

MYANMAR

# MYANMAR COUNTRY ENVIRONMENTAL ANALYSIS

Sustainability, Peace, and Prosperity:

Forests, Fisheries, and Environmental Management

## FISHERIES SECTOR REPORT



**THE WORLD BANK**  
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# ACKNOWLEDGEMENTS

This Country Environmental Analysis Fisheries Sector Report was prepared by a team led by Martin Fodor and Stephen Ling. The core team was composed of Aye Marlar Win, Katelijn van Berg, Khine Thwe Wynn, Lesya Verheijen, Nina Doetinchem, Miguel Angel Jorge, Rory Hunter, Thiri Aung, and Werner Kornexl. The extended team included Aung Aung Naing, Aung Kyaw Thein, Benjamin Belton, Lucy Emerton, Michael di Alessi, Rick Gregory, Tun Tun Thein, and U Win Latt.

The team would also like to acknowledge the generous support provided for preparation of the report by the PROBLUE Multi-Donor Trust Fund.

# ABBREVIATIONS AND ACRONYMS

ADS	Agricultural Development Strategy	LMMA	Locally Managed Marine Areas
CDZ	Central Dry Zone	MCS	Monitoring, control, and surveillance
CSO	Civil Society Organization	MFF	Myanmar Fisheries Federation
DANIDA	Danish International Development Agency	MMK	Burmese Kyat
DFID	U.K. Department for International Development	MOALI	Ministry of Agriculture, Livestock and Irrigation
DOF	Department of Fisheries	MOHT	Ministry of Hotels and Tourism
DRD	Department of Rural Development	MSAM	Marine Science Association of Myanmar
EDF	Environmental Defense Fund	MT	Metric ton
EHP	Enterocytozoon hepatopenaei	MYSAP	Myanmar Sustainable Aquaculture Program
EMR	Enlightened Myanmar Research	NADP	National Aquaculture Development Plan
EMS	Early Mortality Syndrome	NGO	Nongovernmental Organization
EU	European Union	PCR	Polymerase Chain Reaction
FA	Fair Trade Fishery Association	PL	Post Larvae
FAO	Food and Agriculture Organization of the United Nations	QMS	Quality Management Systems
FCA	Fishery Cooperative Association	RFP	Rakhine Fisheries Partnership
FFI	Fauna and Flora International	SCF	Sustainable Coastal Fisheries
FMD	Fishery Management Division	SME	Small and Medium Enterprise
GAD	General Administration Department	SPS	Sanitary and Phyto-sanitary
GAP	Good Aquaculture Practices	SSA	Small-Scale Homestead-Based Aquaculture
GDP	Gross Domestic Product	SSF	Small-Scale Fishers
GIS	Geographic Information System	TDP	Trade Development Programme
GIZ	German Agency for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit)	TSV	Taura Syndrome Virus
GoM	Government of Myanmar	UNDP	United Nations Development Programme
GPS	Global Positioning System	VAD	Value Added Distributor
ILO	International Labour Organisation	VFV	Vacant, Fallow, and Virgin
IUCN	International Union for Conservation of Nature	VMS	Vessel Monitoring System(s)
IUU	Illegal, unreported, and unregulated	WCS	Wildlife Conservation Society
JICA	Japan International Cooperation Agency	WEPA	Water Environment Partnership in Asia
		WSSV	White Spot Syndrome

# EXECUTIVE SUMMARY

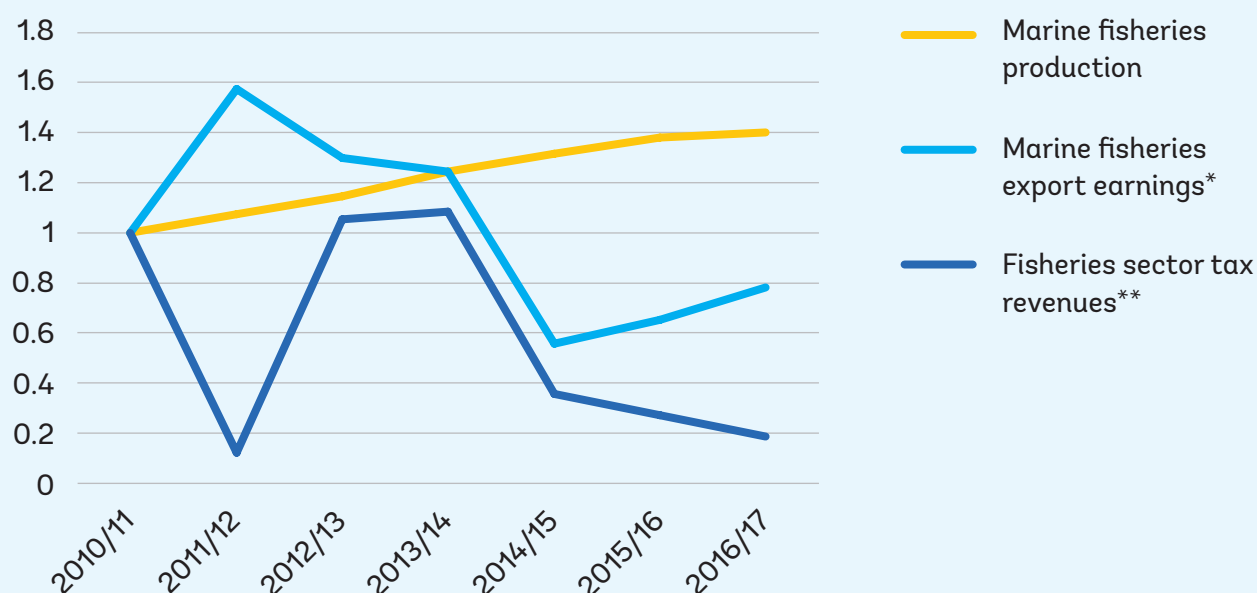
**Fisheries and aquaculture make a significant contribution to Myanmar's economy.** The fisheries sector contributes roughly 2 percent of Myanmar's gross domestic product (GDP), 50 percent of animal protein consumption, 6 percent of employment—rising to as high as 34 percent in some coastal areas—and up to 56 percent of state/regional government revenue. Marine fisheries, freshwater fisheries, and aquaculture contribute to production in roughly equal proportions, for a total annual production of 3 million tons.

**Fisheries' contributions to economic output and employment in Myanmar still lag behind other countries in the region.** For instance, the aquaculture sector alone contributes more to the GDP of Bangladesh and Vietnam (at more than 3 percent and more than 5 percent, respectively) than the entire fisheries sector's contribution to GDP in Myanmar.

**There is a scarcity of scientific data on which to base the management of Myanmar's fisheries.** Official catch estimates show an inexorable rise in marine fisheries' production, but these are contradicted by stock assessment data suggesting that between 1979 and 2013 pelagic stocks fell by as much as 90 percent and demersal stocks by around 50 percent.

Figure E.1

Changes in marine fisheries production, export earnings from fisheries products, and fisheries sector tax revenues (2010–2017; 2010–2011 level being 1)



Source: CSO 2016; CSO 2017; DOF 2017; Boost Dataset.

Note: \*Includes raw fish, prawns, and other marine products; \*\*Data for 2015–2016 is unavailable.



**The potential economic opportunities from improving fisheries management are substantial.** Ballpark estimates suggest that the potential increased production from better-managed marine fisheries could approach US\$1 billion per year. The main constraints faced by capture fisheries are the following:

- Improving governance, by implementing existing laws, reforming the system of leases in inland fisheries (Inns and tender fisheries) to strengthen incentives for sustainable management, strengthening community-based management of inshore and inland fisheries, and moving toward a quota-based management system for offshore marine fisheries.
- Addressing habitat loss, including mangrove restoration and reef protection for marine fisheries and protection of wetlands and migration routes for freshwater fisheries.

**Community-based fisheries management provides opportunities to promote more equitable distribution of benefits** from inland and inshore fisheries and for balancing sometimes competing demands between improving fisheries governance and safeguarding the livelihoods of the poor. Increasing access to affordable credit could also help to address equity and poverty concerns. Myanmar ranks 178 of 190 countries for access to credit by small and medium enterprises (SMEs) and most fishers are locked into debt dependency relationships with traders. Community-based approaches to management have been successfully piloted in Myanmar supported by devolution to the states and regions of legislative power over inland and inshore fisheries. There is a number of international models for how certification, credit access, and devolution of management powers can be used as tools to enhance the incentives for sustainable community-based fisheries.

**Improved fisheries governance and management offers significant opportunities to reduce local conflicts** in coastal and floodplain areas. Major sources of conflict in the fisheries sector are (a) competition in marine fisheries between commercial offshore vessels and small-scale inshore fishers; (b) conflict between farmers and fishers over the management of water levels on floodplains, and (c) conflict between large fish farms and former rice growers and fishers over confiscated land.

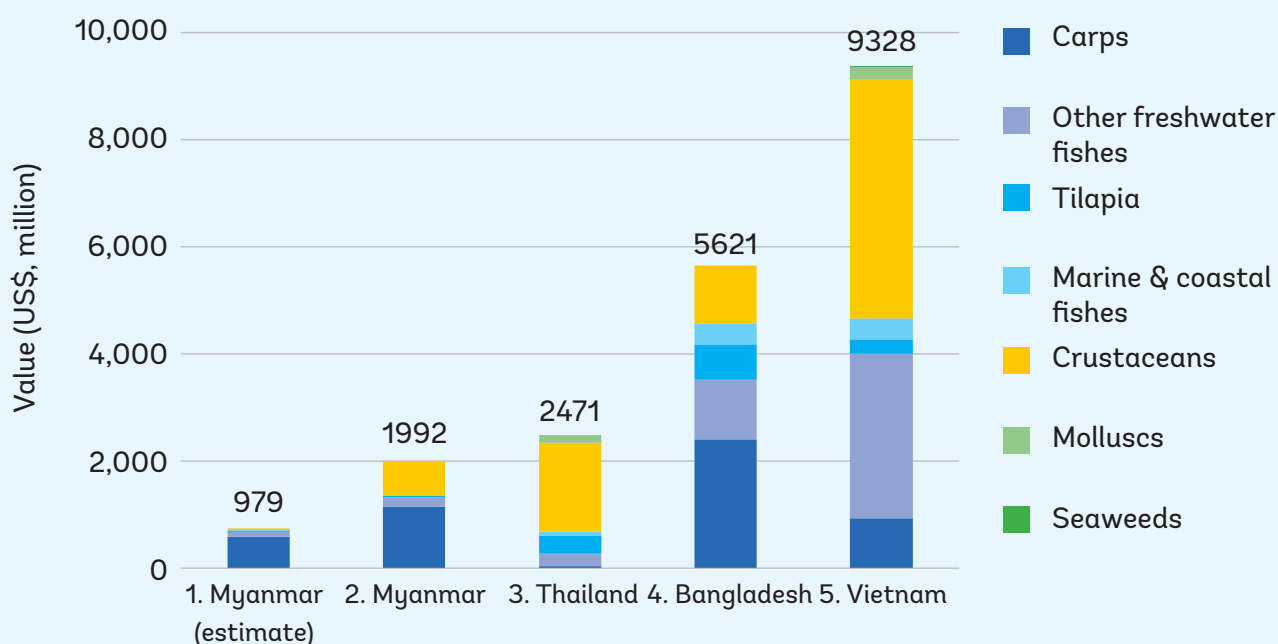
**Vessel monitoring systems (VMS) provide a means of regulating offshore fisheries** to reduce illegal, unreported, and unregulated fishing and protect Myanmar from future trade embargoes. Closer monitoring of offshore vessels could also reduce the risk of labor violations, similar to those seen in other countries in the region. The Department of Fisheries (DOF) at the Ministry of Agriculture, Livestock and Irrigation (MOALI) has recently committed to the installation of VMS for the country's offshore fleet.

**The value of aquaculture production could be increased severalfold** by raising productivity of existing farms to levels similar to neighboring countries, diversifying production to include more valuable species, and particularly by allowing expansion of the area under production. However, progress made by neighboring countries has come at the cost of boom and bust cycles and challenges that Myanmar can learn from and avoid, particularly in relation to managing disease risks. The following observations stand out:

- **Inland aquaculture development has been constrained by restrictions that prevent the conversion of farmland to ponds** despite evidence that fishponds in Myanmar can provide six times more revenue and four times more employment than the same area of rice paddy. Basic market access infrastructure is also a constraint.
- **Mangrove degradation has contributed to the decline of Myanmar's extensive shrimp farm sector**, driving a fall in natural recruitment of shrimp post larvae (PL) and compounding losses due to disease and cyclones. Rehabilitation of mangrove habitats, combined with intensification, hatchery development, and stronger biosecurity protocols could boost productivity and increase the sector's economic contributions.

**Figure E.2**

Value and composition of aquaculture production for Myanmar, Thailand, Bangladesh, and Vietnam 2016



Note: Column 1 is an alternative estimate of likely levels of production for Myanmar, based on yields of fish and shrimp derived from farm surveys. This alternative estimate suggests that Myanmar's actual aquaculture production is about half of reported production.

- **Cage-based aquaculture has substantial growth potential in reservoirs and coastal areas** but is inhibited by the lack of a permitting and regulatory system, targeted R&D, and supporting infrastructure that would allow development to take place sustainably.

**Fisheries and aquaculture value chains are underperforming.** This is apparent in areas including very limited value-added processing postharvest, limited diversity of available fish seed, low levels of adoption of pelleted feeds in aquaculture, and extremely limited veterinary and diagnostic services. This situation is compounded by limited access to formal credit throughout the value chain and insufficient provision of basic infrastructure to support market access. Introducing innovative mechanisms for credit delivery and zoning for aquaculture development could help overcome these constraints and boost the share of value retained by fishers and fish farmers.

**Development assistance to Myanmar's fisheries has generated promising results,** but the scale of investment and implementation has not been large enough to bring about significant transformation in the sector. The traditional role of the DOF focuses on the collection of fisheries revenues from license and tender fees, but a larger allocation of financial and human resources is needed to catch up with its modern mandate to support the sustainable development of the fisheries sector. The DOF's budget has grown from less than US\$2million to over US\$6million per year in recent years but is still a fraction of the total management budgets for other natural resources management agencies. According to official data, central government fisheries revenues from license fees and taxes capture less than 1 percent of fisheries' GDP contribution and around the same amount that is spent on the DOF's budget.

**Key remaining gaps for investment and support include** (a) strengthening the DOF's capacity to enforce regulations; (b) gathering accurate data and conducting comparative cross-country analyses to support legal and policy reform and enable better targeting of investments; and (c) actively supporting co-management and decentralized fisheries governance initiatives.

**Priority recommendations for short- and medium-term actions in the fisheries sector are contained in the table from the following page:**

Context	Key message	Action	Timeframe (S, M, L)	Responsibility
Regulation of capture fisheries				
Marine and freshwater fish stocks are depleted and oftentimes existing fisheries regulations are not properly enforced.	Strengthen DOF for improved monitoring, control and surveillance (MCS)	Enforce closed seasons and gear restrictions in marine and freshwater capture fisheries. Clearly define boundaries of inshore and offshore zones with GPS markers, and apply vessel monitoring system (VMS) to the entire offshore fleet	S	DOF
		Analyse and develop specific recommendations for improving transparency and enforcement in the fisheries sector, and development of capacity, partnerships and procedures to bring legal cases. Expand legislation making it an offence to be in possession of illegal fishing gear, rather than requiring offenders to be caught in the act	M	DOF, coast-guard, police, judiciary
With catch allocations, good scientific advice, strong co-management institutions, and effective monitoring of landing sites, it may be possible to manage catch levels, in addition to managing where, when, and how people fish.	Move to a quota-based fisheries management system, at least in marine fisheries	Assess the potential for organizing the offshore fishing industry into a harvest quota shareholding organization. Bring experts from NZ/Australia/U.S. Pacific NW to offer models of shareholding that increase sustainability and profitability	M	DOF
		Develop stock assessment and monitoring systems, as a foundation for establishment of quotas and auctioning of quota-based licenses	L	DOF
Protection of aquatic habitats				
Conservation of aquatic habitats is critical not only to support fisheries production, but to a range of additional and valuable ecosystem services. Myanmar has a large number of freshwater sites of high ecological value, key fish species, such as Hilsa, which rely on poorly studied migration routes, and mangroves that provide 100s of millions of USD in annual value.	Increase protection of key aquatic habitats	Expand protections for key freshwater wetlands, mangroves and coral reefs, including the establishment of additional Marine Protected Areas Assess models for sustainable mangrove-based livelihoods reforestation, such as mud crab fattening in mangroves and floating fish cage culture in tidal creeks, and potentially sustainable forms of extensive shrimp farming	M	MONREC/DOF
	Establish policy and legal framework for a sustainable blue economy along Myanmar’s coast	Comparative analysis of the legal & institutional framework for coastal and marine area management among Myanmar and its neighbours	M	TBD
		Assess coastal tourism development trends, the status of blue natural capital and mechanisms for engaging local communities in decision-making (consider targeting the Myeik Archipelago)	M	MOHT
		Develop a strategy to integrate conservation of inland fish resources into water resource management, land-use and agricultural policy	M	DOF/MOALI

Context	Key message	Action	Timeframe (S, M, L)	Responsibility
<b>Fisheries co-management</b>				
Empowering communities to set management goals and to receive some of the benefits of more sustainable fisheries will reduce conflict and incentivize stewardship of the resource. There are a number of efforts in other parts of Asia that could provide useful templates, including Fair Trade Fishery Associations (FA) in Indonesia and Japanese Fishery Cooperative Associations (FCAs).	Expand co-management pilots within coastal fisheries and to freshwater fisheries	Conduct objective assessment of success and constraints of co-management pilots Review and develop legal frameworks for co-management, including securing community tenure rights	<b>S</b>	DOF/State & Regional lawmakers
		Identify options for creating strong community and industrial fishing associations/cooperatives that could coordinate efforts to improve the ecology and economics of fishing while ensure that benefits are spread widely in communities Explore examples of strong community associations elsewhere in Asia & Oceania (both developed and less-developed)	<b>S</b>	DOF
Small-scale fishers in Myanmar, largely finance their fishing operations through loyalty arrangements with fish buyers. In some, but not all cases, these relationships can be exploitative and can encourage overfishing and destructive fishing practices. Linking co-management efforts to formal credit provision could provide a means of incentivizing participation and compliance.	Assess credit systems in fisheries value chains	In-depth assessment of informal credit institutions in small-scale fisheries - if/how access to credit could be extended to small-scale fisheries without destroying benefits of informal credit system (incl. payment flexibility and market access) and without directing investment to increased capacity	<b>M</b>	DOF



Context	Key message	Action	Timeframe (S, M, L)	Responsibility
<b>Aquaculture</b>				
There is a clear opportunity for inclusive growth in aquaculture.	On the basis of a detailed assessment of the potentials for freshwater, rice-fish, shrimp, marine and reservoir aquaculture, prepare and implement an aquaculture development strategy	Assess biophysical and market potentials for different types of aquaculture, to inform further steps	<b>S</b>	DOF
		Reform legal frameworks, including: <ul style="list-style-type: none"> <li>• Revision of the Farmland Law (2012) to promote the development of a fish farming sector with more inclusive characteristics</li> <li>• Regularize the status of illegally constructed ponds, if their operators are in possession of legal agricultural use rights and land is not the subject of land restitution claims</li> <li>• Develop regulatory and licensing framework for reservoir aquaculture based on independent scientific assessment of the environmental carrying capacity of receiving waterbodies</li> <li>• Develop regulatory and licensing framework for coastal cage aquaculture based on assessment of potential conflicts with alternate use of coastal resources</li> </ul>	<b>M</b>	DOF/ MOALI
		Assess and prepare investment strategy for the basic market access infrastructure needs to facilitate sustainable and climate-resilient growth in aquaculture	<b>S</b>	DOF
		Assess and prepare investment plan for aquaculture extension services, quality management systems and certification, quarantine facilities and policies to prevent import of infected shrimp and aquatic animal epidemics as the sector grows	<b>M</b>	DOF
		Assess and prepare investment strategy for provision of commercial hatcheries and feed production, and selective breeding programs (especially for rohu)	<b>M</b>	DOF

Context	Key message	Action	Timeframe (S, M, L)	Respon- sibility
Fisheries statistics				
There is very limited scientific information on which to base management of Myanmar's fisheries. Lessons can be drawn from Cambodia in the late 1990s when a concerted effort by Government produced new science-based estimates for freshwater fisheries production, leading to a better understanding of the actual production changes in statistical reporting.	Develop key fisheries management statistics capacity and processes	Conduct a nationally representative survey of fish consumption (potentially through including modules in standard HH surveys), exports and employment in the fisheries and aquaculture sectors	M	Central Statistical Organization
		Develop and implement fisheries management data systems, including: <ul style="list-style-type: none"><li>• Monitoring of fish stocks and landings</li><li>• Registry of vessels and offshore VMS</li><li>• GIS registry of Inns and Tenders</li><li>• GIS registry of fish farms</li><li>• Survey-based system for collection of national aquaculture statistics, starting with a national aquaculture census, potentially incorporated into the national agricultural census</li></ul>	M	DOF
Capacity development in DOF				
DOF has traditionally focussed resources of collection of fisheries license fees, but intensifying pressure and external impacts on fisheries mean more active management of the resource is needed.	Conduct institutional review and strengthening	Conduct a public expenditure and institutional review of the DOF (MOALI), in relation to its legal mandates	S	DOF
		Develop and implement strategy to provide responsible units, staffing and training for: monitoring, control & surveillance; stock assessment & management; community engagement and business development; aquaculture and biosafety; and fisheries monitoring & spatial statistics. An economic and financial analysis of the social benefits and government revenues from improved fisheries management may be necessary to justify the investment in institutional capacity	M	DOF



photo: ©Khine Thwe Wynn

# 1

## WHY ARE FISHERIES IMPORTANT?

# WHY ARE FISHERIES IMPORTANT?

## Fisheries production

1. **Estimates of national fisheries production in Myanmar range from 3 to 5.5 million metric tons per year.** Official Myanmar statistics cite 5.5 million metric tons, but in 2015, the Food and Agriculture Organization of the United Nations (FAO) announced that the official statistics in Myanmar were “based on target levels rather than on real data collection” (FAO 2016, 16), and as a result, the FAO considers 3 million metric tons to be a more reasonable estimate. Fisheries production can be categorized into three categories: (a) marine fisheries, (b) freshwater capture fisheries, and (c) aquaculture.

