,522	48%
Indonesia	239,419	389,435	62%	628,854	8.8%	144,662	1,412,184	53%
Malaysia	112,565	77,354	41%	189,919	2.6%	84,359	1,496,542	57%
Bangladesh	106,941	106,310	50%	213,251	3%	53,245	1,549,787	59%
Myanmar	42,000	48,656	54%	90,656	1.3%	21,121	1,570,908	59%
Philippines	47,417	55,120	54%	102,537	1.4%	8,300	1,579,208	60%
Cambodia	8,244	90	1%	8,334	0.1%	242	1,579,450	60%
Total	2,266,102	3,271,618	–	5,537,720	77%	1,579,450	–	–

imports and consumes it; Europe, the United States, and Japan account for three-fourths of global shrimp imports, with the United States importing more than any other nation (Table 2). Among European nations, Spain and France are the most prominent markets for shrimp (leading importers). According to the World Bank, the importance of the US market for shrimp is slated to increase between now and 2030, while European demand will slacken (World Bank 2013).

Table 2: A comparison of annual shrimp import volumes (in metric tons of product) of the three main shrimp-importing regions and the global proportion of shrimp imports that they accounted for in the last three years for which data is available (2009–2011). For each region, the leading importer among nested countries is also indicated, illustrating that the United States is the world’s leading shrimp importer nation, while Europe is the world’s largest regional market for shrimp (FAO 2015). Note: The data for North America consist of aggregate information for Canada, the United States, and Mexico.

Country /Region	2009 (mt)		2010 (mt)		2011 (mt)	
Europe	930,890	42%	976,926	41%	971,790	40%
incl. Spain	162,975	7%	170,675	7%	179,281	7%
North America	625,434	28%	642,519	27%	655,449	27%
incl. USA	552,570	25%	561,328	24%	576,988	24%
Asia	571,234	26%	626,500	26%	681,174	28%
incl. Japan	266,032	12%	279,152	12%	285,189	12%
Global Totals	2,232,267	—	2,380,705	—	2,439,308	—

The International Market: Differentiation and Trends

In broad strokes, the international shrimp market can be divided into two separate markets for warm-water shrimp and cold-water shrimp (which are not addressed in this report). These two groupings consist of different species (representatives of the *Pandalus* genus are dominant among cold-water shrimp, while *Penaeus* and *Metapenaeus* representatives are common targets of warm-water shrimp fisheries) that differ markedly in size, which is the key factor for market differentiation. Demand and uses for different sizes of shrimp varies by country and region: for example, in the United States, small (“salad”) shrimp are not considered a main dish, and are generally used as a salad garnish. Preparation and processing also vary according to consumer tastes: the shrimp may be left whole or ground into meal or paste; if whole, the shell, veins, heads and tails may be left on or removed; the product may be cooked or raw; and it may be sold fresh, frozen, chilled, dried, salted, or in brine.

In market terms, shrimp body size is expressed as “count per pound,” with the count preceded by a “U” which stands for “under”—i.e., U15 means “under 15 shrimp per pound.” Larger shrimp (“jumbo shrimp,” “colossal shrimp,” “prawns”) with a size between U2 and U15 are exclusively of warm-water origin, while smaller shrimp (U100 and upward) are generally cold-water shrimp. There are, however, exceptions: seabob fished in tropical geographies, for example, compete with cold-water shrimp due to their diminutive size. Pink shrimp and juvenile vannamei shrimp from Southeast Asia are also small enough to fill the salad shrimp niche. Meanwhile, Nephrops, actually a lobster rather than a shrimp, is sourced from cold-water fisheries, but due to its large size it is marketed as “scampi” or “prawns” in Northern Europe. Shrimp farming has “muddied the waters” when it comes to shrimp market differentiation in

that, with improving technology, farmers are able to produce a variety of species and sizes of shrimp, although wild fisheries still have an important niche in production of jumbo shrimp. Product is consequently available spanning the entire size gamut from <U15 to >U100, and supply demonstrates responsiveness to shifting market dynamics and emerging species and size preferences.

A key recent trend in shrimp markets has been the emerging and subsiding of the Early Mortality Syndrome (EMS) in shrimp farms of many of the world's largest producer countries in 2011 through 2014. Countries such as China, Thailand, Vietnam, Ecuador, and Mexico all lost sizeable portions of their production. Indonesia was the notable major farmed shrimp producer that did not suffer from production loss due to the disease. While not in agreement with FAO data, an industry source indicates that global shrimp aquaculture production fell 13% from 2012 to 2013 due to EMS and is not projected to fully recover and surpass the 2012 peak until 2016 (Sackton 2015a). Even upon production recovery, concerns will remain because the disease vector occurs naturally in the environment and its proliferation is triggered by factors such as stocking density and waste removal, as well as the health of juveniles. Meanwhile, the spore-forming parasite *Enterocytozoon hepatopenaei* (EHP), which has been impacting shrimp production in Thailand and China dating back to 2011, appears to be growing in prevalence among Asian shrimp farms due to increasing intensification. EHP does not cause widespread mortality like EMS, but it slows growth and weakens productivity of shrimp (Sackton 2015b).

METHODOLOGY

Examining the global supply chain for shrimp poses some particular challenges: first and foremost, the market for shrimp is extremely heterogeneous. Fisheries, farms, and processors in 123 countries produce an array of species and product combinations. The quantity and variety of fisheries and products represents a difficulty for the seafood sustainability movement when trying to achieve progressive change sector-wide with the active involvement of the supply chain.

Issues of trade data availability further complicate matters. National export statistics often lump multiple species, and wild and farmed production is also generally grouped together. As many leading aquaculture producer countries of shrimp, most of which are located in Asia, are also leading wild shrimp producers, the relative contributions of wild and farmed products to national exports are unknown or not reported to the FAO.

This study attempts to address these challenges of market heterogeneity and data availability by looking beyond published national data and engaging local experts in gathering production, trade, and sustainability information at the provincial scale. We engaged eight in-country consultants and two staff to gather the data for each of the 10 countries. Each data gatherer selected 2–4 high-production provinces for in-depth study. We encouraged the experts to visit these provinces and meet with processing plant and fishing and aquaculture association representatives in order to obtain information not otherwise available. Data requests were also made of local management authorities. The in-country experts compiled information on provincial farm production, provincial fishery production, exported proportions, and destination countries into Excel templates and submitted them to SFP for analysis and compilation.

Findings were limited by data availability: in some included geographies fishery and farm management is not data-intensive and the quantitative information that we were seeking was found to simply not be available. In these cases, we instructed the data gatherers to obtain anecdotal information. While not ideal, this information is still useful for the task of identifying high-production, exporting provinces that are also facing sustainability challenges. Another limitation particular to trade data results from the considerable volumes of Asian shrimp that are transshipped at sea—transshipped product is often unaccounted for and/or relabeled.

In aggregating information into this report, we used simple analysis methods, i.e., linear regression analysis of quantitative production and export data in order to determine trends. We also crosschecked the information received from in-country experts against retailer and supplier information logged into our Metrics system.¹ In Metrics, retailers and suppliers can attribute volumes purchased to fisheries with profiles in our sustainability database, FishSource. While there are no aquaculture profiles in FishSource, we have also made it possible to attribute volumes to BAP-certified aquaculture operations, of which there are hundreds in Asia.

RESULTS

Thailand

National Overview

Thailand is a country made up of 76 provinces located at the center of the Indochina peninsula and bordered by Laos, Burma, Malaysia, and Cambodia. Thailand's coastline stretches along the Andaman Sea to the west and the Gulf of Thailand to the east. Shrimp aquaculture operations are underway in many parts of the country at over 23,800 individual farms. We obtained specific production data for 25 provinces and a lumped total for production in the other 51 provinces combined. Meanwhile, wild-capture shrimp production, in which up to 50,000 fishers (the number of licensees in the permitted 2015 fishery) participate, is attributed to 20 provinces. For aquaculture production, the provinces of Chanthaburi, Nakhon Si Thammarat, Phattalung, and Songkhla were the top four producers as of 2012. Leading provinces for wild-caught shrimp in that same year were Narathiwat, Ranong, and Chonburi (Figure 1).

Country Snapshot: Thailand

Year: 2013

Farmed production: 329,035 tons

Wild production: 47,304 tons

Total production: 376,339 tons

Export volume, product weight: 197,238 tons

Export volume, live weight: ~330,000 tons

Exported proportion: ~88%

Export market value: \$2.16 bil

Ratio farmed:wild of exports: ~ >99 : <1

Ratio of farmed product that is exported:farmed product that stays on the domestic market: ~99:1

¹ Information from Metrics reflects only the purchasing of SFP partners and may not reflect purchasing habits of the retail sector as a whole. While Metrics data is confidential and therefore not comprehensively included in this report (i.e., information on specific transactions is not included and buyer identities are not revealed), it provides a snapshot of trade dynamics between Asian producer countries and western markets, which we used to corroborate the findings of in-country experts.

The predominant species produced by Thai farms is whiteleg shrimp, accounting for 97% of farmed production. Giant tiger shrimp production contributes most of the remaining 3%. As for wild shrimp capture, school shrimp (*Metapeneaus* spp.) account for 35% of harvest and banana shrimp—15%. Giant tiger, green tiger, king, *Acetes*, and other shrimp species comprise the other 50%. Otter trawl gears account for over 60% of wild-capture harvest, with trammel and push nets cumulatively contributing 27%. Information about product types was not available for farmed shrimp, but for wild-capture shrimp harvested by Thailand in 2012 excluding *Acetes* (paste shrimp), half of production was sold as chilled and frozen product, 25% as fresh product, 23% canned, and 1% dried. Product differentiation statistics are available for exported product, most of which is comprised of farmed shrimp: in 2014, 47% of exported shrimp was categorized as fresh, chilled, or frozen, with the remaining 53% consisting of prepared or preserved product. On the basis of these statistics, yield after preparation or processing was estimated at 47%.

We obtained national production information through 2013 for farms and for fisheries (Table 3). Aquaculture production exhibits a rising trend through 2011, with a slight decrease in 2012 and sharp decrease in 2013 as a result of EMS (Figure 2). Meanwhile, fisheries production has decreased since the 1980s, at which time annual production was consistently above 100,000 metric tons (Figure 3). That said, there is uncertainty regarding wild harvest volumes, with various sources reporting markedly different landings. Complicating factors for recording wild Thai harvest include the large number of landing sites, sales to private markets, sales to government markets, direct landings to processors, and the percentage of shrimp caught outside of the Thai EEZ but landed by Thai flagged vessels. Furthermore, information recorded in fishing vessel logbooks is recognized to often be inaccurate or misleading.

Table 3: Thai national aquaculture and wild-capture shrimp production, 2009–2013 (in metric tons). Wild-capture data from five different sources is included in order to illustrate the uncertainty in information. Source 1: Department of Fisheries 2015a (supplemented with FishStat J data for 2013); Source 2: Department of Fisheries 2012; Source 3: Department of Fisheries 2015b; Source 4: Fish Marketing Association of Thailand 2015; Source 5: Thailand Fishery Statistics Analysis and Research Group 2014.

Year	Aquaculture	Wild-Capture				
		Source 1	Source 2	Source 3	Source 4	Source 5
2009	575,098	53,352	44,082	Na	1,675	Na
2010	559,644	52,787	45,308	20,873	1,715	10,947
2011	611,183	47,274	42,234	17,352	1,283	9,748
2012	609,562	43,918	40,555	14,056	1,160	13,068
2013	329,035	47,304	na	na	na	na

The volume of shrimp that is exported out of Thailand peaked in 2010, with the lower export volumes and values in 2013 and 2014 attributable to EMS (Table 4). The USA, Japan, and the EU have been the main destinations for Thai shrimp throughout 2008–2014, cumulatively accounting for 74% of Thai exports in 2014. The main exported species are whiteleg (all production is farmed) and giant tiger shrimp (national production is 91% farm-origin according to Thailand’s data submitted to the FAO for the 2013 season) (FAO 2015). As with wild harvest volumes, there are discrepancies in national export statistics among sources (the Customs Department and the Thai Frozen Foods Association, for example, differ in some of their statistics by ten-fold).

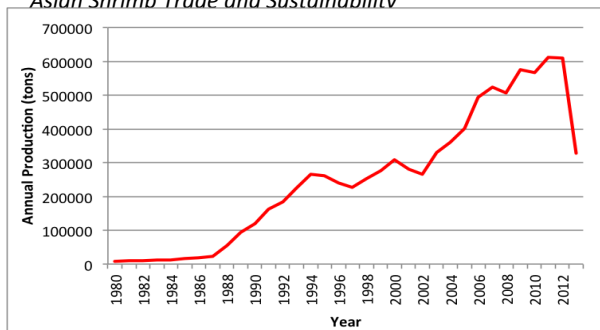


Figure 2: Thai aquaculture shrimp production, 1950–2013 (FAO 2015).

enables them to identify the producer. However, the Thai Information Act requires the approval of individual producers in order for the Customs Department to disclose information relating to producers' production volumes and sale of their harvests. This bureaucratic process unfortunately would take longer than the time allotted for this project but, with adequate time and resources, it would be possible to trace exported shipments back to individual farms or fisheries. However, due to the predominance of farmed product in Thailand, one can feel confident making the assumption that farmed production accounts for most (>99% of) Thai shrimp exports.

Unfortunately, there are no publicly available, separate export statistics for wild and farmed Thai shrimp. The Thai Customs Department database uses generic descriptions for both wild-caught and cultured shrimp species, as well as generic descriptions for the type of processing and packaging of final products for export. That said, each individual export shipment of shrimp is given a unique code by the Customs Department, which

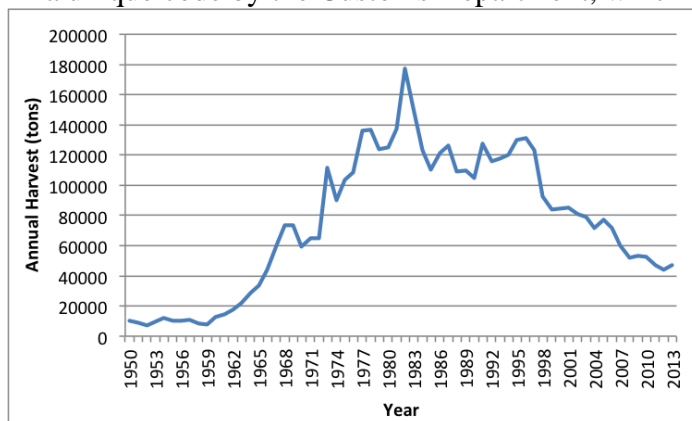


Figure 3: Thai wild shrimp harvest, 1950–2013 (FAO 2015).

Table 4: Thai shrimp exports to main destination nations, 2008–2014 (in metric tons of product), and export market value (in millions of US dollars) (Thai Frozen Foods Association 2009–2014). The listed countries/regions account for approximately 90% of Thai exports. Thai export reports list trade quantities for 31 destination countries, including a lumped entry entitled “others.” In the last three years, Thai export statistics include information on the quantity and market value of exported giant tiger shrimp.

Destination	2008	2009	2010	2011	2012	2013	2014
USA	167,522	176,577	186,985	173,986	119,655	74,288	62,435
Japan	57,821	65,525	74,103	77,050	75,952	54,166	38,046
EU	38,281	49,980	64,527	58,075	47,965	26,336	17,609
Canada	20,040	20,895	21,609	22,047	20,097	9,806	8,751
Australia	7,138	9,393	10,102	9,742	10,503	6,874	7,366
Vietnam	1,476	5,356	5,744	5,233	10,160	4,668	6,227
South Korea	12,599	10,513	1,810	9,331	10,026	5,155	5,169
Total Exports	335,372	366,983	407,978	380,153	323,102	197,237	158,543
Proportion of Nat'l Exports Accounted for by These Countries	89%	94%	91%	92%	92%	89%	94%
Export Market Value (\$ mil)	\$2,388	\$2,595	\$3,066	\$3,559	\$2,897	\$2,159	\$1,934
Proportion of Market Value Comprised of Giant Tiger Shrimp	n/a	n/a	n/a	n/a	2%	3%	4%

Provincial Overview

Production but not trade information was gathered at the province scale for Thailand. Surat Thani was the leading provincial producer in 2012, with Nakhon Si Thammarat indicating the greatest rate of increasing production between 2010 and 2012, with new farming capacity coming online in the province (Table 5). Provincial fishery harvests in key regions, meanwhile, generally trended downward during that period of time.²

As for provincial export data, we were not able to split out exports at a finer scale than the national scale. As explained above, each customs note in which export transactions are recorded cannot be made public without producer agreement, and there are thousands of customs notes and thousands of producers involved in a single shrimp season. We discovered during this study that in order to tally exports for a particular province, all of the customs notes for that province would need to be requested with producer agreement, and then aggregated.

Table 5: Aquaculture and wild production in key Thai provinces for aquaculture and wild-capture shrimp production, 2010–2012 (metric tons) (Department of Fisheries, 2015b). Publication of this data occurs with a two to three-year lag time due to the mammoth task of collecting logbook entries for 50,000 fishing vessels.

Province	Aquaculture Production (metric tons)			Wild Production (metric tons)		
	2010	2011	2012	2010	2011	2012
Surat Thani	57,999	53,074	66,302	1,728	1,796	1,103
Chanthaburi	60,467	67,603	61,594	83	235	223
Songkhla	44,226	43,645	47,596	357	276	236
Nakhon Si Thammarat	28,820	39,781	44,425	2,158	1,558	1,160
Prachuab Khiri Khan	36,326	39,204	40,744	792	473	323
Trat	49,428	42,714	38,154	1,391	1,574	1,298
Trang	33,075	34,898	37,526	1,139	972	749
Satun	35,308	35,570	34,123	348	183	290
Chumpon	25,332	29,718	29,779	869	760	519
Krabi	21,801	23,240	26,421	-	-	-
Rayong	19,630	35,001	25,148	90	229	121
PhangNga	25,335	29,422	23,754	-	-	1
Chachoengsao	29,871	29,420	21,954	191	130	113
Samut Sakhon	8,508	16,399	20,863	1,344	1,065	814
Ranong	14,163	14,964	13,476	2,229	1,734	1,811
Narathiwat	521	936	785	2,359	2,376	2,109
National Totals	559,644	611,183	609,562	52,787	47,274	43,918

Information from SFP’s Metrics database provides some indication of export dynamics at the provincial scale. Suppliers in Metrics have been attributing purchases of shrimp to farms with BAP certification, listing the BAP code for the farm along with volume and species information. For those BAP codes that are current, we were able to identify the province in which the farm is located. If suppliers do not know the BAP code or are sourcing from a non-certified facility, they have the option of attributing their purchases to a general category of “Thai shrimp.”

² Wild stocks are not fished specifically by province but are caught and landed from within any of the 109 designated fishing areas within the Thai EEZ. Therefore, data attributing catch to provinces may be inaccurate, as it is merely reflective of landings at provincial ports that were not necessarily harvested in neighboring waters (and may have even been harvested outside of the Thai EEZ).

Furthermore, suppliers can choose to not reveal volume information and merely indicate that a transaction has occurred.

For Thai shrimp, Metrics includes 2,914 transactions that occurred in 2011–2015 and accounted for an estimated 8% of total Thai shrimp exports in 2011–2014 (see Data Annex). Of the 2,914 transactions, 59% include volume information, amounting to approximately 50,000 metric tons of purchased volume cumulatively. For a subset of the Thai shrimp transactions (705 transactions, including 26,710 metric tons of cumulative volume), we were able to attribute the transactions to the provinces in which the product was produced (Table 6). While suppliers can make mistakes in data entry, resulting in some unreliability, the information generally indicates that several high-production provinces (i.e., provinces with $\geq 20,000$ metric tons of annual production) are exporting their product to western markets (PhangNga, Surat Thani, Trang, Rayong, Songkhla, Trat, Chanthaburi, and Thammarat).

Table 6: Summary of Metrics entries for Thai shrimp. 24% of transactions and 55% of reported volumes for Thai shrimp were attributable to the province in which production occurred. The nine provinces to which transactions were attributed account for 50% of national production (2009–2012, annual average) and eight provinces that produce over 20,000 metric tons of shrimp annually. While we caution against drawing fixed conclusions upon the basis of these data due to likely high error frequency in supplier data entry, it provides a general indication of some of the source provinces for exports to western markets. The information provided here aggregates entries for all companies using Metrics, as Non-Disclosure Agreements prevent the release of information for individual companies.

Province	Number of Metrics Transactions	Volume Reported in Metrics (metric tons)	Avg Provincial Farmed Production, 2009–2012 (metric tons)
PhangNga	331	8,654	27,210
Phetchaburi	119	9,356	10,472
Surat Thani	82	7,141	59,794
Trang	64	673	34,875
Rayong	44	-	25,195
Songkhla	35	-	45,864
Trat	18	418	44,308
Chanthaburi	2	330	63,500
Thammarat	10	138	45,864
TOTAL (FOR IDENTIFIED PROVINCES)	705	26,710	297,348
NATIONAL TOTAL	2,914	49,995	588,872
% REPRESENTED	24%	53%	50%

Fishery Sustainability Information

Thai marine fisheries are broadly divided between the Gulf of Thailand (GOT) and the Indian Ocean, although fisheries in the two geographies share similar sustainability issues. Bottom trawling (single, pair, and beam) is the most common form of gear used in the Thai shrimp fishery. Catches include immature fish, crustaceans, and mollusks. There are no discards, and all harvest is retained and landed.

