Socioeconomic characteristics of hilsa fishers in the Ayeyarwady Delta, Myanmar

Opportunities and challenges

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The Darwin-Hilsa[MM] project is developing an incentive-based system of hilsa fisheries management in Myanmar's Ayeyarwady Delta. This study uses a mixed-methods approach to assess the socioeconomic status of local fishing households. Many are extremely vulnerable, owing to the seasonal nature of fishing and unpredictable flows of income. Coping strategies include informal loans, livelihood diversification, and migration, while many flout fishing restrictions to cover costs and repay loans. Given these household characteristics, we recommend monetary or in-kind incentives for compliance with regulations, more inclusive access to suitable financial products, skills training and small-business investment, more co-management institutions, and awareness-raising campaigns.

Contents

Summary

The fisheries sector employs around 3 million people in Myanmar's most impoverished areas and provides an essential food source for many more. The hilsa fish, which migrates between the Bay of Bengal and the rivers of the Ayeyarwady Delta, is a vital resource for Myanmar's small-scale fishing communities. However, unsustainable fishing practices, habitat destruction, and climate change are threatening the hilsa fishery. There is some legislation and regulation to protect fisheries, for instance freshwater and inshore marine fisheries are subject to seasonal closures. However, capacity for effective monitoring and enforcement of regulations is very low and illegal fishing is common. The small-scale fishing communities of the Ayeyarwady Delta live in difficult circumstances. Many are highly dependent on fishing as a livelihood activity and a source of protein and they are highly vulnerable to the seasonality and unpredictability of income from fishing. Government regulation of fishing to protect fish stocks affects fishing households' ability to earn a sustained income. Frequently they flout fishing restrictions in order to pay for living costs and repay loans.

In Bangladesh, which shares hilsa stocks with Myanmar, the government runs an incentive-based management scheme for the hilsa fishery. Following this experience, the Darwin-Hilsa[MM] project aims to design and implement an incentive-based scheme for sustainable hilsa management in the Ayeyarwady Delta, which will support the households who depend on the resource to comply with regulations. This study used a mixed-methods approach to build understanding of the socioeconomic status of local fishing populations, by identifying the constraints they currently face, the opportunities available for socioeconomic improvement, and local preferences regarding potential future options. Methods included a survey of hilsa fishing households, participatory rural appraisal, focus group discussions, and key informant interviews.

The research confirmed that the majority of hilsa fishing households in the Ayeyarwady Region live in challenging socioeconomic conditions and that many are extremely vulnerable. A strong dependence on fishing as a livelihood activity results in unreliable flows of income, undermining the ability and willingness of fishers to comply with regulations that limit access to the fishery or require investment in specific types of fishing gear.

Local fishers use a range of coping strategies to manage food insecurity and erratic income. Agriculture is an important secondary livelihood activity for many, while casual labour allows landless households to supplement their income. Migration is another livelihood strategy that generates significant remittance income for family back home. With limited access to formal credit, many fishers rely on informal loans from moneylenders, fish collectors, and relatives to meet basic needs and for capital investment in fishing and other livelihood activities. But paying back these loans represents a further challenge, with some fishers becoming indebted to fish collectors, who provide them with advances then pay them lower rates for their catch. Others take out further loans to pay back moneylenders and fall into a cycle of debt that accumulates over the years.

This study has generated several recommendations to promote livelihood diversification and resilience. Introduction of a monetary or in-kind incentive system, designed with proper stakeholder participation, could improve the socioeconomic situation of fishing households and their compliance with regulations. Incentives must be appropriate for the social and institutional context to minimise negative unintended outcomes. Financing also needs to be designed with seasonal fishers in mind, for instance with no requirement for repayment during closed fishing seasons. Alternative livelihood support, in the form of skills training or investment capital for small businesses and farming, could improve socioeconomic conditions by reducing dependence on fishing. Support must be based on rigorous needs assessment, with adequate monitoring to ensure it does in fact discourage unsustainable behaviour.

Co-management initiatives could also incentivise sustainable behaviour and build shared commitment to protect the fisheries. A first step is awareness-raising about co-management opportunities and benefits. Where community-level institutions exist, individuals can work together to agree on the design of the system and participate in monitoring and enforcement. Compliance with regulations would also be expected to improve

through the social norms that emerge from collective action. More community savings groups may provide another opportunity to address the seasonality of fishing income and enable households to reduce their debt dependency.

Local fishers frequently blame large-scale commercial fishing activities for the decline in abundance of hilsa. It is important to raise awareness among local fishers about the potential impacts of their own actions on fish abundance, including fishing during spawning seasons, fishing for juvenile hilsa, using nets with small mesh, and blocking river channels with nets. Local fishery associations could play a valuable role in raising awareness. Efforts to raise awareness on the importance and status of the hilsa fishery and how specific regulations can benefit stocks have great potential to improve compliance with, and acceptance of, fishing regulations.

Introduction

1

1.1 The Myanmar hilsa fishery

Myanmar has fisheries of international significance: it is ranked fourth among global inland waters capture producers and seventeenth among marine capture producers (FAO, 2018a). The Food and Agriculture Organisation of the United Nations (FAO) estimated that Myanmar's 2016 fish production was comprised of 38% marine capture, 29% inland capture, and 33% aquaculture (FAO, 2018b). The fishery sector is the fourth largest contributor to the national gross domestic product (GDP) and the fourth largest source of foreign exchange earnings (DoF, 2018a; ILO, 2015).

According to official records of fishing licences, the sector supports the livelihoods of at least 6% of Myanmar's population (men, women, and children), but this figure is likely an underestimate (DoF, 2016). According to estimates from 2008–2014, the inland fisheries sector employs 1.6 million people among the country's most impoverished communities and the marine sector employs 1.4 million, not including those who engage in subsistence fishing (DoF, 2015). The FAO has estimated that fish accounts for about 20% of protein intake for households in Myanmar and 46% of animal protein (FAO, 2018b). This contribution is higher in coastal and delta regions than in the landlocked region of Upper Myanmar (Belton et al, 2015). Since nearly half of the population resides in coastal and deltaic areas (Gregory et al, 2016), fisheries in these areas are particularly important for livelihoods and food security. The fisheries sector is mostly small scale: 87% of the 25,077 registered fishing vessels in Myanmar were 'small' fishing boats in 2017–2018 (DoF, 2018a). Sixty per cent of these were powered, 27% non-powered.

The hilsa shad (*Tenualosa ilisha*, locally known as *Nga Tha Lauk*) moves between the rivers of Myanmar's Ayeyarwady Region and the Bay of Bengal (BOBLME, 2015a). As a delta region, the Ayeyarwady Region depends heavily on fisheries, which contribute around 56% of Ayeyarwady regional government revenues, excluding central government transfers (Soe, 2018). Although hilsa only makes up 1–4.5% of official fish production, it is one of the most important fish species in the region, owing to its relatively high value (DoF, 2016; DoF, 2018a; DoF, 2018b). Almost all fishers in the Ayeyarwady Region catch it and many depend heavily on it for income (Soe et al, 2018).

Recent data suggest that about 64% of hilsa landings come from a combination of offshore and inshore marine fisheries, using powered boats, while 36% come from artisanal freshwater fisheries, using non-powered boats and fixed fish traps inland (DoF, 2018b). In 2017–2018, nearly 12,000 metric tons of hilsa were reported as exports, worth US$32.17 million, making it Myanmar's fifth most valuable exported fish (DoF, 2018a).

Despite their socioeconomic significance, Myanmar's fisheries are poorly documented, owing to decades of economic and political isolation and limited investment and capacity building in government departments and academic institutions (Tezzo et al, 2018). However, there is evidence that overfishing and habitat destruction are threatening the sustainability of the hilsa fishery. Exploitation rates (the proportion of mortality caused by fishing) have been found to reach 0.7 in the Ayeyarwady Delta, well beyond sustainable levels (BOBLME, 2015b). Too many juvenile hilsa are reportedly being caught by commercial trawlers using purse seine nets with tiny mesh and by small-scale fishers using fine-mesh gill nets (BOBLME, 2015a). Water pollution and climate change are also contributing to the decline (BOBLME, 2015b).

1.2 Fisheries governance in Myanmar

Myanmar has been through four major political regimes in modern history: the British and Japanese occupation (1824–1948), the independence era (1948–1962), the military socialist era (1962–1988), market-reform military rule (1988–2010) and the post-2010 transition towards democracy (Tezzo et al, 2018). Fisheries governance has evolved with this political landscape but tends to focus on revenue generation instead of management or sustainability.