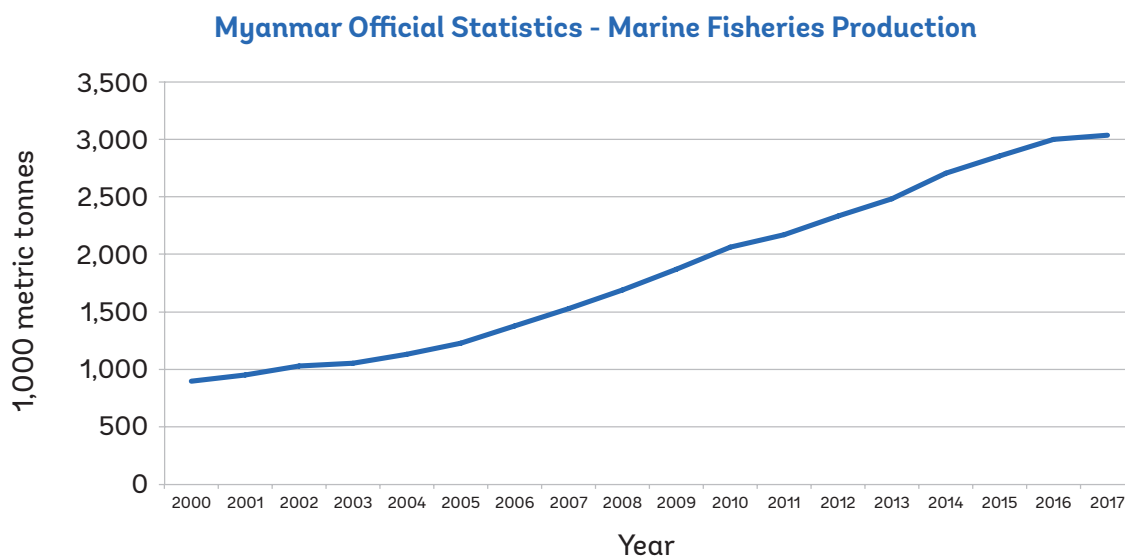
### Marine fisheries

2. **The contribution of Myanmar’s marine capture fisheries production to that total is either 3 million metric tons (official Myanmar statistics) or 1 million metric tons (FAO, 2018).** The reporting of targets rather than actual production is suggested in Figure 1 where despite strong scientific evidence that marine fisheries are in a state of decline (Krakstad et al. 2015), official statistics showed linear growth in production.

3. **Marine fisheries are of special livelihood importance given that nearly half of the population resides in coastal states and regions.** For instance, in Mon State, direct participation in small-scale inshore fisheries by fishing households accounts for around 10 percent of rural employment and 11 percent of rural income, with 34 percent of households in areas engaging in commercial small-scale fishing (Tezgo et al. 2018). In the Ayeyarwady region, fishing is the primary source of income for approximately 13 percent of households (EMR and World Bank 2013).

Figure 1

Marine fisheries production



Source: DOF 2017.



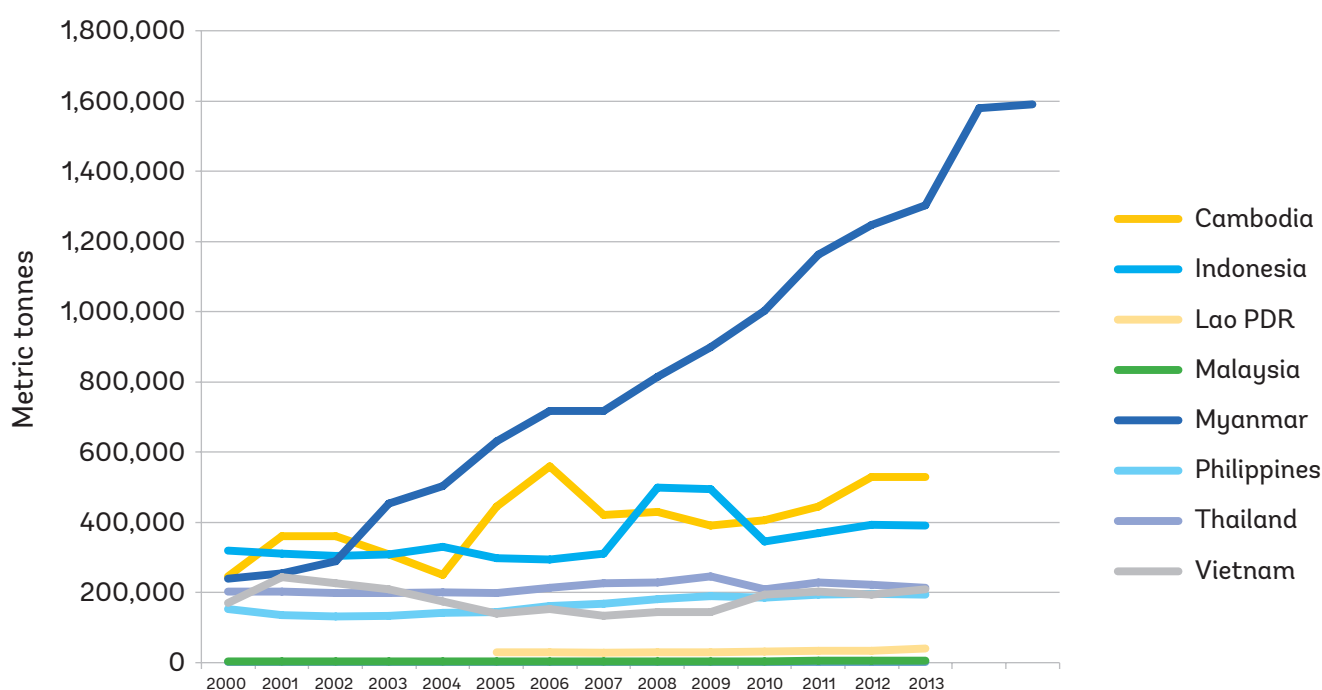
## Freshwater capture fisheries

4. **The Government of Myanmar (GoM) estimates that freshwater capture fisheries production is 1.6 million tons per year.** Myanmar's coastline is dominated by major river deltas and these, along with numerous lakes and smaller river systems, support a wide array of species and productive environments. Much of the inland fisheries productivity stems from the large floodplain areas created during the monsoon and the high biodiversity of fish species. Fishbase lists 511 freshwater fish species as present in Myanmar. A total of 311 fish species are present in the Myanmar portion of the watershed of the Ayeyarwady River, of which approximately 62 percent (193) are endemic and 32 percent (100) are known only from Myanmar (Baran et al. 2017).

5. According to national statistics, between 2003 and 2012, freshwater fish catches in Myanmar increased by 330 percent with catch increasing from 1.25 million tons in 2012 to 1.38 million tons in 2014. In 2014, freshwater capture fisheries accounted for 27 percent of fish production in Myanmar. As with marine fisheries statistics, however, freshwater statistics reveal an unlikely linear growth trend. This is even more striking if Myanmar's performance is compared to that of other Southeast Asian countries (Figure 2).

Figure 2

National freshwater fisheries production in Southeast Asia



Source: Coates 2002; DOF 2013; FAO 2013.

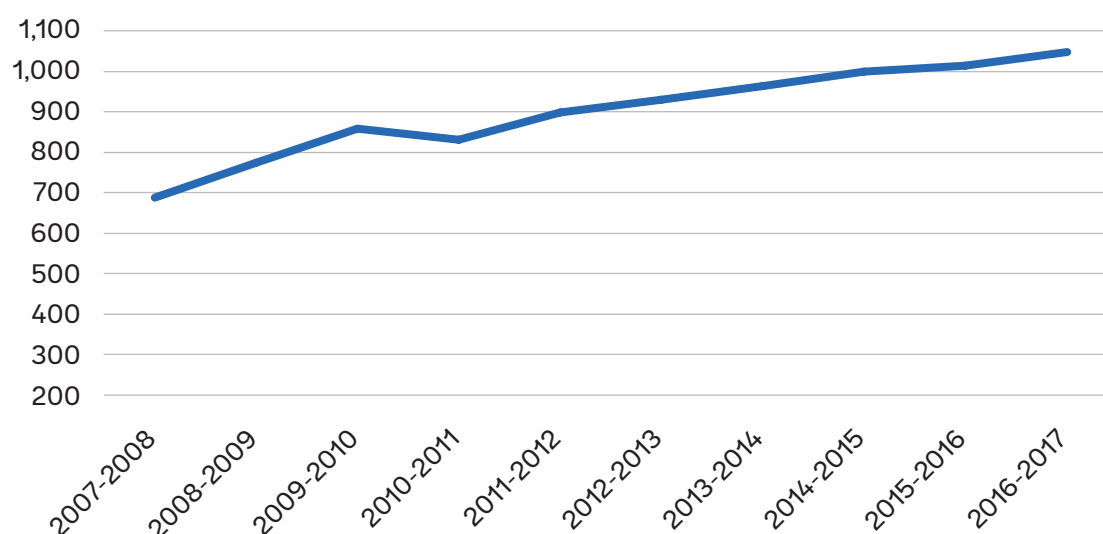
6. It is therefore probable that these figures are over estimates. In a similar way to the marine fisheries, the FAO has revised its estimates for Myanmar's inland fisheries and estimates a total production of 863,450 metric tons for 2015 (Funge-Smith 2018). However, even if a figure of 0.5 million tons is used, Myanmar would still rank fourth in the world for inland fisheries production. There is strong anecdotal evidence suggesting a decline in freshwater fisheries (EMR and World Bank 2013).

## Aquaculture

7. According to the FAO statistics for 2015, Myanmar was the world's eighth largest aquaculture producer (excluding aquatic plants and nonfood products), producing an estimated 1 million tons annually. Two species dominate aquaculture production: Rohu fish (*Labeo rohita*) and Tiger shrimp (*Penaeus monodon*). The importance of farmed fish in the domestic market is growing, and it is estimated that 21 percent of the fish consumed nationally now comes from aquaculture (Belton et al. 2015).

Figure 3

Aquaculture production (metric tons) 2007–2017



Source: DOF 2017.

## Contribution to GDP

8. The share of fisheries is claimed to be substantial, at between 8 percent and 10 percent of GDP (DOF 2017). However, this estimate cannot be considered credible as according to the World Development Indicators, Myanmar's total agricultural GDP (including fisheries) accounts for only 23 percent of national GDP (World Bank 2018). Belton (2018) estimates that aquaculture's contribution to Myanmar's GDP is in the range of 0.6 percent. Taking this figure as a guide and considering the relative contributions of aquaculture and fisheries to fish production in Myanmar, it is probable that aquaculture and fisheries together account for around 2 percent of national GDP. This is well below the contributions of these sectors reported in Bangladesh (3.6 percent of GDP) and Vietnam (5–6 percent) (Belton 2018).

9. Recent studies have been conducted to estimate the sectoral contribution of aquaculture to GDP using primary data by (a) estimating value added at the farm-gate and (b) scaling up to the national level (Bene et al. 2015; Hishamunda, Cai, and Leung 2009). Below the direct component of value added distributor (VAD) for fish culture in Myanmar is estimated using unpublished survey data collected by the Michigan State University, while the VAD of shrimp is computed based on enterprise budget figures presented in Joffre and Aung (2012). Following Hishamunda, Cai, and Leung (2009), direct VAD is equal to farm revenues minus nonlabor

variable costs. VAD per acre was calculated separately for fish and shrimp; it was scaled up to the national level by multiplying by the total area of operational fish and shrimp ponds, respectively. Indirect value added was estimated using data on the ratio of direct to indirect incomes generated by large fish farms in Myanmar, taken from Filipinski and Belton (2018). This multiplier was also applied to shrimp farms in the absence of alternative published data. The results are presented in Table 1 and Table 2.

Table 1

Estimated direct and indirect value added from aquaculture in Myanmar in 2016

Component	Direct VAD <sup>a</sup> (US\$ per acre)	Operational pond area (acres)	Total direct VAD (US\$)	Economic multiplier	Total indirect VAD (US\$)	Aquaculture GDP (US\$) <sup>g</sup>
Fish	693 <sup>b</sup>	260,300 <sup>d</sup>	180,443,537	1.041 <sup>f</sup>	187,808,579	368,252,116
Shrimp	141 <sup>c</sup>	119,166 <sup>e</sup>	16,853,699	1.041 <sup>f</sup>	17,541,606	34,395,305
Total		379,466	197,297,236	1.041	205,350,185	402,647,42

Notes:

a Direct value added = farm gross revenue minus nonlabor variable costs (Hishamunda, Cai, and Leung 2009).

b Own estimate calculated using unpublished survey data, collected 2016.

c Own estimate, calculated based on figures from Joffre and Aung (2012), adjusted for inflation to 2016 prices.

d Belton et al.(2015) estimate of fish pond area in the delta in 2014, based on satellite imagery—this figure exceeds the total area of fish ponds reported nationally in 2017 by DOF (2016), by 14,490 acres.

e Half the area of the 238,331 acres of shrimp ponds reported nationally in 2016 by DOF (2016). Division of total area by 2 is in recognition of observations by Joffre and Aung (2012) and Svevenig and Lwin (2016) that more than half of shrimp ponds in Rakhine State are not operational.

f Estimated based on figures in Filipinski and Belton (2018) for indirect spillover effects of Myanmar fish farms >10 acres. No comparable data is available for shrimp, so same multiplier used for both.

g Aquaculture GDP = total direct aquaculture VAD + total indirect aquaculture VAD.

Table 2

Estimated contribution of aquaculture to Myanmar's GDP, 2016

Aquaculture GDP (US\$, billions)	Agricultural GDP (US\$, billions)	National GDP (US\$, billions)	Agricultural GDP as share National GDP (%)	Aquaculture GDP as share Agricultural GDP (%)	Aquaculture GDP as share National GDP (%)
0.4 <sup>a</sup>	16.1 <sup>b</sup>	63.2 <sup>b</sup>	25.46 <sup>b</sup>	2.50 <sup>c</sup>	0.64 <sup>c</sup>

Notes: a Own estimate (Table 3); b World Bank (2018); c Own estimate based on a and b.

10. **The estimated contribution of aquaculture to Myanmar's agricultural and national GDP is small at just 2.5 percent of agricultural GDP and 0.6 percent of national GDP (Table 2).** The following points stand out from Table 1. First, direct VAD per acre is much higher for fish than for shrimp. This is unsurprising given the very low stocking densities and levels of input use found in Myanmar shrimp aquaculture. Second, indirect VAD is similar in magnitude to direct VAD, given an economic multiplier of just over 1. This indicates that aquaculture development has substantial spillovers beyond the farm by way of labor markets, demand for goods and services used in producing fish, and the consumption expenditures of fish farmers and workers. Third, the contribution of fish farming to GDP of US\$368 million is more than 10 times higher than the US\$34 million contribution of shrimp farming.

# Exports

11. Fish and fishery product exports in 2016–2017 totaled 438,710 metric tons, generating over US\$600 million in value (DOF 2017). Export markets for higher-value fish and fish products are driving significant production, processing, and harvesting investments and are an important contribution to both export earnings and local livelihoods in Myanmar. Figure 4 shows the top export species as reported by the DOF in their official statistics for 2017. Rohu and softshell crab originate from aquaculture. Other exports originate mainly from marine capture.

12. Figure 5 shows export production and value trends over the period 2006–2017 which show that the value per ton of export products is relatively stable. Most rohu are exported to the Middle East. It is widely believed that there are substantial informal and undeclared exports to Thailand by transshipping. Booth and Pauly (2016) claim that landings of fish from Myanmar waters in Thailand alone are comparable in volume to domestic marine landings in Myanmar.

Figure 4

Top 10 species of exported fisheries products of Myanmar (2016–2017)










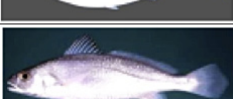
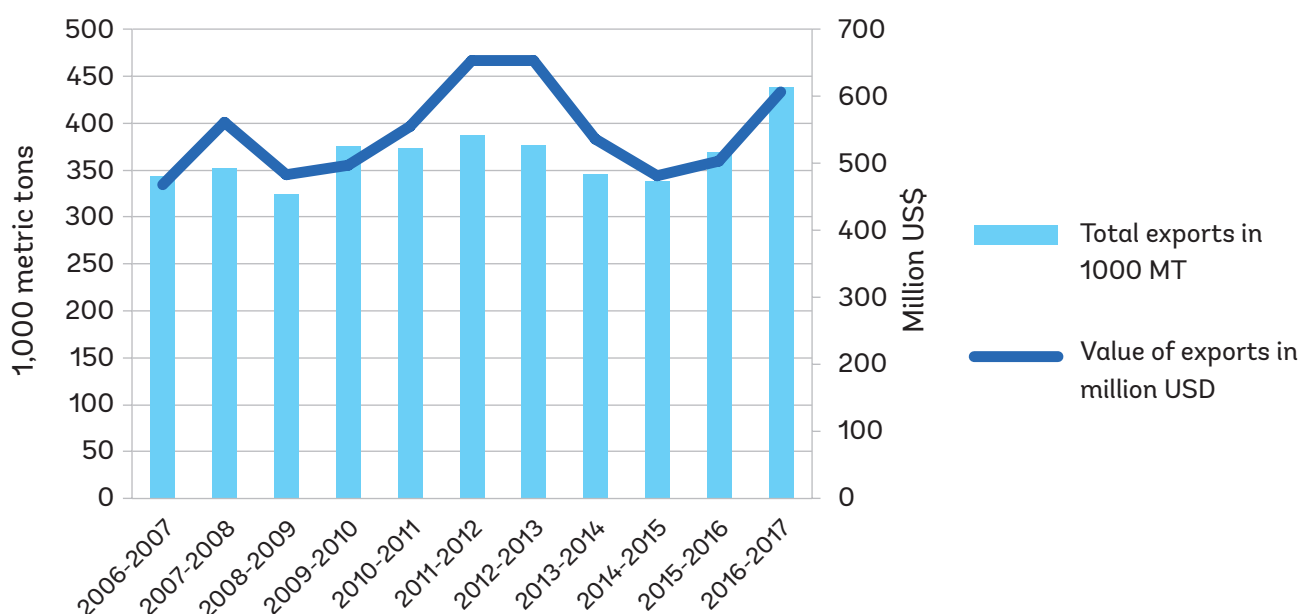
No.	Species (Common Name)		MT (Ordinary)	US\$ (Million)
1.	Rohu		53092.447	54.672
2.	Live Mud Crab		15649.758	45.595
3.	Live Eel		7434.286	25.350
4.	Soft Shell Crab		3037.631	25.073
5.	Fish Meal		37444.871	33.730
6.	Ribbon Fish		20447.705	35.116
7.	Pink		7233.451	19.822
8.	Tiger		2892.161	20.965
9.	Hilsa		12003.643	28.044
10.	Big Eye Croaker		16561.238	18.978



Figure 5

## Myanmar fishery exports 2006–2017



Source: DOF 2017.

