

Report on the Shrimp Sector

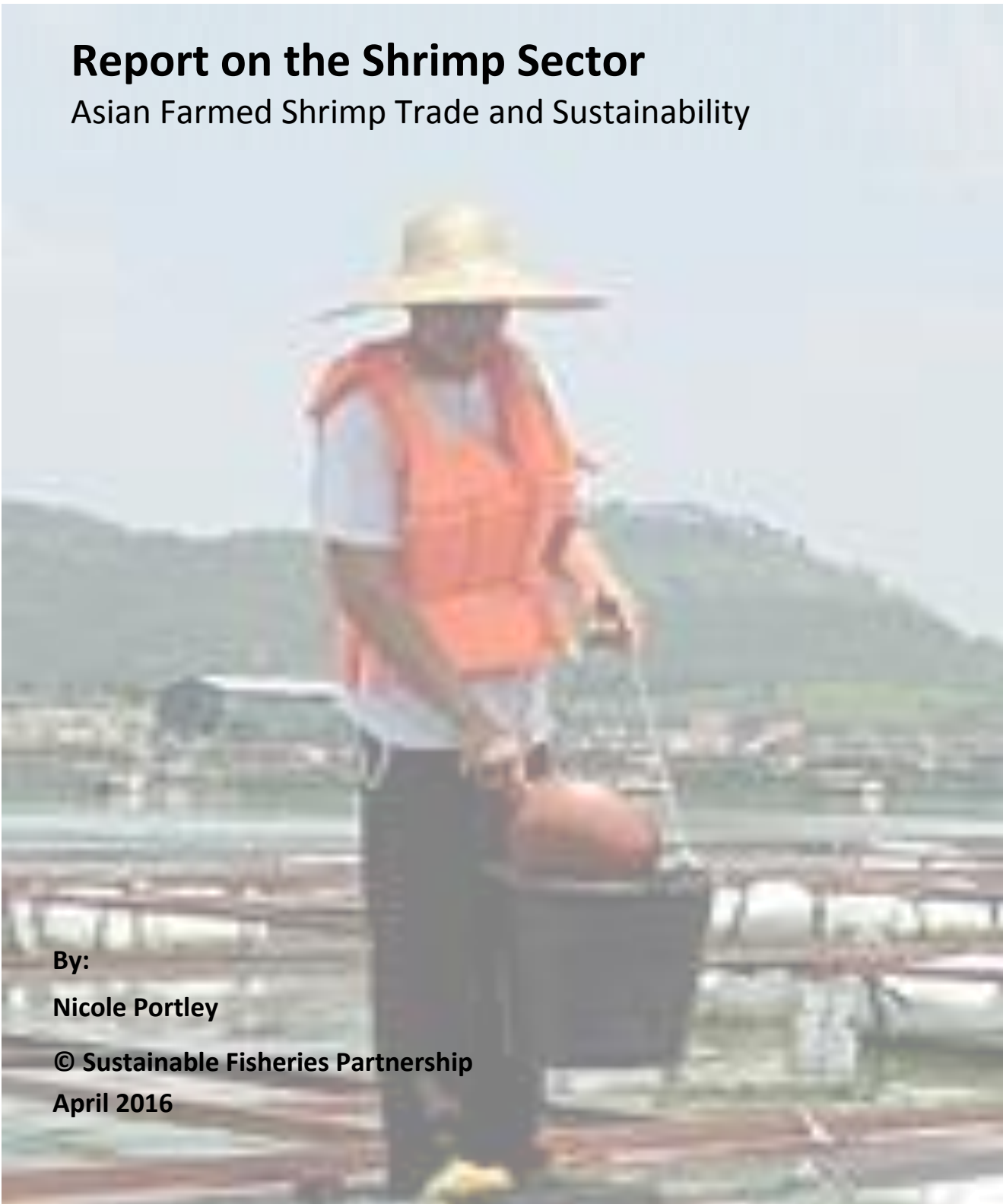
Asian Farmed Shrimp Trade and Sustainability

By:

Nicole Portley

© Sustainable Fisheries Partnership

April 2016



SFP Report on the Shrimp Sector: Asian Farmed Shrimp Trade and Sustainability

Nicole Portley | Salmon and Shrimp Species Coordinator | Nicole.Portley@sustainablefish.org



ACKNOWLEDGEMENTS

Thanks are due to the SFP staff that assisted with the data gathering and analysis for this report (namely, Anton Immink, Pamudi, and Jack Morales), as well as all the in-country consultants that contributed and without whom this report would not have been possible. I'd also like to thank Gordon and Betty Moore Foundation for supporting this work.

CITATION

Portley, N. 2016. *SFP Report on the Shrimp Sector: Asian Farmed Shrimp Trade and Sustainability*. Sustainable Fisheries Partnership Foundation. 22 pp. Available from www.sustainablefish.org.

© 2016 Sustainable Fisheries Partnership

EXECUTIVE SUMMARY

This briefing summarizes findings of a study focused upon Asian shrimp market dynamics and sustainability concerns that was conducted in early 2015. SFP worked with experts on the ground in 10 countries (Thailand, China, Indonesia, Vietnam, India, Bangladesh, Malaysia, Philippines, Myanmar, and Cambodia) in the effort to fill gaps in publicly available information regarding the production and trade of shrimp at provincial and national scales. Information was also pulled from SFP's Metrics database, into which participating retailers and suppliers of seafood log information about their seafood purchases. While individual transaction details from Metrics are confidential and therefore are not included in this report, aggregate analyses are included. The full study is available [here](#).

This project particularly targeted 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?
- What are the prevalent sustainability concerns facing the Asian shrimp industry today?

Key findings 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' 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 (*Pennaeus 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; 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.