The Department of Fisheries (DoF), under the Ministry of Agriculture, Livestock and Irrigation (MoALI), is the main body responsible for conservation and rehabilitation of fishery resources, promotion of fisheries research and surveys, collection and compilation of fishery statistics and information, extension of fisheries sectors, and sustainability of fishery resources (DoF, 2018a). Despite the importance of the sector for the economy, livelihoods, and government revenues, it receives insufficient policy attention and only 0.8% of MoALI recurrent budget goes to the DoF (MoALI, 2016). As a result, monitoring and management are poor across subsectors.

Fisheries legislation is outdated (Soe et al, 2018) and several organisations are helping the DoF to update it.[1] No specific functions are assigned by law to the DoF as a department, but instead they are assigned to individuals, namely the Minister responsible for fisheries and the Director General of the DoF (Tsamenyi, 2011). There is no legislation in place specifically for the hilsa fisheries and a national hilsa fishery action plan is yet to be developed (BOBLME, 2015c).

1.2.1 Inland fisheries

Inland fisheries are managed under three regimes (Soe et al, 2018):

- Leasable fisheries, where fishing rights to floodplain areas are auctioned, usually to individuals on an annual basis
- Tender lot fisheries, where rights to use specific gear (usually large fixed bag nets) in specific stretches of river are licensed to individuals through auction, and
- Open-access fisheries, for which access is free, but most fishing gears still require a licence that can be issued for an annual fee.

Leasable fisheries were introduced during the British colonial era to replace the traditional hereditary system and facilitate the collection of taxes. Tender lot fisheries were introduced in the 1990s, also with the goal of generating revenues. Both these systems of rights allocation reportedly discriminate against small-scale fishers and favour often non-local businessmen who have enough capital to invest in annual fishing licences and who often sublet to operators, leading to conflicts between rights holders and fishers.

Under the *Freshwater Fisheries Law* (1991), a closed season is in place for the protection of spawning and recruitment. This applies generally to all open-access fisheries from May to July, but closure periods can vary between locations depending on the time at which local target species are expected to be spawning and the closures are rarely enforced in the small-scale fisheries (Soe et al, 2018). Catch and captivity of freshwater juvenile fish, spawning fish, and fish ready to spawn are banned from May to August. There are also some species-specific closures and sanctuaries and no fishing is allowed within 300 yards of mangrove forests.

In 2010 the enactment and management of inland fisheries legislation was decentralised, allowing states and regions to address the shortcomings of Union-level fisheries legislation. However, reforms face resistance from powerful business interests and implementation has been slow (Tezzo et al, 2018). The *Ayeyarwady Freshwater Fisheries Law* was drafted in 2012, but it is very similar to the original Union-level law, with a focus on revenue collection and minimal integration of community concerns (Baran et al, 2018; Soe et al, 2018). Nevertheless, co-management approaches have been piloted in leasable fisheries in the Ayeyarwady Region (Langeard et al, 2018) and some community-based fisheries management associations and partnerships have emerged (Soe et al, 2018; Thein et al, 2019). Co-management has also been acknowledged in the amended *Ayeyarwady Freshwater Fisheries Law* (2018).

1.2.2 Marine fisheries

Marine fisheries include inshore fisheries (those located within 10 nautical miles from the coast, including estuaries) and offshore fisheries (those beyond that limit, within the Exclusive Economic Zone). The inshore marine fisheries are managed together with the inland fisheries under the Union-level *Freshwater Fisheries Law* (1991), but poorly defined boundaries make this difficult (Tezzo et al, 2018).

Myanmar's *Marine Fisheries Law* (1990) sets out the country's legal framework for management of offshore national vessels. There is also a law relating to fishing rights of foreign fishing vessels (1989, amended 1993) and although the DoF no longer issues permits to foreign vessels, there are still some joint venture cooperations with foreign-based fishing companies. The navy is responsible for enforcement of offshore fisheries regulations (Ko et al, 2016). Under the *Marine Fisheries Law* (1990) there are two systems for vessel registration: a scheme for national fishing vessels registration and a separate scheme for foreign fishing vessels (Leadbitter, 2017).

The DoF also operates a licensing system to limit access to the fisheries. However, capacity for effective monitoring, control, and surveillance of the marine fisheries is very low. Illegal fishing is common offshore (Ko et al, 2016) and offshore trawlers often stray into inshore fishing grounds. There are also six Marine Protected Areas and some Locally Managed Marine Areas, but enforcement is largely ineffective (Tezzo et al, 2018). Marine fisheries are subject to fishing bans imposed from time to time during the monsoon season (Oo, 2016), but this currently excludes the offshore fishery.

[1] The Danish Government and NGOs including WorldFish are helping the DoF to update the *Marine Fisheries Law*, while others are helping to update the *Freshwater Fisheries Law* at Union and region/state levels.

1.3 Aim and objectives

This study was conducted as part of the Darwin Initiative-funded project 'Carrots and Sticks: incentives to conserve hilsa fish in Myanmar', also known as Darwin-Hilsa[MM]. The project is led by IIED in partnership with WorldFish Myanmar, Network Activities Group (NAG), the Department of Fisheries (DoF) and the Zoology Department of Yangon University. The project aims to design and implement an incentive-based scheme for the sustainable management of hilsa in the Ayeyarwady Delta that also supports the local fisher communities who currently depend on the resource.

In Bangladesh, which shares hilsa stocks with Myanmar, the government runs a compensation scheme for the hilsa fishers who are affected by fishing regulations imposed to protect fisheries. In recognition of the socioeconomic costs of these regulations, the government distributes rice and provides support for alternative income generating activities to affected fishers living inside and around sanctuary areas, which are seasonally closed to fishing (Islam et al, 2016). It also conducts targeted public awareness campaigns. By improving the socioeconomic conditions of fishers, the scheme aims to incentivise compliance with the fishing bans. Although there has been no rigorous monitoring or evaluation of social or ecological impacts, the scheme does appear to have improved socioeconomic conditions and may also be improving compliance with regulations (Bladon et al, 2016).

The design and successful implementation of such a scheme in Myanmar will require some baseline data and a good understanding of the current socioeconomic status of local fishing populations, the constraints they currently face, the opportunities available for socioeconomic improvement, and local preferences regarding potential future options. However, the socioeconomic status of hilsa fishing communities in Myanmar is poorly understood; there are not even any official statistics on numbers of hilsa fishers at township or village level. This study therefore used a mixed-methods approach to collect data on the socioeconomic characteristics and conditions of hilsa fisher communities in the Ayeyarwady Delta. Our aim was to identify the constraints, opportunities, and preferences that will help in the design of incentive-based hilsa fisheries management for Myanmar.