Management of Thai fisheries is weak: outdated legislation, lack of finance, corruption, and insufficient resources to enforce fishery regulations have resulted in severe depletion of marine stocks and damage to the ecosystem within most areas of the GOT. The Thai EEZ in the Indian Ocean is showing the same pattern. Illegal fishing within restricted coastal zones is common, as is the use of unlicensed vessels and gears. Efforts to reduce the number of trawlers have failed. The vast decline in CPUE in Thai waters is well documented, as is the impact of fishing upon the marine environment.

Improvement needs for these fisheries include additional protection of the spawning stock and juveniles during trawl season, enactment of a minimum 2.5 cm mesh size in the purse seine fishery, development and enforcement of a turtle excluder device regulation in the trawl fishery, and enforcement of closed areas (including the existing no-fishing zone within 3 km of the coast).

A new Thai Fisheries Act is due to go into force in 2015. The new legislation will reportedly include more effective measures to target and reduce illegal fishing, increase the number of Marine Protected Areas, and control the number and movements of fishing vessels. Penalties and fines for rule breaking have been increased. However the specific details of the legislation are yet to be finalized as is the means by which these new measures will be enforced.

Aquaculture Sustainability Information

Disease continues to be a significant issue for the Thai shrimp industry, as it has been slow to recover from the impact of EMS beginning in 2012. Many smaller-scale Thai producers are no longer operating as a result of EMS, and some of the larger companies have scaled back their production expectations. The Thai shrimp industry is familiar with major disease outbreaks and has previously put in place measures including specific pathogen free (SPF) larvae that are guaranteed free of particular viral diseases. This is not possible at present with the bacteria causing EMS because it is ubiquitous in the environment and proliferates if ponds are sterilized.

Farmers need to manage the biology of ponds to minimize opportunities for spikes in the bacteria that causes EMS by maintaining balance among other bacteria and algae. In the absence of stringent water management standards, another effective approach is to reduce stocking density, although this goes against the entrepreneurial approach of farmers who are familiar with boom and bust cycles. All of these measures require greater vigilance and management input than previously expected and further drive the need for all farmers—especially the smaller-scale ones—to utilize best practices in order to minimize risks to each other.

The Government of Thailand and many industry partners continue to invest in understanding how the disease proliferated so rapidly and how to control it. Recurring disease issues in the shrimp industry demonstrate the need for better data collection on disease management, the use of that information in real-time to inform farm and sector management decisions, and effective emergency disease response plans at national and local levels. Overall, more effective cooperation is needed between regulators, support services and the industry.

Issues associated with fish feed are also an important sustainability concern in the Thai shrimp farming industry. Farms in all provinces use feeds that are commercially produced in Thailand. Fishmeal is a basic ingredient of any shrimp feed derived from a number of sources, the proportions of which vary by season and source availability. In rough terms, some 3–3.5 tons of raw material are required to produce one ton of fishmeal. The mix of raw materials used to produce meal in approximate percentages:

- tuna trimmings and frames from the canning industry: 40%
- trimmings and offal from the surimi industry: 25%
- wild-caught species from the domestic fishery (includes trash fish and target species): 18%
- wild-caught species from overseas fisheries: 3%
- byproducts such as whitefish trimmings from the fish processing industry: 12%.

Thailand produced approximately 450,000 metric tons of fishmeal in 2014. This would have required some 1,350,000 metric tons of source material. If 18% of the meal was composed of trash fish and targeted fish (including shrimp) from local fisheries, then approximately 243,000 metric tons was taken from a poorly managed, environmentally impacted fishery.

In recent years mangrove areas in Thailand previously destroyed by shrimp farming have partially recovered through re-planting and natural recruitment, as well as enforcement of regulations that prevent new shrimp farms from opening in mangrove areas. Local farmers queried during information gathering also said that they have moved out of mangroves because the costs of managing water and soils were too high, but enforcement of mangrove conservation rules and policies undoubtedly also played a role.

Meanwhile, water pollution has long been a sustainability concern of the Thai aquaculture industry, with access to unpolluted water a key factor in farm site choice. Water quality improvement safeguards are included in the Thai government's GAP (Good Aquaculture Practices) standard under which Thai farms are assessed and certified annually.

Suggested sustainability improvements include continuing efforts at mangrove recovery (replanting, enforcement of regulations) so that new shrimp farms are not opened in mangrove areas; development of zonal management practices; and implementation of disease management plans.

China

National Overview

China has approximately 14,500 km of coastline shared among 10 provinces along the Yellow, East China, and South China Seas, amounting to the tenth largest coastline in the world. It is the world leader for both shrimp aquaculture and wild-capture shrimp fisheries, with over 1.5 million metric tons of annual production in each category. The South China Sea coast is particularly important for aquaculture, while the main fisheries are located along the East China Sea coast. The three highest-producing provinces for shrimp aquaculture are Guangdong, Jiangsu, and Guangxi (in order of descending volume), which cumulatively accounted for 1.36 million metric tons of farmed shrimp production in 2013. Guangdong alone contributed 660,000 metric tons of farmed shrimp. Meanwhile, Zhejiang was the highest producing province for wild-caught shrimp in 2013 with 673,000 metric tons, followed by Shandong and Fujian. The three provinces accounted for 1.09 million metric tons of wild-capture shrimp in 2013 (Figure 4).

Country Snapshot: China

Year: 2013

Farmed production: 1,958,368 tons

Wild production: 1,602,503 tons

Total production: 3,560,871 tons

Export volume, product weight: 212,698 tons

Export volume, live weight: ~425,000 tons

Exported proportion: ~12%

Export market value: \$2.2 billion

Ratio farmed:wild of exports: ~ 85:15

Ratio of farmed product that is exported:farmed product that stays on the domestic market: ~18:82

Whiteleg shrimp accounts for 73% of Chinese farmed shrimp production, with 57% of farmed whiteleg shrimp production occurring in seawater, while the other 43% takes place in freshwater conditions. The other 27% of Chinese farmed shrimp production is accounted for by *Macrobrachium nipponense* (13%), *M. rosenbergii* (6%), giant tiger shrimp (4%), kuruma prawn (2%), and fleshy prawn (2%). Paste shrimp (*Acetes*) is the predominant wild-capture species, accounting for 34.5% of wild-capture production. Southern rough shrimp (20%), *Oratosquilla oratoria* (18.5%), a variety of freshwater shrimp species (18%), and fleshy prawn (8%) comprise the other 65.5% of wild-capture harvest (China Agriculture Press 2015).

Chinese shrimp production has trended sharply upward over the last 20 years, with particularly rapid increase in the aquaculture sector, but rising wild harvests in the 1990s as well (Figure 5). Aquaculture production leveled off in 2013 due to EMS syndrome, while wild harvest has held fairly steady since 2003. As for exports, in contrast to production volumes, exports have fallen sharply in the last three years, with 2014's 178,581 metric tons of exported shrimp 16% lower than the volume exported by China in 2013. Growth in the domestic market and EMS are responsible for this trend. That said, as in Thailand, the United States is the chief destination for Chinese shrimp, accounting for 19% of exports in 2014. Meanwhile, a significant proportion (approximately half) of Chinese exports go to Asian destinations, with Malaysia the leading destination (Table 7). Data maintained by the Chinese customs agency attribute shrimp exports to approximately a dozen product codes, but these codes do not indicate product source (fishery or farm) and species, nor were they easy to use to identify product type for the purposes of

estimating processing and preparation yield, which was placed at 50% in absence of information (most product presumed headless shells-on).



Figure 4: Map of China with major aquaculture (circles) and fishery (squares) provinces indicated.

Provincial Overview

The consultant engaged in this project to cover China gathered quantitative production information and anecdotal export information at the provincial scale. 2013 provincial production data for the 10 most prominent shrimp species in China indicate that various provinces are strong producers of various species: Zhejiang for wild paste shrimp, wild grooved tiger prawn, and Japanese squillid mantis shrimp; Guangdong for wild fleshy prawn, farmed whiteleg shrimp, and farmed giant tiger shrimp; Shandong for farmed Kuruma prawns; and Jiangsu for farmed river prawns (Table 8).

As for exports, the provinces vary in the proportion of production that is exported, with some provinces exporting very little shrimp, while Guangxi exports 50% of its production (Table 9). General trends across the country include declining export proportions due to increasing demand

on the domestic market, as well as the entry of new provinces (Hebei, Tianjin) into the business of shrimp culture. Metrics includes shrimp transactions traceable to farms in one Chinese province, Guangdong.

Fishery Sustainability Information

Bottom trawling occurs all along China's coastline, harvesting not only shrimp but also crab, cephalopods, and a variety of low-trophic level pelagic fish species.

Paste shrimp are also prominently harvested in stow nets in nearshore environments. Among the major wild shrimp-producing provinces, stocks are in the best shape in Fujian, while declines due to overfishing have been observed in Zhejiang. Meanwhile, in Shandong, offshore oil and gas extraction and large vessel traffic have been implicated in the destruction of shrimp spawning grounds and resultant declines in fleshy prawn production. Hatcheries are being used throughout the coastal region to restore wild stocks, with release of over three billion hatchery-raised shrimp

into the ocean annually. There is no evaluation of the effectiveness of these hatchery programs.

Table 7: Chinese shrimp exports to main destination nations, 2013–2014 (in metric tons) (CAPPMA 2013 and 2014). The 2014 total Chinese shrimp export was 16% lower than that of 2013.

Destination	2013	% of total export	2014	% of total export
USA	34,853	16%	33,595	19%
Malaysia	28,665	13%	28,993	16%
Hong Kong	21,784	10%	19,976	11%
Japan	20,520	10%	15,838	9%
Korea	17,059	8%	11,035	6%
Russia	14,739	7%	10,064	6%
Australia	13,342	6%	12,298	7%
Mexico	12,136	6%	7,768	4%
Canada	9,996	5%	8,246	5%
Taiwan	9,967	5%	10,465	6%
Total	212,698	-	178,581	-

fishery; assessing hatchery effectiveness; and expanding closed seasons in the Yellow and East China Seas to promote stock recovery.

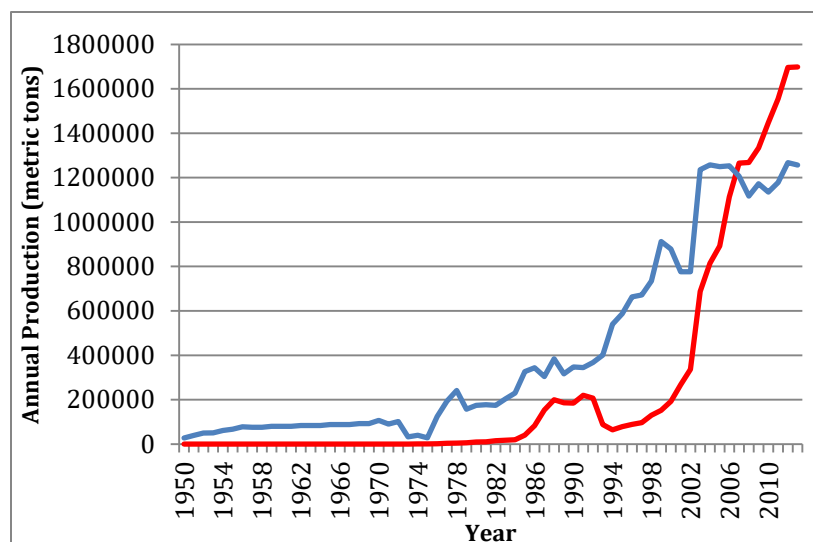


Figure 5: Chinese farmed shrimp (red) and wild shrimp (blue) annual production, 1950–2013 (FAO 2015).

Bycatch is considered a key sustainability issue for the Chinese trawl fishery. Smaller mesh sizes are commonly used in this fishery and harvest is high in species diversity, with impacts to most harvested species not adequately studied.

Improvement recommendations for the fishery include conducting an evaluation of existing bycatch composition in the trawl fishery and risk assessments for individual bycatch species; introducing selective gear regulations for the trawl

Table 8: 2013 production of the 10 most prominent Chinese commercial shrimp species by province (metric tons). Note: the column “Total Farmed Production” is not an aggregate of all the farmed species columns that precede it, and includes production of additional, non-specified species.

Province	Paste Shrimp	Fleshy prawn	Grooved tiger prawn	Japanese squillid mantis shrimp	Total Wild Harvest	Whiteleg shrimp: saltwater	Giant tiger shrimp	Fleshy prawn	Kuruma prawn	Whiteleg shrimp: freshwater	Giant river prawn	Oriental river prawn	Total Farmed Production	Total Production
Zhejiang	267,615	16,110	201,484	72,869	672,742	32,289	718	1,209	1,035	95,218	11,115	18,967	179,772	852,514
Guangdong	41,705	56,641	13,148	21,607	146,548	294,461	46,497	7,844	6,063	155,052	23,390	1,723	661,646	808,194
Jiangsu	21,735	3,001	10,004	9,058	47,829	20,202	2,872	6,499	1,567	126,656	69,019	117,147	470,506	518,335
Shandong	92,696	4,459	31,707	56,341	230,594	63,591	2,520	7,644	19,674	47,790	692	2,958	159,052	389,646
Fujian	58,681	22,160	43,970	35,334	181,714	61,123	5,889	3,882	10,827	59,469	1,133	1,709	147,258	328,972
Guangxi	28,430	18,536	8,146	7,190	70,609	192,227	10,698	-	174	2,175	1,719	749	224,314	294,923
Liaoning	38,550	4,001	7,421	67,217	139,105	12,676	-	10,594	2,794	7,419	-	-	35,631	174,736
Hainan	5,611	3,608	4,487	1,674	18,054	116,420	2,814	-	-	350	-	-	123,845	141,899
Hebei	11,283	1,645	2,613	21,997	40,384	10,813	-	4,254	3,815	26,623	-	825	46,805	87,189
Tianjin	197	88	-	864	1,275	8,743	-	5	-	49,359	-	166	58,273	59,548

Aquaculture Sustainability Information

In the 1990s, shrimp aquaculture expanded quite explosively in China, with mangroves and wetlands replaced by shrimp ponds along the coast. The environmental impact of habitat losses during the 1990s aquaculture boom has been somewhat mitigated in the 2000s by new

Table 9: Anecdotal information on Chinese shrimp exports at the provincial scale.

Province	% of Prod. Exported	Main Exported Species	Destination Countries	Note
Zhejiang	8%	whiteleg shrimp	United States	in recent decade, increasing amounts of Zhejiang shrimp are being sold on the domestic rather than int'l market
Guangdong	30%	whiteleg shrimp	na	exports from this province are also decreasing
Jiangsu	very little	-	-	-
Shandong	7%	farmed Oratosquilla oratoria, but also some wild shrimp	Korea and Japan	decreasing exports during last decade due to shrinking Korean and Japan economies
Fujian	24%	Na	na	exports from this province are also decreasing
Guangxi	50%	whiteleg shrimp	na	exports from this province are also decreasing
Liaoning	12%	mostly wild shrimp	Korea and Japan	-
Hainan	5%	whiteleg shrimp	na	Hainan shrimp is famous for its high quality and tends to be sold at a higher price on the domestic market.
Hebei	very little	-	-	new shrimp supplier
Tianjin	very little	-	-	new shrimp supplier

approaches to structure of the industry and land use: the shrimp farming industry has consolidated and many coastal farms have been sold to resort and other private developers. Many of the developers have restored mangroves for their aesthetic value, simultaneously restoring the ecosystem services that they provide. Farms, meanwhile, continue to operate in coastal regions, but with greater distance from the coastline.

Not only was the amount of land used for shrimp aquaculture expanded in the 1990s, but production densities at individual farms were also increased. The higher densities introduced

higher risks of disease: in the early 1990s, white spot disease ravaged Chinese farms and hindered production for several years. Subsequent recovery and stable growth of the industry ever since has been enabled by farmer investments in aeration and other technologies. Unlike the Chinese tilapia industry, battles with disease have resulted in a technologically and scientifically savvy shrimp farming industry.

In addition to improved technology, the Chinese government also introduced water pollution regulations in the 2000s in the effort to address concerns about environmental impacts of the industry. Despite these regulations and improved farming technology, EMS outbreaks occurred in all major shrimp farming regions in 2013, limiting production in that year. Hainan is a particularly key area with respect to spreading disease, as it is a key hatchery and nursery region. If disease takes hold in this region, as it did with the case of EMS, it is likely to spread elsewhere.

One response to the EMS outbreak has been the growing prevalence of the polyculture approach to aquaculture, whereby more than one species group is cultivated at the same farm (e.g., shrimp and tilapia, or shrimp and crab). The presence of a second species not only limits economic risk should disease strike the other species, but cohabitation also appears to render disease proliferation less likely.

As for feed used in Chinese farms, there are a variety of compound feed brands available for purchase in the farming regions. Sources of fishmeal and fish oil in these feeds are mostly unknown, and it is impossible to assess environmental impacts.

Improvement recommendations for the Chinese shrimp aquaculture sector include conducting Environmental Impact Assessments for major aquaculture zones and encouraging farmers to organize themselves into associations or co-ops to adopt zonal management and best practices. It is noted that, unlike other provinces, Zhejiang has existing, well-organized farm co-ops.

Indonesia

National Overview

Indonesia is the world's second largest seafood producer and a major player in the shrimp subsector, with over \$1 billion in annual shrimp exports. The country's 34 provinces encompass thousands of islands home to artisanal and industrial fisheries, as well as small- and large-scale aquaculture operations. A particular hub for shrimp aquaculture stretches from the southern tip of Sumatra Island through Java Island to the Lesser Sunda Islands—this arc contains the four highest-producing shrimp aquaculture provinces of West Java, Lampung, East Java, and West Nusa Tenggara. Meanwhile, more than 600 trawlers in the Arafura Sea of Eastern Indonesia harvest wild banana, endeavor and giant tiger shrimp, among other species (Figure 6).

In 2013, Indonesia was the one major aquaculture producer of shrimp whose production was not decimated by EMS. According to FAO data, national aquaculture production almost doubled that year, presumably driven by global demand being unmet by production in Thailand and other countries experiencing disease outbreaks (Figure 7). Government data gathered in country, meanwhile, indicated a less dramatic increase in aquaculture production of 53% from 2012 to 2013. This in-country data also indicated that farmed shrimp accounted for 68% of national shrimp production as of 2012, with wild shrimp comprising the remaining 32%. Farmed whiteleg shrimp is the most populous species, accounting for 46% of national production overall and a 68% share of farmed production. Farmed giant tiger shrimp ranks second with 22% of overall production, 32% of farmed production. Banana prawn, meanwhile, is the leading wild species, comprising 16% of

Country Snapshot: Indonesia

Year:	2012
Farmed production:	369,651 tons
Wild production:	178,283 tons
Total production:	547,934 tons
Export volume, product weight:	162,068 tons
Export volume, live weight:	~270,000 tons
Exported proportion:	~49%
Export market value:	\$1.3 billion
Ratio farmed:wild of exports:	~97:3
Ratio of farmed product that is exported:farmed product that stays on the domestic market:	~71:29

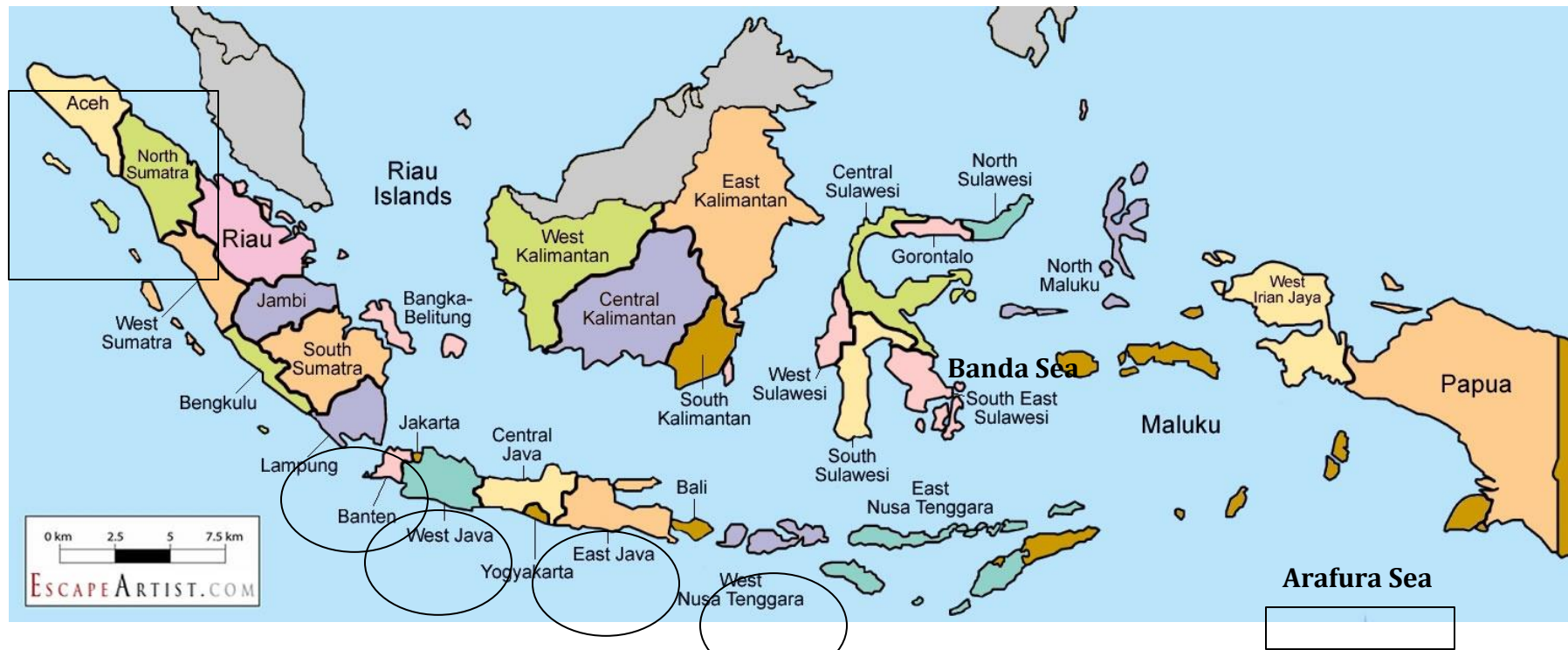


Figure 6: Map of Indonesia with major aquaculture provinces (circles) indicated. Meanwhile, a square marks the Arafura Sea, where the wild trawl fishery occurs in Eastern Indonesia. Another square indicates the provinces of Aceh and North Sumatra, known landing destinations for wild shrimp.