SFP encourages the seafood industry to work with local producers to catalyze shrimp-focused aquaculture improvement projects in the 16 priority provinces and implement zonal management strategies that address the pressing sustainability concerns that these regions are facing.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	iii
TABLE OF CONTENTS	1
INTRODUCTION	1
METHODOLOGY	3
RESULTS: NATIONAL SCALE	4
RESULTS: PROVINCIAL SCALE	10
CONCLUSIONS	11
REFERENCES	18

INTRODUCTION

The importance of Asia's contribution to global shrimp production is indisputable: in 2013, the continent accounted for 85% of global shrimp aquaculture production and 74% of wild shrimp capture. Furthermore, in 2011 Asia accounted for 62% of global shrimp exports by volume (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.

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. This information was combined with an analysis of over 4,500 purchases of Asian shrimp logged into SFP's Metrics database

by seafood retailers and suppliers in 2009–2015 (see Methodology section below for more information about Metrics). Among the findings, we identify provinces that produce and export large volumes of shrimp, as well as their needs for sustainability improvements. This list of priority provinces and improvements can serve as a roadmap for industry leaders seeking to catalyze sustainability improvements in the production regions from which they source.

Catalyzing sustainability improvements in the supply chains: why should farmed shrimp be a priority?

- **High Value:** Shrimp is the most traded global seafood product by value.
- **High Consumption:** In the world's single biggest seafood importer, the United States, shrimp is the most consumed seafood per capita.
- **Wide Scope:** One third of the world (65 countries) farms shrimp, with millions of associated jobs.
- **Fast Growth:** Shrimp farming is a rapidly expanding industry worth \$19.4 billion as of 2012.
- **Big Problems:** Disease, overfishing of low trophic wild stocks to produce feed, mangrove destruction, and poor labor practices are all concerns of the shrimp aquaculture industry.

While the full study comprises wild and farmed production of shrimp, this summary document focuses particularly on farmed shrimp. The decision to focus on farmed shrimp reflects the growing importance of aquaculture for the shrimp sector and seafood industry at large. Aquaculture only began to make significant contributions to global shrimp production in the 1980s, but in the three decades since, it has overtaken wild harvest (in 2007) and has continued to claim a growing share of the market year by year. As of 2013, production from shrimp farms accounted for 56% of global shrimp production (FAO 2015). 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).

In terms of securing a stable supply of product, but also in order to tackle large-scale environmental and social issues that go beyond the confines of individual farms, SFP considers engagement in shrimp aquaculture improvement projects to be a timely endeavor. Asia is a good place to start, with its high

production and proportion of global exports. The continent encompasses six of the 10 leading shrimp exporter nations (Vietnam, India, China, and Thailand—the top four—followed by Indonesia, the sixth, and Malaysia, the ninth). Much of the shrimp exported from Asia ends up in western markets: Europe and the US together account for 64% of global shrimp imports (Table 1). Western supply chains therefore are directly linked to and have a direct interest in the sustainability concerns of Asian shrimp farms. Particularly for the American market, this link is expected

Table 1: A comparison of annual shrimp import volumes in metric tons of the three main shrimp-importing regions and the global proportion of shrimp imports that they accounted for in 2009, 2010, and 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 (t)		2010 (t)		2011 (t)	
Europe	930,890	42%	976,926	41%	971,790	40%
including Spain	162,975	7%	170,675	7%	179,281	7%
North America	625,434	28%	642,519	27%	655,449	27%
including USA	552,570	25%	561,328	24%	576,988	24%
Asia	571,234	26%	626,500	26%	681,174	28%
including Japan	266,032	12%	279,152	12%	285,189	12%
Global Totals	2,232,267	—	2,380,705	—	2,439,308	—

to intensify: according to the World Bank, the importance of the US market for shrimp will increase between now and 2030 (World Bank 2013).

The rapid development of aquaculture technology and resultant explosion in farmed shrimp have revolutionized the global market. While some of the recent growth in aquaculture production is accounted for by conversion of mangroves or agricultural land into new shrimp farms, much of it is rather due to intensification (increasing stocking densities and yields) of existing farms made possible through aeration, pelleted feeds, antibiotics, water treatment practices, and other advanced technologies. Technological advancements are also increasingly allowing farms to produce a variety of shrimp species and sizes, allowing greater responsiveness to shifting market dynamics and emerging species and size preferences. Improvements in quality have also played a defining role in allowing farmed shrimp to surpass wild shrimp as the export product of choice.

There is a major downside to intensification, as exhibited by the emerging and subsiding of Early Mortality Syndrome (EMS) in shrimp farms of many of the world's largest producer countries in 2011 through 2014: increased risk of disease. Countries including China, Thailand, Vietnam, Ecuador, and Mexico all lost sizeable portions of their production to EMS, and recovery is ongoing. 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 full 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 focusing on a discrete region and looking beyond published national data in 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.

Findings were limited by data availability: in some of the 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 and farms with profiles in our sustainability database, FishSource, and receive condensed, quickly digestible sustainability information from FishSource. While there are few 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: NATIONAL SCALE

Compilation of production and trade data for the 10 countries (Table 2) yielded the following insights:

- Aquaculture comprises a growing proportion of Asian shrimp production, accounting for 58% of the cumulative production of these 10 countries in 2013 (Figure 1).
- Shrimp aquaculture production has grown by over 34% in these countries in 2009–2013, with increases in whiteleg shrimp (*Pennaeus vannamei*) production of four countries (Vietnam, India, Indonesia, and China) accounting for 71% of this growth (Figure 2).
- A sizeable proportion (49%) of the countries' total shrimp production remains on domestic markets.
- Despite the growth of local demand for shrimp, western markets are still leading destinations for Asian shrimp.
- Of the 34% of shrimp production that is exported from these countries, 87% of this volume is supplied by farms.
- Thailand, previously the world's leading shrimp exporter, has particularly suffered from production losses due to EMS, and has been surpassed by Vietnam, China, and India (however, a strong recovery of the Thai shrimp industry is ongoing) (Figure 3).
- While EMS affected its production as well, Vietnam currently appears to be the world leader in shrimp exports and farmed exports as of 2013, although it no longer reports export volumes and only export value; thus, export volumes are only estimates.