## Public revenues

13. Currently worth around US\$8 million, fisheries receipts are projected to contribute 6.5 percent of the Ministry of Agriculture, Livestock and Irrigation (MOALI) revenues, although they comprise just 0.15 percent of all general government revenues (BOOST dataset). Fisheries makes a sizable contribution to the revenues of some regional governments, reaching up to 56 percent in the Ayeyarwady region (Teggo et al. 2018).

## Social

### Nutrition

14. **Fish is fundamental to nutrition in Myanmar.** Statistics are again a source of confusion as the official per capita consumption rate is calculated by simply dividing the inflated total production numbers for Myanmar (minus exports) by the total population. As a result, the reported per capita consumption of fish is roughly 60 kg per person per year. Other sources and studies suggest figures in the range of 25–30 kg per year. An FAO study carried out in 2006 suggests a figure of 21 kg per capita per year (Needham and Funge-Smith 2014). Fish accounts for 50 percent of the quantity of animal source food (that is, meat, eggs, dairy, and fish combined) consumed in Myanmar, making it the single most important animal protein (Belton et al. 2015), although there are large regional and state variations. The aforementioned FAO study suggested a per capita fish consumption rate of 6.4 kg in Northern Shan State and a 25.4 kg figure for the Ayeyarwady region.

1 General government revenues exclude receipts from state-owned economic enterprises.

## Employment

15. **Myanmar's fisheries sector is officially reported to provide employment to 3.2 million people**, 800,000 full-time and 2.4 million part-time, amounting to 6 percent of Myanmar's population (WorldFish 2018), though some sources claim that this figure is likely to be an underestimate. Regional participation varies considerably, with the coastal states and regions showing much higher employment levels than most inland areas. The livelihood functions of fisheries are particularly important in coastal areas where there are few alternatives and poverty is widespread. In areas where fisheries have declined, out-migration is common, mostly to more populous areas but also to high-seas fleets in other countries, especially China and Thailand. Labor abuse in the Thai offshore fishing industry, from which Myanmar nationals have suffered disproportionately, has been covered on international news for several years now.

## Conflict

16. **Ethnic states have suffered the most from long-term conflicts and entrenched poverty.** Recent freshwater fisheries laws, however, offer some promise that at least at the state/region level, conservation and co-management are gaining traction. Explicit recognition of co-management at the state/region level is particularly important as experience from forestry co-management has shown that a lack of a comprehensive and complete legal framework can be used as reason to delay implementation changes, especially when these changes are perceived to be against vested interests. These issues are explored in more depth later in this report.

## Ecosystem Services

17. **There is only very limited information on the value of coastal ecosystem services in Myanmar.** Two national-level economic assessments have been carried out in the last five years. The value of marine and coastal ecosystem services was estimated at US\$8.5 billion a year, almost 60 percent of which is contributed by mangrove and coral reef ecosystems. Emerton and Aung (2013) estimated that forest ecosystem services were estimated to be worth more than US\$7.3 billion in 2013 comprising 15 percent (or US\$1.1 billion a year) for mangrove fisheries nursery and habitat and 10 percent (or US\$707.1 million a year) for mangrove coastal protection.





photo: ©Thiri Aung

# 2

## STRUCTURE AND MANAGEMENT OVERVIEW OF THE SECTOR



# STRUCTURE AND MANAGEMENT OVERVIEW OF THE SECTOR

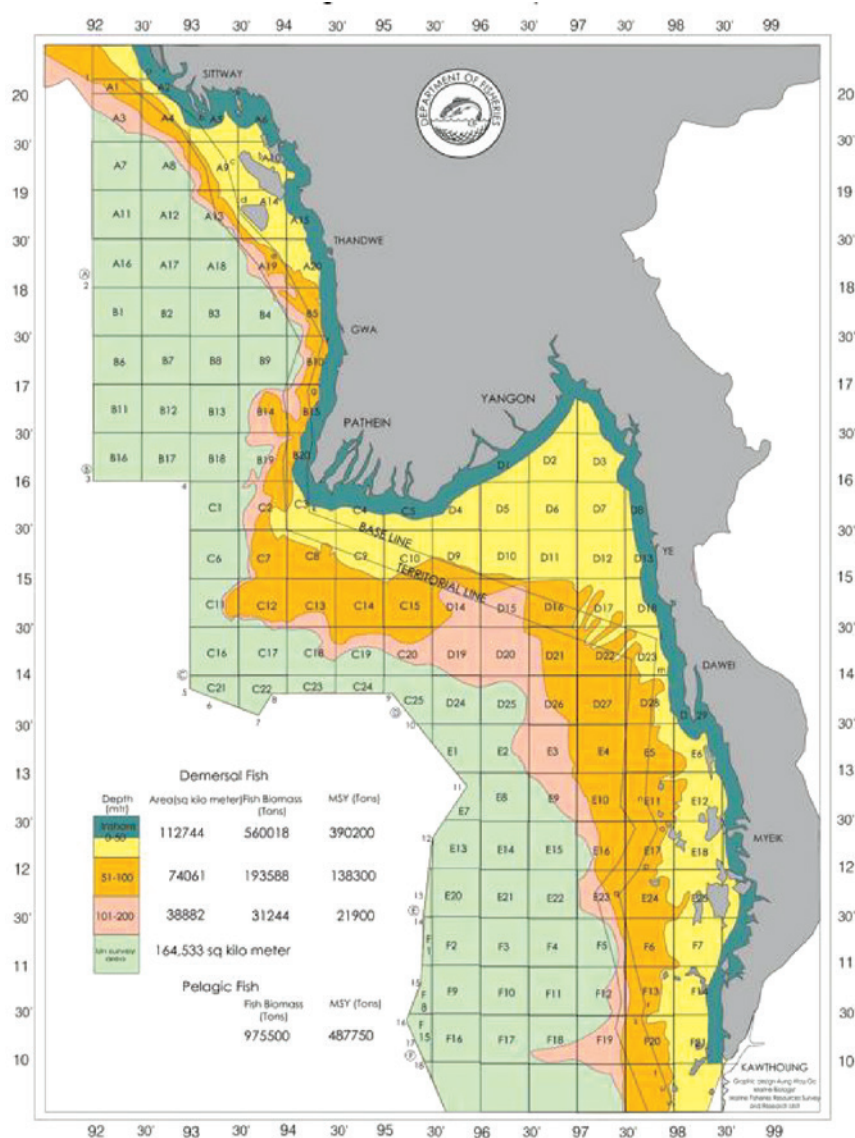
## Marine fisheries

18. Marine fishery covers inshore fishery areas (0 to 10 nautical miles from the coast) and offshore fishery areas (10 nautical miles from the coast to edge of the Exclusive Economic Zone).

Figure 6

Fishing Ground of Myanmar

Department of Fisheries : Fishing Ground of Myanmar, Biomass, MSY and Un-surveyed Areas



Source: DOF 2015

- **Inshore fishery** is reserved for boats under 30 feet and 25 horsepower, licensed by township officers of the DOF. Inshore, there are no limits on either harvest levels, the number of vessels, or fishing gear licenses. The fishery is essentially open access except for some inshore tendered areas. Some fishing gear, such as baby trawls, are not legal, but enforcement is regarded as ineffective with many illegal gears employed. The closed season is also not enforced, although frequent bad weather during the closed season (mid-May to mid-August) does reduce fishing pressure for extended periods. Lax enforcement is often justified by township DOF officers as necessary to enable fishers to be able to maintain their livelihoods. Licenses were issued for 16,012 motorized and 10,704 nonmotorized inshore fishing boats in 2016–2017 (DOF 2017).
- **Offshore fishery.** By the Union Fisheries Law, offshore fishing grounds are open to boats over 30 feet and over 25 horsepower, mostly trawlers and purse seiners. Licensing is done by the union-level DOF. No new offshore licenses are being issued, but offshore fishery is already overcapitalized (that is, too many boats). There are no effective limits on harvest levels and area restrictions, including encroachment into inshore fishing areas, are not effectively enforced. Fishing does appear to be reduced during the closed season, but each year a certain percentage of the fleet are allowed to fish legally which makes gaming the system possible—3,216 offshore vessels were licensed by DOF in 2016–2017, of which 3,168 are national (99 percent) and 48 are international (DOF 2017).

19. **Marine fisheries value chains.** Marine fish are usually marketed in whole chilled fresh form in coastal and urban markets, processed by drying or fermenting, or exported in whole frozen form. In all value chain strands, compliance with food safety and quality standards is weak, appreciation of the benefits of safe handling of fish is low, and access to training on occupational safety and health is lacking. Few services and resources that would support compliance with the food safety standards of more demanding export markets exist. Moreover, high production costs in processing, due to low labor productivity and unstable power supply, hamper diversification into more value-added processing (ILO 2015). Informal sources of value chain finance play an important role in lubricating transactions throughout the chain in the absence of access to formal credit, but leave many actors locked into debt relations at high rates of interest. This situation results in a high level of income forgone for small-scale fishers and other smaller actors in the chain. A similar situation prevails in the value chains associated with freshwater fisheries.

## Inland fisheries

20. Myanmar's freshwater resources are exceptional. The 10 principal rivers have a combined catchment area of 737,800 km<sup>2</sup> and surface water volume is estimated to be 1,082 km (WEPA 2019). Under Myanmar law, freshwaters are defined as "waters, pond, course, river, stream and lake which are of a permanent or temporary nature and in which fish live and thrive and which are situated within the inland boundary along the sea coast of the region." This expression also includes inland tidal waters and brackish waters. Furthermore, waters on the inland side of the straight line drawn from one extreme end of one bank to the extreme end of the other bank of the river mouths (estuary) and creek mouths contiguous to the sea are considered freshwater.

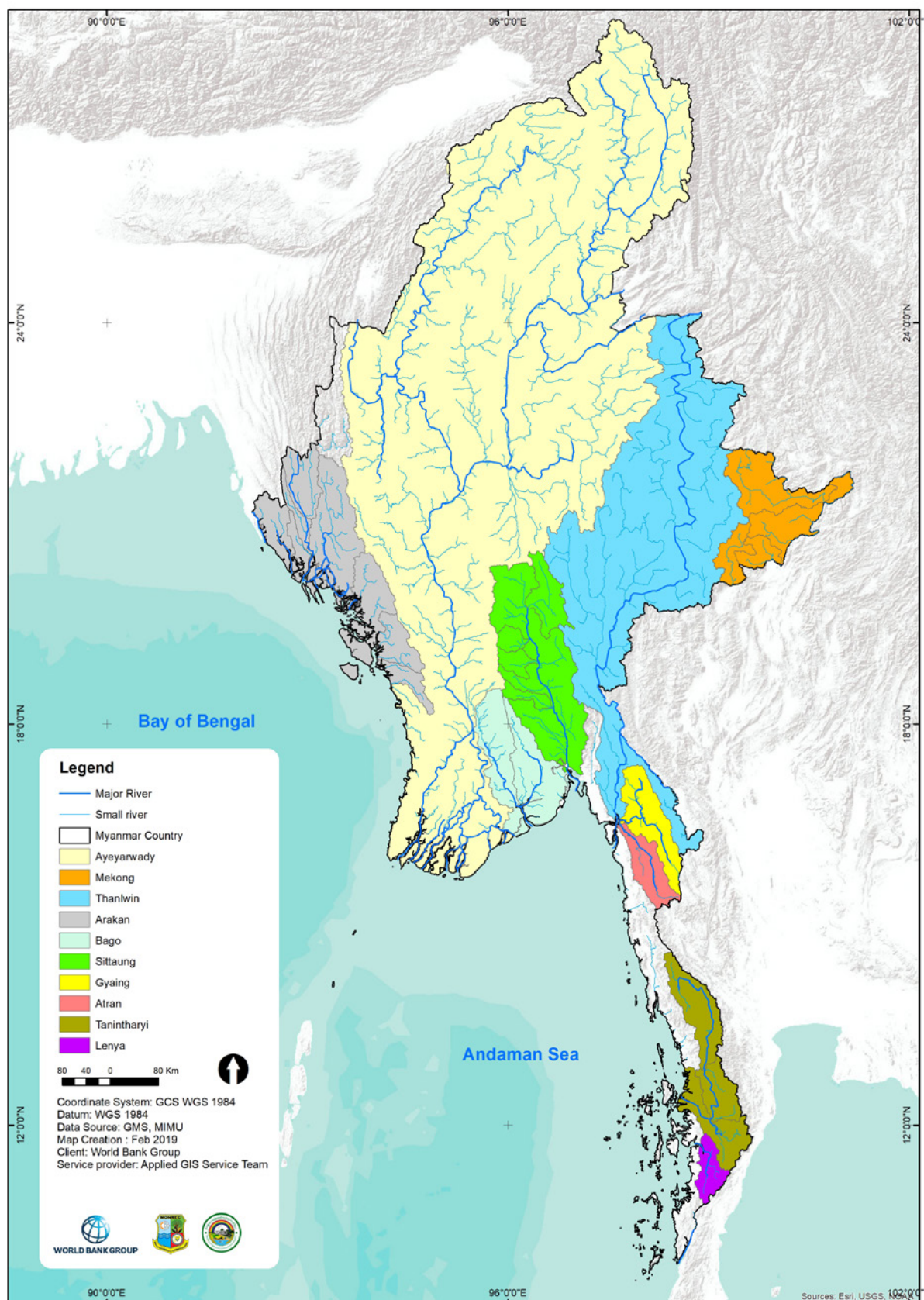
21. Freshwater fisheries in Myanmar are classified as follows:

- **Open:** corresponding to open access areas where licenses are issued for specific fishing gear. There are no restrictions on numbers of licenses available.
- **Leasable fisheries (Inn):** delimited water bodies to which exclusive exploitation rights are sold at auction annually by the DOF. Leases were granted for 3,299 Inns in 2017 (DOF 2017).

22. Confusingly, open waters include tender areas where exclusive rights to operate large fixed gear are licensed on an annual basis through a similar auction process to that deployed for Inn fisheries.

Figure 7

## Myanmar basins



Source: IFC 2018



23. The introduction of the Inn system (by the British in the 1800s) as a means of revenue generation, and the more recent tender system have led to the concentration of the most productive fishing areas among a small number of owners. Over time, small-scale fishers have been gradually disenfranchised as their access to the best parts of the fishery has been eroded. DOF statistics suggest that 1.5 million (full-time, part-time, and occasional) fisher livelihoods depend on freshwater fishing and related activities, accounting for about 50 percent of employment in the fisheries sector. Operators of small-scale fishing gear, (that is, gear used to catch fish for domestic consumption, for example, cast nets) do not need a license but larger, commercial gear (for example, stow nets) do require their operator to purchase a new license every year.

24. The DOF reports stocking 102 million fish seeds originating from the DOF hatcheries in open natural and constructed waterbodies, including Inns, in 2017–2018 (DOF 2018). The effectiveness of these measures in terms of contribution to fisheries productivity has never been evaluated. Inn leaseholders themselves also stock large volumes of seeds sourced from private hatcheries. With some technical assistance in the form of carrying capacity analysis and water quality monitoring, these waterbodies have the potential to produce more fish from either culture-based capture (that is, stocking fish and catching them in nets) or cages where fish are stocked and provided with either complete or supplementary feeds depending upon fertility and the species being produced.

## Aquaculture

25. Aquaculture in Myanmar comprises three subsectors, listed in order of importance as follows: inland (freshwater), coastal (brackish water), and marine. The structure of each subsector is outlined in the following paragraphs, in terms of spatial distribution, ownership and scale, technologies deployed, and growth rates.

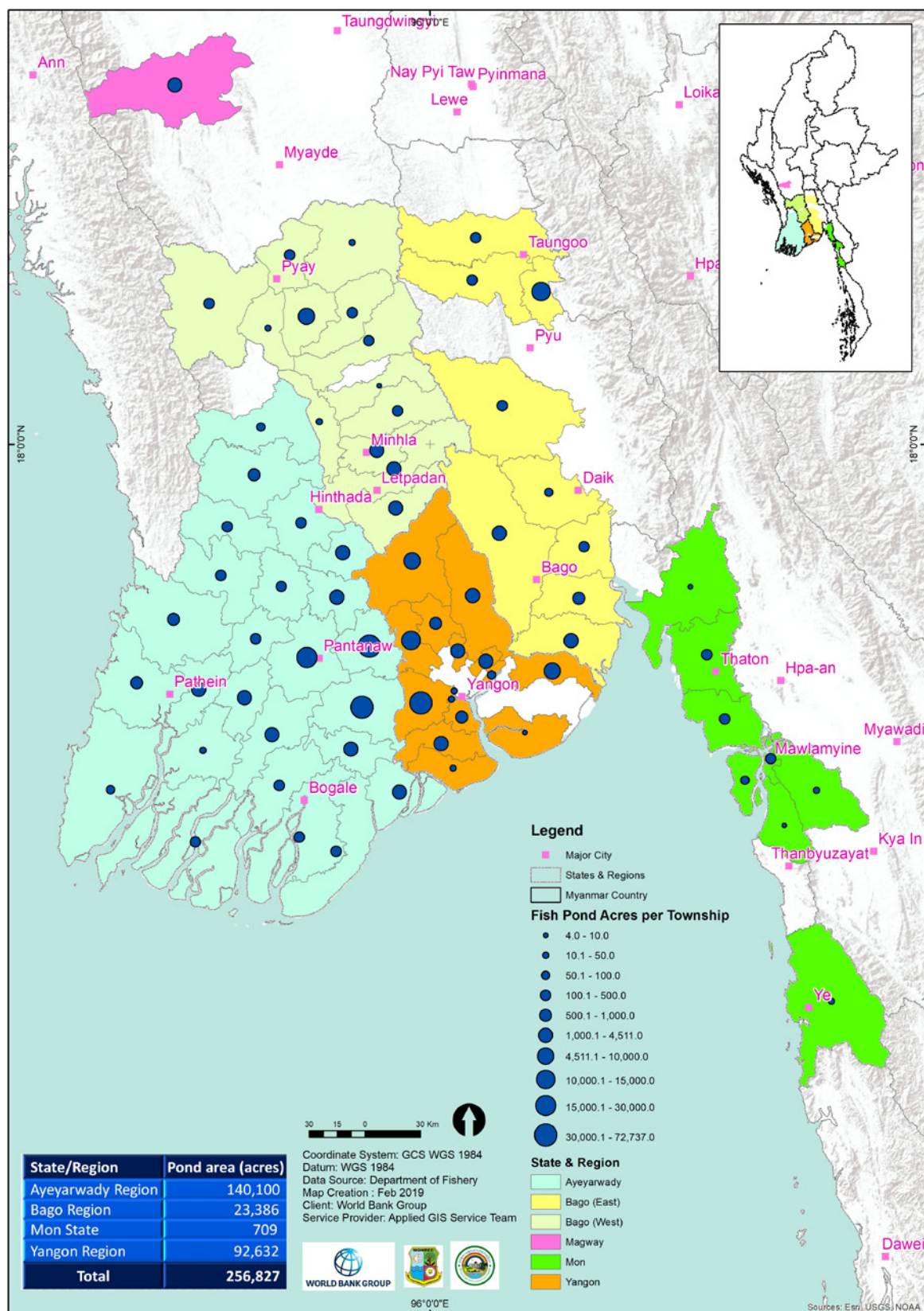
### Inland aquaculture

26. **Freshwater fish accounts for 95 percent of Myanmar's aquaculture production.** Freshwater fish production is highly geographically concentrated. Around 90 percent of Myanmar's inland fish farms are located in the delta area across the Ayeyarwady, Yangon, and Bago regions (DOF 2016). Most of these farms are found within a 25–50 km radius of Yangon. Three townships (subdistricts) to the west of Yangon (Maubin, Twantay, and Nyaungdon) account for nearly two-thirds of the delta's pond area (Figure 8). Based on analysis of satellite images, Belton et al. estimated fish ponds in the delta to total 260,300 acres in 2014 (2015). This is 30 percent higher than the 199,745 acres officially reported by the DOF in 2014. Much smaller clusters of fish farms are also found around the cities of Mandalay and Pyay and close to the Chinese border in Keng Tung (Eastern Shan) with a scattering of ponds found in some areas of the Central Dry Zone (CDZ), but their collective contribution to national fish production is of minor significance (Belton et al. 2015).