Methods

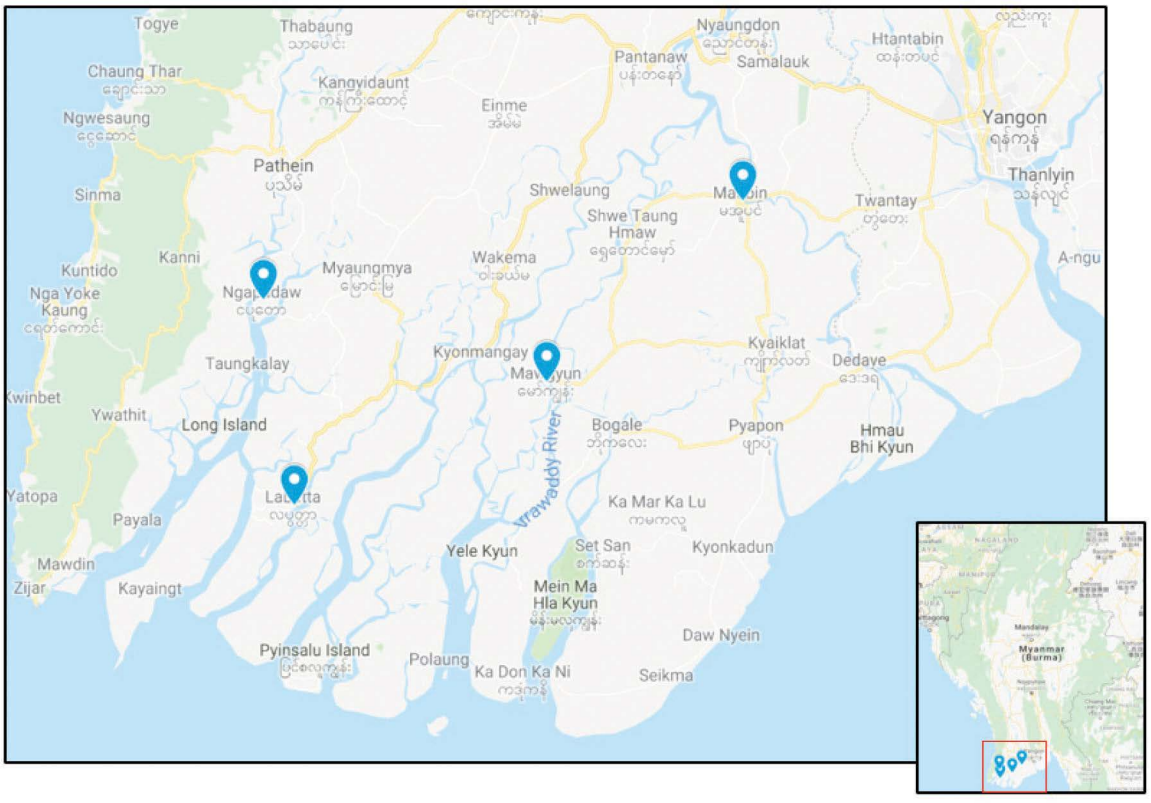
2

Four team leaders and 16 enumerators collected data from the Ayeyarwady Region between 6 April and 13 May 2018 (see Fig. 1). They collected quantitative data through a household survey and qualitative data through focus group discussions, key informant interviews and the participatory rural appraisal (PRA) approach (see Table 1). The household survey targeted hilsa fishing households only, while the qualitative methods were also used to collect information from DoF township officers, local fish collectors, township fish collectors,[2] and ward/village/village tract administrators. We used the qualitative data to triangulate quantitative data and also compared data to those from similar studies, for example studies of small-scale fishing and agricultural households carried out elsewhere in Myanmar.

NAG collected data from four of the 26 townships located within the study site (see Fig. 1). Initially, Maubin, Mawlamyinegyun, Ngapudaw, and Hinthada were selected – in consultation with township DoF officers – for their importance as habitats for hilsa, the potentially large number of hilsa fishers, and accessibility of landing sites. When very few hilsa fishers were found in Hinthada township, it was replaced as a study site with Labutta. Labutta and Ngapudaw are both in a coastal saline area, but Ngapudaw has a brackish water zone in the northern part; Myawlamyinegyun is mainly brackish water with freshwater in the north; and Maubin is freshwater with a floodplain area inland that alternates between freshwater and brackish conditions (Thein et al, 2019).

Forty-six villages were sampled from the four townships (see Appendix A). Again, NAG selected these villages through consultation with township DoF officers, but they made efforts to keep the number of selected villages roughly proportional to the total number of villages in each township, with Labutta being the exception (see Table 1). NAG aimed for equal representation of men and women for the focus group discussions (actual female participation was 26%), the PRAs (actual female participation was 45%) and the key informant interviews with fish collectors (actual female participation was 40%). The other key informant groups did not include women because they are not usually represented in those roles. NAG did not target household surveys by gender, but 18% of respondents were female.

Figure 1. Google map showing location of study site (Ayeyarwady Delta) within Myanmar and the four townships surveyed (Ngapudaw, Maubin, Mawlamyinegyun, and Labutta)



[2] Fish collectors buy fish from fishers at the village level, often selling to other fish collectors at the township level, who sell it at the central fish market in Yangon. They often provide loans to fishers and other collectors.

2.1 Household survey

NAG surveyed 833 households from the four townships. This sample size was derived from a calculation based on the total number of households in the Ayeyarwady Region, which is 298,925 households, according to the Department of Population (DoP, 2014) (see Appendix B). Data on hilsa fishers in each area were unavailable, so it was not possible to stratify sampling by township or village. Instead, NAG divided the total sample by the number of sample villages, sampling an equal number of households in each village. They aimed to interview a large enough number of households in each township (18 households from >1.8% of villages in each township) so that any problems associated with small and non-random sampling were not likely to influence results.

Enumerators selected respondents using purposive sampling, by asking village heads or informal community leaders to identify households in which someone fishes for hilsa. To avoid snowball sampling, they asked leaders to select a broad range of hilsa fishing households on the basis of multiple criteria, including social class, location in the village, and social networks. NAG designed the household survey to minimise instances of non-response to questions.

Enumerators used a semi-structured questionnaire to elicit information from respondents on household demographics and characteristics, hilsa fishing activities, hilsa trends and status, hilsa management, and conservation. They also asked village administrators and village tract administrators to categorise sample households according to four social classes constructed by NAG: *Chan Thar* ('better off'), *Ah Lae Ah Latt* ('middle class'), *Nwan Par* ('poor'), and *Ah Lon Nwan Par* ('very poor'). NAG define the 'better off' class as people who do not need to worry about their daily survival and have a higher living standard and an alternative livelihood, whereas they define the 'very poor' as people who struggle for their daily survival and have many dependents. We compared characteristics between these groups in order to validate the categorisation and identify socioeconomic differences between the groups. Following preliminary analysis, and due to the small number of people identifying as 'better off' (13), we merged this category with the 'middle class'. This allowed for statistical differences to be more clearly identified.

There were limitations to the household survey method. Although NAG calculated the sample size to properly represent the hilsa fishing community in the study region, the sampling design did not allow complex and robust data analysis. Furthermore, some bias may have been introduced by imposing social classes constructed by researchers and having local administrators or informal leaders invite households to participate in the survey.

2.2 Focus group discussions

The focus group discussions aimed to collect qualitative data on fishing activities in the region, constraints on those activities and corresponding coping strategies, fishery groups/organisations, relationships with DoF, networking and coordination with other fishery stakeholders, and perceptions of the current status of natural resources. NAG conducted one focus group discussion in each village (46 in total), each involving a group of 10–12 participants from hilsa fishing households. A total of 94 women and 270 men participated.

2.3 Key informant interviews

NAG conducted 138 unstructured key informant interviews based around specific topics, selecting key informants for their potential knowledge of the hilsa fishery. DoF officers were interviewed for information on fish habitat and migration patterns; fish collectors were interviewed for information on patterns in amount, size and weight of fish caught; and village administrators were interviewed for information on demographics and village conditions (see Table 1).

Table 1. Details of project sites and sample sizes by survey method and category of respondent

TOWNSHIP	TOTAL POPULATION	TOTAL VILLAGES	SAMPLE VILLAGES	HOUSEHOLD SURVEYS	FOCUS GROUP DISCUSSIONS	PRAS	KEY INFORMANT INTERVIEWS				
							TOTAL	DOF	TOWNSHIP FISH COLLECTOR	VILLAGE ADMIN.	VILLAGE FISH COLLECTOR
Labutta	75,583	505	15	274	15	15	45	1	3	15	27
Maubin	71,804	442	9	162	9	9	27	1	0	9	6
Mawlamyinegyun	74,886	676	13	235	13	13	39	1	3	13	19
Ngapudaw*	76,652	411	9	162	9	9	27	1	2	9	10
Total	298,925	2,034	46	833	46	46	138	4	8	46	62

Source: GAD, 2017

* Chaung Wa village was described by DoF as being in Ngapudaw Township and so we included it in Ngapudaw, even though it falls under Pathein Township on the map.

2.4 Participatory rural appraisal

Participatory rural appraisal (PRA) is a set of largely visual techniques for working with local people to assess community resources, identifying and prioritizing problems and appraising existing strategies for solving them. NAG conducted one PRA in each village (46 in total) with individuals from hilsa fishing households (125 women and 263 men). Participants were asked to do the following:

- Visualise fish habitat, migration, and spawning grounds on a map
- Identify fishing and fish spawning seasons on a seasonal calendar
- Visualise networks among fishery stakeholders at village level using a Venn diagram
- Map trends in hilsa fish catches onto a line (i.e. a trend line indicating the general course of catches over time)
- Map the hilsa value chain using a market flow diagram, and
- Describe the relative time used by men and women in different fishery-related activities.

Socioeconomics of hilsa fishing households

3

The majority (71%) of survey households were categorised as 'poor' or 'very poor'. These households generally had high household dependency ratios, poor housing and living conditions, few assets, low income and expenditure, and more debt than other households. Loans from moneylenders, fish collectors, and relatives enable these households to meet subsistence and capital investment needs, but can be difficult to pay back.

3.1 Who are they?

The 833 fishing households surveyed totalled 3,849 people. Of these people, 68% were of working adult age (15–64), while 30% were children (<15) and 2% were 65 and older. The dependency ratio (number of household members of working age compared to those not of working age) ranged from 0 to 300%, with a mean of 58%. Household size ranged from two to 12, with a mean size of 4.6, and the survey population was 53% male and 47% female. Ninety-five per cent of the survey population had finished (or were currently in) primary education and 52% had continued to secondary education, with 1% attending higher education. Three per cent of the survey population had never received any formal education. The overall adult literacy rate was 98%. In the focus group discussions, many fishers and their family members said that they found it difficult to send their children to middle and high schools, largely because of the lack of schools in their area.