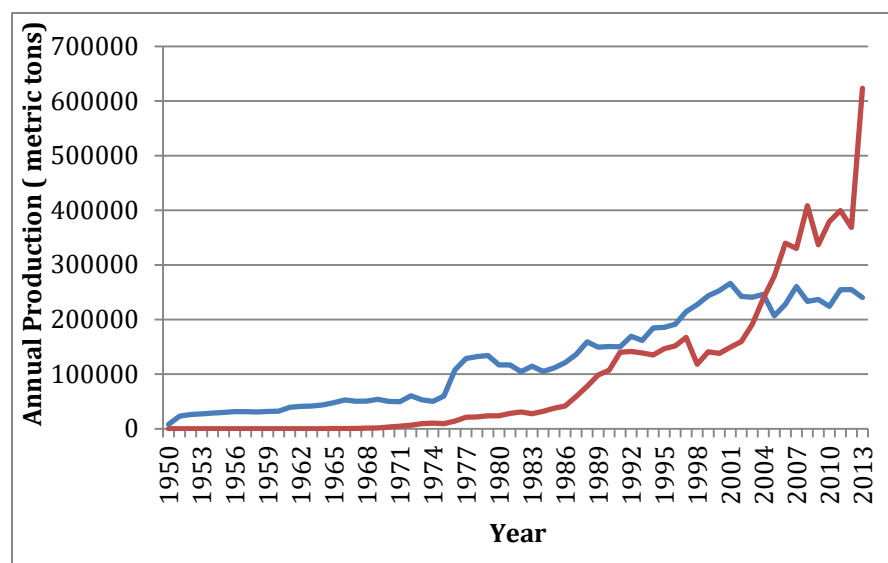


Figure 7: Indonesian farmed shrimp (red) and wild shrimp (blue) annual production, 1950–2013 (FAO 2015).

overall national production. Wild giant tiger shrimp (5%) and a mix of other species including endeavor shrimp, tiger cat/rainbow shrimp, and king/blue-legged prawn (11%) round out the species profile.

Indonesian shrimp exports have held fairly steady over the past decade, with a 2008 peak of 175,000 metric tons exported, which is not much higher than the

figure for the most recent year of available data (2013: 162,410 metric tons exported). The United States is Indonesia's main export destination, followed by Japan and China. US imports of Indonesian shrimp spiked in 2013, a year in which the US accounted for 50% of Indonesian shrimp exports (Table 10). The overwhelming majority of exports are frozen, presumed headless shells-on, with an average yield of 60%.

Provincial Overview

Comprehensive production information for farmed shrimp, but not for wild shrimp, is available at the provincial scale. In 2013, 12 Indonesian provinces farmed over 10,000 metric tons of shrimp (Table 11). In addition to the islands in the key production zone highlighted in Figure 6, other important provinces are found on the islands of Borneo and Sulawesi.

Table 10: Indonesian shrimp exports to main destination nations, 2011–2013 (in metric tons of product). Information is from Indonesian and Japanese customs data, as well as the NOAA Fisheries Statistics Division trade database.

Destination	2011	% of total export	2012	% of total export	2013	% of total export
USA	53,148	34%	57,748	36%	81,147	50%
Japan	30,504	19%	31,537	32%	32,338	20%
China	4,196	3%	2,652	2%	Na	
UK	3,119	2%	1,571	1%	Na	
Total	158,062	-	162,068	-	162,410	

There is export information available for Indonesia by province as well, although the most recent year for which data is available is 2011. However, shrimp exported from a particular province may not have been produced, but rather only processed there, as indicated by Jakarta's status as the second-largest exporter in 2011 despite the fact that the capital province is a very low producer. In order to explore provincial exports further, we used Metrics. For Indonesian shrimp, Metrics includes 484 transactions that occurred in 2012–2015, with the majority (67%) of these transactions occurring in 2012–2013. Transactions in Metrics accounted for an estimated 5% of

Table 11: 2013 shrimp aquaculture production by province and species (metric tons). These 12 provinces all produced over 10,000 tons of farmed shrimp.

Province	Giant tiger shrimp	Whiteleg shrimp	Farmed total
West Java	27,860	57,678	85,538
Lampung	2,791	72,051	74,842
West Nusa Tenggara	4,299	56,960	61,259
East Java	9,842	47,150	56,992
North Sumatra	9,627	19,791	29,418
Central Java	33,580	13,872	47,452
South Sumatra	5,641	40,016	45,657
West Kalimantan	1,865	39,092	40,957
Southeast Sulawesi	13,275	18,369	31,644
South Sulawesi	15,319	8,542	23,861
Central Sulawesi	22,403	91	22,494
East Kalimantan	10,758	-	10,758

Indonesian shrimp exports in 2012–2014 (see Data Annex). 209 (48%) of the 484 transactions include volume information, amounting to 17,840 metric tons of purchased volume cumulatively. For a subset of the transactions (199 transactions, including approximately 6,890 metric tons of cumulative volume), we were able to attribute the purchased volumes to the provinces that produced the shrimp (Table 12). The information indicates that three of the high-production aquaculture provinces (South Sumatra, East Java, and Lampung) exported their products to western markets during the period of 2012–2015.

Fishery Sustainability Information

Since 1983 trawl nets have been banned in Indonesian waters with the exception of the zone east of longitude 130° E (essentially the area east of the Tanimbar Islands in the Arafura Sea). As a result of these regulations, the Arafura Sea trawl fishery is the main shrimp fishery of Indonesia, with over 600 participating trawlers as of 2010. Ongoing issues with this fishery include overexploitation of target stocks, fisher non-compliance with regulations (particularly failure to report catches during transshipment at sea), and inadequately quantified impacts upon bycatch species. Improvement recommendations include establishment of a standardized stock assessment process for target stocks, improving enforcement of catch reporting and VMS use by the fleet, and the development of regulations that will limit bycatch (e.g., larger minimum mesh sizes, stricter enforcement of inshore trawler ban zones, and overall effort reductions).

Aquaculture Sustainability Information

Giant tiger shrimp are native to Indonesia, and thus are favored by most small-scale shrimp farmers that use traditional technology and farm in semi-intensive or extensive (medium- or low-density) conditions. Whiteleg shrimp, meanwhile, are not endemic to the region and can be cultured in intensive (high-density) conditions with the use of appropriate

Table 12: Summary of Metrics entries for Indonesian shrimp. 41% of transactions and 39% of reported volumes for Indonesian shrimp were attributable to the province in which production occurred. The three provinces to which transactions were attributed are all large-scale aquaculture producers and together account for 35% of national production (2010–2013, annual average).

Province	Number of Metrics Transactions	Volume Reported in Metrics (metric tons)	Avg Farmed Production, 2010–2013 (metric tons)
South Sumatra	1	3,292	55,656
East Java	194	3,546	52,776
Lampung	4	52	52,290
TOTAL (FOR IDENTIFIED PROVINCES)	199	6,890	160,722
NATIONAL TOTAL	484	17,840	454,376
% IDENTIFIABLE BY PROVINCE	41%	39%	35%

technology. Therefore, sustainability concerns vary according to the species being cultured and, consequently, by province (see Table 11 above for the proportion of each species cultured in the main production provinces).

Problems with water quality due to farm effluent release are particularly acute for intensive whiteleg culture operations. On Java, the number of intensive-culture facilities has been reduced, thereby limiting the scope of the problem. Meanwhile, in Lampung province on Sumatra Island and in West Nusa Tenggara (Lesser Sunda Islands), intensive farming remains the norm, and water quality is a persistent problem. Escapees and disease issues are also associated with intensive whiteleg shrimp culture.

The island of Kalimantan has only recently become a major contributor to Indonesian shrimp production, with farming output of the province of West Kalimantan jumping almost six-fold from 2012 to 2013's crop of 39,092 metric tons. The increases in production have come at the cost of mangrove habitats—West Kalimantan reportedly lost 7,000 hectares of mangroves due to the recent farming expansion. Meanwhile, much greater losses have occurred recently in East Kalimantan (685,777 ha) and South Kalimantan (35,000 ha), but shrimp farming is only one of several contributing factors in these regions: the oil industry has been active in East Kalimantan, while industry and urban development have played roles in South Kalimantan deforestation. Destruction of mangroves for shrimp farming continues to be a problem on Kalimantan.

Across Indonesia, data availability with respect to shrimp culture is a problem. Data on production, disease, and environmental impacts are lacking. Carrying capacity is poorly quantified. As a result, a key improvement recommendation to government and industry is to work together to improve data availability and quality. Furthermore, the government should conduct assessments on carrying capacity and develop regulations on the basis of results.

Detailed information about East Java shrimp culture is available here:
http://www.fishsource.com/site/aquaculture/shrimp_east_java.

Vietnam

National Overview

For a relatively small country in terms of its geography, Vietnam boasts an impressive coastline of 3,260 km that borders on the Gulf of Tonkin, South China Sea, and Gulf of Thailand. Vietnam has 63 provinces and municipalities, 28 of which are coastal. Twenty-seven of these provinces have registered trawlers that participate in the shrimp trawl fishery, with four major fishing areas located along the Vietnamese coast (Figure 8) (BaNguyen and Van Thi 2007). Shrimp farming also takes place mainly along the coast, albeit occurring in a few inland provinces as well. In contrast with fishing pressure, which is fairly evenly distributed along the coast, farming is concentrated in southern Vietnam, with the provinces of Ca Mau, Soc Trang, and Kien Giang particular epicenters of production (Figure 8).

Vietnamese shrimp aquaculture surpassed wild harvest in 2001, continuing an upward trajectory since then to achieve 2014's historic peak of 568,668 metric tons of farmed production (Vietnamese Directorate of Fisheries 2015).

Wild production has also maintained a steady increasing trend over the last 25 years, with the 2013 harvest of 266,026 metric tons a national record (the 2014 wild harvest volume is not yet available) (Figure 9). Whiteleg and giant tiger shrimp are the major farmed species, accounting for 94% of Vietnam's export value in 2014. A major transition occurred in the farmed sector over the past four years, with whiteleg shrimp, which comprised 58% of farmed production in 2014, overtaking giant tiger shrimp, which accounted for 64% of farmed production in 2011. As has occurred elsewhere in Asia, intensive farming of whiteleg shrimp is quickly becoming the dominant form of shrimp aquaculture in Vietnam. Meanwhile, the predominant wild capture species is white shrimp. Grooved tiger prawn and red endeavor prawn are also common. Over 25 other shrimp species are harvested in Vietnam for commercial use as well (Poseidon 2011).

Starting in 2011, Vietnamese Customs adopted a new export coding system that rendered it impossible to determine shrimp export volume; only shrimp export market value is simply reported by the government since then. Therefore, the current exported proportion of Vietnamese shrimp is not known: over the last six years for which data is available (2005–2010), it averaged 74% (if yield after processing and/or preparation was taken as 49% on the basis of a product breakdown of 2013 Vietnamese exports, in which “live/fresh/frozen shrimp,” presumed to consist mostly of headless shell-on product, predominated). Notably, market value of Vietnamese shrimp exports has risen precipitously (88%) since then (2010–2014), achieving a peak of \$3.95 billion in 2014. Meanwhile, Vietnamese farmed production only increased by 18% over those years. This does not mean, however, that the proportion of Vietnamese shrimp that go

Country Snapshot: Vietnam

Year: 2013

Farmed production: 540,934 tons

Wild production: 266,026 tons

Total production: 806,960 tons

Export volume, product weight: ~300,000 tons

Export volume, live weight: ~600,000 tons

Exported proportion: ~74%

Export market value: \$3.1 billion

Ratio farmed:wild of exports (volume): ~ 88:12

Ratio farmed:wild of exports (value): ~ 97:3

Ratio of farmed product that is exported:farmed product that stays on the domestic market: ~63:37

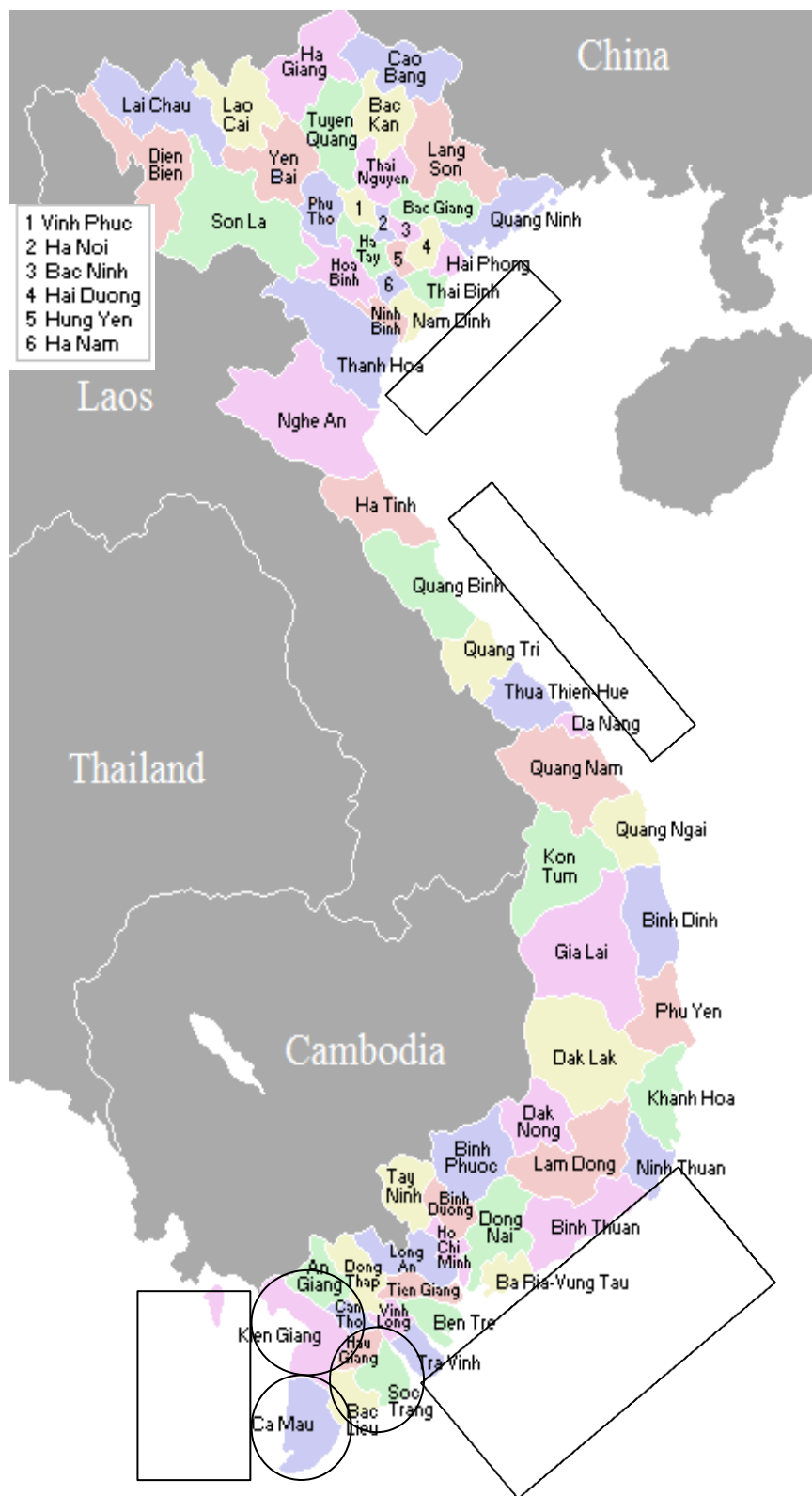


Figure 8: Map of Vietnam with the major aquaculture provinces of Kien Giang, Ca Mau and Soc Trang circled. Four major shrimp fishing areas are also indicated with squares.

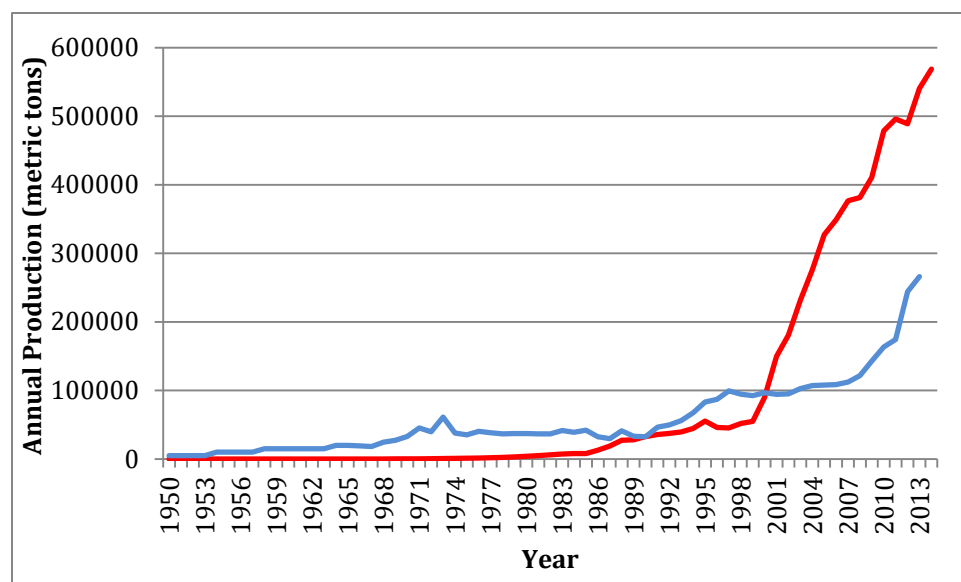


Figure 9: Vietnamese farmed shrimp (red) and wild shrimp (blue) annual production, 1950–2013 (FAO 2015).

to export has increased. The EMS outbreak generally drove up prices for global shrimp over this period of time, and may be responsible for the large increase in market value.

Export value statistics indicate that Vietnam exported shrimp products to 95 nations in 2014. The total value of Vietnamese exports

for that year amounted to \$3.95 billion, 94% of which was accounted for by farmed shrimp and 6% by wild shrimp. Export values for nine importer countries exceeded \$100 million. The United States was the leading importer, accounting for over one-quarter of Vietnamese exports. The US market received more processed whiteleg shrimp, live/fresh/frozen whiteleg shrimp, and live/fresh/frozen giant tiger shrimp from Vietnam than any other country. The second largest importer Japan, meanwhile, was notably the only country to import over \$100 million worth of wild Vietnamese shrimp. China, in third place, imports very little processed product, with live/fresh/frozen whiteleg shrimp and giant tiger shrimp comprising the vast majority of its imports from Vietnam (Table 13).

Provincial Overview

The in-country expert visited and collected production information for five provinces: Ca Mau, Kien Giang, and Soc Trang (high-production farming provinces); as well as Ba Ria Vung Tau (also a southern province) and Khanh Hoa in central Vietnam. Budget and schedule constraints did not allow for a visit to the northern portion of the country, which is chiefly of importance for the adjacent Gulf of Tonkin fishery rather than aquaculture. Provincial production statistics for these five provinces indicate some varied dynamics: in Soc Trang giant tiger shrimp production is quickly being abandoned in favor of whiteleg production, while in Kien Giang production of both species is increasing at a moderate pace. Meanwhile, in Ca Mau, giant tiger shrimp production is decreasing and whiteleg shrimp production is increasing, but giant tiger shrimp production still predominates (Table 14). Together, the five provinces accounted for 44% of Vietnamese farmed production in 2014.