27. **Although it is common throughout Asia for fish farms to be located in deltas, it is unusual for aquaculture production to be as highly spatially concentrated as it is in Myanmar.** This suggests potential for further aquaculture expansion into areas with suitable agroecological conditions (for example, well-watered lowlands), if restrictions on pond construction are relaxed and basic infrastructure installed to enable intensification (for example, electricity to power aerators) and assure market access. However, large-scale conversion of seasonally flooded wetland to ponds could have negative impacts on biodiversity and fisher livelihoods, by reducing available habitat and blocking migration routes (Mark and Belton, forthcoming).

Figure 8

# Location of fishponds in Lower Myanmar



Source: Belton et al. 2015.

28. **The structure of farm ownership is highly concentrated.** Based on the results of a survey in the main fish farming areas of the delta, Belton et al. (2018) found that farms of 100 acres and above accounted for 8 percent of farms but 60 percent of pond area. A subset of these—‘mega-farms’ of over 500 acres—amounts to just 1 percent of operations but almost one third of the total pond area. The largest farm in this size category is reported to be 7,000 acres. According to Belton et al. (2015), these very large farms are owned mainly by private domestic capital and established on land concessions granted during the previous government. Mark (2017) reports that a significant area of fish farm concessions was also granted to State institutions.

29. **Numerically, the majority of fish farms are of small- or medium-size.** Operations sized less than 10 acres account for 49 percent of all farms, while those in the 10–50-acre bracket account for 32 percent of the total. However, farms in this size range account for only 4 percent and 24 percent of the total pond area, respectively. Farms in these size brackets are commercial, fully integrated into input and output markets, and utilize a mix of hired and family labor.

30. **There is a significant stratum of ‘micro’ ponds, sized below 0.5 acres outside of the main clusters of commercial aquaculture.** Ponds of this type are constructed close to homesteads for harvesting rainwater for household use, particularly in areas with saline groundwater. By analyzing satellite images, Belton et al. (2015) estimated that there are 210,000 of these homestead ponds in the delta. Oo and Mackay (2018) show that ponds of this type in Bago are often actively managed by farmers to maximize yields of wild fish. Ponds of this type are generally owned by paddy farming households, for which domestic ponds allow for the production of fish at low opportunity cost, if any, and provides incremental benefits. As such, they represent a different class of producers to small commercial fish farms, which produce exclusively for the market. The small size and multiuse functions of ‘micro’ ponds mean that they are unlikely to make a major contribution to Myanmar’s total aquaculture output in future even with more intensive stocking and management, but this should not be construed as problematic as they perform useful functions in their existing form.

31. **Pond area grew at variable rates in different locations over the past decade.** The DOF statistics show that the area under inland fish ponds expanded by 14 percent over the decade 2008–2017 from 215,373 acres to 245,807 acres. However, analysis of Google Earth images conducted by Belton et al. (2015) suggests a more dynamic picture. Examining rates of pond growth from approximately 2004 to 2014 in four different areas in Ayeyarwady and Yangon using historical satellite imagery, the authors found rates of growth ranging from almost zero in one well established aquaculture ‘cluster’ with no further room for pond expansion to 250 percent in a more recent ‘frontier’ area, and 39 percent and 154 percent in two other intermediate locations.

32. **Reports suggest that fish farm expansion has continued but slowed** since the study by Belton et al. was conducted (2015). Few, if any, new land concessions have been granted for aquaculture in the delta in recent years, so most new aquaculture development is from small- to medium-scale farms (Mark 2017). Moreover, recent reports suggest that the profitability of aquaculture is declining in the face of rising input prices (for example, Hnin 2018) used in the production of relatively low-priced fish. Increased production efficiency and culture of higher value species could enable greater expansion of aquaculture.

33. **Diversity of species farmed is low, yields are modest.** Results from a comprehensive farm survey by Belton et al. (2015) show that almost all farms are managed as polycultures, with an average of 3.3 species stocked. Carp species dominate production. The three most commonly stocked fish are all carp—rohu (94 percent of farms), catla (74 percent), and mrigal (60 percent). The three next most commonly farmed fish are noncarp species: pangasius (28 percent of farms), tilapia (11 percent), and pacu (8 percent). The average yield across all farms is 1.9 tons per acre (4.8 tons per ha).<sup>2</sup> This is comparable to yields from small well-managed commercial carp farms in Bangladesh, but approximately half as much as is typical in Andhra Pradesh, India, where carp-farming technologies are well-advanced (Belton et al. 2015). Yields of pangasius are similar to those of rohu, averaging 2.3 tons per ha. In other countries where pangasius is grown as a major component of polycultures or in monoculture, average pangasius yields are far higher—33 tons per ha in Bangladesh, for example (Jahan et al. 2015).

2 The apparent average yield of inland fish ponds in Myanmar obtained by dividing data on production of freshwater fish (FAO 2018a) by reported fish pond area (DOF 2016) is 3.8 tons per acre (9.5 tons per ha). This cannot be considered a credible average as it is almost double the figure reported by Belton et al. (2015) based on a rigorous survey methodology.

34. **Use of fertilizers and pelleted fish feeds is limited.** Only 25 percent of farms use any kind of fertilizer to boost productivity by stimulating blooms of plankton that provide natural food for fish, and fertilizers accounted for less than 1 percent of total operating costs, suggesting significant scope for increasing fertilizer application. Pelleted feeds are formulated to ensure a complete diet for farmed fish, facilitating more efficient feed conversion and faster fish growth than other commonly used feeds such as rice bran. Only 15 percent of owner-operated farms use any manufactured pelleted feeds. This is considerably lower than in other Asian countries (for example, 38 percent of farms in Bangladesh, 90 percent in China) (Belton et al. 2015). A few of the largest vertically integrated farms manufacture their own feed, but many large farms are also operated semi-intensively, with little or no pelleted feed.

35. **Value chains segments upstream and downstream of the farm and supporting public service delivery are poorly developed and uncompetitive in comparison to other countries in the region.** This is apparent in a number of areas, including (a) the small number of private hatcheries and limited diversity of available seeds; (b) the high cost and low levels of adoption of pelleted feeds and limited network of feed dealerships; (c) almost nonexistent access to veterinary services (private or public); (d) poor access to diagnostic services (for example, polymerase chain reaction (PCR) testing equipment); (e) congested, unhygienic marketing infrastructure (for example, San Pya wholesale market in Yangon, retail markets in many provincial towns and cities); and (f) very little development of value-added post-harvest processing, meaning that fish are exported in whole frozen form with little opportunity for employment generation and value creation. This status is compounded by lack of access to formal credit and restrictive requirements for bank loans (for example, high collateral to debt ratios). Moreover, informal value chain finance often favors large enterprises (for example, loans from traders to farmers). However, rapid growth of transport and other logistics services in the fish value chains, following the liberalization of restrictions in 2012, points to the potential for rapid change if binding constraints can be relaxed.

## Coastal aquaculture

36. **More than two-thirds of Myanmar's shrimp ponds are in central Rakhine State, with the remainder found primarily in the Ayeyarwady region.** The vast majority of these farms are extensive 'trap and hold' systems in which naturally recruited shrimp post larvae (PL) are trapped in shallow coastal ponds at high tide and then grown without feed inputs, relying only on the natural productivity of the pond. Some farms also stock purchased PL—either harvested locally from the wild, illegally imported from hatcheries in Bangladesh, or ordered from local hatcheries operated by the DOF. Muslim fishers were formerly engaged in catching and trading wild shrimp seed.

37. **Most shrimp ponds in Rakhine are no longer in use,** according to a report by Svennevig and Lwin (2016). Joffe and Aung (2012) provide similar evidence, stating that in several of the main shrimp farming townships in Rakhine, more than half of shrimp ponds have been abandoned. This is due to a combination of factors that include damage caused to ponds by a succession of cyclones, and the widespread destruction of mangrove areas that led to the collapse of the availability of wild shrimp seed. In Kyaukpyu township, the area under shrimp farms declined fourfold from around 17,000 acres in 2002 to about 3,950 acres in 2011, and declined further in 2012 (Joffe and Aung 2012). Contrary to this evidence, the DOF (2016) reports that there are 241,718 acres of shrimp ponds in Myanmar, and that this number has increased gradually over the past decade (up from 225,725 acres in 2008).

38. **Shrimp farm productivity has declined dramatically since the mid-2000s.** In 2002, typical yields of the main shrimp species cultured in Rakhine State, black tiger shrimp (*Penaeus monodon*), ranged from 30–50 kg per acre. This fell to 10–20 kg per acre in 2011—a drop of approximately 60 percent<sup>3</sup> (Joffe and Aung 2012; Svennevig and Lwin 2016). Shrimp farm productivity and profitability began declining following three cyclones

3 Joffe and Aung (2012) report that, a mixture of lower value unstocked shrimp species are harvested in addition to tiger shrimp, and typically amount to about 60 percent of the weight of harvested tiger shrimp. It is not known how yields of these other shrimp species have changed.



between 2004 and 2010 that badly damaged ponds. The cyclones' effects were exacerbated by international sanctions imposed on Myanmar exports from 2007 onward, declining abundance of wild PL likely linked to mangrove clearance and the overfishing of brood shrimp at sea, as well as increasing incidence of shrimp disease. Together, these factors resulted in rising indebtedness among shrimp producers and the abandonment of large numbers of ponds (Joffe and Aung 2012). However, despite a large drop in both the area under shrimp production and productivity per farm, Myanmar's production of tiger shrimp is officially reported to have remained quite stable from 2005 to 2016, fluctuating between roughly 49,000 tons and 54,000 tons (FAO 2018a). Given the nature of reports from the field, it seems highly unlikely that these numbers reflect the reality on the ground. Apparent shrimp pond productivity, inferred by dividing officially reported tiger shrimp production by officially reported shrimp pond area, far exceeds levels of productivity reported by farmers (Svennevig and Lwin 2016).<sup>4</sup>

39. **Shrimp hatcheries are virtually inoperational.** Svennevig and Lwin (2016) report that there were once 27 government shrimp hatcheries in operation in Myanmar, but that by 2016, only one was producing shrimp PL. The DOF reports operating four shrimp hatcheries nationally in 2015/16, producing a total of 6.07 million PL (DOF 2016). Joffe and Aung (2012) report that total demand for purchased shrimp PL in Rakhine is around 100 million PL per year. To put this into perspective, Debnath et al. (2016) found that in Bangladesh individual private shrimp hatcheries classed as 'small-scale' have an average production capacity of 55 million PL per year, while 'large-scale' private hatcheries each have an average production capacity of 617 million PL. Bangladesh's total hatchery shrimp PL production for 2013 stood at 8.2 billion (more than 13,000 times greater than Myanmar's), all originating from private hatcheries. It is unclear whether any private shrimp hatcheries are currently in operation in Myanmar, but it appears unlikely. According to Joffe and Aung (2012), reasons for this include high production costs due to the cost of electric power (diesel), competition from cheaper imported PLs, a lack of knowledgeable and competent technicians, and a lack of equipment for disease control.

40. **Poor infrastructure hampers shrimp value chain performance.** Svennevig and Lwin (2016, 21) state that the brief boom in Rakhine's shrimp industry in the early 2000s was "very closely tied towards Bangladesh, as they had the infrastructure such as cold stores and electricity, and importantly they had the market access during the trade ban." Travel times and connections to Bangladesh are also more rapid than those to Yangon (a journey reported by Joffe and Aung [2012] to take 60 hours by road from Sittwe). As a result, most Rakhine shrimp was re-exported through Bangladesh.<sup>5</sup> Joffe and Aung (2012, 33) note that in the areas where most farms are located, "communication is poor, information sparse, and transportation inadequate."

41. **A handful of large semi-intensive farms are piloting white shrimp production.** These are located in Ayeyarwady and (more recently) Tanintharyi, are operated by companies or entrepreneurs with business interests in multiple sectors, and produce the exotic white shrimp (*Litopenaeus vannamei*) using PL and pelleted feed imported from Thailand, along with probiotics/pharmaceuticals, aeration, plastic lined ponds, and liming.

42. **A few large coastal farms produce soft shell crab for export.** There are likely fewer than 10 of these farms, located mainly in Yangon and Tanintharyi. The scale of investment can run up to millions of dollars per farm, and the largest farms may employ as many as 500 workers, mainly to check for molting crabs. Farms are stocked with wild-caught hard-shell mud crabs of size 60–120 g, collected in traps by fishers (Svennevig and Lwin 2016). Wild crabs are reportedly plentiful in Myanmar in comparison to elsewhere in the region. The long-term sustainability and growth of crab farming will depend on the development of crab hatcheries, for which technology is available outside of Myanmar.

4 For example, dividing Myanmar's farmed tiger shrimp production for 2016 as reported by FAO (2018a) by Myanmar's shrimp pond area in 2016 as reported by DOF (2016) gives a yield of 209 kg per acre—at least 10 times higher than levels reported by Joffe and Aung (2012) and Svennevig and Lwin (2016).

5 It is not known whether this trade continues, given the recent events.

## Marine aquaculture

43. **Marine aquaculture development in Myanmar is very limited.** There is one large company (KMK) involved in farming barramundi in cages in Tanintharyi, where it operates farms in three sites, along with its own hatchery. Domestic demand for barramundi is said to be substantial (Svennevig and Lwin 2016). There are also now around 50–60 small-cage farms in the Myeik area, producing barramundi using seed from the KMK hatchery. KMK is seeking to implement changes that will triple production capacity in its hatchery, opening up the possibility for further growth in numbers of smaller producers who can use its seed. A medium-size company with foreign investment capital is awaiting completion of permitting procedures that would allow it to begin barramundi production in Tanintharyi.

## Fisheries governance

### Policy and legal framework

44. The 2008 Constitution is the basis of the legal framework for fisheries. Myanmar's natural resources such as fisheries, land, and forestry are owned by the State and the rights to ownership and access to these assets are assigned by the respective government departments. The fisheries subsectors are regulated under the laws summarized in Table 3.

Table 3

Relevant laws for fisheries subsectors

Subsector	Laws
Offshore marine fisheries	Myanmar Marine Fisheries Law (1990)
Inshore marine fisheries Freshwater fisheries	Freshwater Fisheries Law (1991) <sup>6</sup>
Aquaculture	Aquaculture Law (1989)

45. The **Marine Fisheries Law (1990)** and the **Freshwater Fisheries Law (1991)** are similar in the regard that they both focus on establishing an effective mechanism for taxation and revenue collection. The states/regions do not have any constitutional rights for management of Myanmar's offshore marine fisheries. The Union Marine Fisheries Law is currently being revised and is in an advanced draft form, but this has yet to be released due to procedural issues. Inshore marine fisheries and inland fisheries are both regulated under the Union-level Freshwater Fisheries Law (1991). Inshore marine fisheries is covered under this legislation since the 2015 Constitutional Reform. Decentralization under the New Constitution (2008) allows each state and region to draft their own freshwater fisheries legislation. Rakhine, Tanintharyi, Ayeyarwady, Bago, and Mon have drafted their own fisheries laws, but only Mon and Tanintharyi have included inshore fisheries in their regulations.

46. The Aquaculture Law (1989) legalized ponds which had been constructed previously and promoted the expansion of large-scale aquaculture by providing a mechanism for allowing pond construction on 'wastelands' (land for which no legal title has been issued). Following the law's implementation, large areas of 'wasteland' (much of it already cultivated by farmers without land-use certificates) was allocated to companies and individuals with close links to the military. The Aquaculture Law remains a union level law, meaning that states and regions cannot draft their own legislation with respect to aquaculture. The Aquaculture Law is similar to the

<sup>6</sup> Inshore marine fisheries have been covered under this legislation since the 2015 Constitutional Reform.



marine and freshwater fisheries laws, in that it is mainly an instrument for revenue collection. Issues such as water rights, protection from other user impacts, exotic species control, and zoning are not included.

47. Aquaculture development is also constrained by the **Farmland Law (2012)** and the **Vacant, Fallow, and Virgin (VFFV) Land Law (2012)**:

- **Farmland Law (2012)** restricts the conversion of land registered for rice cultivation for any other permanent purposes without authorization being given.
- **VFFV Land Law (2012)** has contributed to weakening land tenure for small landholders.

## Land-use policy with respect to aquaculture

48. The current land-use policies are constraining the emergence of small-scale aquaculture in many parts of Myanmar as potential fish farmers are discouraged from converting even small parcels of lands to ponds, for fear of losing their land-use rights. Many of the fishponds dug in areas of concentrated aquaculture development such as Ayeyarwady and Sagaing regions do not have the correct land titling and are, therefore, illegal. At a meeting with the DOF in Nay Pyi Taw on May 15, 2018, it was understood that there will be a new Ministerial Order issued soon that will provide amnesty for owners of aquaculture ponds dug illegally in paddy land, for those willing to pay a penalty of MMK 30,000 per acre. It has since been learned that the process will include an environmental impact assessment of the ponds in question. In Ayeyarwady, it is estimated that this would legitimize 300,000 acres of fish ponds in addition to 100,000 acres that have already been legally registered.

49. There are implications of this policy: (a) some of the ponds dug in the 1990s were on land grabbed from local communities. The amnesty and legitimization of the illegal ponds could destroy any faint chance local communities or farmers had for any recourse or compensation; and (b) given the power of the irrigation and agriculture departments, enforcement of the Farmland Law (2012) can be expected to be more rigorous following the amnesty period, and owners of any new ponds dug illegally can be expected to be punished more quickly and possibly more severely.

50. There is a need to harmonize natural resource-related laws and policies, including forestry and land-use, including mangrove areas, which come under different governance arrangements depending on the state of the tide line. This may be difficult to achieve given the history of the two respective institutions, which have long fought over control of flooded forest areas.

## Institutional framework

51. The DOF is the primary agency responsible for fisheries management and collection of fish production-related statistics. The DOF is one of the 11 departments within the MOALI that was created in 2016 by merging the Ministry of Livestock, Fisheries and Rural Development with the MOALI. The DOF is administered by 365 officers and 2,104 staff - a total number of 2,469 people working at the central, regional, district, and township levels (Figure 6). The DOF is organized into four divisions dealing with (a) capture fisheries, (b) aquaculture, (c) research and development, and (d) administration.