These demographics are broadly similar to national and/or regional demographics, indicating that the survey sample was representative of the population as a whole, but there were some key differences (see Table 2). The percentage of female-headed households (3%) was much lower in the survey population than that of the national population and the Ayeyarwady Region population, which has the lowest percentage of any region in Myanmar (DoP, 2014). This indicates that hilsa fishing households tend to have fewer female heads than other households in the same region.

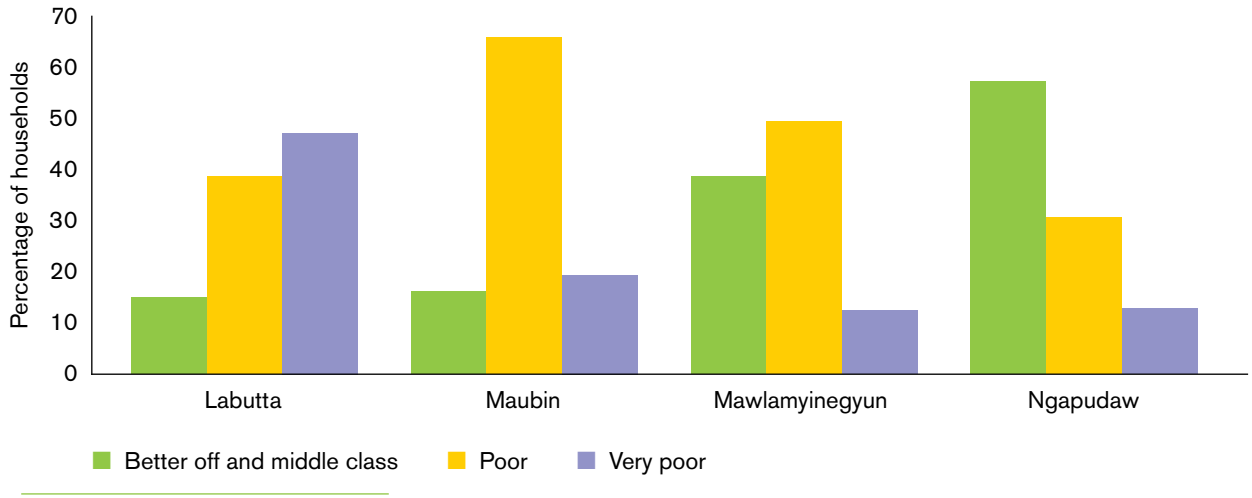
The majority of survey households in this study were categorised as 'poor' (45%) or 'very poor' (26%), while the remaining 29% were categorised as 'better off and middle class'. We found significant socioeconomic differences between social classes (see Appendix C), which are described in detail in sections 3.2–5.2. Social class was also significantly associated with township: Ngapudaw township had the greatest share of 'better off and middle class' households (57%), Maubin had the greatest share of 'poor' households (65%), and Labutta had the greatest share of 'very poor' households (47%) (see Appendix C and Fig. 2). The relative poverty in Labutta might be a legacy of Cyclone Nargis, which hit in 2008: due to their remote and exposed position, villages in Labutta were some of the hardest hit. The cyclone destroyed paddy, livestock and housing and killed a large portion of the population, and although fishing has played an important role in recovery, the impacts of the event are still being felt (Thein et al, 2019).

Table 2. Demographic profile of household survey population, national population, and Ayeyarwady Region population

	SURVEY POPULATION	NATIONAL POPULATION	REGIONAL POPULATION
Age distribution			
Children (<15 years)	30%	29%	29%
Economically productive (15–64 years)	68%	66%	65%
Elderly (>=65 years)	2%	6%	1%
Dependency ratio (mean)	58%	53%	55%
Household size (mean)	4.6	4.4	4.1
Gender distribution			
Men	53%	48%	49%
Women	47%	52%	51%
Female-headed households	3%	24%	19%
Adult literacy rate (mean)	98%	90%	94%

Sources: household survey and DoP, 2014

Figure 2. Percentage of households in each social class by township (Labutta [n = 292], Maubin [n = 162], Mawlamyinegyun [n = 217], Ngapudaw [n = 162])



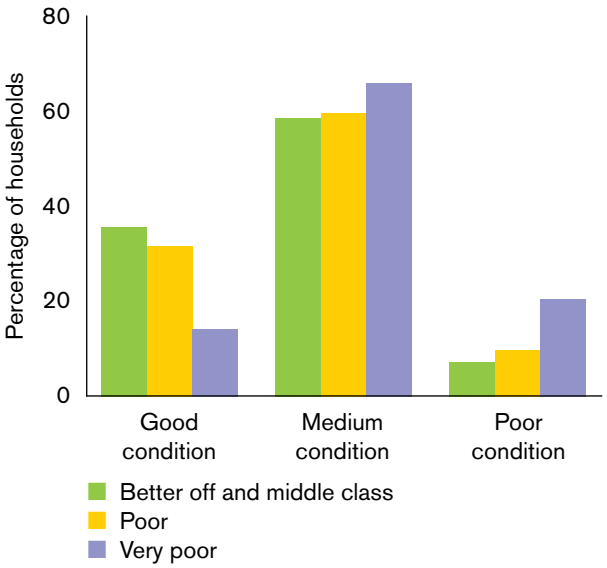
Source: Household survey

3.2 Housing, infrastructure and assets

When asked whether their housing conditions were 'good', 'moderate', or 'poor',[3] the majority (62%) of survey respondents selected 'moderate', another 28% selected 'good' and the remaining 10% selected 'poor'. The 'very poor' class was significantly more likely than other classes to say that they lived in 'poor' housing conditions and less likely to say that they lived in 'good' conditions (see Appendix C and Fig. 3). There was also variation between townships: households in Maubin were most likely to say they lived in 'good' conditions, whereas those in Labutta and Mawlamyinegyun were more likely to say they lived in 'poor' conditions (see Appendix C). This could be explained by the relative isolation of these latter villages, which means people in these areas probably rely more on locally available construction materials, which are likely perceived to be less good. Many households are likely still to be suffering from the impacts of Cyclone Nargis on their housing conditions, particularly in Labutta (Thein et al, 2019).

The majority of surveyed households were living in houses made of wood (65%) and bamboo (31%), while only 2% lived in reinforced concrete or brick houses. This is much lower than the national average for concrete and brick housing (16%) (DoP, 2014). Although concrete and brick tend to be associated with wealth, wooden frames actually keep a house cooler. In our survey, wood was associated with the 'better off and middle class', whereas bamboo – which is cheaper but extremely fragile – was associated with 'poorer' households (see Appendix C). Thirty-nine per cent of houses had good quality roofing (corrugated iron sheet as opposed to shingle or thatch, which are more fragile), compared to 60% at the national level (DoP, 2014), highlighting the vulnerability of fishing communities in the Ayeyarwady Region.

Figure 3. Percentage of households living in good, medium, and poor housing conditions, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])



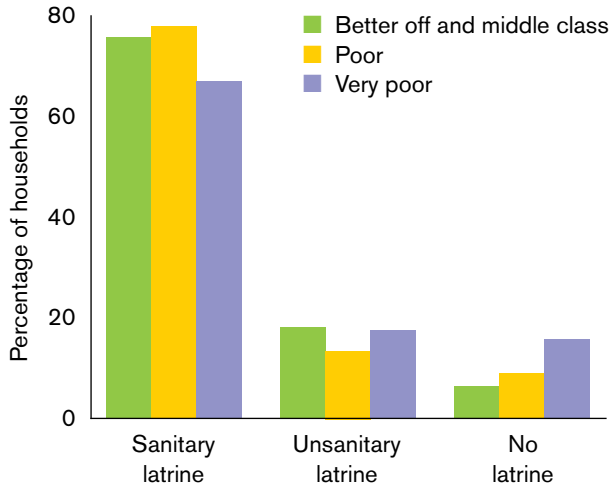
Source: Household survey

Ninety per cent of survey respondents reported owning a latrine, 82% of which were sanitary and 18% of which were unsanitary. This differed between townships (see Appendix C): households in Labutta Township were the least likely to own a latrine (20% did not), whereas households in Maubin were the most likely to own a sanitary latrine (87% had one). These results follow the

[3] The terms were not defined, but open to interpretation by the respondents.

geographical pattern of housing conditions. Households in Ngapudaw were the most likely to own a latrine overall (96% had one), but also the most likely to have an unsanitary one (32%). Households in the 'very poor' class were significantly less likely to own a latrine than other classes, as would be expected: 15% of these households did not own a latrine (see Appendix C and Fig. 4).