Through 2010 Vietnamese customs maintained export volume and value information at the provincial scale, but these statistics were discontinued by the change in coding in 2011. In the last year of the old coding system (2010), the four provinces for which wild and farmed export

Table 13: Value (in US dollars) of 2014 Vietnamese exports of eight products to the nine top export destination countries (Vietnam Association of Seafood Exporters and Producers—VASEP).

Country	Processed shrimp (whiteleg shrimp)	Live/fresh/frozen shrimp (Whiteleg shrimp)	Processed shrimp (Giant tiger shrimp)	Live/fresh/frozen shrimp (Giant tiger shrimp)	Farmed Total	Processed shrimp (others)	Dried shrimp (others)	Canned shrimp (others)	Live/fresh/frozen shrimp (others)	Wild Total	TOTAL
US	427,059,748	348,649,723	45,012,471	225,716,386	1,046,438,328	13,215,969	242,158	1,610,160	2,542,692	17,610,979	1,064,049,307
Japan	169,473,222	208,971,137	39,378,744	215,132,383	632,955,485	66,411,955	2,721,489		41,349,672	110,483,116	743,438,601
China	1,716,338	96,946,102	88,228	224,131,435	322,882,103	2,010,862			2,668,992	4,679,854	327,561,957
Korea	75,725,432	184,303,322	5,083,609	26,634,529	291,746,892	9,813,989	2,016		16,235,267	26,051,272	317,798,164
Canada	63,790,489	51,120,630	14,488,512	70,816,033	200,215,665	1,343,820	18,501		4,484	1,366,805	201,582,470
Australia	29,206,591	25,696,306	67,132,434	22,892,532	144,927,862	3,835,940	314,590	185,471	2,120,021	6,456,022	151,383,884
Germany	31,846,442	49,510,441	8,504,492	40,217,044	130,078,418	7,801,799	21,239	51,750	2,299,865	10,174,653	140,253,071
Netherlands	44,635,636	30,790,990	4,609,998	43,442,046	123,478,670	4,048,029	169,458	57,760	1,347,122	5,622,369	129,101,039
England	37,002,375	46,832,345	637,752	13,515,242	97,987,714	9,234,381	112,439	102,600	7,146,029	16,595,449	114,583,163
TOTAL	997,990,028	1,312,541,057	203,820,432	1,181,689,684	3,696,041,201	156,851,228	5,422,910	6,455,202	88,139,697	256,869,038	3,952,910,239

Table 14: Production (in metric tons) by species and year (2011–2014) for five priority provinces.

	Ca Mau			Soc Trang			Khanh Hoa				Ba Ria Vung Tau			Kien Giang	
Year	Black tiger	White-leg	Wild Spp.	Black tiger	White-leg	Wild Spp.	Black tiger	White-leg	Wild Spp.		Black tiger	White-leg	Wild Spp.	Black tiger	White-leg
2011	112,296	4,500	14,161	39,084	13,580	3,217	1,909	11,099	n/a		4,725	2,133	6,321	26,581	13,020
2012	114,110	11,448	14,810	39,051	15,519	4,100	1,481	10,788	n/a		2,205	2,204	7,569	27,369	12,921
2013	107,500	26,000	14,228	23,000	45,500	4,500	980	8,500	1,182		2,245	2,300	7,563	28,250	13,728
2014	86,795	29,205	14,490	10,727	56,585	4,520	645	8,214	1,361		1,965	2,637	7,505	32,430	19,000

Table 15: 2010 export information for the five provinces visited by the in-country expert. These provinces accounted for 67% of national exports in that year (VASEP 2015).

Province	2010 Wild Prod. (metric tons)	2010 Farmed Prod. (metric tons)	Wild: Farmed Export Proportion	Main Destinations (% of total provincial export)
Ba Ria Vung Tau	2,959	3,362	47:53	1. Japan (47%)
Ca Mau	13,601	89,720	13:87	1. USA (20%) 2. Japan (20%)
Soc Trang	2,280	34,127	6:94	1. USA (42%) 2. Japan (36%)
Khanh Hoa	0	15,912	0:100	1. USA (40%) 2. Taiwan (13%)
Kien Giang	n/a	2,872	n/a	1. Japan (35%) 2. Russia (17%)
Total	18,840	143,121	12:88	-
% Nat'l Total	51%	70%	-	-

data was compiled accounted for 67% of national exports, including 51% of wild exports and 70% of farmed exports. Taken in aggregate, the four provinces' exports consist of 143,121 metric tons, 12% of which is comprised of wild shrimp, and 88% of farmed shrimp.

Main destinations and volumes exported to destination countries vary by region. Notably, Ca Mau exports a large proportion of both its farmed and wild supplies (Table 15).

Metrics information for Vietnam corroborates the in-country experts' findings with respect to provincial exports. Ca Mau, Soc Trang, and Khanh Hoa are among the provinces from which Metrics users purchased shrimp in 2011–2015, as are Kien Giang, Thua Thien Hue, and Bac Lieu.

Fishery Sustainability Information

Vietnamese fishery management is generally based upon the Vietnam Fisheries Law, the Five-Year Master Plan for Fisheries Sector Development 2006-2010, and the recently approved Fisheries Development Strategy Towards 2020. There are also extensive legislative regulations (from 1987 to 2003, over 100 legal instruments have been issued in the fisheries sector alone). However, the quality of the management of specific

Table 16: Summary of Metrics entries for Vietnamese shrimp. 31% of transactions and 58% of reported volumes for Vietnamese shrimp were attributable to the province in which production occurred. The six provinces to which transactions were attributed together accounted for at least 37% of national production in 2011–2014, annual average, production data missing for two provinces and incomplete for a third).

Province	# of Transactions	Volume	Avg Production, 2011–2014 (metric tons)
Kien Giang	67	7,762	43,325 (farmed only)
Khanh Hoa	19	2,200	11,540
Thua Thien Hue	33	868	n/a
Ca Mau	20	379	137,386
Soc Trang	29	1,239	64,846
Bac Lieu	26	600	n/a
TOTAL (FOR IDENTIFIED PROVINCES)	194	13,048	>257,097
NATIONAL TOTAL	624	22,583	~700,000
% IDENTIFIABLE BY PROVINCE	31%	58%	>37%

fisheries, including the shrimp fishery, depends very much on the quality of social and biological information used in policy development and decision-making. Monitoring and research are currently insufficient to provide a good foundation for sustainable management of the shrimp fishery, and must be improved at both the national and provincial levels.

Enforcement has also been inadequate and inconsistent. Non-compliance with fishing gear regulations is a particular concern for the shrimp fishery. Mesh size violations contribute to bycatch rates of 60–80% of the total catch in shrimp trawls or 40–80% in fish trawls, 90% in fixed nets, and 90–93% in push nets. Meanwhile, despite the comprehensiveness of Vietnamese fishery law, some necessary regulations have not yet been put into place. For example, explosives and chemical substances are still used for fishing in some provinces, including Ca Mau and Khanh Hoa.

Despite these issues, stock status and harvests are relatively stable. However, existing assessments suggest that overfishing has occurred in some coastal areas, included Soc Trang province.

Recommended improvements include strengthening data gathering capacity in order to provide a better biological and socio-economic basis for fishery management, implementation of fishing capacity reductions, adoption of bycatch reduction device regulations, and establishment of Marine Protected Areas. Harmful fishing practices also need to be entirely phased out. Surveillance and enforcement are other areas with room for growth.

Fishing co-management pilot projects that allow for the involvement of provincial and district authorities in fishery management represent promising opportunities for changing management practices. The ongoing Coastal Resources for Sustainable Development Project (CRSD 2012-2018) is another potential lever for change. Key activities within the Project that are relevant to fisheries management include (a) integrated spatial planning of coastal areas; (b) upgrades to the Vietnam fisheries database; and (c) selected policy research. CRSD is being accomplished in eight different provinces including Ca Mau, Soc Trang and Khanh Hoa.

Aquaculture Sustainability Information

Disease is the main problem for Vietnamese shrimp aquaculture, especially among intensive farming operations. The most common diseases are EMS, white spot, runt syndrome caused by MBV or HPV, and white feces syndrome. Farmers are combatting disease risk through the use of prophylactics and disinfectants, which may impact the environment negatively or compromise the quality of shrimp products. Many Vietnamese shrimp farmers understand that antibiotics should not be used and have instead applied probiotics to enhance water quality and/or prevent disease outbreaks in shrimp ponds. The collection of disease information, confirmation of reported disease outbreaks using appropriate diagnoses, and effective screening for SPF postlarvae are all limited by financial resource availability at both national and provincial levels.

Farmer education is key to the industry faring better with respect to disease. Particular guidance is needed regarding the following:

- Development of pond preparation plans,

- Use of certified, free pathogen seed or specific pathogen resistant seed,
- Stocking of shrimp culture systems with densities appropriate for the type of farming (extensive, semi-intensive, intensive),
- Feed characteristics (stability, protein content, type, etc.) and additives, and associated risks of disease and water quality impacts,
- Monitoring practices that allow for determination of FCR, growth rate, and mortality, as well as tracking of water quality (e.g., pH, dissolved oxygen, salinity, etc.), and
- Disease prevention and water treatment methods.

The following recommendations are also offered to national and provincial authorities:

- Conduct trainings covering the areas of guidance listed above,
- Strengthen and expand the environmental and disease warning and monitoring systems that are currently operating in Vietnamese aquaculture regions, and
- Promote Good Aquaculture Practices (VietGAP).

Shrimp farming associations (clubs) provide possible forums for farmer training and organization of improvement efforts. The number of shrimp clubs is increasing in Vietnam, mainly at the community scale. Official statistics are, however, not available. Clubs are either formed independently by the farmers or upon recommendation of local government, NGOs, national projects, etc. Tasks of the clubs include facilitation of joint negotiation with suppliers and development of agreements among neighboring farmers regarding zonal management. Examples of established clubs include the My Thanh Shrimp Association, Cai Doi Vam Shrimp Farmers Group in Phu Tan, Ca Mau Club (established with strong supports from the Department of Agriculture and Rural Development of Ca Mau, SFP, and Mekong Tomland Co.), and several groups established by the CRSD project in its eight target provinces. Thus far, My Thanh has established itself as the largest association. At the national scale, all of these clubs could be supported or coordinated by the Vietnam Fisheries Society (VINAFIS). However, activities of VINAFIS are currently limited.

India

National Overview

India has quickly become a major player in the global shrimp industry since the country initiated culture of whiteleg shrimp in 2009, with production rising from 1,700 to over 250,000 metric tons in a span of five years. Of India's 36 states and territories, eight account for 98% of national shrimp production: Andhra, Tamilnadu, Kerala, Karnataka, Maharastra, Gujarat, Odisha, and West Bengal. Of those eight, Andhra is, by far, the leading farmed shrimp producer, accounting for 64% of Indian farmed shrimp production. The Arabian Sea harvests by Maharastra and Gujarat fisheries, meanwhile, comprise 63% of Indian wild-capture shrimp production (Figure 10).

Unlike the four countries described above, wild harvest still exceeds farmed harvest in India, but this is likely to no longer be the case in the near future should current dynamics persist (Figure 11). Since 2009, Indian shrimp aquaculture production has more than tripled due to rapid development of whiteleg shrimp semi-intensive farming capacity. Meanwhile, farming of other species, particularly giant tiger shrimp, has declined in recent times, although the increase in whiteleg shrimp production has more than made up for this. As for wild harvest species composition, more than 15 species are treated as targets of the fishery in terms of stock assessment. Among main species on the west coast are kadal shrimp, kiddi shrimp, Kuruma shrimp, and red-legged banana prawn. On the east coast, grooved tiger prawn is a key species. Harvest statistics are lumped as "penaeids" and "non-penaeids," and they account for roughly equivalent volumes at the national scale.

The in-country expert for India was able to obtain separate export statistics for wild and farmed shrimp, albeit with some recent wild export volumes missing. Farmed production accounted for 82% of national shrimp exports in 2013, the most recent year for which data is available. Farmed dominance of national exports is a fairly new phenomenon, as wild product accounted for a comparable portion of exports through 2010 (Figure 12). However, following 2010, farmed exports rose sharply, while wild exports appear to have held steady. The overwhelming majority (>99%) of farmed product leaves the country, a figure arrived at using an estimate of 60% yield of prepared or processed product from wild production (the 2013 national export breakdown by product indicates that frozen shrimp, assumed to be mostly headless shell-on, account for 99% of exports).

As for export destinations for Indian shrimp, the United States leads the way, followed by Vietnam, Japan, and Europe, respectively. Export trends have been quite dynamic over the past eight years: Europe was the leading destination for Indian shrimp in 2007–2009, while at that time Vietnam was a very minor player. Since then, Vietnam has increasingly looked to India for

Country Snapshot: India

Year: 2013

Farmed production:	333,382 tons
Wild production:	410,416 tons
Total production:	743,798 tons
Export volume, product weight:	255,603 tons
Export volume, live weight:	~426,000 tons
Exported proportion:	~57%
Export market value:	~\$3 billion
Ratio farmed:wild of exports (volume):	82:18
Ratio of farmed product that is exported:farmed product that stays on the domestic market:	>99 : <1



Figure 10: Map of India with the major aquaculture province of Andhra indicated with a circle. A square encompasses the major shrimp fishery regions of Gujarat and Maharashtra.

raw material for processing and re-export (Table 17).

Provincial Overview

Provincial production statistics for 2000–2013 illustrate the rapid rise of aquaculture in Andhra, as well as more modest investments in aquaculture in other provinces: farmed production has steadily increased in West Bengal over the past six years, and in Tamilnadu over the past five years. Other regions with aquaculture expansion are Gujarat, Maharashtra, and Odisha. Meanwhile, shrimp farming has contracted in Karnataka and Kerala, and production in these regions is mostly from wild fisheries (Table 18).

Provincial export data was not available, but the in-country expert gathered anecdotal information for three priority provinces: Andhra, Tamilnadu, and Kerala. In all three of these regions, more than 90% of farmed supply is being exported. However, fisheries also make

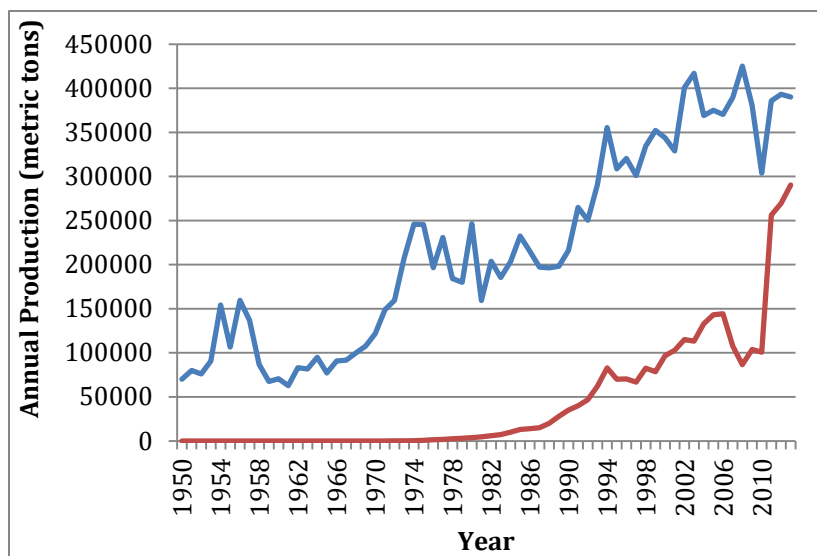


Figure 11: Indian farmed shrimp (red) and wild shrimp (blue) annual production, 1950–2013 (FAO 2015).

significant contributions to the provincial exports of the three regions. Indian shrimp transactions in Metrics were traceable to four provinces: Andhra, Gujarat, Tamilnadu, and Orissa. The Andhra transactions accounted for more volume than those of the other three provinces combined, a reflection of the province's growing importance for the national shrimp aquaculture industry (Table 19). Metrics data for India was remarkable compared with the other countries included in this analysis in terms of the high proportion of transactions (22%)

accounted for by wild shrimp. However, it should be noted that Metrics is estimated to have accounted for less than one percent of Indian shrimp exports in 2009–2013 (see Data Annex).

Fishery Sustainability Information

Fishery management is well-structured in India, with state governments serving as the main regulatory bodies while the national Centre for Agriculture Research, part of the Ministry of Agriculture, gathers data on stock status and environmental impacts. The main harvest method is trawl netting. Harvests are delivered to several harbors along the Indian coastline—the major harbors for the shrimp fishery are Chennai, Tuticorin, Chinnamuttom, Mallipattinam, Pazhayar, and Valinokkam.

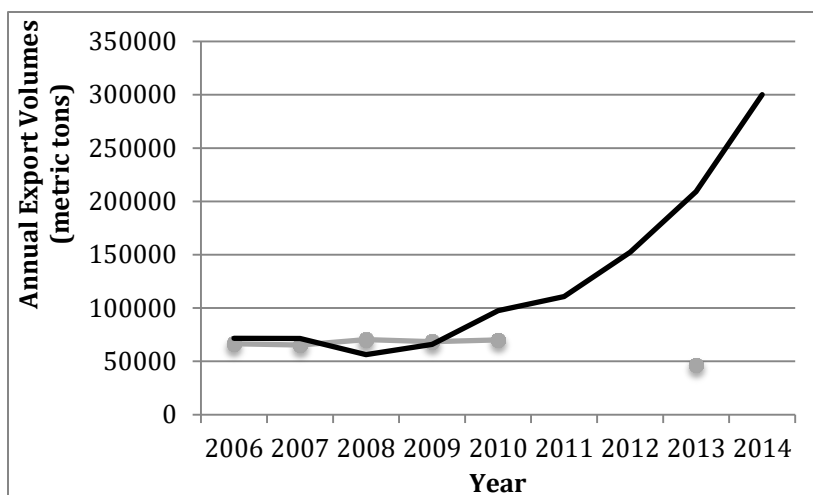


Figure 12: Indian exports of shrimp from wild (gray) and farmed (black) sources, 2006–2014. Farmed exports now far exceed wild exports, although the two sources were approximately equal contributors to national exports as of 2010. Wild export information was not available for all years in the series.

Stock status of wild shrimp differs by region. While harvests in the main producer regions of Gujarat and Maharashtra have been stable, shrimp catches in Kerala have dropped off since 2010, with particular abundance declines within 12 nautical miles of the coastline.

Table 17: Indian shrimp exports to main destination nations, 2007–2014 (in metric tons of product) (New Delhi Export Inspection Agency 2015).

Year	USA	Vietnam	Japan	EU
2007	25,228	346	25,840	34,882
2008	25,012	322	25,312	33,136
2009	22,231	808	25,258	32,452
2010	44,997	2,094	32,436	35,120
2011	98,674	13,129	37,687	39,499
2012	101,794	13,991	31,534	40,731
2013	92,014	35,917	21,534	17,134
2014	86,576	47,419	27,275	15,763

Table 18: Production of wild and farmed shrimp in coastal provinces of India, 2000–2014 (metric tons) (Central Marine Fisheries Research Institute 2015).

Year	Andhra		Gujarat		Karnataka		Kerala		Maharastra		Odisha		Tamilnadu		West Bengal		National Total
	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	
2000	22,573	0	121,562	0	6,876	0	-	0	n/a	0	9,508	0	24,006	0	12,796	0	440,575
2001	17,676	0	91,731	0	8,933	0	-	0	n/a	0	5,199	0	21,748	0	21,238	0	449,119
2002	19,378	59,190	80,466	1,050	17,782	2,620	-	7,570	n/a	640	5,999	10,280	24,803	4,990	27,098	28,270	491,397
2003	32,827	53,124	75,601	1,510	12,072	1,828	40,204	6,461	n/a	981	10,316	12,390	17,651	6,070	33,497	29,714	500,153
2004	28,384	61,609	68,355	1,500	9,147	1,328	39,201	7,573	n/a	1,068	14,003	9,896	17,783	6,674	22,138	35,432	452,262
2005	24,778	70,669	72,769	3,322	21,523	1,843	38,752	6,883	n/a	683	17,293	9,739	15,493	7,036	27,787	42,336	479,196
2006	32,937	75,414	109,868	3,227	11,147	1,883	47,650	5,151	n/a	979	13,094	9,726	22,171	5,307	n/a	42,006	517,709
2007	35,623	56,557	99,550	3,149	13,895	2,119	43,191	5,903	n/a	946	23,077	5,410	18,294	3,438	n/a	28,000	467,630
2008	44,068	29,706	111,811	3,107	10,593	2,138	51,084	4,309	101,040	1,130	13,373	3,544	23,258	4,133	16,000	27,418	491,661
2009	44,357	42,951	101,081	3,970	-	1,581	50,170	7,495	109,955	1,805	14,065	7,873	23,092	2,814	12,364	35,410	517,842
2010	48,692	66,631	53,093	6,392	11,855	2,090	49,371	8,225	102,253	1,721	14,363	7,995	23,554	4,279	13,731	42,983	532,778
2011	27,449	126,941	n/a	6,064	n/a	841	41,460	8,190	n/a	2,700	n/a	11,514	21,752	15,245	n/a	48,905	679,493
2012	31,416	159,363	n/a	9,393	n/a	664	39,036	5,181	n/a	3,573	n/a	15,124	24,040	25,869	n/a	55,027	694,526
2013	31,328	213,543	137,442	10,688	10,514	576	35,756	3,511	116,616	4,458	15,557	14,436	28,226	27,256	25,926	56,302	743,798

Table 19: Anecdotal information on exports from three priority provinces of India. Information was gathered from shrimp processors and exporters, fishermen cooperatives, aquaculture societies, NaCSA, NETFISH, and MPEDA.