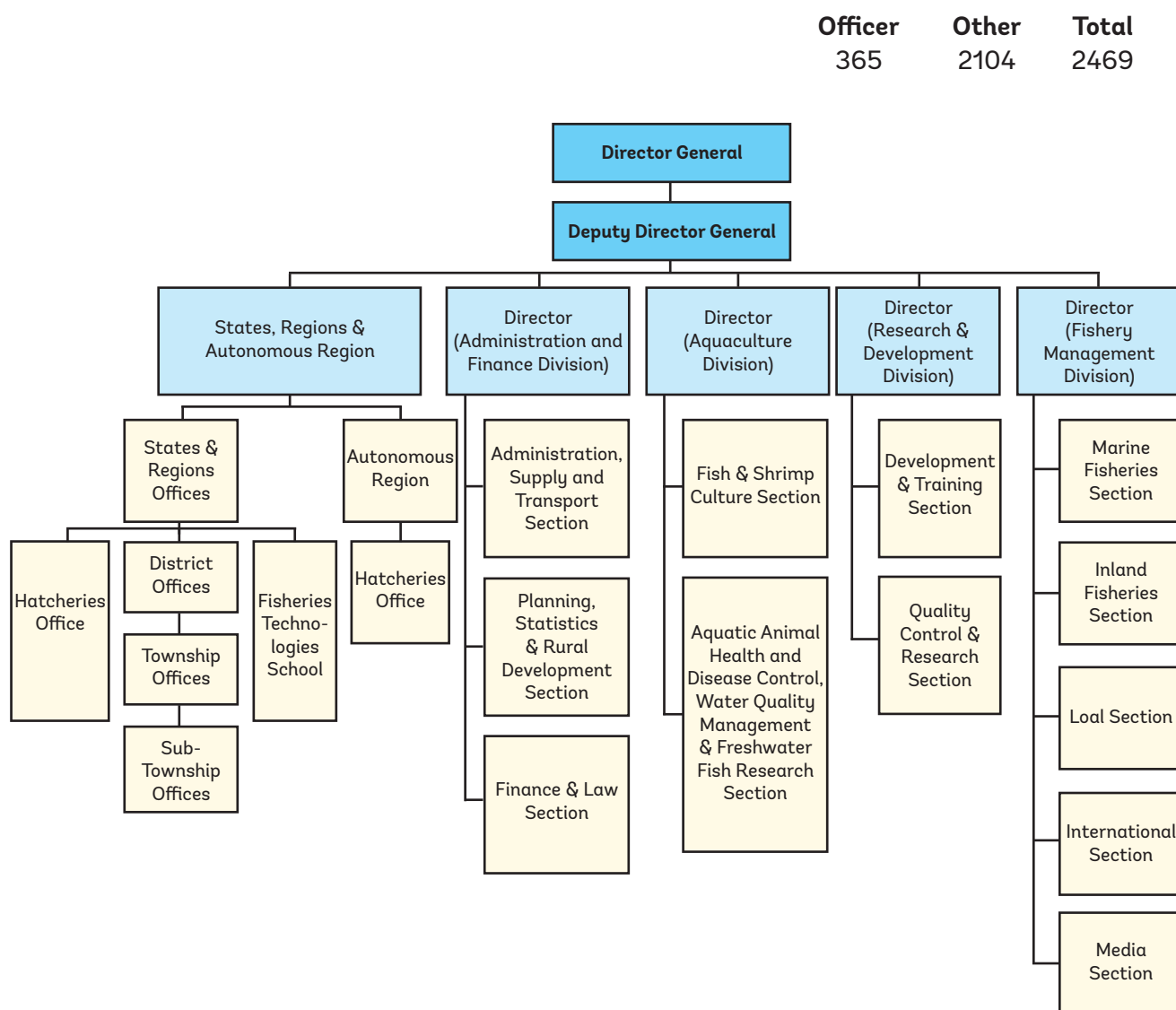
52. Only 0.8 percent of the recurrent budget of MOALI is allocated to the DOF (Teggo et al. 2018). Partly as a result, the DOF capacity to conduct research and extension, or otherwise engage substantively in the development of the sector, is extremely limited. The DOF operates three training centers for the promotion of knowledge dissemination and capacity building for DOF staff, fishers, and fish farmers. These are as follows: (a) Institute of Fisheries Technology, Yangon; (b) Upper Myanmar Fisheries Training Center, Sagaing; and (c) Pyapon Fisheries Training Center, Ayeyarwady. The facilities deliver training to private sector stakeholders and DOF staff, but the number of courses and trainees is limited, and it is unclear whether course content is of practical use to those trained. There is little, if any, other government aquaculture extension and research.

53. Other government departments involved in fisheries management and rural development include the following:

- **Department of Rural Development (DRD)** was established within MOALI to focus on assistance for rural areas—rural development committees established at the township level DRD could assist in co-management but the coordination between the DOF and DRD would need to be improved.
- **General Administration Department (GAD).** Under the 2008 Constitution, the GAD has custodial rights to natural resources on behalf of the State and is obligated by law to maximize their value to the nation's citizens. For decades, however, the value maximized has been extractive and not necessarily for all citizens of Myanmar. This poses substantial challenges to both equitable benefits and sustainability in Myanmar and highlights the need to reform the GAD. This need is recognized by the government, which plans to move the GAD under civilian control by transferring it out of the Ministry of Home Affairs to the Ministry of Union Government.

Figure 9

Organizational structure of DOF



Source: DOF 2017.

## Institutional capacity

54. **The allocation of only 0.8 percent of the ministry's recurrent budget to the DOF confirms the government's relative disregard toward the sector** despite the size of its contribution to the revenues of some regional governments, reaching up to 56 percent in Ayeyarwady region (Tezgo et al. 2018). It may also be a result of the perception that fisheries still remain a sector that can stay productive and generate large amounts of revenue without good governance and management.

55. **Human resources and capacity are inadequate to support effective resource management, training, and extension activities.** Currently, where technical ability exists in the DOF, it tends to be in aquaculture, (for example, conventional hatchery management). Although the Fishery Management Division (FMD) exists, few, if any, capture fisheries specialists, either freshwater or marine, are employed by the DOF. Many of the staff to be found in township or district offices have been educated and trained for administration roles. The routine rotation of the DOF state/region fisheries officers every few years by the ministry may be an attempt to increase broad-based knowledge of fisheries, but these rotations also disrupt many long-term development projects that depend on collaboration with the DOF. Most senior DOF staff are former military officers and lack a background in formal fisheries education, or practical experience in fisheries and aquaculture management.

56. **The DOF has a research and development division but it is not well-supported.** The DOF staff have been involved in the stock assessment surveys carried out by the Dr. Fridtjof Nansen in 2013, 2015, and 2018. This work is enormously important to Myanmar's marine fishery sector but may send a message that fisheries research is necessarily expensive and high-tech when there are many other more modest field-level research studies that could be done effectively.

## Other stakeholders

57. **Myanmar Fishery Federation (MFF)** is a member organization of the Union of Myanmar Federation of Chambers of Commerce and Industry that supports and promotes the fisheries sector in Myanmar. The MFF is divided into functional associations ranging from subsectors such as the Marine Fisheries Association to individual fisheries product amalgamations, such as the shrimp entrepreneur association. The MFF has a technical advisory board where several specialists from the private sector, universities, and retired fisheries department's high-ranking officers are members. The federation carries out advocacy on behalf of its membership at the local, provincial and national levels, and promotes foreign investment in and export from the Myanmar fisheries sector. The most active and influential members are owners of very large fishing and farming operations, and it is the interests of this segment of the industry that the MFF generally seeks to promote rather than small-scale activities. The MFF was established under the auspices of the former military government. Senior MFF members continue to enjoy close relationships with senior-level military or ex-military officials. These relationships give the MFF a high degree of influence over policy initiatives in the fisheries sector giving it, reputedly, the power to block or water down reforms that do not to favor members' interests such as the implementation of more stringent fisheries management initiatives.

58. **The fisheries sector is now supported by several international organizations and donors.** The FAO has been active in Myanmar for more than 50 years but since the government reforms of 2011, the fisheries sector has attracted a great deal of interest from foreign organizations and donors and many new fisheries focused projects have been initiated through WorldFish, International Union for Conservation of Nature (IUCN), Wildlife Conservation Society (WCS), Fauna and Flora International (FFI), and supported by Australian Aid, Swedish International Development Agency, and Danish International Development Agency (DANIDA).

# Decentralization

## States/Regions

59. **Under Myanmar's 2008 Constitution and 2015 Constitutional Amendment, revenue collection and legislative power for freshwater and inshore fisheries were decentralized to states/regions.** With this policy shift, many states/regions have been active in drafting their own legislation.

60. The Ayeyarwady region drafted the Ayeyarwady Freshwater Fisheries Law (2012), which recognized the rights of 'flooded area fishers' (that is, small-scale flood-plain fishers). The Ayeyarwady Region enacted the new Ayeyarwady Freshwater Fisheries Law (2018) that recognized the rights of communities to form community fisheries associations. The accompanying regional fisheries policy is now to offer all Inn and tenders below a value of MMK 4 million and fishing grounds with a history of conflict to communities for co-management.

61. The Rakhine State Freshwater Fisheries Law was passed in 2014. This law provides a legal basis for community fisheries co-management. In 2016, Mon State also enacted a single State Fishery Law that covered freshwater and inshore areas although the legality of that law has not yet been tested.

62. Under the 2008 Constitution, the governance of aquaculture and land both remain union-level responsibilities. This severely limits the scope for initiatives to promote aquaculture emanating from the state and region level as decisions regarding land use are ultimately decided at the union level and cannot be legally circumvented at the subnational level.

## Local communities

63. Fisher communities are often located in remote areas lacking infrastructure such as roads and electricity and are often unattractive posts for qualified professionals that limits the capacity of these communities to engage in activities such as postharvest product development. However, a number of community co-management projects managed by such organizations as DANIDA, Pyoe Pin, WCS, and the Smithsonian, most notably in Rakhine, Ayeyarwady, and Tanintharyi, have demonstrated not only that there is a strong desire within communities to manage their own fishing grounds and improve value-added technology but also that the establishment of effective community co-management organizations requires considerable external support.

64. NGOs' interest in fishing communities gathered momentum during the post-cyclone Nargis disaster period of 2008–2010. Several of them, including NAG (now Network Activities Group; formerly Nargis Action Group) expanded from disaster relief to fisheries management. Unfettered by organizational structure and institutionalized thinking, several of these NGOs have lobbied for legal reform and now dominate field support for fisheries development in some areas. Their success has also attracted considerable international funding.

65. Supported by NGOs and bilateral donors, the Rakhine Fisheries Partnership (RFP) was formed in 2012, comprising the state DOF, the private sector, universities, civil society organizations (CSOs), and fishermen to support the development of fisheries legislation and governance based on shared interests and the recognition of historical, structural, and political relationships that shape traditional coastal fisheries. The U.K. Department for International Development (DFID) supported Pyoe Pin Program that spearheaded the fisheries governance reforms in Rakhine in 2014/15 through the work of the RFP. The RFP brought together community- and state-level positive interests for change in fisheries management. These inclusive processes challenged vested interests in the previous system leading to positive changes in legislation and informal behaviors. The RFP model has now been replicated in other coastal regions; (Ayeyarwady, Bago, Mon, and Tanintharyi) and are contributing to the broader resource governance reform and peace. The close involvement of NGOs in supporting the development of fisheries legislation in states/regions such as Rakhine and Ayeyarwaddy may have left some in the DOF feeling circumvented.

# Myanmar's share of the sunken billions

66. **It is estimated that a better-managed fisheries sector in Myanmar could add US\$1.5 billion in value to Myanmar's economy.** The World Bank report *Sunken Billions Revisited* (World Bank Group 2017) used 2012 landings data to calculate that ecologically and economically well-managed fisheries could produce an additional US\$54.8 billion in value throughout all of Asia. If Myanmar is actually capturing the 1,131,500 metric tons of marine fish estimated by the FAO, this would represent 2.7 percent of the total marine capture fisheries production from Asia (41,205,165 metric tons), they might be able to recapture something in the order of US\$1 billion in additional revenue.

67. Environmental Defense Fund (EDF) has been assembling abundance data from fishery-independent surveys as well as life history data for species found in Myanmar's waters, representing one of the most comprehensive databases available for Myanmar fisheries. This data was used in a multispecies model that evaluates the effects of different management interventions (ranging from simple reductions in fishing pressure to minimum size limits and closed areas) in a highly overexploited ecosystem. The model also explores outcomes for reducing fishing pressure on different components of the ecosystem (for example, large predators versus smaller species). The model will soon be adapted to provide economic estimates, but initial results suggest that compared to the 'status-quo' reductions in catch can produce significant recovery of biomass, and that a shift to larger, higher-value species would yield disproportionately greater economic returns beyond simple yield increases.

68. Running the same model with data from Thanintharyi shows that the same measures could increase offshore biomass by a factor of 3 and yields by 30 percent in Thanintharyi. The difference is accounted for by different habitats and species complexes. Economic model estimates are not available yet, but with a shift to higher-value species, the increase in economic returns would be significantly greater than simple yield increases, possibly doubling in both Rakhine and Thanintharyi (EDF-WCS 2019).

69. Another approach to estimating the potential gains from better-managed fisheries is to use fisheries export data. Fisheries exports are only a fraction of total production, but the numbers are probably more reliable than fisheries production data. In Myanmar, marine capture fisheries account for approximately 55 percent of fish exports, or more than US\$300 million annually. The value of locally consumed fish is likely to be far lower than exported fish, but even a factor of two would take this number close to US\$1 billion. Because exact production is uncertain, the US\$1.5 billion number may also be a significant overestimation. However, the number underscores the importance of collecting better data to understand the extent of the potential gains to Myanmar from better-managed fisheries.

# Myanmar's missed opportunities in aquaculture

70. There are also missed opportunities in terms of Myanmar's potential for sustainable and inclusive aquaculture development. These are presented by sector in the following paragraphs.

71. **Converting 1 percent of the land currently under paddy in Myanmar to small fish farms would generate additional net VAD of US\$193 million**, after accounting for all agricultural VAD lost as a result of land conversion. This would take aquaculture's contribution to agricultural GDP to 3.7 percent and its contribution to national GDP to 0.94 percent. Inland fishponds in Myanmar cover an area of 98,922 ha—equivalent to just 1.6 percent of total paddy area (calculated from Belton et al. 2015; FAO 2018), so even doubling the area under inland fish production would have a negligible impact on rice output. Thailand and Vietnam are both major rice exporters and Bangladesh is self-sufficient in food grain production. These countries' experiences with aquaculture development show that fears that it could jeopardize rice production are unfounded.

72. **Unless production diversifies to include new species, prospects for further growth are limited.** The range of freshwater fish species farmed and variety of technologies deployed in their production is extremely limited, being comprised largely of Indian major carps raised in polyculture in semi-intensively managed ponds. Based on production estimates presented in Figure 3, availability of carp already stands at nearly 8 kg per capita. Demand for fish is likely to continue to grow with rising average incomes, but consumers already consuming large quantities of carp will seek to diversify their diets to include alternative fish species or will turn to substitutes such as chicken or pork. As the market for carp becomes saturated and profit margins erode, producers will need to diversify into production of new species and/or raise existing species in more efficient ways to maintain profitability. This situation creates a variety of opportunities for species diversification, technological development, and the establishment of new niche markets that could be realized through investments in hatchery technology and new financing mechanisms.

73. **Myanmar possesses more than 280,000 acres of reservoirs** (FAO 2013), some of which would be suitable for cage-based aquaculture, if restrictions on their use for this purpose are removed.

74. **Myanmar has a unique opportunity as a late entrant into the global shrimp market.** The very limited extent of shrimp farm development in Myanmar presents an opportunity to foster well-regulated and sustainable sectoral expansion, in a manner that has eluded most other countries. Increasing black tiger shrimp yields in half of Myanmar's existing shrimp ponds to match Bangladesh's average productivity of 677 kg per acre would equate to an additional 80,650 tons of product with an approximate value of US\$403 million—almost 10 times greater than at present. Expansion of capital-intensive closed systems producing white shrimp has potential to support the development of value chain infrastructure (for example, hatcheries, disease diagnostics, and cold chain facilities), potentially creating positive externalities for the revitalization and modernization of extensive smallholder systems.

75. **Tanintharyi could have significant potential as a site for cage-based marine aquaculture.** Svennevig and Lwin (2016) list several factors that make it an attractive site for investment: (a) the archipelago has 800 medium and large islands with a large number of protected sites with sufficient water depths for developing large-volume marine fish cage farming; (b) cyclones rarely make a landfall in Tanintharyi; (c) most of the islands are more than 20 km from the mainland, meaning that there is low water turbidity; (d) Tanintharyi has good market access, being close to Yangon and Thailand and having processing plants, port facilities, and airports. Efforts to develop marine aquaculture in Tanintharyi would need to be planned in coordination with other activities, such as tourism development, to ensure complementarity.



# The structure and performance of aquaculture in Bangladesh, Thailand, and Vietnam

76. The following section sets out comparative examples from three major aquaculture-producing countries in the region: Bangladesh, Vietnam, and Thailand.

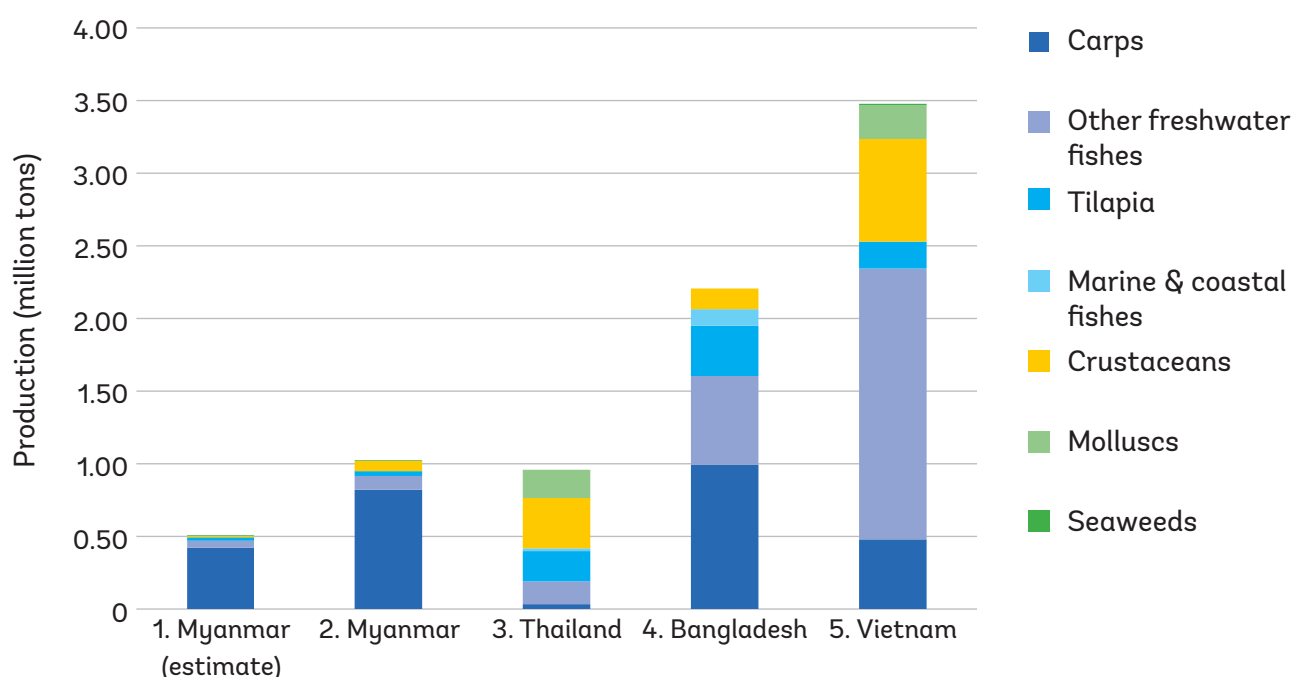
## Volume, value, and composition of production

77. Figure 10 presents an analysis of the volume and composition of aquaculture production in Myanmar, Bangladesh, Thailand, and Vietnam. Columns 2–5 report figures published by FAO (2018). Column 1 is an alternative estimate of the likely levels of production for Myanmar, based on yields of fish and shrimp derived from farm surveys. The Column 1 estimate indicates that Myanmar's actual aquaculture production is about half of the reported production (0.5 million tons versus 1.02 million tons). The magnitude of the gap between reported and estimated production is consistent with another estimate of actual farmed fish production by Belton et al. (2015), made using a different methodology. The estimate made here puts Myanmar's actual aquaculture production at about half of Thailand's, one quarter of Bangladesh's, and one-seventh of Vietnam's.