Figure 4. Percentage of survey households that owned a latrine, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

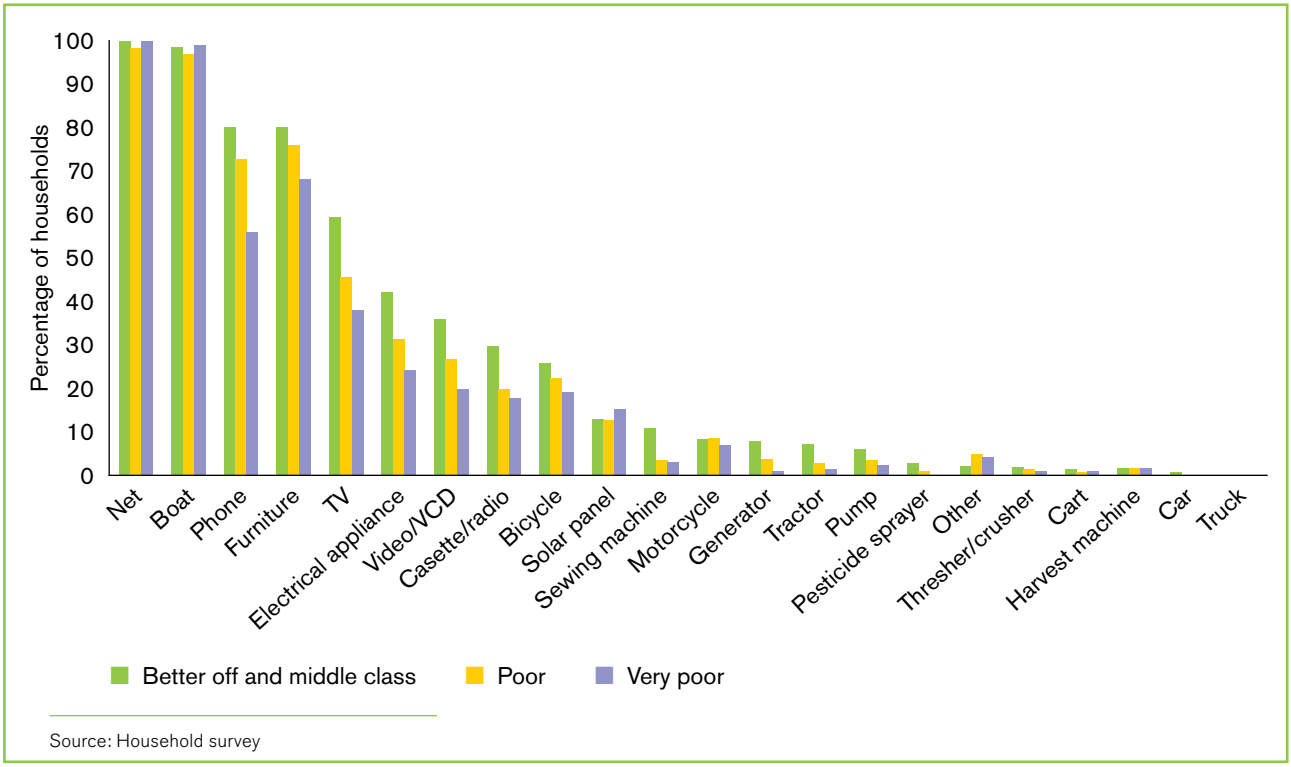


Source: Household survey

Eighty-five per cent of survey respondents reported dependence on an unprotected water source, such as rivers, streams, a poorly constructed well, or rainwater, while 15% reported access to a protected water source, such as a tube well. Twenty-nine per cent of respondents reported having difficulty accessing water at some point over the preceding year, with a mean of 2.7 months of difficulty. Significantly more households in Ngapudaw experienced difficulties in accessing water (51%), while significantly fewer experienced such difficulties in Maubin (1%), which might be related to Maubin's proximity to Yangon or its less remote location (see Appendix C). No significant association was found with social class.

Almost every surveyed household said they owned a net (99%) and a boat (98%) (see Fig. 5). While boats are an important means of transportation in the Ayeyarwady Delta, this fact, along with the net ownership, indicates that nearly every household engages in fishing activities. Furthermore, less than 5% of households owned assets that could be used to generate income in other ways, such as a pesticide sprayer, thresher, crusher, sewing machine, or tractor. The next most commonly owned asset was furniture (75%), a mobile phone (71%), and a TV (48%). Only 13% of households had solar panels and the majority of these were 'very poor' households,

Figure 5. Asset ownership of survey household respondents by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

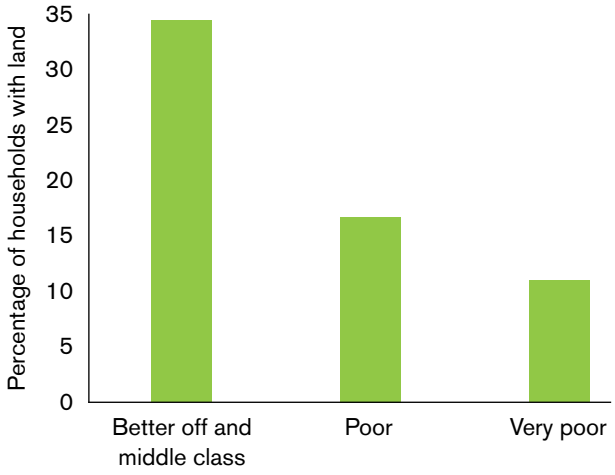


Source: Household survey

indicating that they might have been provided by NGOs or government agencies. All surveyed villages had limited access to grid electricity, while only 4% of households owned a generator. In total, the 'poor' and 'very poor' classes had significantly fewer assets and particularly non-productive assets like a TV and phone (see Appendix C).

Nineteen per cent of households reported owning one or more pieces of land, with an average size of 6.6 acres; these were mostly paddy fields (63%) and gardens (29%).[4] Land ownership was significantly more common among the 'better off and middle classes' and less common among the 'very poor' (see Appendix C and Fig. 6). This indicates that farming – particularly rice farming – is an important livelihood activity for some households, although less so for the 'poor' and 'very poor' households. There was also significant variation between townships: households in Maubin and Mawlamyinegyun were much more likely to own land than others, perhaps due to the quality or suitability of these areas for farming or the legacy of Cyclone Nargis in more exposed townships. For example, integrated rice-fish farming systems are being promoted by WorldFish and others as an efficient way for people in flood-prone areas of the Ayeyarwady Region (such as Maubin) to increase their income (Akester, 2018).

Figure 6. Land ownership of household survey respondents, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

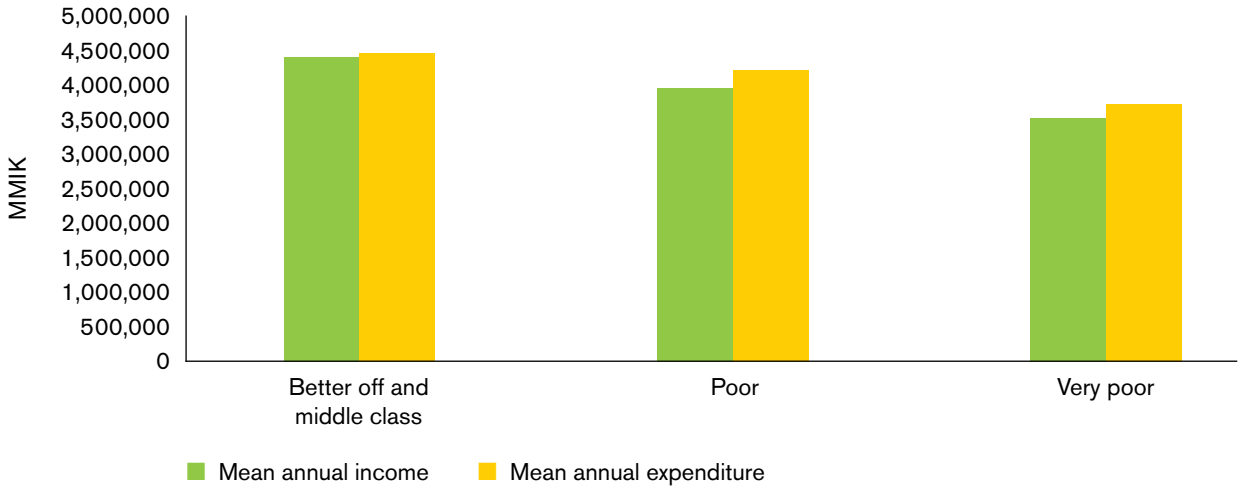


Source: Household survey

3.3 Income, expenditure and debt

On average, annual household income (MMK3,987,770 or US$2,640) does not appear to be high enough to cover annual expenditure (MMK4,175,284 or US$2,764). This is particularly the case for 'poor' households, for whom expenditure is 6.8% higher than income, and the 'very poor', for whom expenditure is 5.7% higher than income (see Fig. 7). To cover the deficit, many households rely on informal loans to meet their needs, but encounter challenges in paying them back.