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.

- 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; these countries each export \$500 million or less of shrimp annually and keep over half of their shrimp in-country for domestic consumption.
- Four nations that have made large-scale investments in intensive whiteleg shrimp farming (Vietnam, Thailand, India, and Indonesia) all export over half of their shrimp production and have shrimp export values of over \$1 billion each.
- 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.
- Only a very small proportion (1–11%) of the national shrimp production of the seven largest Asian producers is certified under the Best Aquaculture Practices (BAP), Aquaculture Stewardship Council (ASC), and/or GlobalGAP standard (Table 3). Globally, only 5% of farmed shrimp by volume is from certified farms, with most of the uncertified volume accounted for by Asian shrimp (Figure 4).

Table 2: Production and trade data for the 10 countries included in this study in the most recent year for which data is available for each, listed in order of export volume. 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

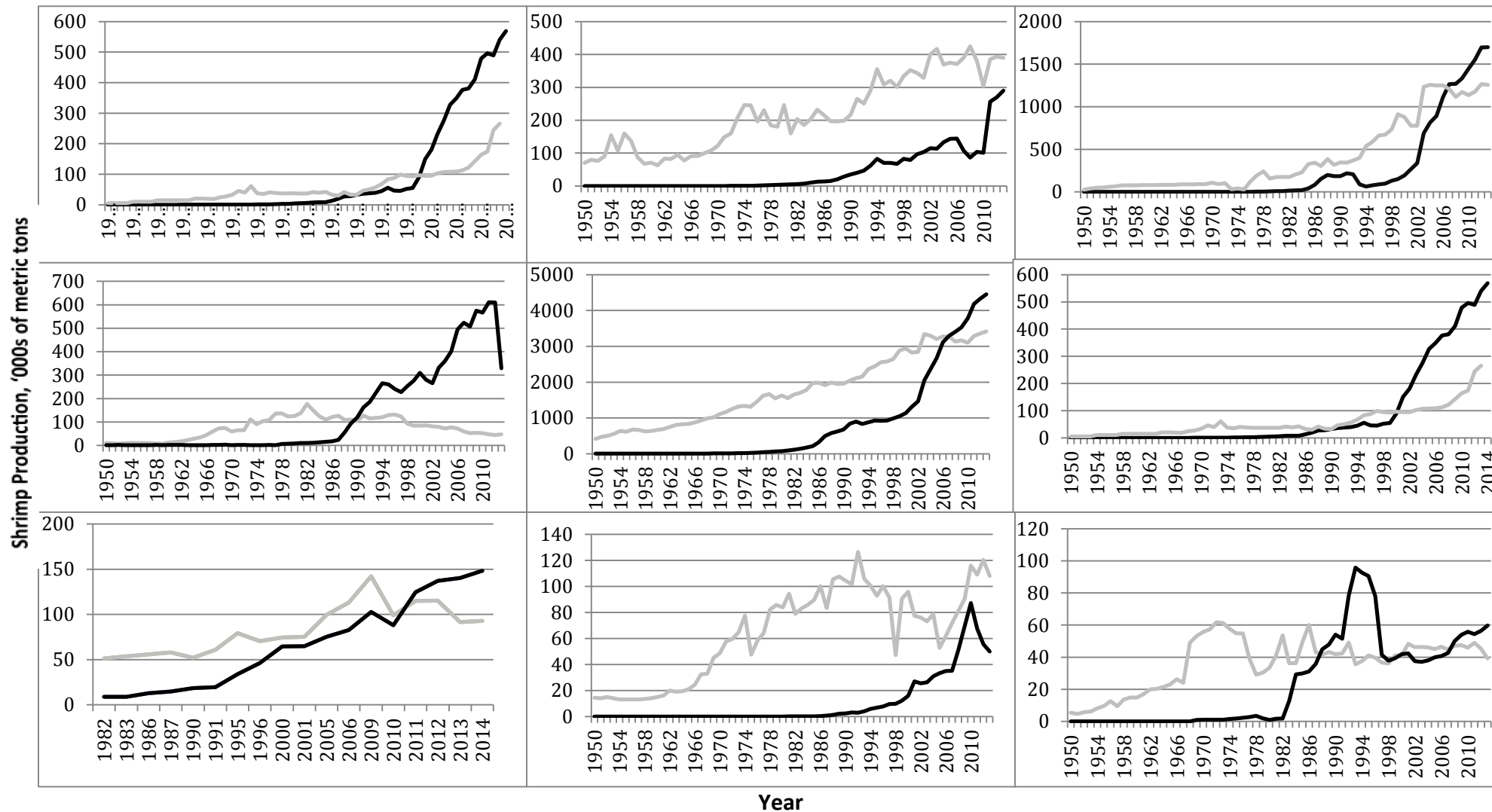


Figure 1: Shrimp production from aquaculture (black line) and wild-capture fisheries (gray line) in individual Asian countries and worldwide, 1950–2013. Top row (L-R): Vietnam, India, and China. Middle row (L-R): Thailand, worldwide, and Indonesia. Bottom row (L-R): Bangladesh, Malaysia, and the Philippines. China's important role in determining global production trends is visible here, as is the destructive impact of EMS upon the Thai shrimp industry in 2013 and the rapid growth of aquaculture generally in Asia.