78. Evaluating the species composition of production across the four countries, four major groups dominate—carps, 'other freshwater fishes' (comprised mainly of catfish species), tilapia, and shrimp. Myanmar is alone in having production comprised almost entirely of carps. The other three countries have much more diverse profiles, with tilapia, catfish, and shrimp accounting for substantial shares of output. Farms in Bangladesh, Thailand, and Vietnam produce a far more diverse mix of 'niche' species than those in Myanmar (for example, climbing perch, snakehead, gourami, mullet, barramundi, and grouper). Vietnam reports more than 1 million ha of land under aquaculture, Bangladesh reports around 0.8 million, and Myanmar reports just under 0.2 million ha.

Figure 10

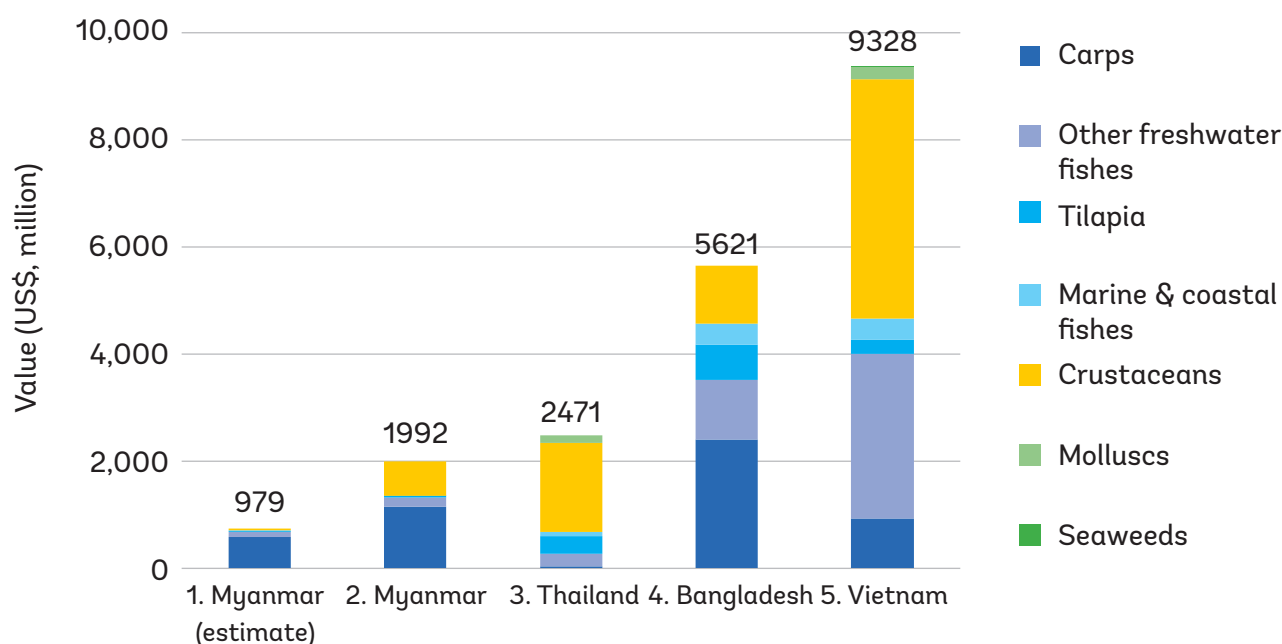
Volume and composition of aquaculture production for Myanmar, Thailand, Bangladesh, and Vietnam, 2016



Source: FAO 2018; author's own calculations.

Figure 11

Value and composition of aquaculture production for Myanmar, Thailand, Bangladesh, and Vietnam, 2016



Source: FAO 2018a; author's own calculations.

## Sectoral structure and performance

79. **Thailand.** Aquaculture production is split fairly evenly between inland (mainly fish) and coastal (shrimp and molluscs), with some limited culture of higher-value fish species in marine cages. Tilapia and clarias catfish are the main species produced in freshwater. Inland fish production is concentrated most heavily in ponds in the provinces surrounding Bangkok, but fishponds are common in rural areas throughout the country wherever there is sufficient water. Monosex Nile tilapia and red tilapia are farmed in cages in major rivers, irrigation canals, and reservoirs across the country, as well as in ponds. About 90 percent of freshwater aquaculture farmers are classified as small-scale by the government, officially defined as operating a farm of less than 12 acres (Phillips et al. 2016). Almost all freshwater fish production is destined for domestic consumption. Shrimp farming is by far the most important form of Thai aquaculture in terms of value. Shrimp farms are concentrated on the upper Gulf of Thailand, and to the south, most notably in Surat Thani Province. Thailand was the world's largest producer of shrimp until 2013, when it was overtaken by Vietnam following the collapse of Thai production due to an outbreak of early mortality syndrome (EMS). Production has begun to recover slowly since this time but remains at less than half of 2010 levels. These events have driven concentration in the shrimp farm sector, with many small farms unable to afford the modifications needed to operate under bio-secure conditions. Smaller farmers who remained in production are reported to face difficulties in complying with the traceability and certification requirements needed to gain access to some markets. While some smaller farms may persist over at least the medium term, it seems likely that large capital-intensive operations using modern inputs such as improved strains of white shrimp developed by the company CP are the future for Thai shrimp.

80. **Vietnam.** Aquaculture sector is diverse and highly dynamic. Inland aquaculture is dominated by intensive production of pangasius for export. Pangasius farming boomed during the 2000s but has remained relatively stable in quantity terms since 2011, at a little over 1.2 million tons. Production of pangasius is concentrated in four provinces in the upper Mekong Delta. Production began on a small scale, but very rapidly expanded and intensified, reaching extremely high yields of around 400 tons per ha, with very slim margins per unit of fish produced. Overproduction coupled with negative media coverage in key European markets increased

demands for traceability and certification, resulting in very rapid consolidation within the industry. At present, a small number of processing companies with vertically integrated farming operations that are able to achieve economies of scale and meet standards account for the vast majority of production. Smaller-scale commercial production of a mix of carps, monosex tilapia, snakehead, and other 'niche' species in ponds and to a lesser extent cages, is found throughout lowland areas of Vietnam though concentrated particularly in the Mekong and Red River deltas. These fish are destined for consumption in domestic markets. Export-oriented shrimp aquaculture, concentrated most heavily in the lower Mekong Delta and coastal areas of Central Vietnam, has also boomed. Vietnam overtook Thailand as the world's largest exporter of shrimp in 2013 but has since been surpassed by India. Vietnamese shrimp farming is more diverse than that of Thailand, encompassing a range of systems, from relatively extensive smallholder operated rice-shrimp rotations and integrated mangrove-shrimp ponds producing *P. monodon* to large-scale biofloc systems producing *L. vannamei* at extremely high densities, with a wide range of variants in between. Though small in absolute volume terms, Vietnam's marine aquaculture is diverse, with species including spiny lobster, pompano, and cobia produced mainly in small sea cages. Phillips et al. (2016) report that the number of people involved in aquaculture and related activities along the aquaculture value chain in Vietnam ranges from 3.2 million to 4.2 million, of whom about 1.6 million are employed in shrimp value chains; 240,000 are employed in catfish value chains; and between 1.5 million and 2.2 million are in other aquaculture systems. About three-quarters of the 2.4 million households engaged in aquaculture production operate farms of less than 5 acres, and 90 percent of households have farms of size less than 7.5 acres (Phillips et al. 2016).

81. **Bangladesh.** Aquaculture in Bangladesh is perhaps even more diverse than in Vietnam. A recent survey of 2,678 farmers in six major fish producing zones identified a total of 14 distinct production systems, producing 54 species of fish and crustacean (Jahan et al. 2015). Traditionally, production was concentrated on extensive and semi-intensive production of carps in homestead ponds for semi-subsistence purposes. However, inland aquaculture has transformed since the mid-1990s, when the introduction of pangasius catalyzed the intensification and commercialization of production. Since this time, production of pangasius has continued to grow, alongside monosex tilapia, climbing perch, and several 'niche' species of catfish. Carp production has become commercial and intensive, and use of pelleted feeds has become widespread. The vast majority of Bangladesh's fish farms are small-scale (averaging 0.75 acres) but are strongly commercially oriented (Hernandez et al. 2018). Enterprises in off-farm segments of the fish value-chain have proliferated to the extent that there are more than 750 private fish hatcheries and over 100 feed mills in operation (Hernandez et al. 2018). Fish from inland aquaculture accounts for approximately 95 percent of Bangladesh's total aquaculture production and is consumed almost entirely in domestic markets. Coastal shrimp aquaculture contributes to 5 percent of aquaculture production, but almost 20 percent of value and is destined almost exclusively for export, making aquaculture one of Bangladesh's main sources of export earnings. Shrimp farming is concentrated mainly in three districts in southwest Bangladesh and is mostly extensive although semi-intensive operations have begun to emerge in recent years. Black tiger shrimp is the main species cultivated in saline areas, while giant freshwater prawn is produced in integrated rice-vegetable-prawn-fish systems further inland. Most of the tiger shrimp PL used in farming is produced in hatcheries. Shrimp production is smallholder-dominated, but some very large farms exist. Shrimp farming in Bangladesh has a contentious history, marked by land grabbing, violence, salinization of croplands and surface waters, and enclosure of common property resources. Crab fattening has taken off in coastal districts in recent years. Marine aquaculture has not developed due to a lack of demand and suitable sites. Phillips et al. (2016) estimate that 3.15 million full-time equivalent jobs exist in the fish farm segment of the value chain and that 642,000 jobs are generated in other segments.

## Implications for Myanmar

82. The structure of the fish farming sector in Myanmar reflects the policy of promoting very large farms by awarding land concessions, while simultaneously inhibiting the emergence of small farms with restrictions on agricultural land use, enshrined in the Farmland Law 2012. If the sector had continued down the trajectory that it started out on in the late 1970s and early 1980s, it would likely look quite close to that in Thailand, where distribution of land is quite similar to Myanmar (average landholdings in Bangladesh are very small, and

average fish farm size reflects this). Implementing policies that support the development of a fish farm sector with structural characteristics closer to those found in other countries in the region would be desirable from the perspective of stimulating rural development for two reasons.

83. First, fish farming generates higher incomes and spillovers than agriculture. Filipski and Belton (2018) modelled direct and indirect income effects associated with a one-acre increase in agricultural land or fishpond holdings, using data collected from a representative survey of fish farm households in Myanmar. They found that use of one additional acre of land for aquaculture generated about US\$140 of additional direct income for the farmer, compared with US\$69 generated by use of 1 additional acre of land in crop farming. The indirect spillovers generated by expanding the area under aquaculture by one additional acre are also much larger than those associated with putting an additional acre of agricultural land into production (US\$153 versus US\$50). Aquaculture generates larger spillovers because its input- and labor-intensive in comparison to agriculture and generates higher revenues than crop farming, resulting in larger production and consumption link effects.

84. Second, small commercial fish farms generate larger indirect spillovers than big fish farms. Indirect spillovers created by small commercial fish farms (defined as <10 acres) are larger than indirect spillovers created by large fish farms, accounting for 56 percent and 51 percent of total income generated, respectively. This is mainly because small fish farms create higher demand for labor than large farms and purchase more locally produced inputs. Landless households provide most of this labor (Filipski and Belton 2018). Average wages for casual day labor are higher in areas with high clusters of fishponds than in comparable areas with little aquaculture (Belton et al. 2017). Moreover, increasing the area of land under small fish farms has the effect of decreasing income inequality within the local rural economy, whereas increasing the area under large fish farms increases inequality (Filipski and Belton 2018).

85. The history of aquaculture development in Myanmar's neighbors offers a number of other salient lessons. EMS decimated the Thai shrimp industry and seriously affected shrimp production in Vietnam, while White Spot Syndrome Virus put an end to semi-intensive shrimp farming in Bangladesh and contributed to the decline of Myanmar's shrimp industry, also causing serious economic damage in Vietnam and Thailand. Serious environmental and social problems have been associated with unplanned growth of aquaculture (for example, mangrove loss in Thailand and Vietnam, land-grabbing and salinization of arable lands in coastal areas of Bangladesh). Unregulated use of antibiotics and other chemicals, along with poor environmental stewardship and inadequate protections for workers in aquaculture value chains have contributed to the imposition of rejected shipments and periodic trade restrictions or trade bans in all three countries and tarnished the national image of their respective industries. All these precedents highlight the need for Myanmar to act proactively and responsibly to minimize the risk of systemic shocks and negative externalities to create a sustainable and equitable aquaculture industry. Myanmar's status as a comparative 'late developer' in aquaculture places it in a unique position to learn from its neighbors' mistakes as it seeks to develop the sector.

86. Aquaculture development in Thailand, Vietnam, and Bangladesh has benefited, to varying degrees, from good enabling environments. These include dense rural canal and road networks; good access to electricity; supportive and/or *laissez faire* government policies; proactive industry bodies; good access to formal credit; and openness to foreign direct investment—all of these have been missing or patchy in Myanmar during the past three decades of aquaculture development. Myanmar might seek to address some of these gaps in the enabling environment through a system of land-use zoning. This could prioritize establishment of hard infrastructure (feeder roads, connections to the electricity grid, canal rehabilitation, and so on) in areas with high potential for future aquaculture development, while prohibiting aquaculture expansion in ecologically critical habitat (for example, mangroves, wetlands, sites of importance to endangered species) or competing resource uses (for example, fishing and tourism). Any zoning system should seek to improve the competitiveness of existing clusters of farms (including small- and medium-scale operations) and should not result in the confiscation of lands under cultivation or customary use.





photo: ©Michael de Alessi

# 3 ISSUES AND DRIVERS OF DEGRADATION



# ISSUES AND DRIVERS OF DEGRADATION

## Over exploitation of fish stocks

87. **Limited stock management, monitoring, and enforcement of regulations have contributed to a severe decline in Myanmar's marine fish resources, reportedly by as much as 90 percent since 1979/80** (Krakstad et al. 2015). As a result, Myanmar's fisheries are underperforming both commercially and as a source of livelihood for small-scale fishing community. To increase the production from marine fisheries, to create more revenue for commercial operations, and to strengthen livelihoods among small-scale fishers, fishing methods and harvest levels must be constrained to sustainable levels and the incentives of fishers must align with those constraints. Profitable, sustainable marine fisheries depend on enforcing existing rules and boundaries, developing new rules based on conservation, science, economics, and social awareness, and collecting and analyzing fisheries-related data.

88. Research on marine fisheries has been limited in the past, but the Marine Science Association of Myanmar (MSAM) is now active in research and survey work in marine ecosystems, mangroves, seaweed and sea grass, marine protected areas, and so on. It collaborates with other international and local nongovernmental organizations (NGOs) including IUCN on Locally Managed Marine Areas (LMMA) in Tanintharyi region.

89. **Illegal fishing in the inshore and offshore segments of Myanmar's marine fisheries is commonplace and many marine fisheries are de facto unregulated, making illegal, unreported, and unregulated (IUU) fishing extremely pervasive.** Licenses for inshore vessels are gradually acquired throughout the fishing year by fisheries officers visiting villages and fishing grounds and selling the licenses in the field. This coverage is incomplete, meaning that the true size of the inshore fleet is unknown. A fully illegal fleet of inshore fishing vessels operates along Myanmar's coast made up of fishing vessels that are rigged with wholly illegal gear, such as baby trawls, pair trawls, and push nets. The presence of these vessels is widely known and largely tolerated by the authorities. Operation of gears that do not conform to regulatory specifications (for example, mesh sizes too small, nets exceeding regulatory lengths, and light fishing) is also very common. In the offshore fishery, 'copy-cat vessels' (vessels which exist in duplicate versions, share the same looks and name, but operate using a single fishing license) are thought to operate in significant numbers. Many fishing vessels over 30 feet in length are licensed as inshore fishing vessels, even though their size characteristics establish them as offshore vessels. This way of registering and licensing vessels allows larger-scale vessels to fish in inshore areas from which they would otherwise be excluded. It is thought that if vessels were licensed in line with official size rules, the offshore fleet would multiply severalfold. Some offshore vessels are known to tranship illegally at sea for direct exportation to other countries in the region. More significant, especially in the south in Myanmar, is the unreported landing of fish directly in Thailand by Myanmar vessels. Efforts in monitoring, control and surveillance and active law enforcement by the DOF are largely insufficient. The limited management regulations that exist are not policed or enforced to a sufficient degree (Hosch 2015).

90. **Open access and the 'race to fish' is the primary driver of depletion and overfishing.** Open access also plays a significant role in the decline of freshwater fisheries. Although a tender system exists in many freshwater areas, tender rights are allocated on an annual basis, creating incentives that favor maximizing extraction over management. Poor enforcement of laws and regulations has compounded the problem. There are five key problems that demand the attention of policymakers:



- (a) A lack of effective leadership and accountability for deciding who should get what and how it should be managed
- (b) A weakened rule of law
- (c) The unequal distribution of power and influence
- (d) Corruption
- (e) A lack of management capacity and expertise

91. **For marine fisheries, the primary conflict is over the dividing line between inshore and offshore.** By law, inshore fisheries lie within 10 nautical miles of the coastline and are reserved for SSF. Incursion of offshore vessels into inshore fishing grounds is said to occur particularly in areas where deep water is found within 10 nautical miles of the shore, such as the Mawtin Coast region of Rakhine (WCS Myanmar 2018). Islands and other geographical features also allow for broad interpretation of where the inshore-offshore line lies and both offshore and inshore vessels routinely follow the fish wherever that takes them.

92. Despite common illegal practices among inshore fishers (for example, fishing in closed areas and using illegal gear such as baby trawls), illegal encroachment by offshore fishing vessels is commonly believed to be the major cause of rapid resource depletion inshore. Illegal trawling of inshore waters by large vessels licensed to fish in the open waters (or not licensed at all) also appears to be the most common source of resentment among inshore fishers. At the very least, offshore vessels seem to be responsible for localized depletion. Anecdotally, inshore fishers in southern Rakhine say that they do not bother fishing for up to a week after a large trawler sweeps their fishing grounds.

93. However, the scale and complexity of the governance challenge appears to make the DOF reticent to put a lot of effort into it solving it. Control of illegal fishing offshore is the responsibility of the Myanmar Navy, Army, and Combined Security Team and does not include any DOF personnel or any knowledge of fisheries law. This lack of focus and expertise on fisheries reduces management effectiveness.

94. Large declines in numerous species of freshwater fish are reported throughout the Ayeyarwady Basin. Based on interviews with fishers, Baran et al. (2018) report that perceptions of inland stock decline increased from 2007 onward and that the decline has accelerated particularly rapidly from 2012. Affected stocks include commercially valuable species, such as eel, hilsa, freshwater shrimp, and Wallago catfish, brackish water species such as barramundi and Indian threadfin, and a variety of cyprinid and catfish species and smaller endemic fishes. Declines in freshwater capture fisheries production as reported by Baran et al. (2018) were ascribed by the fishing communities interviewed to combinations of the following:

- Loss of wetlands to agriculture and aquaculture ponds
- Pollution from industry and agriculture
- Overfishing of dry season refuge areas
- Harmful fishing practices such as poisoning and electro fishing
- Habitat degradation, for example, the clearing of flooded forests and mangrove areas

95. Despite these pressures, the capacity for regeneration of freshwater fisheries is remarkable. This may be due to the fact that much of the annual catch from freshwaters are of young fish, of less than one year in age, and the capacity that inundated floodplains have for renewing fish resources. Anecdotally, the value of fish produced from freshwater fisheries has declined, with larger more valuable fish species being replaced by smaller, fast recruiting species.