Figure 7. Mean annual household income and expenditure by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])



Source: Household survey

[4] A 'garden' usually refers to a vegetable garden on the homestead, in contrast to 'agricultural land' which is larger scale.

3.3.1 Income

Mean annual household income varied significantly between social classes (see Appendix C): it was 20% higher for the 'better off and middle class' than the 'very poor' (see Fig. 7). Overall, income was dominated by fishing (63% of total household income), followed by cultivation (10%) and casual labour (8%), but this also varied with social class (see Fig. 8). Income dependence on fishing was significantly higher for the 'poor' and 'very poor', who appear to supplement their income mostly with casual labour, probably seasonally.[5] The 'better off and middle class' rely less on fishing for income and supplement it mostly with agriculture, but also with a range of other activities, particularly small business and casual labour. All social classes, but especially the 'poor', depend on remittances for a small portion of income (mean of 6% across all classes). Remittance income from migrants has become important for landless and marginal households across Myanmar (Belton and Filipski, 2019). Income generated from land ownership is low across all classes (mean of 3%). Around 25% of households reported generating income from land ownership (see Section 5.1), but this result indicates that few of these households have the capital or skills required to make their land a more substantial income stream.

The market price of hilsa fish is mainly determined by its weight, following the relationship shown in Table 3. Income from hilsa therefore varies seasonally according to unit price and yield (see Fig. 9). Using the unit price and weight data reported in the household survey, we estimated the mean hilsa fishing income to be MMK250,000 (US$166) per month, which is around 75% of annual income and therefore the majority, if not all, of total annual fishing income.

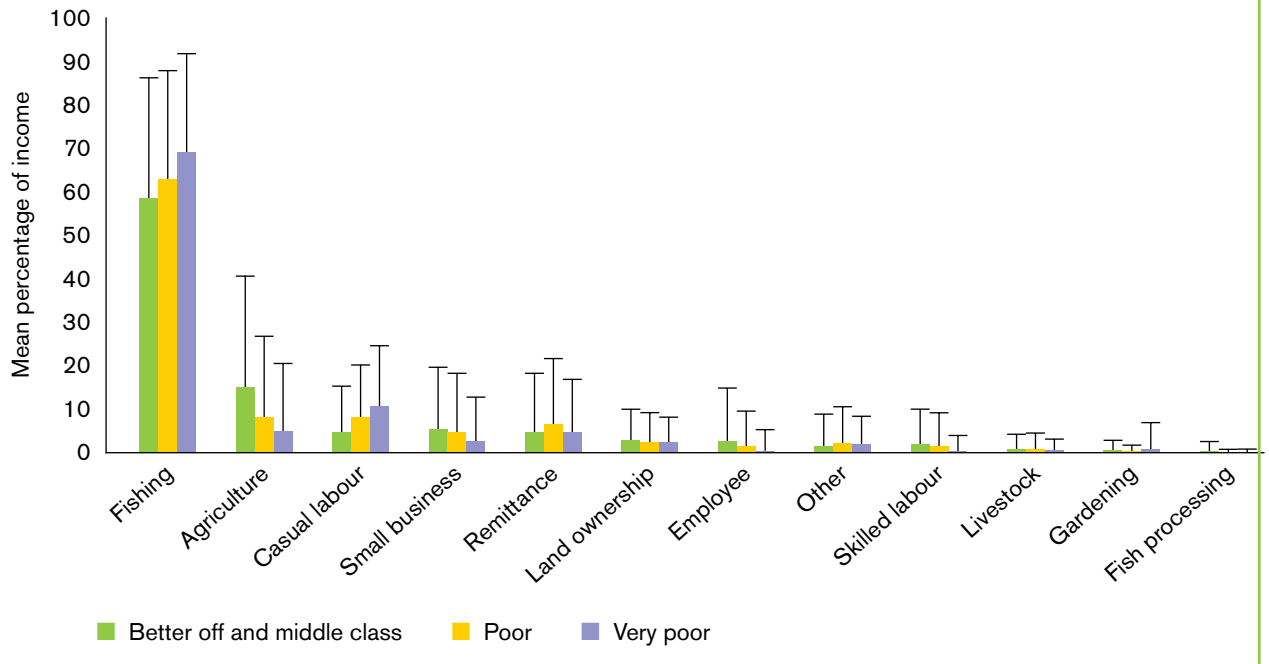
Table 3. Average hilsa market prices by weight at village level

WEIGHT (VISS)[6]	PRICE (MMK)
>=1	30–35,000
0.75–0.99	25–30,000
0.70–0.74	20–25,000
0.50–0.69	15–20,000
0.35–0.49	10–15,000
<=0.34	8–10,000

Source: Key informant interviews

This income is highly seasonal, ranging from MMK300,000 (US$199) to MMK450,000 (US$298) from September to January, which appears to be the

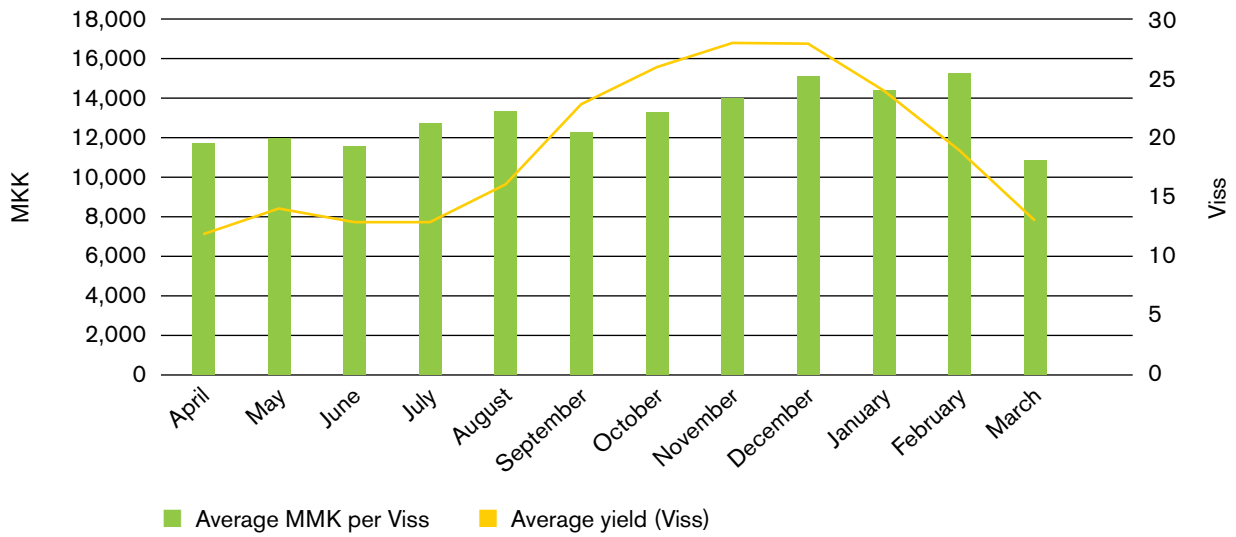
Figure 8. Mean percentage of household income generated by different livelihood activities by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216]). Error bars show standard deviation of the mean



Source: Household survey

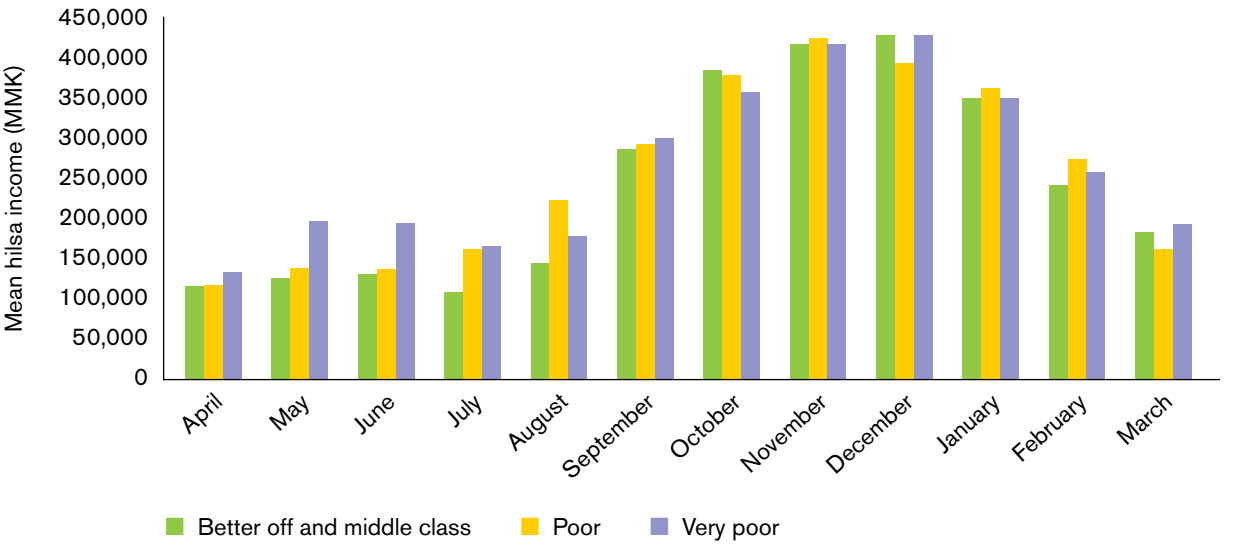
[5] 'Casual labour' refers to a wide range of activities, but historically small-scale fishers have seasonally engaged in rice farming activities such as preparing land, transplanting, harvesting, and milling (Thein et al, 2019).
[6] A viss (Myanmar's unit of weight measurement) is about 3.6 pounds or 1.6 kilos.