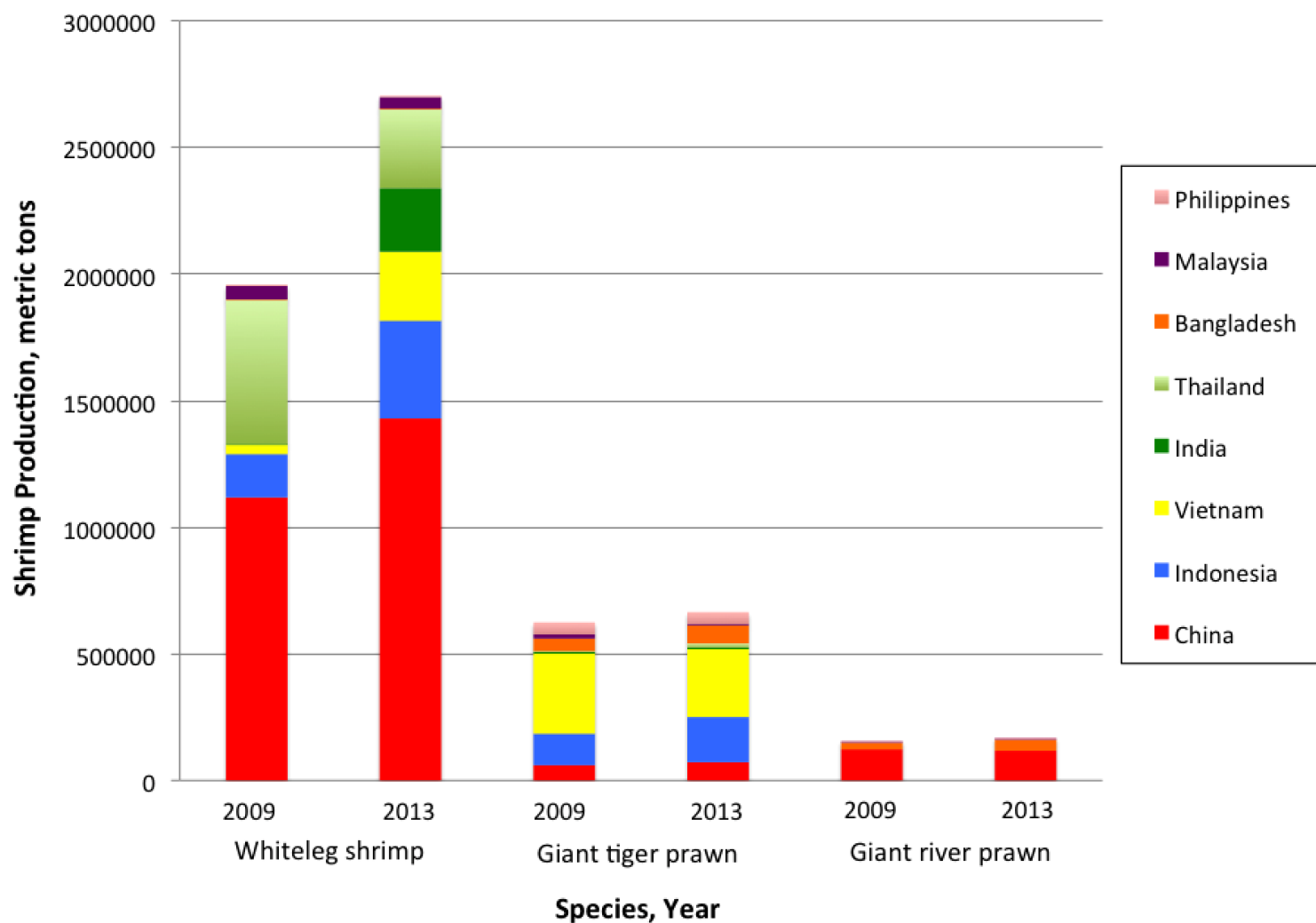


Figure 2: Production of the three main shrimp species farmed in Asia—whiteleg shrimp (*Penaeus vannamei*), giant tiger prawn (*Penaeus monodon*), and giant river prawn (*Macrobrachium rosenbergii*)—by the eight most significant producer countries in Asia, 2009 and 2013. The major growth of Asian whiteleg shrimp production over the 5-year period due to intensification is visible, with the drop in Thai production due to EMS more than made up for by growth in India, China, Indonesia, and Vietnam.