96. **Parliament has mandated the installation of a Vessel Monitoring System (VMS) to track the location of offshore fleet** by September 1, 2019. The DOF is now in the process of issuing a tender notice to solicit proposals from international VMS service providers. According to DANIDA, which is supporting efforts by the DOF to install

VMS on offshore vessels, the Government of Myanmar (GoM) will fund and build the onshore infrastructure and the lease software necessary for the management of VMS. The offshore fishing industry has agreed to pay for the transponders (roughly US\$3,500 per vessel) and annual satellite subscriptions (roughly US\$1,200 per year). It appears that a significant driving factor in the adoption of VMS has been the Thai experience with the European Union (EU) yellow card restrictions on importing fish products from Thailand. Now successfully lifted due to reforms in Thailand that included VMS installation, Myanmar also covets EU market access. From interviews with DOF officials, it also appears that a VMS system will be a part of future DOF plans to lease access to Myanmar waters to international fishing operations.

## Conflict between farmers and fishers over water and land use

97. Many rice farmers will want their fields drained at the end of the wet season so that they can plant the summer crop, whilst fishers may want to retain water on the floodplain for as long as possible to increase production and until a time when fish prices rise. Reportedly, most weirs and gates installed are primarily used for flood protection purposes, whereas portable surface water pumps are mainly for irrigation. Oftentimes, water regulation decisions are taken without consultations with a wide range of stakeholders, resulting in conflict among them. Such conflict can be serious, resulting in violence in some cases in the Delta, such as when employees hired to guard leasable or tender fisheries target local residents whom they suspect of poaching fish.

98. Conflict between shrimp farmers and rice farmers can also be serious, particularly in some townships of Rakhine once the wet season has ended and shrimp farmers allow saline water to enter neighboring paddy land. It may even have been a deliberate strategy used by unscrupulous shrimp farmers to allow for the expansion of their shrimp farms. Conflict can also exist between large-scale and small-scale fishers contesting the same fishing grounds. For example, most tenders awarded to stow net fishers will be in the open fishery, but small-scale fishers are not allowed to fish in nearby areas. 'Inn-thagyi' (fishery leaseholders) will often employ (local) guards to prevent poaching of stocks by small-scale fishers, increasing tension in the community.

99. Large-scale fish farming was promoted by the military government from 1989 onward as part of a wider policy to encourage industrial scale forms of agriculture. As a result, large areas of untitled land were allocated to investors in what are now the main fish farming areas. These concessions included a mix of wetlands used for fisheries and untitled lands that were utilized for paddy cultivation. Households who lost access to agricultural land reported declines in income of up to 75 percent in the first few years following confiscation. Fishing incomes also fell dramatically due to loss of access to fishing grounds. Food insecurity rose and older children were forced to drop out of school to work. In some cases, entire households migrated permanently as a coping strategy (Mark and Belton, forthcoming). Officially sanctioned fish farm development in the delta has thus resulted in highly inequitable outcomes. Future efforts in fish farm development should not replicate these mistakes.

## Aquaculture environment interactions and habitat conversion

100. **The area of mangroves in Myanmar is the second largest in Southeast Asia after Indonesia, totaling over 500,000 ha. Rates of mangrove loss in Myanmar are the highest in the region,** with the total mangrove area declining by 5.5 percent over the period 2000–2012, against an average for Southeast Asia of 2.1 percent (Richards and Friess 2016; Table 4). Nevertheless, rates of clearance appear to have slowed compared to the decade 1990–2000, when the annual rate of mangrove deforestation in Myanmar stood at 2.9 percent (Giri et al. 2008). Myanmar has three major mangrove areas: Rakhine State, the Ayeyarwady Delta, and Tanintharyi.

From 1980 to 2007, total mangrove coverage in Rakhine State decreased from 413,850 ha to 240,968 ha. There were also major reductions in mangrove cover in Ayeyarwady. Mangroves in Tanintharyi, the second largest mangrove area in Myanmar, are relatively well-preserved (Veettil et al. 2018), but even here, major deforestation fronts have been identified (Giri et al. 2008).

Table 4

Myanmar mangrove area and loss from 2000–2012

Total mangrove area in 2000 (ha)	Mangrove deforestation (ha)	Mangrove habitat area lost (ha)	Mangrove loss, 2000–2012 (%)
502,466	27,957	27,770	5.53

Source: Richard and Friess 2016.

101. **Aquaculture has not been a leading cause of mangrove loss in Myanmar.** Giri et al. (2008) find that mangrove deforestation in Myanmar over 1975–2005 occurred mainly due to overexploitation of mangrove forests for fuel wood collection, charcoal production, and illegal logging, followed by encroachment for paddy cultivation. They estimate that 98 percent (293,035 ha) of mangrove deforestation in Myanmar during 1975–2005 was due to agricultural expansion. During the same period, approximately 2 percent (6,870 ha) of forests were converted to aquaculture. Richards and Friess (2016) found that rice agriculture was the major driver of mangrove loss in Myanmar from 2000 to 2012, accounting for 87 percent of mangrove deforestation over that period, whereas aquaculture expansion contributed 1.6 percent.

102. Banner-Stephens (2018) reports that although some primary conversion of mangrove forests to shrimp farms has occurred historically in Myanmar (mainly before 2000), present-day shrimp farms, located in areas once covered by mangrove forests are typically not the primary drivers of deforestation. Rather, they have been constructed in places where the mangrove has already been cleared for charcoal production and paddy cultivation. Regardless of the drivers, mangrove habitat conversion has likely contributed to declines in coastal fisheries resources, given the crucial ecological role that mangroves play as nursery habitat. Mangrove loss is also likely to have affected the potential for shrimp aquaculture in Myanmar, which is largely dependent on naturally occurring shrimp PL from estuarine and mangrove environments.

103. **Conversion of wetlands to inland fishponds has had significant environmental impacts.** Lands that have no formal title are legally defined as ‘wastelands.’ Large-scale aquaculture development in the delta during the 2000s took place largely on ‘wastelands’ allocated to concessionaires. Mark and Belton (forthcoming) report that the expansion of fish and paddy farms during this period transformed seasonally flooded pasture and permanent wetlands that had previously been used for fishing and disrupted the annual spawning migrations of wild fish between river and floodplain, causing fish populations to decline significantly. Informants from Maubin township estimated that they lost access to more than 50 percent of the area that they had previously fished as a result of fish farm development and that peak season fishing incomes fell by three to four times.

104. **The breeding habitat of the endangered sarus crane is threatened by fish farm expansion.** This iconic species (the world’s tallest flying bird) is highly endangered globally. A resident population is found in the townships of Maubin and Wakema where they nest and feed in deep water rice fields and seasonally flooded wetland habitat. Maubin is one of the three delta townships with the highest rates of fish farm development. Wakema is located just to the west of Maubin and is a new frontier for spillover development of fish farms. The deepwater rice fields on which these birds depend are less productive than fields in areas with better drainage, making their conversion to aquaculture an attractive option for those who can afford, and obtain permission, to do so (Slover 2018).

# Labor and working conditions in fisheries

105. There is mounting evidence of exploitative labor conditions in Myanmar's offshore fishery, comparable to those recently exposed in Thai fisheries. Workers on rafts in the set bagnet fishery in Ayeyarwady Region and Mon State face conditions of bonded labor, extremely arduous and dangerous working conditions, and violence (BBC 2018; Nyein and Matthew 2017; Wai 2018). Workers in other sections of the offshore fleet (for example, the driftnet fishery) may also face similar problems, but information is scant. In the wake of a series of slavery scandals in the Thai offshore fishing fleet, the EU along with U.S. buyers of farmed shrimp have placed considerable pressure on Thailand to clean up its trawl fishery (which provides fishmeal for feed). Thailand implemented a series of reforms in response and is acknowledged to have turned the corner on transparency especially in terms of human rights and labor abuses in their offshore sector. This experience offers lessons to Myanmar on how to tackle dangerous and exploitative work in fisheries and preempt international censure for failing to address these problems.





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# 4 CURRENT CONTEXT FOR ACTION



# CURRENT CONTEXT FOR ACTION

## National Plans for agriculture, livestock, and fisheries

106. The **Myanmar Agricultural Development Strategy (ADS)** provides strategic directions for the Myanmar Agriculture Sector for 2018–2023. In relation to fisheries, the ADS includes the following outputs on fisheries and aquaculture under the productivity ‘pillar’.

- 2.7.14. Aquaculture seedling infrastructure (hatcheries and breeding ponds) for production and distribution of fish and shrimp seeds reorganized, including privatization where appropriate.
- 2.7.15. Identification, inventory, and fishery resource conservation of adaptable fish species established.
- 2.7.16. Network of Aquaculture Technology Centers (Koica Research Center - Marine Biology Departments of Universities of Mawlamaine, Patheingyi, Meiktila, and Yangon), with supporting laboratory facilities established.
- 2.7.17. Provision and availability of fishing infrastructure facilitated and aquaculture initiatives including land development and cage and pen technology integrated with existing ponds or reservoirs under appropriate legal frameworks.
- 2.7.18. Preparation of a new Fisheries Law.

107. Although the **DOF Annual Yearbook (2018)** remains production-focused, it is worth noting the inclusion of an introductory section entitled “Vision, Objectives, Policy and Plans” (see in the following paragraphs) that demonstrates awareness of the FAO Code of Conduct for Responsible Fisheries and of current international standards of best practice for fisheries management.

- **Vision.** Sustainable development of fisheries sector for security, improvement of the socioeconomic condition of rural people, and contribution to the economic development of the nation based on fisheries industry.

### **Objectives:**

- o Promulgation of fisheries laws and implementation of action plans in line with Sustainable Development Goals.
  - o Availability of qualified information and collection of statistical data related to fisheries sector in line with the standard indicators.
  - o Systematic implementation of fisheries co-management and ecosystem approach to improve the fisheries management.
  - o Development of aquaculture industry by implementation of advanced techniques, including Good Aquaculture Practices (GAP).
  - o The implementation of research and development, extension and awareness services, and human resources development oriented toward sustainable use of fisheries resources.
  - o The compliance with quality standards of fishery products aligned with market requirements.
- **Policy:** Ensuring food security, food safety, and sustainable development of fisheries sector by conservation of fisheries resources in accordance with the fisheries laws.

108. The **DOF National Plan 2018** also includes plans to conducting routine research on marine and freshwater habitats for fish species identification and stock assessment. Enhancing research activities in support of fisheries management and development, including research in conservation and protection of enlisted endangered aquatic species and their habitats is recognized as a priority.

## Efforts to improve fisheries in Myanmar

109. There are currently four bilateral donor and two FAO-funded aquaculture development projects operating in Myanmar, with a total value of approximately US\$39 million (DOF 2016). Most projects have a focus on extension provision, with the aim of directly enhancing incomes and/or nutrition for very small-scale fish farming households. The largest of these projects (the Myanmar Sustainable Aquaculture Program [MYSAP], funded by the EU) has a policy component, which aims to facilitate the DOF in developing a National Aquaculture Development Plan (NADP) in consultation with other stakeholders. MYSAP also has a coastal aquaculture development component, but its implementation has been hampered by an inability to obtain permission to work in Rakhine State. Three of these projects work in Myanmar's CDZ (an arid area with few ponds), with rather limited efforts targeted at the Ayeyarwady Region, where the majority of Myanmar's aquaculture occurs. A small FAO-funded project (US\$0.25 million) is piloting improvements to data collection on fisheries and aquaculture production in the Yangon Region, with a view to possible national scale-up.

110. Fisheries have received less donor support than aquaculture. The largest project is the DANIDA-funded Sustainable Coastal Fisheries (SCF) project (approximately US\$10 million) which aims to improve management of coastal fisheries in Tanintharyi and Rakhine. Like MYSAP, SCF implementation has been hampered by an inability to obtain access to project sites in Rakhine. Some smaller projects implemented by conservation NGOs WCS and FFI seek to promote marine conservation and marine spatial planning. Inland fisheries are relatively underrepresented. A medium-size project (AU\$2.6 million) implemented by WorldFish aims to improve inland fisheries governance in the delta, and a US\$6million FAO-funded project seeks to strengthen adaptive capacity and resilience in fisheries and aquaculture.

111. These efforts represent a number of potentially useful approaches to aquaculture and fisheries development but are not well-coordinated and have somewhat patchy geographical coverage and are often small-scale. The level of investment accorded to fisheries in general, and inland fisheries in particular, is disproportionately small, given that they continue to account for a much larger share of fish production and livelihoods than aquaculture, and face more severe challenges to long-term viability than aquaculture. Moreover, most of these projects focus primarily on producers or communities, with less attention to supporting value chain issues, including infrastructure and credit supply. Moreover, many of the governance and policy issues affecting both aquaculture and fisheries (for example, land-use policy, enforcement in offshore fishing activities) are outside the sphere of influence of the DOF, and thus require higher-level policy engagement if change is to occur.

112. Until very recently, no Myanmar university had a dedicated fisheries or aquaculture curriculum, but the Department of Zoology, University of Yangon, has recently opened a B.Sc. Fisheries and Aquaculture program and an M.Sc. Aquaculture program with support from the MYSAP project. The national parliament voted in favor of establishing a national fisheries university in 2017, but it appears that this is yet to be initiated. Building human and institutional capacity to effectively support the modernization of Myanmar's aquaculture industry will be crucial if it hopes to follow a similar development trajectory to that of neighboring countries. Bangladesh, Vietnam, and Thailand have all benefited from strong fisheries departments and research and education systems in the field of aquaculture. Institutions including Bangladesh Agricultural University, Thailand's Department of Fisheries Research Stations, Kasetsart University, and Asian Institute of Technology, and Vietnam's Can Tho University and two research institutes for aquaculture—all play an important role in supporting industry and government through the provision of well-trained workers and practically oriented research.

# Ongoing projects in Fisheries

113. There are a number of ongoing projects in Myanmar on marine fisheries, freshwater capture fisheries, and aquaculture as summarized in the following tables.

## Cross-Cutting Fisheries-Aquaculture Projects

1. Strengthening the Adaptive Capacity and Resilience of Fisheries and Aquaculture-dependent Livelihoods in Myanmar		
<b>Budget</b>	US\$6,000,000	<b>Objective:</b> To enable inland and coastal fishery and aquaculture stakeholders to adapt to climate change by understanding and reducing vulnerabilities, piloting new practices and technologies, and sharing information
<b>Duration</b>	2016-2020	
<b>Implemented by</b>	FAO	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Mainstreaming adaptation into the national-, regional/state-, and township-level policy and regulatory framework for the fisheries/ aquaculture sector</li> <li>• Development of community-based adaptation and disaster risk management plans based on climate change vulnerability assessments</li> <li>• Demonstration of adaptation practices and demonstration of early warning systems in fishers and fishing communities in vulnerable coastal and inland water regions as well as fish farming communities</li> </ul>
<b>Geographic focus</b>	Nationwide	

2. Improvement of Data Collection of Fisheries and Aquaculture Production: Pilot System for the Yangon Region		
<b>Budget</b>	US\$250,000	<b>Objective/activity:</b> To develop better knowledge of the exploitation of fisheries resources and livelihoods of fishing communities, contributing to a more sustainable development of fisheries for food security and poverty alleviation
<b>Duration</b>	2016-2018	
<b>Implemented by</b>	FAO	
<b>Geographic focus</b>	Yangon region	

## Aquaculture Projects

1. Myanmar Sustainable Aquaculture Program (MYSAP)		
<b>Budget</b>	EUR 22,250,000	<b>Objective:</b> To support sustainable intensification of the aquaculture sector, thereby, realizing its potential for food security, nutrition, and livelihoods
<b>Duration</b>	2017-2021	
<b>Implemented by</b>	German Agency for International Cooperation ( <i>Deutsche Gesellschaft für Internationale Zusammenarbeit, GIZ</i> )	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Policy development and reform, including elaboration of the NADP</li> <li>• Improvement of the quality of service provision in the aquaculture value chain through development of higher education curricula and relevant job profiles</li> <li>• Sustainable intensification of small-scale freshwater aquaculture through improvement of seed and feed quality, strengthening of hatchery and nursery facilities, and enhanced biosecurity and disease management and control</li> <li>• Improvement of coastal aquaculture value chains through establishment and strengthening of hatcheries and rehabilitation of mangrove forests</li> </ul>
<b>Geographic focus</b>	Ayeyarwady, Mandalay, Sagaing, Shan, Rakhine, Yangon	

## 2. Promoting Sustainable Growth of Aquaculture in Myanmar to Improve Food Security and Income for Communities in the Ayeyarwady Delta and Central Dry Zone (MYFish-Culture-MYFC)

<b>Budget</b>	US\$3,284,592	<b>Objective:</b> To conduct research on the development of small-scale homestead-based aquaculture (SSA)
<b>Duration</b>	2015–2018	
<b>Implemented by</b>	WorldFish	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Organization of smallholders with commercial potential to form SSA producer groups</li> <li>• Provision of technical extension services and financial assistance to smallholders</li> </ul>
<b>Geographic focus</b>	Ayeyarwady Delta and CDZ	

## 3. Managing Aquatic Agricultural Systems to Improve Nutrition and Livelihoods in Rural Myanmar (MYNutrition)

<b>Budget</b>	Unknown	<b>Objective:</b> To improve the nutrition and livelihoods of poor, rural households in aquatic agricultural systems in Myanmar
<b>Duration</b>	2015–2018	
<b>Implemented by</b>	WorldFish	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Improving production and productivity of household ponds and dykes, using innovative technologies that include small fish and carp in ponds</li> <li>• Increasing total and small fish production and fish species diversity in wetlands through sustainable management and enhanced stocking of small fish</li> </ul>
<b>Geographic focus</b>	Ayeyarwady Delta and CDZ	

## 4. Improvement of Tilapia Seed Production and Grow-out Culture Management in Myanmar

<b>Budget</b>	US\$204,000	<b>Objective/activity:</b> To provide technical assistance to Myanmar on introduction of advantaged tilapia strain/breeds, building fish bloodstock management, fish breeding system, hatchery management and culture technique to resolve the key issues in every step of tilapia production procedure
<b>Duration</b>	2016–2018	
<b>Implemented by</b>	FAO	
<b>Geographic focus</b>	n.a.	