Figure 9. Comparison of average price (MKK) per viss and average yield (viss) per month



Source: Household survey

Figure 10. Mean monthly income from hilsa by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])



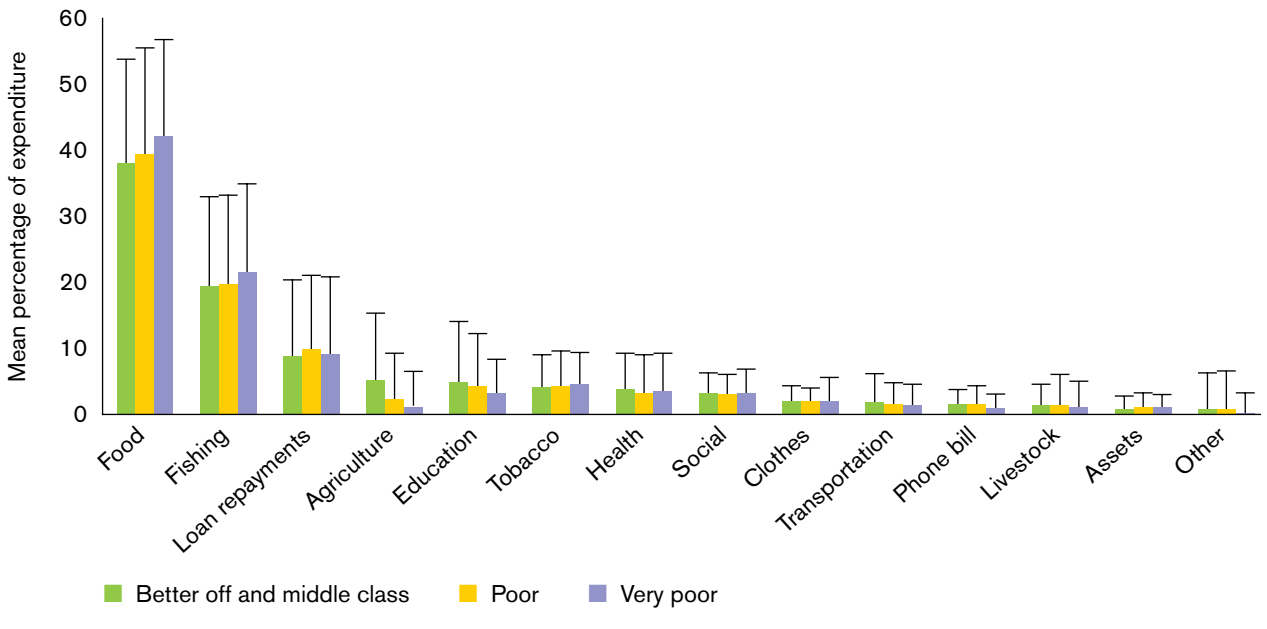
Source: Household survey

peak fishing season, and from MMK150,000 (US$99) to MMK200,000 (US$132) from February to August (the low season) (Fig. 10). BOBLME (2015c) also estimated that fishers experience a decrease of 58% in daily income from hilsa fishing between high and low season in Myanmar. During the low season, the 'very poor' households had the highest monthly hilsa income, whereas during the peak season, income levels out more between classes. This suggests again that the 'very poor' are more dependent on fishing for income, even during times when catches are lower (see Section 4.3).

3.3.2 Expenditure

Mean annual expenditure was 16% higher among the 'better off and middle class' than the 'very poor'. Overall, household expenditure was dominated by spending on food (mean 40%), followed by fishing (20%) and loan repayments (10%). On average, the 'very poor' households tend to allocate more of their spending to food and fishing – again highlighting their dependence on fishing – while the 'better off and middle class' allocate more to agriculture and education (see Fig. 11).

Figure 11. Mean percentage of household expenditure on different goods and services by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216]). Error bars show standard deviation of the mean



Source: Household survey

This expenditure on fishing highlights its importance as a primary livelihood in this region. In addition to the costs of purchasing and maintaining boats and nets, licence fees are also required. Reported gear licence fees in the study area ranged from MMK3,500 (US$2) to MMK12,000 (US$8) per annum, although fishers said they sometimes pay bribes to the DoF instead of the fees, and bribes for illegal fishing nets. Even though boat licence fees are also required by law (see Section 1.2), survey findings indicated that this is generally not enforced. Fishers paid boat licence fees in only 13% of study villages, within Ngapudaw and Labutta townships.

3.3.3 Debt

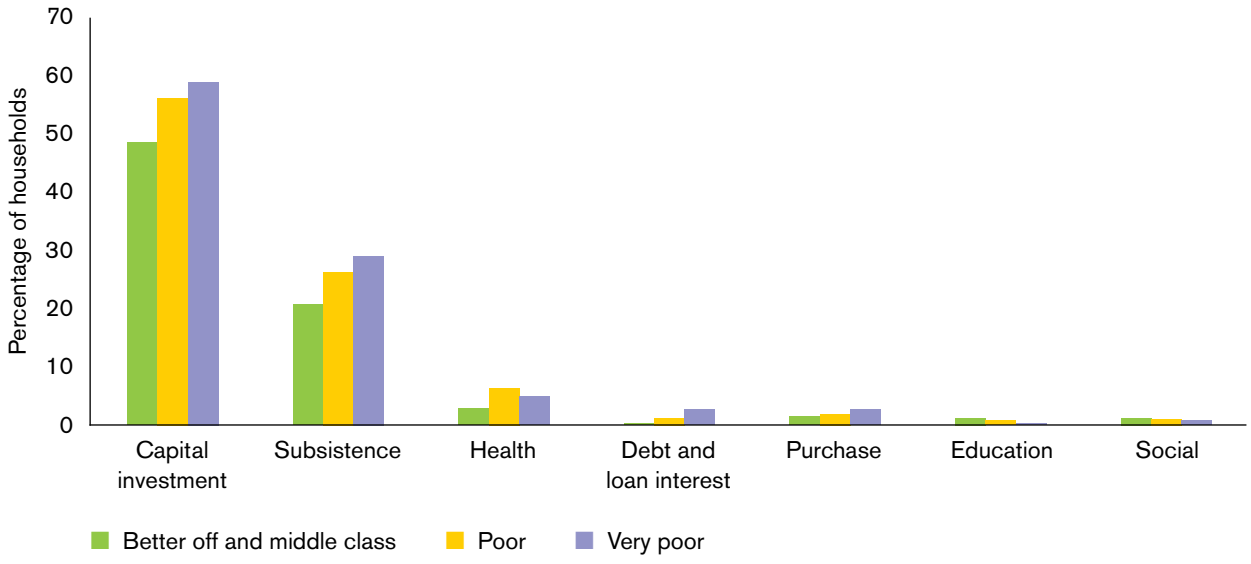
Most fishing households in the study site use debt to support their needs and cope with the seasonality of income; 76% of survey households took a loan in 2017–18. However, loan taking was positively associated with the 'poor' and 'very poor' social classes (see Appendix C). The most common reason for borrowing was capital investment (50% of households), followed by subsistence (20%) and health (4%) (see Fig. 12). These results were supported by focus group discussions and other surveys in Myanmar (Salagrama, 2015). According to the focus groups, households often take loans for food and living costs during the time when there is no or less fish catch, highlighting the role of debt as a coping strategy.

However, some households (particularly the 'very poor') also take loans to repay interest to previous creditors, resulting in a cycle of debt that can pass from generation to generation. Mean household debt was MMK606,191 (US$401), which is much higher than the mean difference between annual expenditure and income (MKK187,515 or US$124). This is probable evidence of multi-year accumulation of debt.