Province	% of Prod. Exported	Main Exported Species	Destination Countries	Note
Andhra	90% of farmed supply and 50% of wild supply	whiteleg shrimp	USA, Britain, Belgium, Chile, Canada	Of the total provincial export, 15% is being procured from other provinces and then departing abroad from Andhra
Tamilnadu	99% of farmed supply, unknown proportion of wild supply	whiteleg shrimp, penaeid wild shrimp	Britain, Japan, USA, Vietnam	Export was mainly wild shrimp until 2010, now aquaculture also a major contributor. Export proportion of production for this province is increasing
Kerala	99% of farmed supply, unknown proportion of wild supply	penaeid wild shrimp, whiteleg shrimp	USA, Belgium, Britain, Vietnam	Export mainly comprised of wild shrimp. Export proportion of production for this province is increasing.

Table 20: Summary of Metrics entries for Indian shrimp. 37% of transactions and 69% of reported volumes for Indian shrimp were attributable to the province in which production occurred. The four provinces to which transactions were attributed together accounted for 53% of national production in 2010–2013.

Province	# of Transactions	Total Volume Accounted for in 2009-2015 (metric tons)	Avg Production, 2010–2013 (metric tons)
Andhra	155	2,819	176,341
Gujarat	4	77	103,808
Tamilnadu	4	363	42,555
Orissa	4	165	26,176
TOTAL (FOR IDENTIFIED PROVINCES)	167	3,425	348,880
NATIONAL TOTAL	450	4,953	662,649
% IDENTIFIABLE BY PROVINCE	37%	69%	53%

State

governments have put into place some precautionary management measures, including net mesh size restrictions (generally diamond meshes of >30 mm are required of trawlers by the coastal states) and 45-day closed seasons during breeding and monsoon seasons. However, there are additional measures that would further ensure healthy status of Indian shrimp stocks, including:

- Extension of trawl closed seasons from 45 to 60 days split into two periods that cover breeding timing of the major species,
- Analysis of reasons for stock status declines on the west coast (Kerala),
- Fishing pressure reductions in Kerala accomplished by strict regulations of the number and size of trawlers, as well as engine power to a maximum of 250 HP (there is general concern among the local scientific community over high power engines, which maximize fishing capacity and allow for fishing in deeper waters with associated bottom habitat impacts),

- Reduction of pollution in coastal waters,
- Risk assessment of bycatch species, as trawlers are increasingly retaining bycatch for use in the fishmeal and fish oil industries,
- Development of forums for consensus-based decision making that engage policy makers, fishermen, the scientific community, and NGOs together,
- Improvements to enforcement capacity to ensure that mesh size regulations and closed seasons are complied with, and
- Organized outreach to the fisher community regarding sustainability concerns.

Aquaculture Sustainability Information

As described above, the Indian shrimp aquaculture industry has rapidly transitioned from giant tiger shrimp to whiteleg shrimp in terms of focal species. Increased production efficiency and profits lie behind this trend, as semi-intensive whiteleg shrimp farming has an output of approximately six tons per hectare, compared with one ton per hectare for giant tiger shrimp farming. A key difference between production of the two species is broodstock source: Indian whiteleg shrimp broodstock is entirely produced in hatcheries, while giant tiger shrimp broodstock has, until recently, been sourced entirely from wild stocks (the government has recently started a domestication program for giant tiger shrimp). There is also production of scampi in traditional-style, freshwater reservoirs using broodstock from hatcheries.

Most Indian shrimp farms were sited and zoned in the 1990s without serious problems with respect to vegetation and mangrove loss. However, concerns about land salinization were raised by agricultural farmers and residents in areas adjacent to shrimp farms. In response to those concerns, India established the Aquaculture Authority of India, a central government body tasked with regulation of the aquaculture industry (now the Coastal Aquaculture Authority). At this point in time, best practices for giant tiger shrimp farming are well defined and codified in India, whereas guidelines for whiteleg shrimp production practices are lacking, as regulation has not kept up with the fast pace of development of the industry.

While most farms were built during the 1990s, in regions of major aquaculture development such as Andhra, agricultural lands are still being converted into shrimp farms. In Andhra due to a temporary peak in costs associated with rice farming, over the last two years over 1,000 hectares have been converted from rice to shrimp farming in the Godavari Delta. There is concern that the balance of land use between rice and shrimp farming should be more closely regulated rather than being allowed to vary with market forces. Impacts of shrimp farms upon rice farms and vice versa are also not adequately studied. In Kerala, innovative crop rotation (shrimp/rice) approaches are being used, but the aquaculture in this region is mostly traditional and extensive (i.e., focused upon production of giant tiger shrimp).

Polluted effluent is one means by which shrimp farms can impact surrounding farmland. Generally the water source for shrimp aquaculture is the same as that for agriculture, albeit with seasonal variations. Agricultural farmers in Andhra have complained about high organic loads in their water supply due to adjacent shrimp farming operations. In other regions where shrimp aquaculture is less developed (e.g. Tamilnadu, Kerala, etc.) such concerns about water quality have not been raised. There is not a system in place for regular water quality monitoring,

although the Central Institute of Brackish Water Aquaculture in Chennai near Andhra has organized some relevant studies recently. Cluster management of farms (see below) appears to have significant benefits for water quality in India.

The shrimp farming industry in India uses pelleted feed. Up until 2000, there was no domestic production of fishmeal and oil. However, local production of these items has been quickly organized, with a current annual fishmeal production volume of 200,000 metric tons, of which 70,000 metric tons are exported. Trawl bycatch (small pelagic species) is being used to produce the fishmeal, and there is concern that fishers are violating mesh size violations and disturbing the seafloor bottom in order to harvest more small pelagic species. Most (95%) of fishmeal and oil production occurs along the west coast of India, and issues with wild stock status in western India may be directly related to the increased demand for bycatch in the region.

As for disease, no outbreaks of EMS have been officially confirmed in India, despite earlier worries regarding EMS-like symptoms at farms in Ponneri, Tamilnadu. However, farmers in several regions, including Andhra, are dealing with Running Mortality Syndrome, which is resulting in small-scale, daily production losses. In association with this disease, survival rates of 40–50% were noted at Andhra farms in 2014, compared with 80% survival in 2012.

Since 2002, the Marine Products Export Development Authority (MPEDA) has been working to organize farmers into clusters (groups of approximately 25 farmers that reside together in a single village and can work together upon shared sustainability issues). A separate organization, the National Centre for Sustainable Aquaculture, was subsequently launched by MPEDA to further the cluster initiative. Over 750 clusters have been formed to date in six provinces, but not all of the clusters are active (of 601 clusters in Andhra, about 50% are active, while 10 of 49 clusters in Tamilnadu are active). Cluster activities have been associated with improvements to local water quality.

Below follows a list of recommended improvements for the Indian shrimp aquaculture industry:

- Outline best practice guidelines and associated regulations for whiteleg shrimp production, with particular focus upon proper water and soil management, as well as disease prevention,
- Encourage formation and activation of farm clusters;
- Ensure that all hatcheries are using SPF broodstock,
- Revise regulations regarding approval of new farms to ensure a desirable local balance between agriculture and shrimp farming, and
- Elucidate best practices regarding crop rotation (rice/shrimp) in order to control disease spread.

Bangladesh

National Overview

In terms of global shrimp markets, Bangladesh is overshadowed by its neighbor India. However, as in India, shrimp aquaculture is also on the rise in Bangladesh, albeit with more modest growth. Information gathered in country indicates how Bangladeshi shrimp aquaculture has grown steadily since the 1980s, surpassing wild production in 2012 (Figure 13). Highlighting the importance of shrimp for the Bangladeshi seafood industry, in 2013 shrimp accounted for 59% of national seafood exports by volume and 81% by value.

Bangladesh is divided into six divisions, three of which have coastline along the Bay of Bengal: Khulna, Barisal, and Chittagong. Khulna is the largest farmed shrimp producer, accounting for 86% of national shrimp aquaculture production in 2014. Chittagong ranks second with 10% of farmed production. Meanwhile, Chittagong, the only region where trawling occurs, led the other two coastal divisions in terms of wild shrimp capture in 2014 (Figure 14).

Among major Asian aquaculture producers Bangladesh is notable for its ban upon vannamei (whiteleg shrimp) production, in place until 2012, at which time the government began a pilot vannamei production program. Despite initiation of the pilot project three years ago, whiteleg shrimp has yet to become a commonly produced species in the country. Bangladesh has been reluctant to allow commercial whiteleg shrimp production due to concerns over the lack of

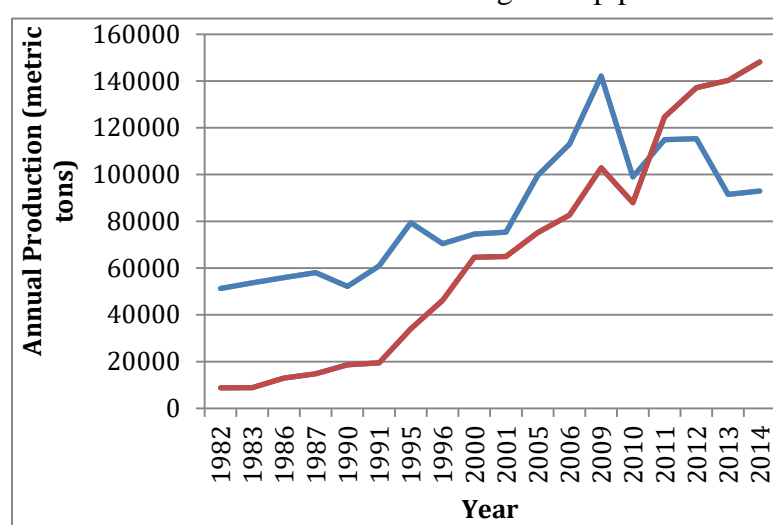


Figure 13: Bangladeshi farmed shrimp (red) and wild shrimp (blue) annual production in metric tons, 1982–2014 (FRSS 1983–2015).

Country Snapshot: Bangladesh

Year: 2014

Farmed production:	148,200 tons
Wild production:	92,917 tons
Total production:	241,117 tons
Export volume, product weight:	54,500 tons
Export volume, live weight:	~109,000 tons
Exported proportion:	~45%
Export market value:	~\$500 million
Ratio farmed:wild of exports (volume):	89:11
Ratio of farmed product that is exported:farmed product that stays on the domestic market:	~66:34

technical and financial resources needed to cultivate the species safely.

In the absence of intensive whiteleg shrimp production, more traditional, extensive approaches to farming are dominant in Bangladesh. The main farmed species is giant tiger shrimp (49% of farmed production), followed by giant river prawn (31%), brown shrimp (*Metapenaeus monoceros*) (6%), and Indian white prawn (*Penaeus*



Figure 14: Map of Bangladesh with the major shrimp aquaculture division of Khulna indicated with a circle and the 2014 leading division for wild harvest, Chittagong, indicated with a square.

indicus) (2%) (Figure 15). These species are all native to the region and comprise the Bangladeshi wild harvest together with a variety of other species, some found in salt water (*Penaeus merguensis*, *P. semisulcatus*, *P. japonicus*, *P. latisulcatus*, *P. canaliculatus*, *P. penicillatus*; *Metapenaeus monoceros*, *M. affinis*, *M. brevicornis*, *M. dobsoni*, *M. ensis*, *M. lysianassa*, *M. tenuipes*, *Parapenaeusopsis coromandelica*, and *Parapenaeusopsis lysianassa*) and some in fresh water (*Parapeneopsis coromandelica*, *Parapeneopsis hardwickii*, *Parapeneopsis maxillipedo*, *Parapeneopsis sculptilis*, *Parapeneopsis stylifera*, *Parapeneopsis uncta*, *Trachypenaeus curvirostris*, *Metapenaeopsis stridulans*, *Solenocera crassicornis*, *S. hextii*, *S. indica*, *S. melantho*, *Acetes chinensis*, and *A. erythraeus*).

Along with production, national exports have also been steadily increasing over the past two decades. While farmed giant tiger shrimp account for 30% of Bangladeshi shrimp production (farmed and wild combined), they account for 59% of shrimp exports (Table 21). Bangladesh exports approximately half of its shrimp (if yield after preparation and

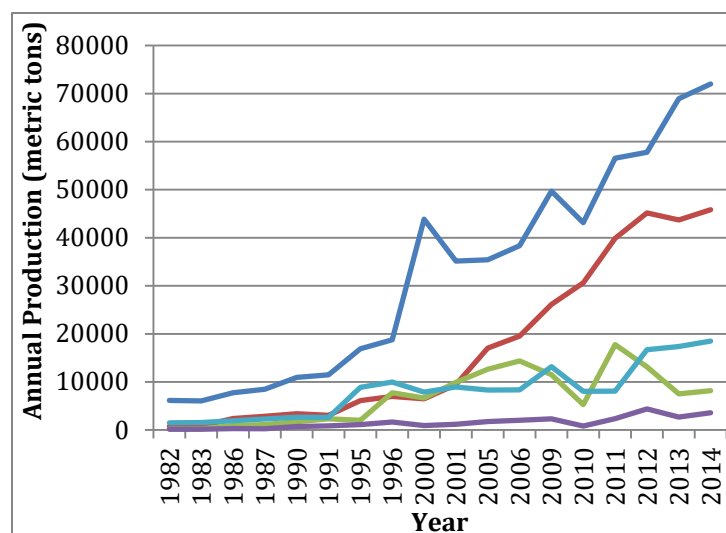


Figure 15: Bangladeshi farmed shrimp production, 1982–2014, by species in metric tons: giant tiger shrimp (blue), giant river prawn (red), others (turquoise), brown shrimp (green) and Indian white prawn (purple).

processing is estimated at 50% on the basis of product information provided from two exporter- processing plants, which indicated that most product is headless shell-on, some deveined, some not). As for export destinations, quantitative figures were not available at the national scale (see Provincial Overview below for province-scale information regarding export destinations).

Provincial Overview

Production information was gathered for the three coastal

provinces by species and gear type (for wild fisheries). Wild fishery production information indicates that marine and estuarine set netting is the most important gear

Table 21: Bangladeshi shrimp exports in metric tons of product by species, 1982–2014.

Year	Wild spp.	Farmed giant tiger shrimp	Farmed giant river prawn	Farmed brown shrimp	Farmed Indian white prawn	Other farmed spp.	TOTAL EXPORTS
1982	3,542	2,347	294	89	64	569	6,903
1983	3,421	3,993	561	165	99	1,041	9,312
1986	3,345	6,134	1,886	733	241	1,528	13,631
1987	3,542	7,287	2,458	975	216	1,985	16,275
1990	3,876	7,988	2,468	1,263	532	1,937	17,505
1991	3,679	8,393	2,238	1,698	621	1,916	17,985
1995	4,568	12,816	4,919	1,288	719	1,678	26,277
1996	5,023	14,221	4,026	528	521	936	25,255
2000	4,876	17,678	3,800	550	498	1,112	28,514
2001	4,656	20,413	3,715	324	315	290	29,713
2005	5,295	24,980	6,282	2,528	822	2,500	42,943
2006	5,654	25,182	7,158	2,178	982	5,379	46,533
2009	5,805	28,658	9,282	1,928	678	4,017	50,368
2010	5,365	30,172	11,322	1,623	876	2,241	51,599
2011	6,217	31,371	11,980	1,820	996	2,507	54,891
2012	5,666	28,556	10,228	1,529	835	1,193	48,007
2013	5,977	30,124	10,615	1,126	927	1,564	50,333
2014	5,929	32,188	11,622	1,218	955	2,588	54,500
% Total	11%	59%	21%	2%	2%	5%	-

type, with set net fisheries in the three provinces accounting for over one-third (38%) of total shrimp harvest (Table 22). Meanwhile, provincial aquaculture statistics indicate the dominance of Khulna in production of each of four species, plus all others combined (Table 23). As for trade, two prominent processing plants located in Chittagong and Khulna were visited (there is no processing capacity in Barisal). Information regarding the processing volumes and exports out of the two plants indicates growing importance of Europe as a shrimp trade destination for Bangladesh and waning importance of the United States. Notably, the Khulna plant is exporting predominantly farmed product, while one-third of the exports out of Chittagong are of wild origin (Table 24).

Among 33 transactions for Bangladeshi shrimp registered in Metrics, 10 were traceable to Satkhira district within the division of Khulna. The Satkhira district accounted for 33% of Khulna shrimp farm production and 28% of national shrimp farm production in 2013. The other 23 transactions could not be traced to a particular division or district.

Fishery Sustainability Information

Generally, fishery management in Bangladesh is more vigilant when it comes to the open-water, trawl fishery as compared with coastal, artisanal fisheries. The Chittagong Port Authority, for example, conducts active surveillance of the trawl fleet. However, the problem with this approach is that coastal and estuarine set nets account for a much greater proportion of total shrimp harvest than trawls, and there are compliance issues in these artisanal fisheries (unlicensed fishing) as well as lack of adequate regulations (for example, regulations governing set net mesh size are absent).

There is no regional stock assessment of wild shrimp in Bangladesh. However, there is concern that populations of wild, commercial shrimp species are not as healthy as they could be: declines in average body sizes of harvested individuals have been noted. Particularly in the case of giant river prawn, these declines have been linked to indiscriminate harvest of immature shrimp in set net fisheries for use in shrimp farming. This used to be a grave problem for giant tiger shrimp as well, although now giant tiger shrimp farming operations are dependent upon hatcheries for their post-larvae supply rather than wild sources. This change seems to have slowed the declines in body size of giant tiger shrimp, presumably because harvest of immature individuals was reduced. A similar approach to giant river prawn farming could have positive impacts for wild stocks.

In summary, the following sustainability improvements are recommended to the Bangladeshi authorities:

- Outlaw set net fisheries altogether or put into place and adequately enforce mesh size regulations,
- Reduce fishing pressure in coastal and estuarine areas,
- Outlaw brood and post-larvae harvest of giant river prawn from river mouths, estuaries and mangroves, and
- Encourage brood farming of giant river prawn so that the farming industry will no longer need so many immature giant river prawns.

Table 22: Wild shrimp harvests of the three coastal divisions of Bangladesh separated by gear type, 2000–2014 (in metric tons).

Div.	Barisal					Chittagong						Khulna					Others	TOTAL
Year	Marine & Estuarine Set Nets	Trammel Nets	Other Gear, Sea-water	Other Gear, Fresh-water	Total	Marine & Estuarine Set Nets	Trawl	Trammel Nets	Other Gear, Sea-water	Other Gear, Fresh-water	Total	Marine & Estuarine Set Nets	Trammel Nets	Other Gear, Sea-water	Other Gear, Fresh-water	Total	All gear	All gear
2000	4,057	38	102	6,475	10,672	13,523	2,915	604	340	2,158	19,540	9,466	113	238	8,633	18,450	25,900	74,562
2001	3,935	41	121	6,726	10,823	12,116	3,172	660	383	2,242	18,573	9,181	124	283	8,969	18,557	27,427	75,380
2005	5,574	96	281	8,299	14,250	18,579	3,311	1,538	935	2,766	27,129	13,005	288	654	11,066	25,013	33,199	99,591
2006	5,850	93	303	9,736	15,982	19,545	3,444	1,484	1,010	3,246	28,729	13,650	278	707	12,982	27,617	40,701	113,029
2009	6,903	109	166	9,124	16,302	23,112	2,932	1,740	554	7,105	35,443	16,100	326	388	18,566	35,380	54,993	142,118
2010	6,699	192	239	6,958	14,088	22,329	2,496	3,074	798	2,319	31,016	15,630	576	558	9,278	26,042	27,834	98,980
2011	6,956	287	313	8,687	16,243	23,187	2,785	4,594	1,044	2,896	34,506	16,231	861	731	11,582	29,405	34,747	114,901
2012	7,065	307	330	6,347	14,049	23,551	2,212	4,917	1,121	2,116	33,917	16,486	922	770	8,462	26,640	40,742	115,348
2013	5,079	361	362	6,739	12,541	16,930	3,083	5,780	1,211	2,247	29,251	11,851	1,083	840	8,987	22,761	26,948	91,501
2014	n/a	n/a	n/a	n/a	n/a	17,890	3,000	5,860	1,200	2,256	30,206	11,980	987	857	9,123	22,947	39,764	92,917
% of Total (2013)	6%	0.4%	0.4%	7%	14%	19%	3%	6%	1%	2%	32%	13%	1%	1%	10%	25%	29%	-

Table 23: Farmed shrimp production of the three coastal divisions of Bangladesh, separated by species of production, 2000–2014 (in metric tons).