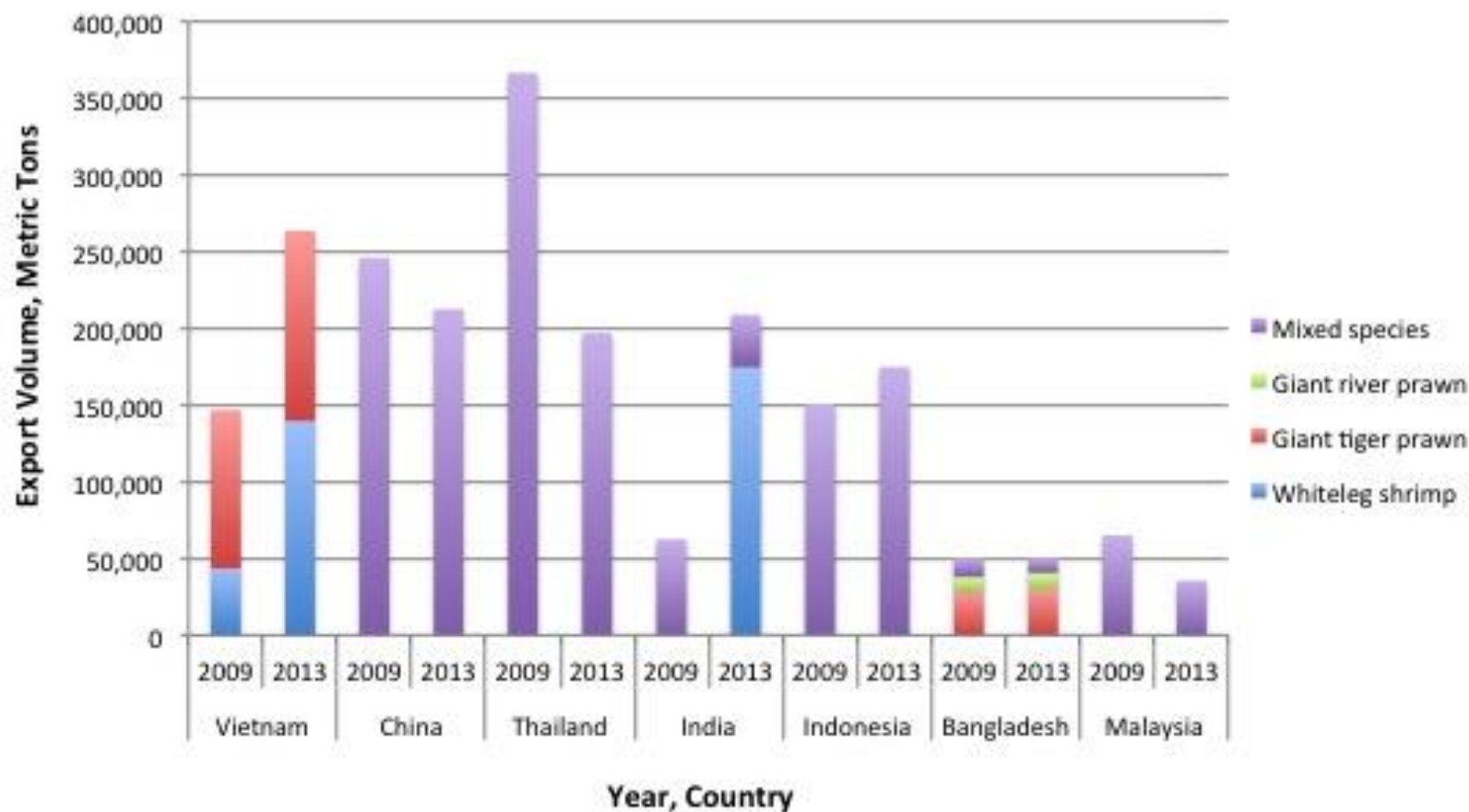


Figure 3: Shrimp export volumes by species of the seven most important exporter nations in Asia, 2009 and 2013. For many of the countries, export data by species is unavailable, and therefore volumes are indicated as “mixed species” (purple). The Vietnamese export volume of 2013 is an estimate based upon the value of shrimp exports in that year. The Indonesian export volume of 2013 is an estimate upon the basis of exports in previous years. Drops in Thai and Chinese exports over the 5-year period are visible. EMS accounts for the Thai export decline, while in China multiple factors probably interact—mortality from EMS, drops in body size due to EHP, and growth in domestic demand. As indicated in the graph, the Thai and Chinese declines have been made up for by significant increases in Vietnamese and Indian exports.

Table 3: Estimates of the proportions of total farmed national shrimp production certified under the BAP, GlobalGAP, and/or ASC schemes as of the spring of 2015. Not all farm production volume information is made public by the certifiers, resulting in some uncertainty in these figures. Nevertheless, the numbers rightly indicate that a minority of Asian shrimp producers is currently engaged in these programs (ASC, BAP, GGAP 2015).

Country	BAP (Farm Cert)	GGAP	ASC	BAP & GGAP	BAP & ASC	GGAP & ASC	All Certs	No Cert.
Bangladesh	1.2%	-	-	-	-	-	-	98.8%
China	1.5%	0.3%	-	-	-	-	-	98.2%
India	1.1%	-	-	1.4%	-	-	-	97.5%
Indonesia	6.0%	1.2%	-	-	0.3%	-	-	92.5%
Malaysia	5.8%	-	-	-	-	-	-	94.2%
Thailand	5.1%	0.7%	-	-	-	-	-	94.2%
Vietnam	1.6%	6.2%	0.4%	0.5%	0.002%	1.3%	0.3%	89.6%
All Seven Countries	2.4%	1.2%	0.1%	0.2%	0.05%	0.2%	0.04%	95.9%

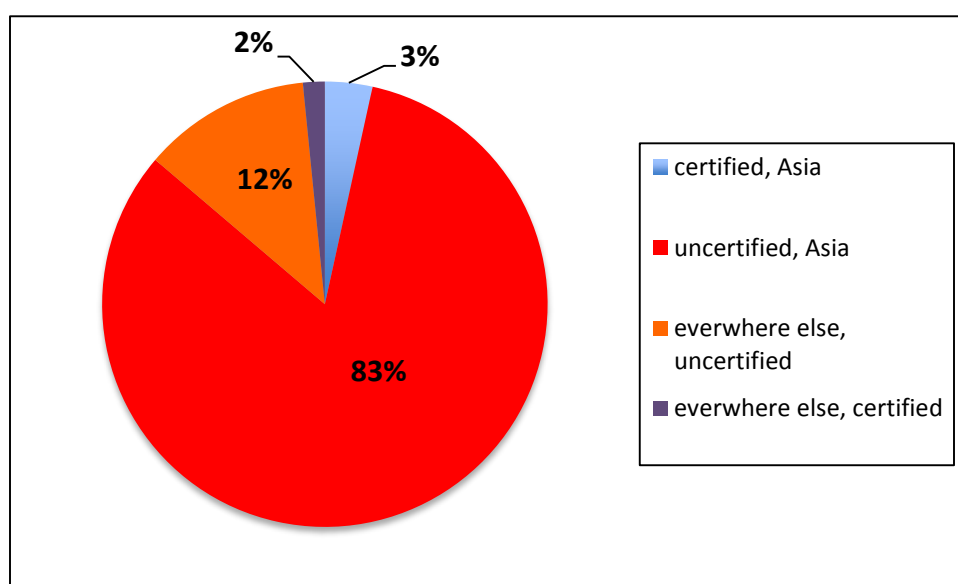


Figure 4: Estimates of current global farmed shrimp engagement in the BAP, GlobalGAP, and/or ASC certification programs. 95% of farmed shrimp by volume comes from uncertified farms, including 83% of uncertified product from Asia.