## 5. Project for Small-scale Aquaculture Extension for Promotion of Livelihood of Rural Communities in Central Dry Zone

<b>Budget</b>	JPY 420,000,000	<b>Objective:</b> To promote small-scale aquaculture for the improvement of livelihoods
<b>Duration</b>	2014–2019	
<b>Implemented by</b>	Japan International Cooperation Agency (JICA)	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Demonstration of seed production and aquaculture technologies</li> <li>• Capacity development of extension service providers on aquaculture technologies</li> <li>• Establishment of effective small-scale aquaculture promotion processes at the state/region and district levels, including farmer-to-farmer exchange procedures</li> </ul>
<b>Geographic focus</b>	CDZ	

## Fisheries Projects

1. Improving Fishery Management in Support of Better Governance of Myanmar's Inland and Delta Fisheries (MYFish 2)		
<b>Budget</b>	Unknown	<b>Objective:</b> To maximize sustainable small-scale fisheries (SSF) production in ways that provide equitable benefits to stakeholders in fish-dependent communities
<b>Duration</b>	2017–2020	
<b>Implemented by</b>	WorldFish	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Studies on existing fishery management practices and the assessment of their performance on fish production and benefit distribution</li> <li>• Field testing and adapting improved fisheries management approaches for different access arrangements</li> <li>• Strengthening of the research and development capacities of the government and other stakeholders</li> </ul>
<b>Geographic focus</b>	Ayeyarwady Delta and CDZ	

2. Sustainable Coastal Fisheries		
<b>Budget</b>	DKK 66,000,000	<b>Objective:</b> To secure sustainable livelihoods of coastal communities through co-management of inshore fisheries
<b>Duration</b>	2017–2020	
<b>Implemented by</b>	DOF with support from DANIDA	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Integration of co-management into the legal and regulatory framework</li> <li>• Capacity development on co-management, monitoring, control, surveillance, and marine inspection at country, state/region, and district levels</li> <li>• Establishment of community-level co-management institutions</li> </ul>
<b>Geographic focus</b>	Rakhine State and Thanintharyi region	

## Natural Resources Management Projects with Anticipated Co-Benefits on Fisheries

1. Ridge to Reef: Integrated Protected Area Land and Seascape Management in Tanintharyi		
<b>Budget</b>	US\$5,250,000	<b>Objective:</b> To secure the long-term protection of Key Biodiversity Areas in Tanintharyi through integrated planning and management at land and seascape scales, with interconnectivity from ridge to reef
<b>Duration</b>	2017–2023	
<b>Implemented by</b>	United Nations Development Programme (UNDP)	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Enhancing the connectivity of biodiversity-rich land and seascapes in Tanintharyi and integrating their planning and management processes</li> <li>• Strengthening management and threat reduction in target proposed protected areas, smallholder zones, and corridors</li> <li>• Piloting a National Biodiversity Survey framework and operationalizing a geospatial platform within Tanintharyi regional government</li> </ul>
<b>Geographic focus</b>	Tanintharyi region	

2. Strengthening the Inle Lake Management Authority to Improve Conservation and Development		
<b>Budget</b>	US\$1,419,000	<b>Objective:</b> To address the adverse environmental and socioeconomic impacts of environmental degradation through enhanced management of the Inle Lake watershed
<b>Duration</b>	2018–2020	
<b>Implemented by</b>	UNDP	<b>Activities:</b> <ul style="list-style-type: none"> <li>• Strengthening the capacity of the Inle Lake Management Authority</li> <li>• Development of a sustainable financing plan for the management of the Inle Lake watershed</li> <li>• Provision of support to community-level activities to address environmental challenges</li> </ul>





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# 5

## RECOMMENDATIONS



# RECOMMENDATIONS

114. The following set of recommendations is provided for the fisheries sector. The recommendations build on the preceding review, which has identified significant untapped potential of fisheries and aquaculture to contribute to more sustainable and equitable development and growth in Myanmar. They also take into account, and seek to build on, promising approaches and initiatives piloted by ongoing overseas development-assistance-funded projects in Myanmar. The recommendations add value to the existing efforts within the sector by providing an integrated approach based on a sector-wide assessment and if implemented, would have the potential to generate impact at a far larger scale than the incremental contributions made by the existing project portfolio.

## Marine fisheries

### Governance

115. **Establish effective monitoring, control, and surveillance (MCS) to improve conservation and reduce the inevitable conflict that surrounds unclear rules and boundaries.** The following issues are fundamental to effective MCS:

- Developing capacity in the DOF and relevant enforcement/judicial agency for MCS—establishing an MCS Unit and developing the capacity to collect data and prepare a case against illegal fishing activity.
- Enforcing the closed season—the annual closed season extends from mid-May to mid-August but is often not enforced or are too many loopholes.
- Enforcing the ban on illegal fishing gear.
- Monitoring fishing by foreign and domestic vessels using VMS.
- Enforcing the inshore-offshore fisheries boundaries—the zones need to be clearly defined by GPS points and enforced through VMS and other methods.
- Creating and enforcing Marine Protected Areas

116. **Rationalize fishing boat and gear licenses.** There are currently too many boats chasing too few fish. This excess fishing capacity is very common under open access and is a significant driver of overfishing and depletion as well as economic waste. Combined, stronger access rights, co-management institutions, and catch allocations create the incentive to reduce both overfishing and overcapitalization (too many boats) while still delivering community benefits to inshore fisheries.

117. **Allocate catch within and between offshore commercial and inshore small-scale fishers to reduce conflict.** This will mean setting quotas for inshore and offshore fisheries based on assessment of target fish stocks, licensing all vessels, and clearly defining and enforcing the physical boundaries between inshore and offshore fisheries. The limits between the two should remain geographical, not based on relative volume of catch. This would reduce conflict and create opportunities to reduce economic waste and destructive fishing practices.

118. **Combine input restrictions (for example, licensing, gear restrictions, and closed seasons) with output restrictions (for example, catch quotas) based on stock assessments.** With catch allocations, good scientific advice, strong co-management institutions, and effective monitoring of landing sites, it may be possible to manage catch levels, in addition to managing where, when, and how people fish. Giving greater control, subject to strict sustainability criteria, empowers fishers to maximize their own preferences for economic and social

benefit. It will be necessary to assess the health of marine fish stocks to set sustainable target harvest levels for quotas. Once data collection capacity has increased, that information should be used to assess the health of fish populations, including scientifically rigorous stock assessments. Tropical fisheries are typically multispecies fisheries, making them more complex than temperate fisheries where fish populations are often more distinct. However, there are many options for data-poor stock assessments using fishery-dependent data (that is, combining landings data with localized biological parameters), and these assessments are crucial for understanding the dynamics of fished populations and for informing management decisions, including setting sustainable harvest targets for species or complexes of species.

119. **Conduct an assessment of how Thailand has gone about making regulatory changes in fisheries to prevent labor abuses at sea** and develop recommendations on how Myanmar could do the same.

## Financial and institutional

120. **Assess debt relationships in SSF and offer alternative financial mechanisms.** Small-scale fishers in Myanmar largely finance their fishing operations through loyalty arrangements with fish buyers and collectors (middlemen) who commonly advance money, fishing gear, petrol, food, and even cigarettes to fishers. These arrangements are important drivers of fishing practices, including where, when, how, and how much fishing takes place and without them, many small-scale fishers would be unable to finance their fishing operations. In some, but not all cases, these relationships can be exploitative and can encourage overfishing and destructive fishing practices. More research needs to be done to better understand these relationships and when and how alternative forms of credit may benefit small-scale fishers. The potential role of community organizations in managing credit, including lessons learned from the DRD Mya Sein Yaung (MSY or Evergreen Village Development Program), which includes a revolving fund, needs to be considered. Linking lower-cost financing of fishing operations to legal and (eventually) sustainable fishing practices would help support stock recovery.

121. **Increase participation of communities in co-management.** Empowering communities to set management goals and to receive some of the benefits of more sustainable fisheries will reduce conflict and incentivize stewardship of the resource. There are a number of co-management efforts already underway in Myanmar, however, these are all pilot projects and there will need to be widespread legal reform, as well as extensive capacity building at the community level and the DOF before these projects can be expanded. There are a number of efforts in other parts of Asia that could provide useful templates, including Fair Trade Fishery Associations (FAs) in Indonesia and Japanese Fishery Cooperative Associations (FCAs). Linking co-management efforts, as recommended earlier, to formal credit provision could provide a means of incentivizing participation and compliance.

## Freshwater fisheries

### Governance

122. **Enforce closed seasons.** As in marine capture fisheries, the closed season is largely ignored by small-scale fishers, although Inn-thagyi (owners) appear more likely to adhere to the restrictions. The enforcement of the closed season (typically May–June) for freshwater is not well backed up by science. For floodplain fisheries, this period is too late in the year to protect broodstock upon which the following season's productivity depends. The decentralization of freshwater fisheries governance and development of locally applicable legislation, rules, and regulations could allow for more accurate closed season timings to be introduced. However, enforcement will remain a major challenge.

123. **Reduce the use of illegal gear and techniques.** The use of illegal fishing gear such as electro fishing is widespread, especially during the dry season. Other gear such as fence nets and trammel nets are tolerated by the authorities despite being technically illegal. Legal types of gear that are outside stated specifications, such as mesh size are also commonplace, including stow net code ends. Some regions and states have now passed legislation making it an offence to be in possession of illegal fishing gear rather than previous laws which required offenders to be caught in the act of using the illegal gear.

124. **Use GIS for demarcation of Inn, tender, and open fishing grounds; license freshwater fishers; and issue ID cards.** The maps and charts used by the DOF in the Inn Book date back many years and need to be updated to include hydrological changes in river courses, wetland extent, and land use. Modern GIS and mapping techniques should now be used to demarcate Inn and tender boundaries. This would reduce conflict between fishing and farming areas. The MFF dabbled with small-scale fisher registration after Cyclone Nargis. These efforts could be renewed and expanded. WorldFish recently started a project, MyFish 2, to explore management options for leasehold fisheries (Inn) in the delta. This project is accumulating the first detailed database for Inn in modern times. It is also evaluating the effectiveness of the common practice of stocking with fingerlings from hatcheries.

## Financial and institutional

125. **Reform the freshwater fishery law using a broad consultative approach to reduce conflict among fishers and between fishers and farmers.** Conflict in freshwater fishing areas can be over water, land, or fish stocks. In the delta, there are several well-documented cases of violence and even deaths over water management disputes between fishers and farmers.

126. **Increase participation of inland communities in fisheries co-management.** Myanmar is only beginning to involve communities in co-management of freshwater fisheries. As co-management approaches are piloted, it is important that objective assessments of their success or failure are recorded and shared. Changes to tender allocations for communities will require changes in both formal and informal institutions.

## Technical

127. **Improve the information base for freshwater fisheries.** Information on freshwater fisheries ecology, biology, catch, bycatch, and effort is inadequate to inform effective management. Creating a clear picture of production trends is also compounded by the fact that freshwater fish production levels will vary from year to year, based on the extent of the flood, that is, longer, stronger wet seasons being significantly more productive than shorter, weaker ones (El Niño versus La Niña years). Lessons can be drawn from Cambodia in the late 1990s when a concerted effort by the government produced new science-based estimates for freshwater fisheries production, leading to a better understanding of the actual production changes in statistical reporting.

128. **Protect important areas of freshwater biodiversity.** Myanmar has a large number of freshwater sites of high ecological value. The 2004 Myanmar Wetland Inventory surveyed 99 different wetlands and identified 17 sites as globally important. Inle Lake, Indawgyi lake, and Mogaung Chaung are all Ramsar sites and stretches of the Ayeyarwaddy River support populations of Irrawaddy Dolphin. Inle Lake, which forms part of the 1,891 square mile Inlay Lake Biosphere Reserve has at least nine endemic fish species including the famous Inle Carp (*Cyprinus intha*). In recent years, a number of exotic fish species, including *Oreochromis nilotica* have found their way into the lake and look to be displacing some of the native fish species. A long-term Restoration and Conservation Plan for Inlay Lake was agreed in 2014 but funding for full implementation is yet to be found. Action needs to be taken urgently to conserve this unique resource and the iconic livelihoods of the Intha people.



129. **Strengthen the conservation of migratory species.** Very little is known about the migratory patterns of fish in Myanmar. WorldFish has carried out studies looking at the main Hilsa migration routes in the delta. Hilsa species are anadromous (that is, migrate from marine waters to freshwaters to breed) and protection of breeders and juveniles is essential in helping maintain stocks in the region. Other important and high-value migratory species include the catadromous (living in freshwater and breeding at sea), *Macrobrachium* prawns, but their life cycles must be better understood before management measures can be introduced.

# Aquaculture

## Governance

130. **Design a completely new survey-based system for collection of national aquaculture statistics, starting with a national aquaculture census.** This could be incorporated into the national agricultural census if the frame is designed so that key locations for aquaculture are sampled adequately.

131. **Establish a national registry of fish farms using georeferenced data** as a basis for future monitoring and licensing. Regularize the status of illegally constructed ponds, if their operators are in possession of legal agricultural-use rights and land is not the subject of land restitution claims.

132. **Reform the Farmland Law (2012) to promote the development of a fish farming sector with more inclusive characteristics.** Current restrictive land classification definitions in the Farmland Law should be revised as follows: first, designate aquaculture as a form of agriculture, in line with the definition of “agricultural land” found in the National Land Use Policy (2016); and second, grant smallholders the freedom to farm in the manner of their choosing on any land for which they have use rights. Implemented together, these reforms would allow smallholders to legally convert farmland to which they possess use rights into ponds, increase fish farm tenure security, and facilitate establishment of fish farms outside the handful of areas where regulations have already been relaxed informally.

133. **Establish a system for leasing fishing rights and licensing aquaculture sites in reservoirs and assign regulatory responsibility and control over reservoir fisheries and aquaculture to the DOF.** Base licensing decisions on independent scientific assessment of the environmental carrying capacity of receiving waterbodies. Currently, the MOALI regulations prohibit private sector aquaculture in lakes, reservoirs, and irrigation systems. Impact studies should be conducted to assess the potential for sustainable aquaculture in these areas.

134. **Establish a national legal framework for licensing marine aquaculture sites.** Siting criteria should be based on principles of integrated coastal zone management to ensure complementarity with other potential uses of coastal space (for example, fishing, tourism). Siting decisions should also take into account best practice from countries with significant experience of regulating marine aquaculture (for example, prohibit siting in ecologically sensitive habitats, set minimum requirements for water depth and current speed, do regular fallowing and rotation of sites, and avoid conflicts with resource users with preexisting customary rights). Use of trash fish as feeds and use of wild seed should be banned to encourage sustainable practices.

135. **Establish a system of land-use zoning** to prioritize establishment of hard infrastructure (feeder roads, connections to the electricity grid, canal rehabilitation, and so on) in areas identified as having high potential for future aquaculture development and prohibit future aquaculture expansion in ecologically critical habitats (for example, mangroves, wetlands, sites of importance to endangered species). Aquaculture zoning cannot be developed without a clear policy for land-use planning. Especially in coastal zone, there are many conflicting interest groups and different sectors competing for resources. Aquaculture can conflict with other sectors such as agriculture, industry, tourism, transport, and also within the aquaculture sector.

136. **Establish an integrated coastal zone management starting with Tanintharyi Region to prevent conflicts and protect essential coastal ecosystems as shrimp farming expands.** Intensive white shrimp culture with modern technology started approximately three years ago in Myeik District, Tanintharyi with imported seed, feeds, pond inputs, and equipment from Thailand. Recent success in production has spurred other investors to follow suit and shrimp farming may now develop rapidly in the region. Tanintharyi still has abundant mangrove forests, but shrimp aquaculture has already damaged natural resources and fuelled conflict in other coastal areas. Highlighting the need for an integrated coastal zone management for Tanintharyi.

## Financial and institutional

137. **Support commercial loan facilities for small and medium enterprises (SMEs) in all segments of the aquaculture value chain.** Aquaculture SMEs' access to formal finance is limited. Credit requirements for capital investments and operating costs may be substantial, ranging from the tens of thousands to millions of dollars. The main government agricultural bank Myanmar Agricultural Development Bank does not have the mandate or capacity to provide loans of this kind. Providing partial loan guarantees to commercial banks for loans made to SMEs in the aquaculture value chain could increase financial access by reducing risks to lenders.

138. **Financial sector adjustments and new facilities to support aquaculture investment.** One factor constraining aquaculture development in Myanmar is the lack of financial institutions where financial policies, procedures, capacities, and competency affect demand for aquaculture investment. Interest rates of private banks are high (12–14 percent) and the government-owned Agriculture Development Bank and Economic Development Bank do not favor the aquaculture sector. One option for the government is to work in collaboration with the financial sector to set up pilot scale “aquaculture financing and insurance models” that demonstrate sustainable aquaculture business to stakeholders.

139. **Invest in higher education and vocational training for aquaculture.** Modernizing Myanmar's aquaculture will require a skilled workforce with specialized science-based knowledge in fields including nutrition, animal health, biosecurity, breeding, technical and operational farm management, environmental management, animal welfare, food safety, and logistics (see Svennevig and Lwin 2016). At present, few personnel working in aquaculture have received training of this type. Before a new generation of aquaculture professionals can be trained in Myanmar, it will be necessary to provide opportunities for Myanmar nationals to be educated in practical aquaculture related subjects to post-graduate level at international institutions. Long-term North-South and South-South university-to-university capacity building and training programs should be supported to facilitate this process.

140. **Introduce aquaculture extension services as well as education and awareness to the stakeholders.** Currently, the DOF does not have an active aquaculture extension service. Lessons from neighboring Asian countries with high levels of aquaculture development such as Thailand and Indonesia suggest that government technical extension is important in the early stages of development, but eventually the private feed or medicine distributors take a lead extension role, including the collection of data.

## Technical

141. **Support private producers to shift to domestically produced hatchery shrimp PL.** Myanmar's shrimp sector cannot grow if it remains largely reliant on wild PL, but existing levels of demand for purchased PL are very low. These constraints must be overcome simultaneously if the sector is to expand. Facilitating the uptake of improved production technologies (for example, deepening and liming ponds, treating water and nursing PL before stocking) can increase returns and reduce risk for farms and create sufficient demand for PL to make investing in hatcheries viable.

142. **Revitalize shrimp farming in Rakhine State with a focus on smaller ponds, the use of hatchery seed, feeds, aeration, and independent water supplies.** The gains could be significant. For example, a rough estimate, based on typical production rates in semi-intensive systems elsewhere in the region indicates that if 20 percent of idle traditional ponds in Rakhine State were rehabilitated with sustainable culture systems and designs, including local mangrove rehabilitation, approximately 23,000 tons of shrimp could be produced and US\$115 million gross annual income generated (at US\$5 per kg shrimp).

143. **Help traditional shrimp farms shift to mud crabs.** Traditional shrimp farming areas, especially in Rakhine and Ayeyarwady, that have ceased production should be assessed for mangrove reforestation and the potential expansion of mud crab cage culture and other activities that do not damage mangroves, while cautiously weighting the pros and cons of conducting such activities. Any form of aquaculture would be strictly limited to outside of protected areas, drawing from successful models from neighbouring countries. Some NGOs and CSOs have already been involved in the rehabilitation of mangroves, hence this project could be linked or collaborated with such on-going projects. Small-scale mud crab fattening in mangroves and floating fish cage culture in tidal creeks could generate extra income for communities, if hatchery produced crablets can be used for grow-out instead of wild crablets. In addition to supporting small-scale aquaculture, mangroves also protect coastal communities from floods and provide other ecosystem benefits for fisheries and tourism.

144. **Establish an effective aquaculture animal health management systems and facilities.** If aquaculture is to grow successfully in Myanmar, it must avoid the mistakes made in neighboring countries resulting in epidemics in cultured species that have led to production crashes and significant economic losses. The importation of aquatic animal seed from neighboring countries has become widely practiced especially in shrimp culture. EMS, Enterocytozoon hepatopenaei (EHP), White Spot Syndrome (WSSV), Taura Syndrome Virus (TSV), and other diseases are known to exist in the exporting countries and thus health certificates from seed origin alone is no longer sufficient to prevent the spread of such diseases. Myanmar's health management plan would establish procedures to prevent, treat, and control diseases from imported seed as well as from domestic hatcheries. Strict inspection, quarantine measures, and serious enforcement are necessary to prevent importation of seed with diseases.

145. **Establishment of aquaculture quality management systems (QMS) and certification.** Although there are a few components such as sanitary and phyto-sanitary (SPS) and GAP within the Trade Development Programme (TDP) funded by EU readily available to the seafood export sector in Myanmar, all sustainability programs along production lines (from hatchery to export) should be organized under one umbrella IQMS (Integrated-QMS) system where the QMS of each subsector could be incorporated. Establishment of a QMS for each subsector is necessary before linking to a main IQMS program. In other Asian countries, QMS is available for seed production, grow-out production, post-harvest and processing sectors, and it is a key area reviewed by auditors from certification organizations.

146. **Support production of monosex tilapia seed by the private sector.** Monosex tilapia seed produced by private hatcheries has been crucial to the commercial success of tilapia in Thailand, Bangladesh, and Vietnam. Ensuring seed availability is paramount, and hatcheries can import improved tilapia strains privately, so introducing improved strains such as GIFT through public sector channels is not a major priority. Establishment of monosex hatcheries could be catalyzed by providing support for training, business planning, and co-funding or partial risk guarantees to private sector partners. Companies whose business model is built on the wide dissemination of seed, feed, and information (for example, feed producers that can distribute high quality feed and tilapia seed together as a package) are likely to be suitable partners.

147. **Establish a selective breeding program for rohu.** Successful implementation would likely yield substantial returns to investment over the long term, given that rohu accounts for 70 percent of inland aquaculture production and will remain the mainstay of aquaculture even as it diversifies. Improved brood should be made available at market rates to any private hatchery that wishes to use them. Public sector capacity to operate such scheme is inadequate at present so it should be implemented as a long-term program by an international organization such as WorldFish, with a view to transferring to the DOF at such time as capacity for successful management exists.

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