Year	Barisal						Chittagong						Khulna					
	Giant tiger shrimp	Giant river prawn	Brown shrimp	Indian white prawn	Others	Total	Giant tiger shrimp	Giant river prawn	Brown shrimp	Indian white prawn	Others	Total	Giant tiger shrimp	Giant river prawn	Brown shrimp	Indian white prawn	Others	Total
2000	29	491	45	10	811	1,386	9,786	21	1,646	414	1,932	13,799	33,885	5,013	5,128	501	7,560	52,087
2001	34	384	40	10	216	684	9,413	34	2,345	693	1,386	13,871	25,704	9,072	7,560	504	1,386	44,226
2005	722	1,290	45	20	262	2,339	8,871	42	2,836	1,161	1,140	14,050	28,748	18,252	11,538	262	6,759	65,559
2006	743	1,543	53	23	440	2,802	8,303	72	4,503	411	1,820	15,109	30,187	19,686	1,836	10,083	5,696	67,488
2009	992	2,016	58	27	320	3,413	10,242	97	4,525	1,526	3,899	20,289	38,475	23,568	6,975	810	3,822	73,650
2010	731	1,987	55	31	234	3,038	13,751	110	2,863	1,238	4,201	22,163	34,621	27,693	5,256	841	1,677	70,088
2011	858	3,284	240	32	48	4,462	17,260	122	1,200	950	4,502	24,034	38,451	35,165	17,489	2,331	3,498	96,934
2012	1,558	1,689	449	150	106	3,952	16,302	640	2,580	860	1,147	21,529	39,924	41,768	10,114	3,341	10,894	106,041
2013	2,084	2,642	278	89	58	5,151	13,400	483	321	108	143	14,455	52,906	40,633	6,954	2,502	10,720	113,715
2014	n/a	n/a	n/a	n/a	n/a	n/a	14,000	510	320	110	210	15,150	55,500	40,800	7,650	2,550	10,500	117,000

Table 24: Processing and export statistics for two shrimp processing operations located in the divisions of Chittagong and Khulna. For each processing plant the top three export destinations and the volumes shipped are indicated in metric tons of product, as is the proportion of processed product that was from farmed sources and from wild sources.

Plant	Chittagong Plant							Khulna Plant						
Year	Farmed:Wild	EU	USA	Far East	Russia	Other Destinations	Total Export Volume (metric tons)	Farmed:Wild	EU	USA	Far East	Russia	Other Destinations	Total Export Volume (metric tons)
1982	49:51	532	152	684	-	76	1,519	mostly farmed	2,154	538	2,423	-	269	5,384
2000	55:45	2,096	2,395	898	-	599	5,988	mostly farmed	7,884	9,010	3,379	-	2,253	22,526
2001	58:42	2,236	2,555	958	-	639	6,388	83:17	8,164	9,330	3,499	-	2,333	23,325
2005	62:38	3,350	3,350	837	-	837	8,374	mostly farmed	13,828	13,828	3,457	-	3,457	34,569
2006	62:38	4,293	3,339	763	-	1,145	9,539	mostly farmed	16,647	12,948	2,960	-	4,439	36,994
2009	65:35	4,533	3,526	806	-	1,209	10,074	mostly farmed	18,132	14,103	3,224	-	4,835	40,294
2010	63:37	5,602	3,361	1,008	-	1,344	11,204	mostly farmed	20,198	12,119	3,232	-	4,847	40,395
2011	64:36	6,351	2,309	808	-	1,848	11,547	mostly farmed	23,839	8,669	3,901	-	6,935	43,344
2012	65:35	6,101	1,279	-	-	1,771	9,841	mostly farmed	23,663	4,962	2,672	-	6,870	38,166
2013	65:35	7,082	951	-	317	2,220	10,570	mostly farmed	26,521	3,562	-	1,187	8,312	39,583
2014	65:35	7,333	850	-	372	2,126	10,628	mostly farmed	30,272	3,510	-	1,536	8,774	43,872

Aquaculture Sustainability Information

As stated above, Bangladesh does not currently farm whiteleg shrimp intensively. For this reason, it was able to avoid the EMS outbreak. However, a growing number of farmers in Khulna and Chittagong are upgrading from extensive to semi-intensive or intensive giant tiger shrimp cultures, and this has resulted in cases of white spot disease in both divisions. There have also been some isolated cases in Barisal, although farming in this region is still entirely traditional.

The transition toward intensive cultures is resulting in farm management changes including changes in the types of feed used. Traditional farming practice in Bangladesh entails preparation of mash feed from low-cost, locally available ingredients including rice bran, wheat bran, oil cake, snail meat, and fishmeal. However, there is now increasing demand for supplemental pellet feed, and this is likely to result in higher organic loads in effluent as well as impacts to small pelagic fish species harvested in order to manufacture the pellet feed. With respect to effluents, there are some farms in Khulna and Chittagong that are now operating as closed systems within which water is being treated. Meanwhile, in Barisal, water continues to be handled traditionally (intake and discharge occur during new and full moons): in the absence of supplemental feeds, this does not pose a problem to water quality in surrounding territories.

As for sustainability issues associated with the siting of farms, there is a precedent for destruction of valuable mangrove habitat: Chittagong's Chokoria Sundarban mangrove forests have been converted to shrimp farming areas. There are vast mangrove forested areas in Khulna (known simply as "Sundarban") and these areas need to be protected so that they do not face a similar fate as Chokoria Sundarban. There are also coastal mangroves and offshore islands in Chittagong that could be encroached upon by further development of the industry. Meanwhile, Barisal, particularly its southwestern portion, is home to the world's largest continuous mangrove tract, which has been granted the status of Ecologically Critical Area, preventing the encroachment of new shrimp farms upon a 10 km-wide swath of mangrove forest.

The Bangladeshi coastal zone is prone to floods and other natural disasters. Frequently, farmed shrimp escape to the wild during floods. However, impacts upon wild populations have not been studied.

The following recommendations are made to the Bangladeshi industry and regulatory authorities:

- Farms should not source post-larvae shrimp from the wild, and instead source from hatcheries (see "Fishery Sustainability Information" section above),
- Dykes and embankments should be strengthened to prevent escape of farmed shrimp during floods, and
- Closed culture systems in Khulna and Chittagong merit expansion both within those provinces and in Barisal.

The national farmers association, Fish and Shrimp Exporters Association, and Khulna regional farmers association are all organizations that could be engaged in improvement efforts.

Malaysia

Of all countries covered by this report, data gathering for Malaysia was among the most challenging, as we had trouble identifying an in-country expert to collect information. The data gatherer ultimately engaged in the project was based in neighboring Indonesia, and gathered mainly production and sustainability information while providing limited trade information. An in-country expert may have been able to gather some of the missing Malaysian trade information.

Malaysia is divided into western and eastern portions that together comprise 13 states and three federal territories. Western Malaysia consists of the Malaysian Peninsula (11 states and two federal territories) and Eastern Malaysia's main feature is the island of Borneo, which two Malaysian states share with Indonesia and Brunei. Important states for fishing are located along the west coast of the Malaysian Peninsula (Perak and Selangor), while the top two shrimp aquaculture states of Sabah and Pulau Penang are situated in eastern Borneo and in the northwest portion of the Malaysian Peninsula, respectively (Figure 16).

Country Snapshot: Malaysia

Year: 2013

Farmed production:	50,414 tons
Wild production:	109,216 tons
Total production:	159,630 tons
Export volume, product weight:	33,584 tons
Export volume, live weight:	~56,000 tons
Exported proportion:	~35%
Export market value:	\$355 million
Ratio farmed:wild of exports (volume):	~50:50
Ratio of farmed product that is exported:farmed product that stays on the domestic market:	~55:45



Figure 16: Map of Malaysia with the major shrimp aquaculture states of Sabah and Pulau Penang indicated with circles and the main states for wild harvest, Perak and Selangor, indicated with a square.

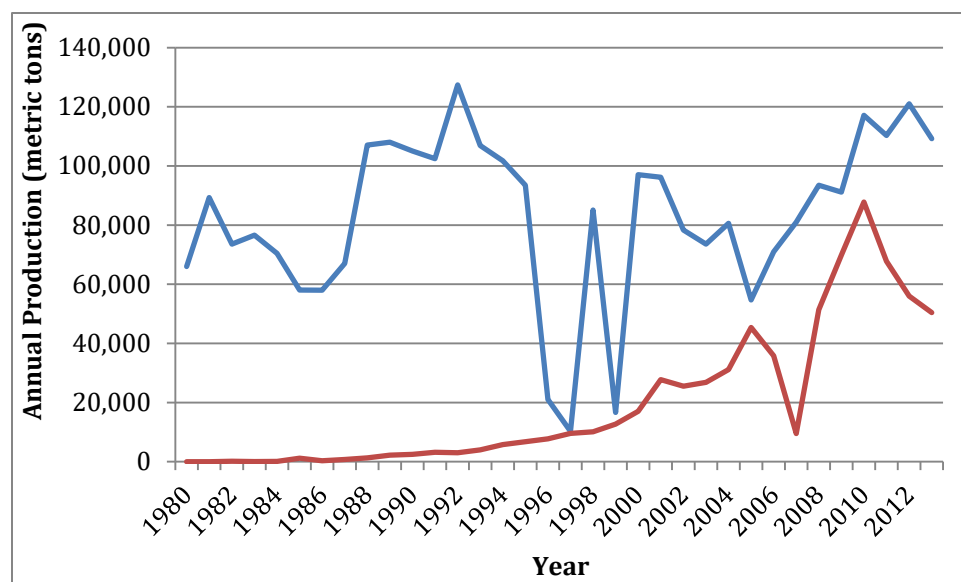


Figure 17: Malaysian wild shrimp (blue) and farmed shrimp (red) annual production in metric tons, 1980–2013 (Fisheries Department of Malaysia 2015).

Wild shrimp harvest has always and continues to exceed farmed shrimp production in Malaysia, although as of 2010 farmed production appeared on track to overtake wild shrimp, buoyed by new intensive whiteleg shrimp production facilities (Figure 17).

However, problems with EMS and other diseases have since hampered

Malaysia's farmed shrimp industry. Wild target species include banana prawn (10% of national wild harvest) and giant tiger shrimp (1% of national wild harvest), with a variety of species accounting for the remaining 89% of harvest (flower prawn, geragau shrimp, king prawn, *Parapenaeopsis* spp., pink shrimp, red Sandakan prawn, red Semporna shrimp, red tiger prawn, yellow shrimp, etc.). Meanwhile, whiteleg shrimp is the dominant aquaculture species (89% of farmed production), with giant tiger shrimp (10%) and giant freshwater prawn (1%) comprising the remaining 11% of farmed production.

As for national trade statistics, the proportion of shrimp production that is exported has fluctuated over the years, even exceeding 100% of production in a couple of years, drawing into question the accuracy of data and suggesting the occurrence of illegal harvest. In 2013, the most recent year for which data is available, Malaysia exported an estimated 35% of its shrimp harvest (Table 25—yield after preparation and processing was estimated at 60% on the basis of national export statistics, which indicated that most product was frozen and presumed headless shell-on). Frozen shrimp exports to the United States, Japan, Korea, Vietnam, Taiwan, and Hong Kong account for over 80% of total national exports. Generally, the United States has consistently been the leading export destination for Malaysian shrimp over the last 10 years, but the importance of the Asian market has also been growing over the last several years (Table 26).

Clear, detailed information on the proportion of exports accounted for by wild and farmed shrimp was not available, but some customs information on frozen shrimp exports was provided indicating volumes of frozen whiteleg shrimp, giant tiger shrimp, giant river prawn shrimp, and other shrimp that were exported in 2013. If the “other” category is presumed to be all wild-origin shrimp and the remaining three categories are presumed to be all farmed-origin shrimp (this may not be true in the case of giant tiger shrimp, as 26% of this species' production in Malaysia is attributed to wild sources), and if frozen export ratios are presumed to be representative of ratios across all products, then farmed shrimp comprise approximately half of Malaysian shrimp

Table 25: Malaysian shrimp production and Malaysian shrimp exports, 1991–2013.

Year	National Production (metric tons)	Exported Production (metric tons of product weight)	Exported Production (metric tons of live weight)	Percent Exported
1991	105,627	31,634	52,723	50%
1992	130,447	19,895	33,158	25%
1993	110,893	21,017	35,028	32%
1994	107,558	25,199	41,998	39%
1995	100,256	25,300	42,167	42%
1996	28,765	25,553	42,588	148%
1997	19,845	24,520	40,867	206%
1998	95,216	28,703	47,838	50%
1999	29,364	35,362	58,937	201%
2000	114,143	37,084	61,807	54%
2001	123,921	40,069	66,782	54%
2002	103,870	79,012	131,687	127%
2003	100,353	49,879	83,132	83%
2004	111,784	62,349	103,915	93%
2005	100,072	71,012	118,353	118%
2006	106,771	67,063	111,772	105%
2007	90,547	72,336	120,560	133%
2008	144,877	71,955	119,925	83%
2009	160,969	65,211	108,685	68%
2010	204,957	81,023	135,038	66%
2011	178,097	85,748	142,913	80%
2012	177,014	65,535	109,225	62%
2013	159,630	33,584	55,973	35%

Table 26: Top destination-product type combinations for Malaysian shrimp exports and the volumes exported (in metric tons of product), 2004–2013.

Destination:	Australia	Hong Kong	Japan	South Korea	Taiwan	US	Vietnam	Thailand	Singapore
Product type:	Frozen	frozen	frozen	frozen	frozen	frozen	Frozen	frozen	fresh or chilled
Year									
2004	280	1,431	3,519	336	108	13,966	437	-	6,817
2005	316	1,291	3,321	319	109	26,653	221	-	8,126
2006	413	643	3,022	588	70	21,165	122	-	8,326
2007	895	1,145	3,816	1,747	400	26,017	59	-	8,174
2008	2,232	1,013	4,830	3,723	1,025	32,808	746	309	8,187
2009	2,098	1,292	5,620	6,348	1,231	20,290	1,366	585	10,395
2010	3,253	1,100	8,491	8,548	3,148	25,269	4,261	499	-
2011	2,822	1,327	9,940	8,261	2,775	28,324	2,819	5,844	-
2012	2,892	1,231	7,126	4,273	1,475	20,921	6,414	2,368	7,779
2013	3,609	1,217	5,277	4,434	1,675	8,735	2,341	-	-

exports (47% to be exact).

Provincial Overview

Top Malaysian states for farmed shrimp produce over 10,000 metric tons annually (Sabah and Pulau Penang), while leading states for wild shrimp harvest over 25,000 metric tons a year (Perak and Selangor) (Table 27). While Sabah and Pulau Penang have recently become important states for shrimp aquaculture due to investments in whiteleg shrimp culture, Selangor continues to be the main producer of giant tiger shrimp, accounting for over 75% of national farmed production of the species.

Table 27: Annual production of farmed and wild shrimp in metric tons in the seven most productive states of Malaysia, 2000-2013.

Year	Kedah		Pulau Penang		Perak		Selangor		Johor		Sarawak		Sabah	
	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed
2000	7,614	503	7,217	126	30,967	2,718	15,447	1,357	2,387	2,613	17,293	3,521	11,529	2,067
2001	5,761	780	2,535	309	23,117	5,447	14,124	1,775	5,069	3,734	12,839	4,201	10,109	5,470
2002	5,180	1,339	2,558	357	22,547	5,385	11,450	2,272	5,628	3,517	15,475	5,986	8,601	3,105
2003	4,419	1,623	2,187	486	24,859	5,489	10,019	3,004	4,509	2,989	11,948	6,737	9,390	3,080
2004	3,566	1,891	2,347	541	25,360	7,781	11,115	3,354	5,484	3,368	18,637	8,110	9,269	2,241
2005	3,217	861	1,683	621	14,165	8,828	4,992	5,272	4,649	5,065	12,798	8,147	7,435	1,602
2006	3,080	1,308	2,916	896	2,859	11,951	4,534	4,729	6,035	6,010	3,966	2,242	2,568	2,242
2007	5,032	349	4,165	239	20,461	3,184	13,847	1,260	5,711	1,601	9,378	1,092	8,209	597
2008	3,391	892	3,628	2,664	17,582	13,119	28,797	8,620	3,109	10,217	9,619	3,362	8,498	10,746
2009	3,587	3,063	3,666	5,175	25,786	16,542	29,968	8,413	3,663	9,587	8,049	4,708	9,204	9,860
2010	3,325	3,135	6,758	7,984	29,538	18,216	45,773	8,549	6,295	13,859	6,401	7,501	10,503	14,145
2011	3,261	2,167	10,454	11,275	30,787	10,470	33,505	6,870	8,412	7,479	6,763	8,591	10,973	14,792
2012	3,335	1,504	9,399	11,341	32,229	5,237	33,672	5,896	16,305	5,419	7,665	8,972	11,848	12,070
2013	3,516	2,567	10,260	11,733	31,357	5,262	26,800	5,201	12,243	4,573	9,574	2,054	10,912	11,883

No information on the province of origin of exports was obtained, and the single Malaysian shrimp recordable transaction in Metrics is not traceable to a province. However, incomplete information was provided on the locations of the 98 Malaysian businesses engaged in exporting shrimp: of 34 exporters for which locations were pinpointed, 19 are in Sabah; four in Johor; three each in Lebuan and Selangor; two in Kedah; and one each in Penang, Perak, and Sarawak. Note that product processed and exported from these facilities may not all have originated in the provinces in which the facilities are located. Information on facility processing capacity indicated that the greatest processing capacity exists at facilities located in Sabah.

Fishery Sustainability Information

The west coast of Peninsular Malaysia, bordering on the Malacca Strait and Andaman Sea, is the most important for Malaysian shrimp fisheries, although surveys from the early 2000s indicated overfishing and declining productivity (Chee 2000; Talib et al. 2000; Talib 2002). Meanwhile,

the eastern Peninsula coastline of the South China Sea is less productive, but the shrimp catch here is still of importance for meeting the subsistence needs of rural economies. Landings of shrimp on the east coast have always been seasonal, usually becoming available during the northeast monsoon months from November to March. Available data indicate that east coast shrimp resources have been fully exploited. The potential yield has been estimated at around 6,000 metric tons (Pathansali 1976) as compared with a catch of between 3,926–5,615 metric tons annually in 2005–2009.

Fisheries management in Malaysia is chiefly the responsibility of state government. The state of Sabah represents the only exception to this rule, as there is a mix of federal and state responsibility over the fisheries there. Previously, fisheries in Malaysia were organized into four zones by the Fisheries Act of 1985 (which was amended in 1993): Zone A (0–5 nautical miles from the coast—artisanal fisheries only), Zone B (5–12 nautical miles from the coast—owner-operated, small trawlers and purse seiners), Zone C (12–30 nautical miles from the coast—trawlers and purse seiners) and Zone C2 (30 nautical miles from the coast up to international waters—larger trawlers and purse seiners). In June 2014, these zones were redrawn with the implicit goals of reducing trawler intrusions into traditional, coastal fishing grounds and phasing in trawl bans at the beginning of 2016. The new zones are as follows: no-fishing zone (within one nautical mile of the coast), Zone A (1–8 nautical miles from the coast—artisanal fisheries only), Zone B (8–15 nautical miles from the coast—as of 2016, only seiners will be allowed to operate here), and Zone C (15 nautical miles from the coast through to international waters).

Main sustainability concerns of the Malaysian shrimp fishery include overfishing (as indicated by declining CPUE in surveys as well as the greater incidence of small and juvenile fish in landings), habitat destruction (coastal disturbance due to land-based activities, as well as ocean bottom disturbance by trawlers), and water pollution (due to sewage release, as well as agricultural and industrial effluents).

Adoption of more of an ecosystem-based management approach is encouraged in order to address current challenges. Presently, fisheries management in Malaysia is quite focused upon controlling fishing effort and does not take a holistic approach. There are also some issues involving cross-jurisdiction collaboration: for example, marine protected areas are managed by the federal government, while fisheries are mostly managed by state governments. The two entities need to communicate and collaborate in order to ensure effectiveness.

Aquaculture Sustainability Information

As of 2013, there are 5,800 hectares of shrimp ponds in Malaysia, as well as 94 shrimp hatcheries with an annual production capacity of 12 billion fry. Cages are also used for shrimp culture. As with fisheries, management jurisdictions overlap: aquaculture is defined in the National Land Code as an agricultural activity, and states are charged with management of agriculture on their respective territories. However, there is also a National Agriculture Policy that sets broad guidelines for the Malaysian agriculture industry. Particularly, national government has authority over farm licensing, prescribing fish feed standards, and prescribing measures for disease control.