RESULTS: PROVINCIAL SCALE

On the basis of the trade analysis, 16 provinces with relatively large production, high export proportion, and significant sustainability issues were identified (Figure 5; Table 4). Flow of product from these provinces to western markets was confirmed through the Metrics database. The following insights 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.

CONCLUSIONS

- Areas of neighboring farms, termed “aquaculture zones,” share environmental impacts and disease threats due to shared water resources.
- Therefore, zonal management practices are necessary to address the pressing sustainability concerns that these regions are facing.
- SFP encourages the seafood industry to work with local producers to catalyze shrimp-focused aquaculture improvement projects in the 16 priority provinces and implement zonal management strategies.
- The industry is encouraged to source preferentially from those production regions that are implementing zonal management strategies. GlobalGAP is considering integration of a zonal management benchmark into its existing standard. When and if this occurs, GlobalGAP certification can be used to identify regions with zonal management.
- Preferential sourcing from farms that are BAP, ASC, and/or GlobalGAP certified is also encouraged, although it is noted that these certifications presently indicate improvements only at the farm, and not at the zonal, scale.

Table 4: Trade and sustainability information for 16 provinces with high shrimp production, known exports to western supply chains, and significant sustainability issues.

Country	Province	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	% of Farmed Production with BAP, ASC, and/or GGAP cert.	Sustainability Issues, Notes on Data
Thailand	1. Surat Thani	67,405	33,703	>99%	2.9%	- disease transmission
	2. Chanthaburi	61,817	30,909		3.2%	- sourcing fish feed from depleted small pelagic fisheries
	3. Songkhla	47,832	23,916		1.4%	- mangrove habitat destruction
	4. Thammarat	45,585	22,793		1.7%	Provincial production data from 2012. Nationally, approx. 50% of production was exported in that year. Applied this ratio to yield exported volume per province.
	5. Trat	39,452	19,726		2.9%	
	6. Trang	38,275	19,138		1.7%	
	7. Rayong	25,269	12,635		0	
	8. PhangNga	23,755	11,878		10.9%	
China	9. Guangdong	808,194	117,396	>90%	3.8%	- disease transmission in farms - mangrove and wetland habitat destruction - poor data availability on shrimp culture - source of feed unknown
	10. Guangxi	294,923	98,838		0	Provincial production and export data from 2013. Anecdotal information on proportion of exports that are farmed.
Indonesia	11. Lampung	74,842	59,874	>99%	7.8%	- 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
	12. East Java	56,992	45,594		47.8%	Provincial production information from 2013, aquaculture only. Anecdotal information on proportion exported from these provinces (80%).
	13. South Sumatra	45,657	36,526		0.1%	
Vietnam	14. Ca Mau	130,490	103,320	87%	2%	- 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 Pradesh	244,871	192,189	>99%	5.2%	- 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"	0	- 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.