According to the National Agriculture Policy, aquaculture in Malaysia is intended to supplement wild fishery resources that have already reached maximum sustainable yield. With this mandate, the shrimp farming industry has grown over the past 15 years, albeit in dynamic spurts due to disease outbreaks. Generally, periods of lucrative growth have interchanged with crop failures and low production due to disease. Diseases that have affected the industry include white spot syndrome, gill-associated virus, Taura syndrome virus, Monodon Baculo virus, Hepatopancreatic parvo virus, and EMS. The latest case of EMS occurred in July 2013 in Johor, with all shrimp in seven ponds dying due to infection. The lack of water treatment facilities for farm pond effluent has played a role in enabling the spread of disease. Effluent needs to be both treated and released slowly so that pond bottom sediments are not disturbed in the process and become suspended (Nyanti et al. 2011).

Coastal cage culture facilities, meanwhile, also have impacts on the environment. Cages are generally located in protected and shallow coastal areas with less water circulation. Water in such areas can undergo eutrophication more quickly than more exposed areas of the coastline. So effluent in these ecosystems can also be damaging despite the perception that, being immersed in natural waters, there is no need to treat effluent or mitigate its impacts. One phenomenon associated with coastal cage shrimp culture is the red tide (blooms of phytoplankton). Annual red tides in the Strait of Malacca have been associated with coastal aquaculture (Khoo 1985).

Further expansion of the Malaysian shrimp farming industry also represents a threat to the country's mangrove ecosystems, which account for 641,172 hectares of the country's territory. Approximately 65,000 ha of mangroves are currently impacted by shrimp farming.

One recommended improvement is revision of the National Agriculture Policy to reflect that Malaysian shrimp farming is not exclusively focused upon increased shrimp production, but rather upon balancing production and conservation goals. It is also recommended that Fisheries Protected Areas, allowed for under Section 65 of the Malaysian Fisheries Act, be used more liberally to protect not only reef areas, but also mangroves endangered by expansion of the shrimp farming industry.

Philippines

National Overview

In 2014, Undercurrent News called out the Philippines for not taking advantage of opportunities in the global shrimp market in the last decade and “being left in the dust” by other Asian countries (Undercurrent News 2014). Indeed, current farmed shrimp production in the Philippines is comparable to that of the late 1980s, and giant tiger shrimp continues to be the focal species, with very limited production of whiteleg shrimp. The Philippines consists of over 7,000 islands that comprise 81 provinces and the world’s fifth largest coastline, which borders on the South China and Sulu Seas to the west, the Philippine Sea to the east, Luzon Strait to the north, and Celebes Sea to the south. Main provinces for shrimp aquaculture are located on Luzon Island in the north and Mindanao Island in the south (Figure 18).

Country Snapshot: Philippines

Year: 2012

Farmed production:	50,858 tons
Wild production:	20,042 tons
Total production:	70,953 tons
Export volume, product weight:	2,985 tons
Export volume, live weight:	~6,000 tons
Exported proportion:	~8%
Export market value:	\$67.5 mil
Ratio farmed:wild of exports:	~90:10
Ratio of farmed product that is exported:farmed product that stays on the domestic market:	~11:89

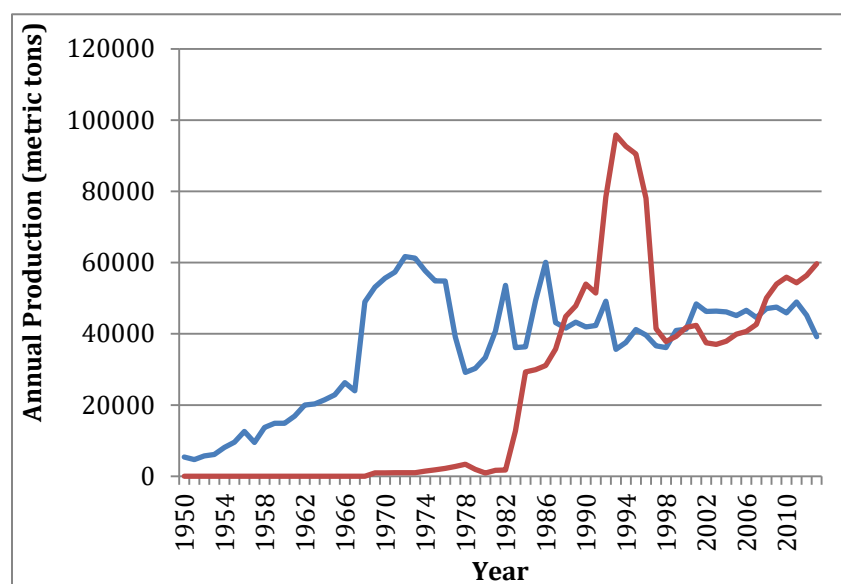


Figure 19: Filipino farmed shrimp (red) and wild shrimp (blue) annual production in metric tons, 1980–2013 (FAO 2015).

Farmed production currently accounts for 72% of shrimp output in the Philippines, having surpassed wild production in 2007 (Figure 19). Giant tiger shrimp account for 94% of farmed shrimp in the Philippines, followed by whiteleg shrimp (4%), endeavor prawn (2%), and freshwater prawn (0.01%). Akiami paste shrimp, meanwhile, comprise 67% of the wild shrimp harvest, followed by freshwater prawn (27%), endeavor prawn (4%), and banana prawn (2%). Reported

production volumes differ remarkably between the FAO and Philippine Statistic Authority (Table 28).

Farmed shrimp production in the Philippines achieved a peak in the 1990s and then dropped off sharply and has not recovered since. Generally, production cycles in the country have followed a boom-and-bust cycle as has been observed elsewhere in Asia, with disease, particularly white spot syndrome, counteracting periods of production expansion, such as that of the early 1990s.

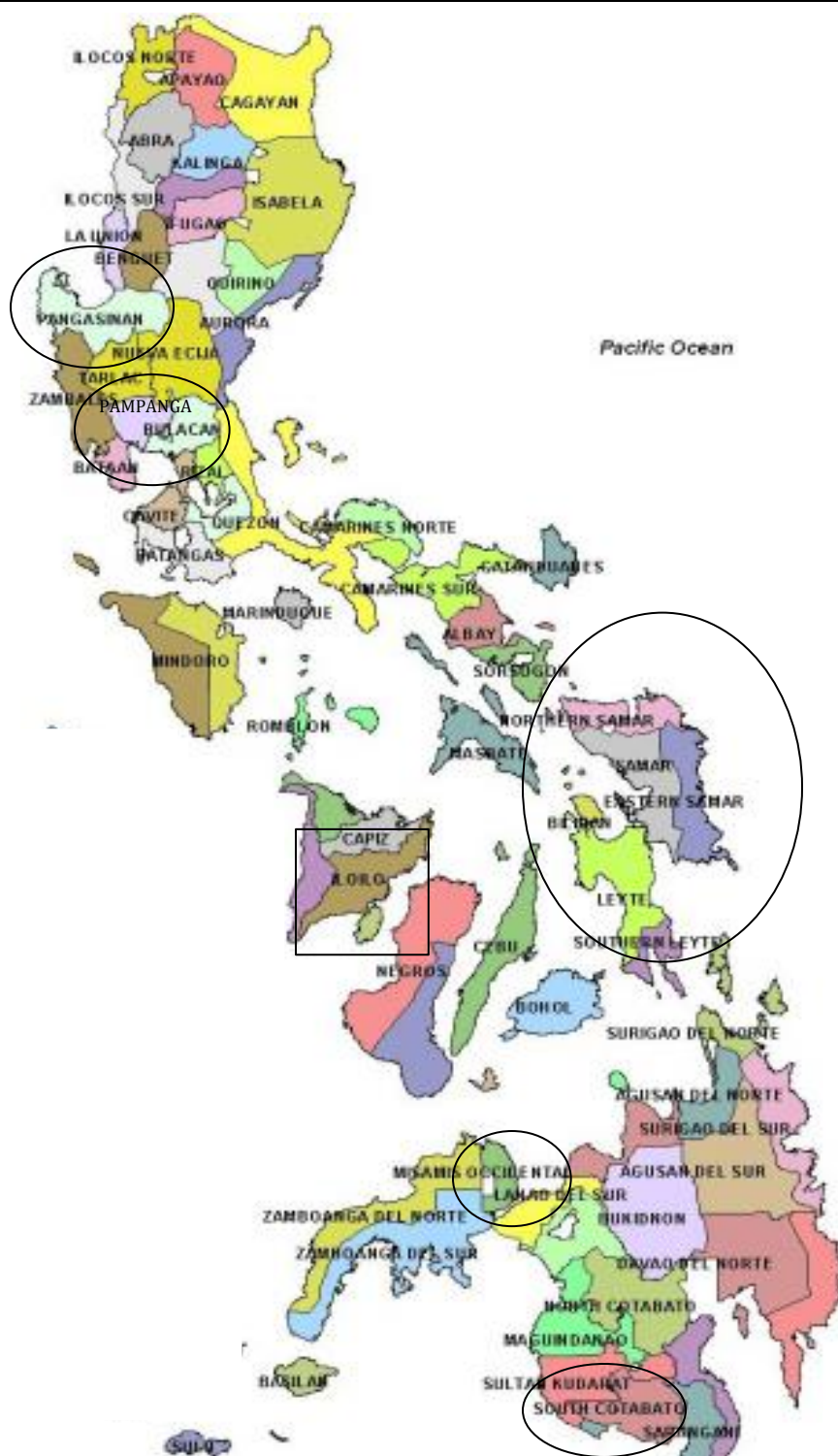


Figure 18: Map of the Philippines with the major shrimp aquaculture provinces of Pampanga, Bulacan, and Pangasinan on the northern island of Luzon encompassed by circles. Lanao del Norte on the southern island of Mindanao, another important farming province, is also indicated with a circle. Two geographies of reported farm expansion are also circled: South Cotabato province in Southern Mindanao and the Bicol Region (largest circle, includes six provinces). A square also encompasses the main province for wild harvest, Iloilo.

As for trade, according to FAO, national shrimp exports peaked in 1991 at 31,200 metric tons, but have since fallen precipitously. The Philippines exported only 2,985 metric tons of shrimp in 2012, or approximately 8% of production when processing yield is estimated at 50%. The leading destination for Philippine shrimp is Japan, followed by the United States, Korea, Hong Kong, the Trust Territory of the Pacific Islands, Taiwan, and France.

Provincial Overview

Major Filipino regions for shrimp production (Table 29) include:

- Central Luzon: includes the provinces Pampanga, Bataan, Bulacan, and Zambales. Pampanga is the country's largest farmed shrimp producer in terms of volume and area. Most producers here operate extensive systems with an average recovery rate of only 40%,
- Northern Mindanao: Lanao del Norte province and the city of Cagayan De Oro are particularly important for farming, and farming is mainly intensive,
- Southern Mindanao: production information was not obtained for provinces here, but 35% of Malaysian shrimp reportedly is processed in General Santos City of South Cotabato province, and the industry is hoping to expand production here in coming years, Bicol: as with Southern Mindanao, production figures were not obtained for the six provinces that comprise this region, but the industry has expansion plans for shrimp aquaculture here,
- Northern Luzon: Pangasinan province is significant for farmed production and home to many shrimp hatcheries,
- Western Visayas: Iloilo province is an important producer of wild shrimp. Farming in this region is mainly intensive, and
- Central Visayas: farming in this region is also predominantly intensive.

Provincial export information obtained from the in-country expert is incomplete and anecdotal in nature. Pampanga, where 97% of production is of farmed origin, is the major exporting province, with 30% of provincial production exported annually. 90% of these exports are of farmed origin, and Japan is the main destination. If these statistics are correct, Pampanga alone accounts for the lion's share of national exports. Bulacan, another province where production is predominantly of farm origin (98%), reportedly exports 75% of its production, although this amounts to less exported volume than that of Pampanga, because Pampanga is a much larger producer than Bulacan. The farmed proportion of Bulacan's exports is unknown.

Table 28: National Filipino production in metric tons of shrimp by species, 2010–2014. All data are from the Philippine Statistic Authority (2015) with the exception of the columns marked “FAO,” which are taken from FAO’s FishStat J (2015). There is a sizeable discrepancy between the two sources, particularly with respect to wild harvest.

Year	Wild Harvest						Farmed Production					
	Akiami paste shrimp	Endeavor prawn	banana prawn	freshwater prawn	Total	FAO	Giant tiger shrimp	Endeavor prawn	whiteleg shrimp	freshwater prawn	Total	FAO
2010	11,865	1,015	703	4,933	18,517	45,889	48,162	689	2,077	3	50,931	55,899
2011	14,704	992	665	5,072	21,433	48,944	47,495	690	1,974	3	50,161	54,341
2012	13,336	864	632	5,264	20,095	45,219	48,197	778	1,879	5	50,858	56,412
2013	9,484	709	463	5,398	16,053	39,189	49,467	757	1,871	6	52,101	59,692
2014	13,433	782	416	5,411	20,042	n/a	47,843	1,151	1,827	3	50,824	n/a

Table 29: Filipino shrimp production in metric tons by province and source (wild/farmed), 2010–2014. Provinces are grouped by region.

Year	Central Luzon								Northern Luzon		Western Visayas							
	Bulacan		Bataan		Zambales		Pampanga		Pangasinan		Antique		Aklan		Iloilo		Capiz	
	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed
2010	131	4,759	107	1,122	502	5	586	19,356	199	850	35	365	287	365	3,605	113	60	1,484
2011	120	5,206	107	1,052	481	1	619	19,232	128	940	39	474	207	474	4,741	46	69	1,418
2012	115	5,253	143	1,048	532	18	686	18,978	71	1,364	38	597	276	597	3,797	51	60	1,522
2013	102	4,649	139	1,066	595	13	693	19,581	128	1,531	36	695	267	695	2,317	39	65	1,410
2014	102	3,980	142	1,049	543	9	673	19,684	263	2,436	40	610	360	610	2,548	40	45	1,340

Year	Central Visayas						Northern Mindanao						Calabarzon (Southern Luzon)			
	Negros		Cebu		Bohol		Misamis Oriental		Misamis Occidental		Lanao del Norte		Cavite		Batangas	
	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed
2010	25	71	58	408	5	894	144	32	103	1,770	243	6,777	57	10	17	155
2011	45	138	66	528	4	412	49	1	89	2,040	232	6,679	101	7	21	51
2012	28	108	59	577	3	411	100	1	70	2,203	190	7,845	28	7	31	43
2013	15	81	97	265	3	259	78	1	75	1,584	164	11,553	30	1	23	-
2014	27	37	109	119	3	104	191	1	64	1,685	140	10,590	68	2	15	-

Fishery Sustainability Information

Artisanal push nets and lift nets are used to harvest paste shrimp in coastal areas. Trawlers, meanwhile, target an aggregate of species including banana prawn and endeavor prawn further from the coast. Important trawling areas are Samar Sea, Lingayen Gulf, San Miguel Bay, and Manila Bay. Trawling was more widely distributed in earlier times (e.g., the 1950s), with 24 designated trawling areas, but in the 1980s some of the areas have been closed in reaction to declines in CPUE. There are ongoing issues with enforcement of trawling closures.

There are also issues with illegal gear use in some areas: for example, the use of motorized scissor nets in Pampanga province. Furthermore, there is a history of friction over allocations between trawlers and artisanal fishermen (Gillett 2008). Overall, wild shrimp abundance appears to be holding steady, with some upward and downward trends for particular species in particular provinces. Furthermore, in some regions, stock dynamics have shifted (species that were once abundant year-round are now only seasonally abundant).

Fisheries management in the Philippines entails national, provincial, and municipal components, but generally there was a push in the 1990s to decentralize the management of coastal resources and increase the responsibility of municipalities. The National Fisheries Code 850 from 1998 is a seminal piece of legislation for the accomplishment of this decentralization, as it granted municipalities (also known as LGUs—Local Government Units) jurisdiction over fisheries occurring up to 15 km from shore. The Code also provided for the creation of Fisheries and Aquatic Management Councils (FARMCs, also known as “Fisherfolk Councils”) to serve as advisory bodies in helping municipalities to fulfill their new management duties. While the Code transferred many management responsibilities to municipalities, two national government entities, the Bureau of Fisheries and Aquatic Resources (BFAR) and the Department of Environment and Natural Resources (DENR), continue to wield some important authority—notably, BFAR retains an important role in enforcement and both agencies are charged with protection and management of mangrove forests (Lowry et al. 2005).

The municipalities and provinces are at various places in terms of the process of decentralizing fishery management effectively. For example, municipalities in Pangasinan have put into place a coastal resource management plan, and local government fishery managers in Pampanga are deputized and conducting enforcement activities. Meanwhile, Bulacan lacks municipal ordinances relevant for shrimp conservation, and Bataan is generally behind when it comes to passing municipal ordinances governing fishery management.

The following general sustainability improvements are suggested:

- Lagging municipalities need to pass needed ordinances providing for adequate fishery management and resource conservation, and can use the more advanced municipalities as models.
- Some municipalities are lacking adequate funding to implement the Fisheries Code, and require increased support from the federal government
- Municipalities need support from national-level experts (education, capacity building) in order to best fulfill their management duties.

Aquaculture Sustainability Information

As with fisheries management, Fishery Code 850 decentralized management of aquaculture, granting municipalities authority over zoning and permitting of shrimp farms, as well as oversight over pollution from aquaculture facilities. Sustainability concerns associated with farm effluent release and feeds used in farms are not as much of a concern for the Philippines as for neighboring countries due to the Philippines' relatively small scale of production and mostly traditional approach to farming. However, there generally are not data to back up the assumption that polluted effluent is not a problem in the Philippines, and producers in some provinces have switched to using commercial feed (for example, in Pangasinan, 60% of producers are using commercial feed), indicating that a local commercial feed industry may develop down the road and put additional pressure on local marine resources. There are some sustainability concerns associated with traditional feed, in which bivalves are a key ingredient: the bivalves are collected from seafloor bottoms in bays in a way that disturbs the seafloor habitat and associated organisms.

As mentioned above, disease has been a persistent problem for the Philippines' shrimp aquaculture industry. In addition to white spot syndrome, EMS has been documented in the Philippines, as has Taura syndrome and luminous bacterial disease. An associated issue is the failure of producers to report disease outbreaks.

As the Fishery Code covers both fisheries and aquaculture, the improvement recommendations listed above for fisheries are equally relevant for aquaculture. In addition, there is a need for outreach to producers regarding best practices in shrimp aquaculture as detailed in the ASEAN Good Aquaculture Practices (GAqP) document. Improvements in pond preparation and sourcing of stock only from accredited hatcheries could go a long way in the effort to mitigate disease.

Myanmar

National Overview

Myanmar proved a difficult country to gather data for. Published information on particular fisheries and farms is limited, and local experts are also wary of sharing unpublished information with outsiders.

Myanmar is comprised of 21 states, territories, regions, and self-administered zones, with coastline along the Bay of Bengal and the Andaman Sea. Shrimp are farmed in seven of the 21 regions, with Rakhine, Ayeyarwady, and Yangon setting aside the most territory for shrimp ponds (155,533, 57,149, and 10,229 acres, respectively). As for shrimp fisheries, trawlers are registered in the provinces of Taninthayi, Yangon, and Rakhine (Figure 20). Shrimp are also harvested by artisanal fishers using trammel nets in waters closer to shore.

Myanmar began farming shrimp in the mid-1990s, comparatively late with respect to the Southeast Asia region. Production ramped upward in the early-2000s and then plateaued, and has been holding fairly steady for the last 10 years. Farmed and wild sources presently make approximately equal contributions to national shrimp production (Figure 21).

Myanmar's main farmed shrimp species are giant tiger shrimp and freshwater prawn, although national production volumes by species were not obtained. A minor amount of whiteleg shrimp is also farmed in Myanmar. Meanwhile, approximately 25 species are endemic to the region. Two *Metapenaeus* species, pink shrimp and yellow shrimp, predominate in offshore trawl catches, while tiger prawn, banana prawn, and redbait prawn (all *Penaeids*) commonly occur in the coastal, artisanal harvests.

National export information for 2013 was reported in the government publication "Fishery Statistics 2014" both by country and by species, although there is a discrepancy between the two sets of data (Table 30) (Myanmar Department of Fisheries 2014). If all giant tiger shrimp are presumed to be of farmed origin and other species of wild origin, then wild shrimp account for the majority (82%) of national exports. Leading destinations for Myanmar shrimp are Japan, China, Thailand and Malaysia, with a general preponderance of Asian rather than European, American, or Oceanic destinations.

Species-specific 2013 export information was also provided by an in-country expert for three destination countries: Thailand, China, and Bangladesh. Pink shrimp accounted for 65% of the shrimp exports to these three destinations, and if all giant tiger shrimp are presumed to be of farmed origin, wild shrimp accounted for 80% of exports (Table 31).

Country Snapshot: Myanmar

Year: 2013

Farmed production:	52,000 tons
Wild production:	49,409 tons
Total production:	101,409 tons
Export volume, product weight:	16,509 tons
Export volume, live weight:	~22,000 tons
Exported proportion:	~22%
Export market value:	\$62 mil
Ratio farmed:wild of exports:	~18:82
Ratio of farmed product that is exported:farmed product that stays on the domestic market:	~8:92



Figure 20: Key regions of Myanmar for both shrimp aquaculture and wild harvest are indicated with both a square and a circle: Rakhine (with coastline along the Bay of Bengal) and Yangon (bordering on the Andaman Sea). Additionally, Ayeyarwady (circled) is a major aquaculture region and Taninthayi (square) is home to a trawl fleet.