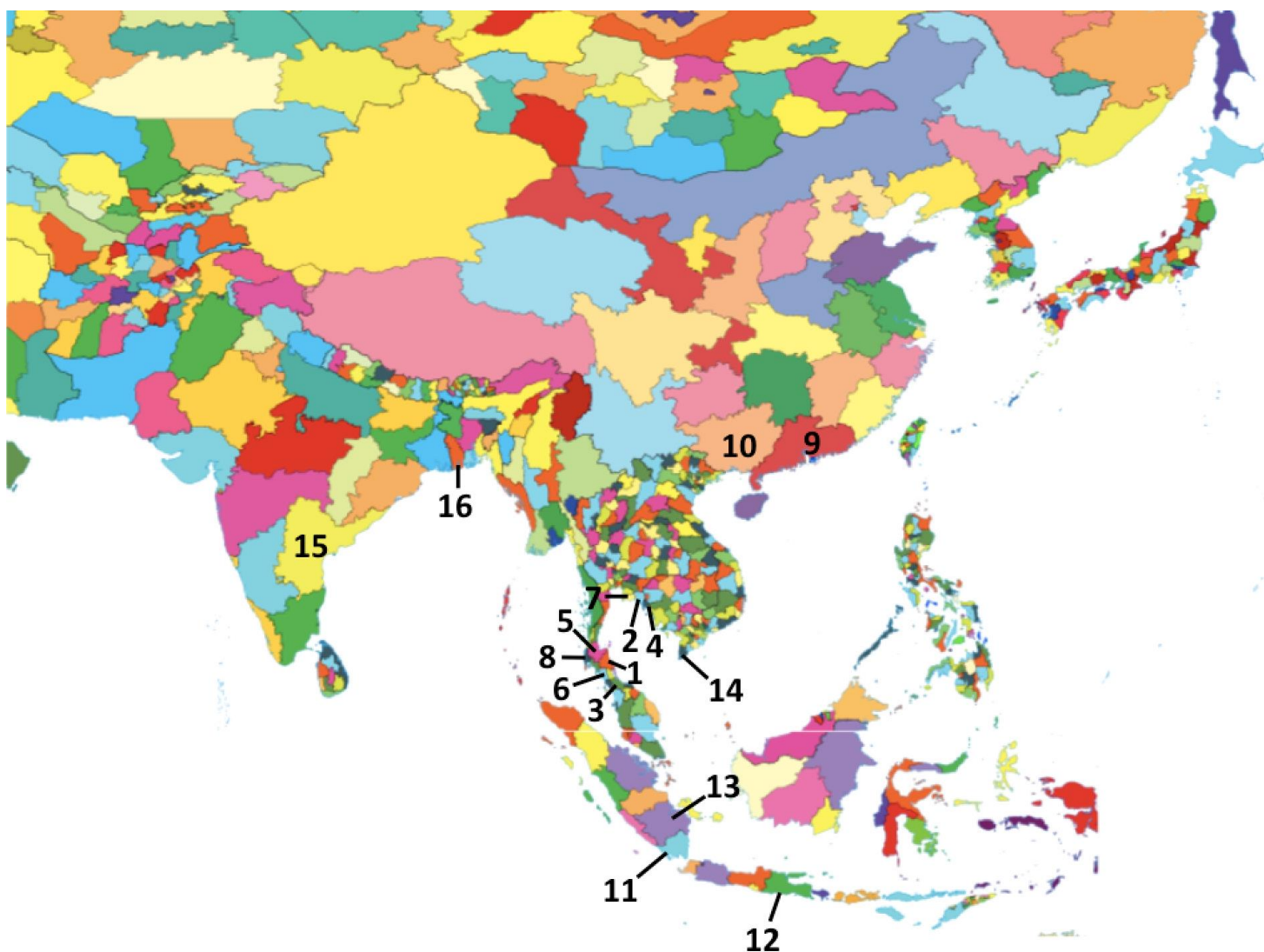


Figure 5: The 16 priority shrimp-farming Asian provinces. In Thailand: Thammarat (1), Chanthaburi (2), Songkhla (3), Trat (4), Surat Thani (5), Trang (6), Rayong (7), and Phangnga (8). In China: Guangdong (9) and Guangxi (10). In Indonesia: Lampung (11), East Java (12), and South Sumatra (13). In Vietnam: Ca Mau (14). In India: Andhra Pradesh (15). In Bangladesh: Khulna (16).

REFERENCES

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 we encountered 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 many do not have corresponding in-text citations.

General References

ASC (Aquaculture Stewardship Council). 2015. "Certified Fisheries." Final reports and audits for shrimp fisheries. Available online at:

<http://www.asc-aqua.org/index.cfm?act=tekst.item&iid=4&iids=204&lng=1#bbxnwtmkaxma>

BAP (Best Aquaculture Practices). 2015. "Find Certified Facilities." Database of BAP-certified facilities. Available online at:

<http://bap.gaalliance.org/find-certified-facilities/>

FAO (Food and Agriculture Organization). 2015. "Wild and Aquaculture Capture Production 1950–2013." FishStat J software and databases. Available online at

<http://www.fao.org/fishery/statistics/software/fishstat/en>

GGAP (GlobalG.A.P.). 2015. Database. Available online at:

<https://database.globalgap.org/globalgap/search/SearchMain.faces?init=1>

Poseidon Aquatic Resource Management Ltd. 2011. A blueprint for moving toward sustainable tropical shrimp trawl fisheries. World Wildlife Foundation, 125 pp.

Sackton, J. 2015a. Shrimp Panel: factors impacting the shrimp market in 2015. A presentation to the National Fisheries Institute Global Seafood Market Conference. January 19–21, 2015, Miami, FL.

Available online at:

www.intrafish.com/incoming/article1404952.ece/BINARY/Shrimp+Panel_GSMC2015.pdf

Sackton, J. 2015b. EHP Disease in Shrimp May be Hard to Control, Likely Will Increase Volatility in Market. November 17, 2015. Available online at:

<https://www.undercurrentnews.com/2015/11/17/commerce-proposes-hike-in-shrimp-duties-for-india-lowers-vietnamese-rates-across-the-board-2-31/>

Torry Research Station. 2001. Handling and Processing Shrimp. Torry Advisory Note No. 54. Available online at: <http://www.fao.org/wairdocs/tan/x5931e/x5931e00.HTM>

World Bank. 2013. Fish to 2030: prospects for fisheries and aquaculture. World Bank Agriculture and Environmental Services, Washington, D.C., 80 pp. Available online at:

<http://www.fao.org/docrep/019/i3640e/i3640e.pdf>

Bangladesh

Bangladesh Fisheries Research Institute. 2015. Data provided upon request.

Bangladesh Frozen Food Exporters Association. 2015. Data provided upon request.

Bangladesh Shrimp and Fish Foundation. 2015. Data provided upon request.

Department of Fisheries, BD. 2015. Data provided upon request.

Export Promotion Bureau, BD. 2015. Data provided upon request.

Individual Processing Plants. 2015. Data provided upon request.

World Fish Center. 2015. Data provided upon request.

Cambodia

Fisheries Administration (FiA). 2015. National production and export data provided upon request.

Provincial Fisheries Administration Cantonments. 2015. Provincial production and export data provided upon request.

China

China Agriculture Press. 2015. China Fishery Statistical Yearbook for 2014. 141 pp.

Chinese Aquatic Product Processing & Marketing Alliance. 2013–2014. Customs data provided upon request.

India

Central Marine Fisheries Research Institute. 2015. Data provided upon request.

Export Inspection Agency, New Delhi. 2015. Data provided upon request.

Individual processors, exporters, fishermen cooperatives, and aquaculture societies. 2015. Data provided upon request.

Marine Products Export Development Authority, Kochi, India. 2015. Data provided upon request.

Ministry of Commerce and Industry, Government of India (MPEDA). 2015. Data provided upon request.

National Centre for Sustainable Aquaculture (NaCSA). 2015. Data provided upon request.

Network for Fish Quality Management and Sustainable Fishing (NETFISH), MPEDA India. 2015. Data provided upon request.