Provincial Overview

Anecdotal trade information at the province scale was provided by an in-country expert for one province, Yangon. 80% of shrimp production in this region is currently exported, with wild shrimp predominating among the outbound product. The proportion of production that is exported is reportedly decreasing.

Fishery Sustainability Information

Production of Myanmar wild shrimp has generally been increasing over the last decade, although some declines at the regional scale are noted (for example, abundance has declined over recent years in Yangon). Bycatch is an important concern in the trawl fishery, which has a lot of discards due to the lack of sufficient, low-priced ice for trawlers to take on their trips. Generally, fishery management

Table 30: Myanmar shrimp exports in metric tons of product weight, 2013, listed by destination and by species. Note that there is a discrepancy in total exported volume between the two sets of data (Myanmar Department of Fisheries 2014).

Country	Volume Exported		Species/Product	Volume Exported
Japan	5,266		Pink Shrimp	9,839
China	4,152		White Shrimp	2,605
Thailand	2,048		Dried Prawn	2,654
Malaysia	1,587		Wild Total	15,098
Singapore	896			
Vietnam	704		Giant tiger shrimp	3,383
USA	438			
15 others	1,418			
Total	16,509		Total	18,480

been an issue for Myanmar. The minuses, meanwhile, are economic: Myanmar, a very poor country, is largely missing out on the global market for shrimp. Cyclone Nargis, which hit Myanmar in 2008, destroyed shrimp farming infrastructure and left some local companies in the industry in a crippled state from which they still have yet to recover.

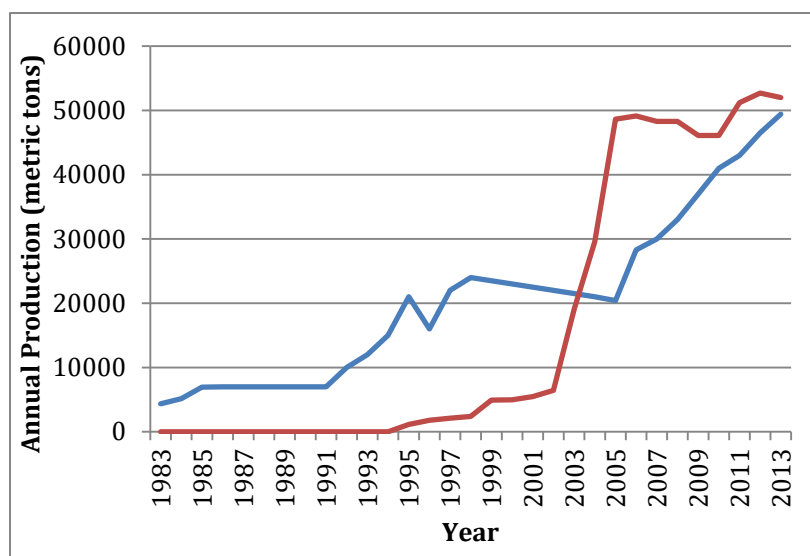


Figure 21: Myanmar farmed shrimp (red) and wild shrimp (blue) annual production in metric tons, 1983–2013 (FAO 2015).

structures in Myanmar are young and capacity building is a priority. In addition to building expertise at the national level (e.g., in the Myanmar Department of Fisheries),

Myanmar can look to neighboring countries with relatively successful decentralization models and likewise hand off a portion of management to structures at the regional and municipal scales.

Aquaculture Sustainability Information

The shrimp aquaculture industry in Myanmar is in an underdeveloped state presently, which has pluses and minuses. On the plus side, with only six companies pursuing intensive farming operations, EMS has not

Table 31: Myanmar's 2013 shrimp exports by species to Thailand, China, and Bangladesh in metric tons of product.

Country	Wild Shrimp Exports						Farmed Shrimp Exports				TOTAL
	Pink	White	Flower	Cat Tiger	Bait Jade	Wild Total	Whiteleg	Giant Tiger	Freshwater Prawn	Farmed Total	
Thailand	1,306	440	-	-	-	1,746	22	24	256	301	2,047
China	2,784	476	38	19	-	3,316	-	770	66	835	4,152
Bangladesh	-	-	-	-	-	-	-	133	-	133	133
TOTAL	4,090	916	38	19	0	5,062	22	927	322	1,270	6,333

Recommended improvements include overhauling existing hatchery facilities in order to produce better-quality seed, as well as publication of materials for farmers describing best practices in shrimp aquaculture that can be implemented at the farm scale.

Cambodia

National Overview

Among the countries profiled in this report, Cambodia is the smallest shrimp producer, with national production consistently below 10,000 metric tons and only 103 metric tons of farmed shrimp production in 2014. The provinces of Koh Kong and Sihanoukville account for 68% of national production and all national shrimp exports (Figure 22).

Fisheries account for almost 99% of Cambodian shrimp production (Figure 23). The Cambodian shrimp fishery uses five gear types, listed in order of importance: trawls, gillnets, push nets, stow nets, and barbed spears. As of 2004, 1,186 trawlers were registered in Cambodia, with 94% of the fleet based in Koh Kong and Sihanoukville. The provinces of Kep and Kampot accounted for the remainder of boats. In the same year, there were 515,250 shrimp gillnets set along the coast of Koh Kong province, and 239,500 nets in Sihanoukville, accounting for 98% of the total gillnets used in the national fishery (Gillett 2008).

Country Snapshot: Cambodia

Year: 2014

Farmed production: 103 tons

Wild production: 8,257 tons

Total production: 8,360 tons

Export volume, product weight: 1,732 tons

Export volume, live weight: ~2,300 tons

Exported proportion: ~28%

Export market value: ~\$5 million

Ratio farmed:wild of exports: <1% : >99%

Ratio of farmed product that is exported:farmed product that stays on the domestic market: ~100:0

There is some uncertainty regarding the taxonomy of the shrimp catch in Cambodia (Gillett 2008). The in-country expert engaged in this project provided a list of eight species and their relative contributions to Cambodian shrimp production, but some of the Khmer species names could not be matched with their English language counterparts with certainty (Table 32). Farmed production consists of three species, with whiteleg shrimp the predominant farmed species. Individual farmed species' production volumes were not available.

As for national exports, Cambodia currently exports its shrimp only to Thailand. Thailand has been the exclusive destination for Cambodian shrimp since 2008; before then, Vietnam and

Hong Kong also purchased shrimp from Cambodia. In 2014, Cambodia exported approximately 28% of its shrimp production. It is presumed that practically all of the country's farmed production was included among this exported volume. Quantitative per-species or per-product export information was not available, but exports are known to consist of the following products: mixed fresh shrimp (generally Jinga shrimp), frozen shrimp, and salted dry shrimp.



Figure 22: Key provinces of Cambodia for both shrimp aquaculture and wild harvest are indicated with both a square and a circle: Kaoh Kong (in pink) and Sihanoukville (in darker pink).

Provincial Overview

Production and export data was obtained for the two main producer provinces, Koh Kong and Sihanoukville. The information indicates that Sihanoukville is the more important of the two provinces in terms of both fishery and farm production of shrimp, as well as exports (Table 33). Koh Kong does not have any processing facilities, and thus exports are entirely comprised of fresh product, mostly wild Jinga shrimp, but also some farmed product. Sihanoukville, meanwhile, has some processing capacity, and 2014 provincial exports were comprised mainly

of wild shrimp sold as fresh (46%), frozen (44%), and salted dry (10%) products. Exports from both provinces have decreased over the last several few years, and domestic demand is said to be increasing.

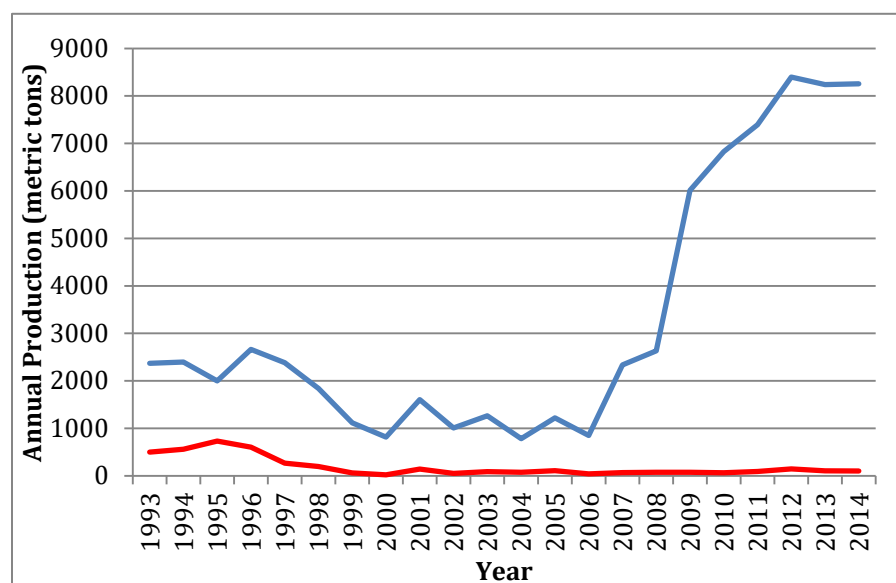


Figure 23: Cambodian farmed shrimp (red) and wild shrimp (blue) annual production in metric tons, 1993–2013 (Cambodian Fisheries Administration 2015).

Fishery Sustainability Information

The in-country analyst noted some regional variation in wild shrimp stock status: while Koh Kong white shrimp production has recently increased, possibly in connection with the creation of conservation areas in 2005, shrimp abundance in Sihanoukville has trended downward in association with overfishing, trawler damage to the seafloor,

and mangrove forest destruction. Generally, there is a need for more qualified fishery managers, particularly at the provincial scale. Outreach efforts are also necessary to increase fisher knowledge of the resource and sustainability issues. Finally, the budget for monitoring and enforcement in the Cambodian shrimp fishery is extremely limited.

Suggested improvements include creation of conservation areas in Sihanoukville, capacity building at the scale of community fisheries committees, and increasing enforcement with respect to the use of illegal fishing gears.

Table 32: Shrimp species harvested and farmed in Cambodia, and their relative contributions to national production.

Aquaculture Sustainability Information

The shrimp farming industry in Cambodia has declined since the 1990s, when there were over 40 shrimp farms operating in Koh Kong Province. Today, there are only three, plus a handful more in

	Khmer Name	English or Latin	Farmed/Wild	Contribution to Nat'l Production
1	Bangkea Khhleung	giant tiger shrimp	Wild & Farmed	0.3%
2	Bangkea Sor	whiteleg shrimp	Wild & Farmed	11.7%
3	Bangkea Kong Lai	?	Wild	4.7%
4	Bangkea Para	green tiger shrimp	Wild	3.3%
5	Bangkea Aukhhak	Jinga shrimp (?)	Wild	46.7%
6	Bangkea Chhe Bouy	freshwater prawn (?)	Wild & Farmed	5.0%
7	Bangkea Lilong	?	Wild	1.7%
8	Bangkea Khloy	<i>M. spinulatus</i> (?)	Wild	26.7%
				100%

Table 33: Wild and farmed production of shrimp (live weight) and exports of shrimp (product weight), 1993–2014, in metric tons, from Koh Kong and Sihanoukville Provinces, Cambodia.

Year	Koh Kong Province			Sihanoukville Province		
	Wild harvest	Farmed Production	Export	Wild harvest	Farmed Production	Export
1993	2,368	398	-	-	-	-
1994	2,395	509	-	-	-	-
1995	2,000	730	-	-	-	-
1996	2,664	604	-	-	-	-
1997	2,383	264	-	-	-	-
1998	1,840	151	-	-	-	-
1999	1,115	50	-	-	-	-
2000	815	20	-	-	-	-
2001	1,606	60	-	-	-	-
2002	1,008	27	-	-	-	-
2003	1,265	27	1,022	-	-	-
2004	783	18	600	-	-	-
2005	1,220	7	976	-	-	-
2006	850	-	550	-	-	-
2007	987	24	640	-	-	-
2008	1,034	30	480	-	-	-
2009	85	-	40	4,076	7	855
2010	1,140	16	473	3,719	21	776
2011	1,298	60	525	3,994	32	1,247
2012	1,568	65	710	4,430	80	1,315
2013	1,213	11	555	4,425	95	1,185
2014	1,277	24	582	4,280	79	1,150

Sihanoukville. The farmers in Koh Kong operate semi-intensive facilities and use feed pellets imported from Thailand, while their colleagues in Sihanoukville operate more traditionally and use natural feeds.

In the 1990s, water quality of the coastal areas of both Koh Kong and Sihanoukville was adversely affected by shrimp farms, which discharged their effluent directly into the sea. Due to the decline of the industry, this is no longer a concern. Now, Cambodian shrimp farmers are mainly preoccupied with keeping their fledgling industry alive. Disease has also been a recurring problem, with cases of EMS and

“red body disease” reported.

Recommended improvements include overhauling existing hatchery facilities in order to produce better-quality seed, as well as providing information on best practices to local farmers.

CROSS-COUNTRY RESULTS

Compiling the numeric data presented in the “Country Snapshots” above (Table 34) brings to light the following:

- Aquaculture is comprising a growing proportion of Asian shrimp production, currently accounting for 58% of the cumulative production of these 10 countries,
- Approximately half (49%) of these countries’ total shrimp production remains on domestic markets,
- Despite the growth of local demand for shrimp, western markets (the United States and the European Union) are still leading destinations for Asian shrimp, as is Japan,

- Of the 34% of shrimp production exported by these countries, 87% of the exported volume is supplied by farms,
- Thailand, previously the world's leading shrimp exporter, particularly suffered from production losses due to Early Mortality Syndrome (EMS), and its export volume was surpassed by Vietnam, China, and India,
- While EMS affected its production as well, Vietnam currently appears to be the world leader in shrimp exports and farmed shrimp exports, although it no longer reports export volumes and only reports export value; thus, volume figures are only estimates,
- Four nations that have made large-scale investments in intensive whiteleg shrimp farming (Vietnam, Thailand, India, and Indonesia) all export more than half of their shrimp production and have shrimp export values of over \$1 billion,
- Nations that have not made large-scale investments in intensive whiteleg shrimp aquaculture (Bangladesh, Malaysia, Cambodia, the Philippines, and Myanmar) have struggled to compete for the international market with those that have, and these countries all export \$500 million or less of shrimp annually and keep more than half of their shrimp in-country for domestic consumption, and
- China is an exceptional country in that it has both invested heavily in whiteleg shrimp (*Penaeus vannamei*) culture and keeps 88% of its shrimp production for domestic consumption. This is indicative of the high demand for shrimp in the Chinese market.

Table 34: Production and trade data for the 10 countries included in this study in the most recent year for which data is available for each. Several of the presented statistics are dependent upon estimates of processing yield. Country-specific estimates were generated on the basis of export information indicating the product breakdown of national exports. Yields per product type, drawn from the FAO (Torry Research Station 2001), are as follows: frozen headless shells-on—60%, frozen headless shell-less—45%, cooked—28%, dry—20%. If product export information was not available for a country, national yield was taken as 50%, as the majority of exports were presumed to be headless shells-on (with the exception of Myanmar and Cambodia, for which yield was taken as 75% as a large proportion of exports are presumed to be delivered to neighboring Asian countries without significant processing). Because of the general uncertainty in yield estimates, the symbol “~” is used in the table below to indicate the approximate nature of associated data points.

Country	Total Production in Metric Tons of Live Weight (Year)	% of Production that is Farmed	% of Production that is Exported	Export Value	Export Volume in Metric Tons of Live Weight	Export Volume in Metric Tons of Product Weight	Ratio Farmed:Wild of Exports (volume):	Farmed Exports in Metric Tons of Live Weight	Ratio of Farmed Product that is Exported:Farmed Product that Stays on the Domestic Market
Vietnam	806,960 (2013)	67%	~74%	\$3.1 billion	~600,000	~300,000	~88:12	~528,000	~97:3
India	743,798 (2013)	45%	~57%	~\$3 billion	~426,000	255,603	~82:18	~349,000	~ >99: <1
China	3,560,871 (2013)	55%	~12%	\$2.2 billion	~425,000	212,698	~85:15	~361,000	~18:82
Thailand	376,339 (2013)	87%	~88%	\$2.16 billion	~330,000	197,238	>99 : <1	~327,000	~99:1
Indonesia	547,934 (2012)	67%	~49%	\$1.3 billion	~270,000	162,068	~97:3	~262,000	~71:29
Bangladesh	241,117 (2014)	61%	~45%	~\$500 million	~109,000	54,500	89:11	~97,000	~66:34
Malaysia	159,630 (2013)	32%	~35%	\$355 million	~56,000	33,584	~50:50	~28,000	~55:45
Myanmar	101,409 (2013)	51%	~22%	\$62 million	~22,000	16,509	~18:82	~4,000	~8:92
Philippines	70,953 (2012)	72%	~8%	\$67.5 million	~6,000	2,985	90:10	~5,400	~11:89
Cambodia	8,360 (2014)	1.2%	~28%	~\$5 million	~2,300	1,732	<1% : >99%	~100	~100:0
TOTAL	6,617,371 (2012–2014)	58%	~34%	\$12.75 billion	~2,246,300	1,236,917	87:13	~1,961,500	~51:49

CONCLUSIONS

On the basis of the trade analysis, Table 35 (below) indicating 16 provinces with relatively large production, high export proportion, and significant sustainability issues was compiled.

Table 35: Trade and sustainability information for sixteen provinces with high shrimp production, known exports to western supply chains, and significant sustainability issues.

Country	Province, Country	Production in Most Recent Year of Data Availability (metric tons of live weight)	Volume Exported in That Year (metric tons of product weight)	% of Exports That Are Farmed	Sustainability Issues, Notes on Data
Thailand	1. Surat Thani	67,405	33,703	>99%	<ul style="list-style-type: none"> - Disease transmission - Sourcing fish feed from depleted small pelagic fisheries - Mangrove habitat destruction Provincial production data from 2012. Nationally, approx. 50% of production was exported in that year. Applied this ratio to yield exported volume per province.
	2. Chanthaburi	61,817	30,909		
	3. Songkhla	47,832	23,916		
	4. Thammarat	45,585	22,793		
	5. Trat	39,452	19,726		
	6. Trang	38,275	19,138		
	7. Rayong	25,269	12,635		
	8. PhangNga	23,755	11,878		
China	9. Guangdong	808,194	117,396	>90%	<ul style="list-style-type: none"> - Disease transmission in farms - Mangrove and wetland habitat destruction - Poor data availability on shrimp culture - Source of feed unknown Provincial production data from 2013. Anecdotal information on proportion exported, and proportion of exports that are farmed.
	10. Guangxi	294,923	98,838		
Indonesia	11. Lampung	74,842	59,874	>99%	<ul style="list-style-type: none"> - Water quality, disease transmission, and escapee issues in intensive-culture whiteleg shrimp facilities (esp. Lampung, South Sumatra) - Poor data availability on shrimp culture - Source of feed unknown Provincial production information from 2013, aquaculture only. Anecdotal information on proportion exported from these provinces (80%).
	12. East Java	56,992	45,594		
	13. South Sumatra	45,657	36,526		
Vietnam	14. Ca Mau	130,490	~103,320	87%	<ul style="list-style-type: none"> - Diseases (EMS, white spot, runt syndrome, white feces syndrome) and the use of prophylactics and disinfectants to combat them, resulting in negative environmental impacts. Note: Production info is for 2014, but amount exported is for 2010.
India	15. Andhra	244,871	192,189	>99%	<ul style="list-style-type: none"> - Water quality issues due to intensive whiteleg shrimp farming. Water quality is also inadequately monitored. - Feed used to be sourced from abroad, but now is entirely sourced from domestic small pelagic fisheries, which have poorly quantified impacts on harvested species and the seafloor bottom. Provincial production data from 2013. Anecdotal information on proportion and type exported.
Bangladesh	16. Khulna	139,947	44,974	“mostly farmed”	<ul style="list-style-type: none"> - Growing concerns about effluent and water pollution as the province transitions toward semi-intensive and intensive culture operations. Provincial production data from 2014. Quantitative export volumes from two local processing plants.

The following conclusions are noted:

- Approximately 35% of global warm-water shrimp exports are accounted for collectively by these 16 provinces,
- Farmed shrimp generally account for >80% of the exports out of each of these provinces,
- Disease proliferation, water pollution, and sustainability of feed are universal concerns of these provinces and, generally, of whiteleg shrimp intensive culture,
- Mangrove habitat destruction is also a localized sustainability issue.

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Much of the information used in preparation of this report was gathered by in-country experts who requested unpublished information from government agencies, fishing associations, and other local sources. In some cases there are confidentiality issues; i.e., local sources did not want to be indicated in the report. To account for the frequent use of unpublished information and sources' interest in anonymity, the information sources used in preparing each of the country sections are listed below, but some do not have corresponding in-text citations.

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