Indonesia

Indonesian Fishery Marketing and Processing Employers Association (APSI). Customs data provided upon request.

Ministry of Marine Affairs and Fisheries (MMAF), Republic of Indonesia. National and provincial production data provided upon request.

Malaysia

Chee, P.E. 2000. The Pelagic Fishery of the West Coast of Peninsular Malaysia. In: Shariff, M., F.M. Yusoff, N. Gopinath, H.M. Ibrahim, and R.A. Nik Mustafa (eds.). *Towards Sustainable Management of the Straits of Malacca*. Malacca Straits Research and Development Centre (MASDEC), Universiti Putra Malaysia, Serdang, Malaysia, pp. 127–143.

Fisheries of Malaysia, 1980–2014. Annual fishery statistics (production and export/import).

Khoo, E.W. 1985. Occurrences of ‘red-tide’ along Johore Straits, Malaysia resulting in heavy mortality of shrimp. *World Mariculture Society Newsletter* 16.

Nyanti, L., G. Berundang, and L.T. Yee. 2011. Shrimp Pond Effluent Quality during Harvesting and Pollutant Loading Estimation using Simpson’s Rule. *International Journal of Applied Science and Technology*, 1(5).

Pathansali, D. 1976. Assessment of Marine Fisheries Resources of Malaysia—Part 3: Assessment of Potential Yield from the Coastal Marine Fisheries Resources of Malaysia. *Fisheries Bulletin* No. 15, Ministry of Agriculture, Malaysia.

Talib, A. 2002. Demersal Fisheries: Have We Surpassed the Straits’ Sustainable Capacity? In: Yusoff F.M., M. Shariff, H.M. Ibrahim, S.G. Tan, and P.Y. Tai (eds). *Tropical Marine Environment: Charting Strategies for the Millennium*; Malacca Straits Research and Development Centre (MASDEC), Universiti Putra Malaysia, Serdang, Malaysia, pp. 155–173.

Talib, A., M.I. Mahyam, I. Mohamad-Saupi, and Y. Sharum. 2000. Abundance and Distribution of Demersal Fish Resources in the Northern Part of the Straits of Malacca. In: Shariff M., F.M. Yusoff, N. Gopinath, H.M. Ibrahim, and R.A. Nik Mustafa (eds). *Towards Sustainable Management of the Straits of Malacca*. Malacca Straits Research and Development Centre (MASDEC), Universiti Putra Malaysia, Serdang, Malaysia, pp. 25–45.

Myanmar

Myanmar Department of Fisheries. 2014. *Fishery Statistics 2014*. Ministry of Livestock, Fisheries and Rural Development, Nay Pyi Taw: 78 pp.

Philippines

Bureau of Agriculture Statistics. 2015. Provincial production data provided upon request.

Department of Agriculture Bureau of Fisheries and Aquatic Resources. 2013. Philippine Fishery Profile, 2012. Available online at: <http://www.bfar.da.gov.ph/publication.jsp?id=2328#post>.

Gillett, R. 2008. Global study of shrimp fisheries. FAO Fisheries Technical Paper 475. Food and Agriculture Organization of the United Nations, Rome: 331 pp.

Lowry, K., A. White, and C. Courtney. 2005. National and local agency roles in integrated coastal management in the Philippines. *Ocean and Coast Management* 48:314–335.

Personal Communications. 2015. Interviews with Provincial and Municipal Fishery Officers in Sasmuan, Bulacan, and Bataan.

Philippine Statistic Authority. 2015. National production data provided upon request.

Undercurrent News. 2014. Philippines remains lowest volume Asian shrimp producer. July 21, 2014. Available online at: <http://www.undercurrentnews.com/2014/07/21/philippines-remains-lowest-volume-asian-shrimp-producer/>.

Thailand

Department of Fisheries. 2015a. Logbook survey for Gulf of Thailand and the Indian Ocean.

Department of Fisheries. 2015b. Statistics of marine fish at landing place. 2555/2556/2557.

Department of Fisheries. 2012. Marine Shrimp Survey (excludes *Acetes*).

Fish Marketing Association of Thailand. 2015. Annual landing statistics at association ports.

Thai Frozen Food Association. 2009–2014. Export shrimp of Thailand. Data compiled from the Information and Communication Technology Center with Cooperation of the Customs Department.

Thailand Fishery Statistics Analysis and Research Group. 2014. Fishing community production surveys 2010–2012, no. 11.

Information Technology Centre, Fishery Statistics Analysis and Research Group. 2015. Marine shrimp culture surveys.

Vietnam

BaNguyen, T., and Van Thi. 2007. National Report on bycatch management and reduction of discards. Available online at: <http://www.rebyc-cti.org>.

General Statistical Office of Vietnam. 2015. Data provided upon request.

Government of Vietnam. 2015. Master plan on Fisheries Development for Vietnam and Four Provinces to 2020, with a vision to 2030.

Ministry of Agriculture and Rural Development (MARD), Directorate of Fisheries (D-Fish), and DARD

(MARD district offices) 2010–2014. Annual Reports.

Ministry of Agriculture and Rural Development (MARD) and Danida (FSPS II: POSMA), 2010. The Fisheries Sector in Vietnam – A Strategic Economic Analysis. Project Document Regarding Capacity Development for National Climate Change Focal Point in Viet Nam. Embassy of Denmark in Hanoi, Vietnam.

Pomeroy, Robert, Nguyen Thi Kim Anh, and Ha Xuan Thong. 2009. Small-scale Marine Fisheries Policy in Vietnam. *Marine Policy* 33:419–28.

Vietnam Association of Seafood Exporters and Producers (VASEP). 2015. Data provided upon request.

World Bank. 2011. Vietnam Development Report (VDR) 2011: Natural Resources Management.