The 'very poor' social class mostly reported taking loans from informal moneylenders (36% of households), the 'poor' households mostly reported taking loans from moneylenders, relatives, and NGOs (25–25%), while the 'better off and middle class' said they mostly take loans from NGOs (24%) (see Fig. 13). These 'better off and middle class' households also rely more than others on banks (13%) as well as the informal lenders. Although these households have better access to formal finance, most formal financial and microfinance institutions focus on farmers, and their inflexible repayment timeframes do not fit the seasonality of hilsa fishing income (Lwin and Htun, 2016). The Global Treasure Bank, formerly known as Myanmar Livestock and Fisheries Development Bank, paid 30% of its total loans to the fisheries sector in 2013–2014, but only large-scale fishery businesses have access to these loans (Myanmar Times, 2015).

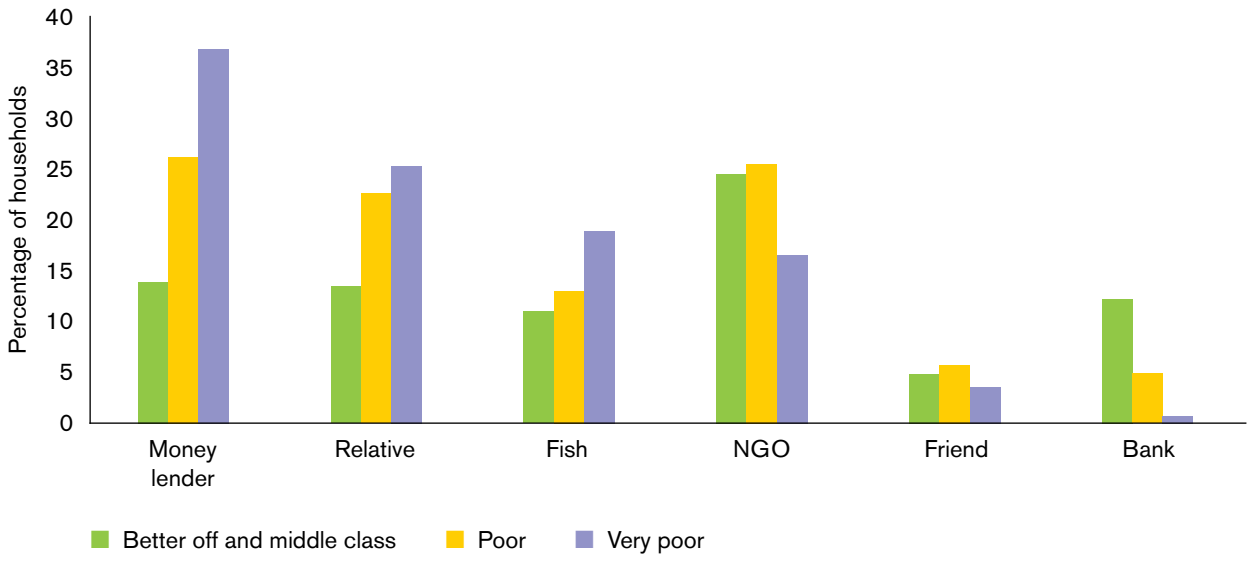
During focus group discussions hilsa fishers and family members said that fishers from villages with limited farm land tend to borrow from moneylenders with high interest rates (higher than microfinance institutions) or take zero-interest advances from fish collectors, which bind them to sell their catch to those fish collectors (see Section 4.4). This allows fishers to sustain their livelihoods in periods of no or low catch and to invest

Figure 12. Percentage of household survey respondents taking loans for different reasons, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216]). Households were able to give more than one answer



Source: Household survey

Figure 13. Percentage of household survey respondents taking loans from different providers, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

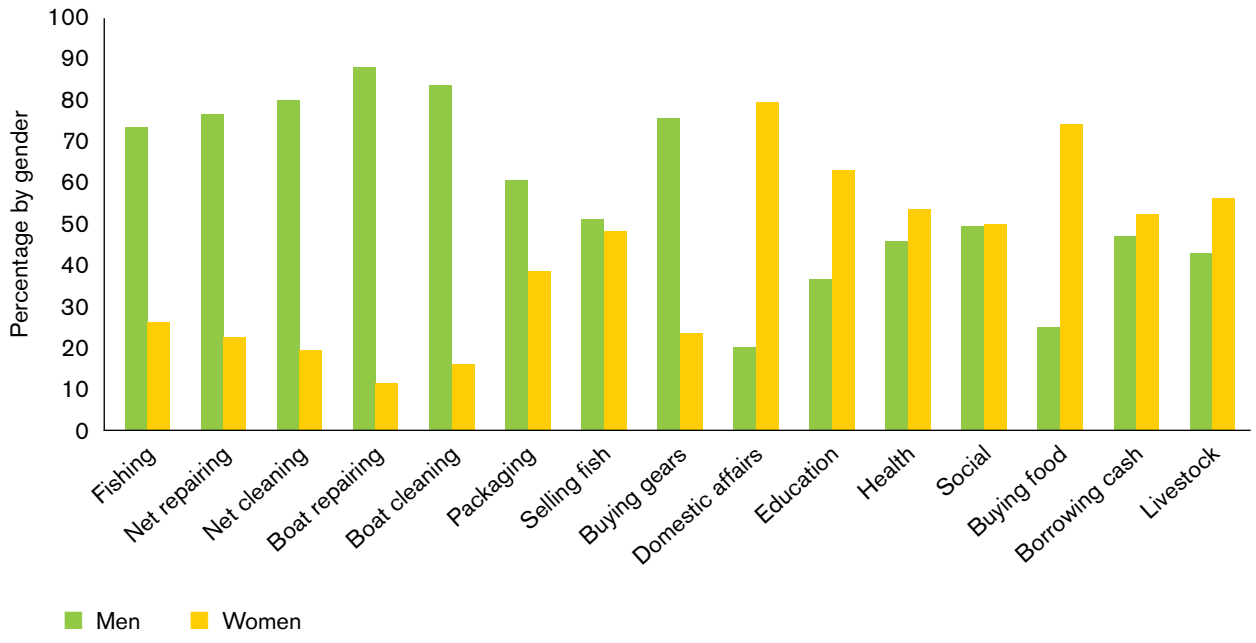


Source: Household survey

in fishing nets, gear or boats when they would not otherwise have the capital (Joffre and Aung, 2014). We found that it is often the women in households who take loans, particularly from relatives and local money lenders (see Box 1).

Monthly interest repayments reported by hilsa households ranged from 10% to 13% of their average monthly expenditure, depending on whether they were long-term or short-term loans and whether collateral was provided or not.

Figure 14. Distribution of household tasks by gender



Source: Household survey

BOX 1. GENDER ROLES IN THE HILSA FISHING HOUSEHOLD

From the household survey and PRAs, we identified gender variation in participation in income generation and household tasks. The daily schedule for men and women is similar. The day starts at around 4am and ends at 6 or 7pm. In the morning, women take care of house chores such as cooking, cleaning, and preparing children for school, while men prepare for fishing by checking their boats, preparing fishing gear, and filling petrol.

No activities are exclusive to men or women, but women tend to participate more than men in domestic affairs, education, raising livestock, and buying food, whereas men tend to engage more in fishing, net cleaning and repairing, boat cleaning and repairing, buying gear, and packaging fish. A similar participation of men and women is found in selling fish, health, social life, and taking loans. The distribution of these tasks by gender is similar across social classes (Fig.14).

Although some studies suggest than women's involvement in fisheries in Myanmar is limited (Joffre and Aung 2014), we found that women play a key role in the hilsa fishery, not only in selling and packaging, but also in fishing itself. Discussions suggested that they fish both with their husbands and independently. Salagrama (2015) also found that during the low season, when men might not consider it worth their time to go fishing, women often go fishing to ensure a supply of food for their family.

Fishing activities

4

Fishing, and particularly hilsa fishing, is a major livelihood activity in the Ayeyarwady Region for both men and women (see Box 1). It is also an activity in which people tend to engage over the long term: 30% of respondents reported 11–20 years of fishing experience and another 28% reported over 20 years of experience. The seasonality of hilsa fishing and dependence upon it varies geographically and with social class.

4.1 Hilsa fishing

Hilsa is a major target species in the region, owing to its relatively high value (DoF, 2018a) and consistent market demand. Sixty-nine per cent of household survey respondents ranked hilsa the dominant species in terms of catch, while 95% ranked hilsa the dominant species in terms of fishing income (see Section 3.3.1).[7] Village administrator key informants estimated that 91% of households in Maubin Township catch hilsa, compared to 66% in Ngapudaw, 49% in Mawlamyinegyun and 36% in Labutta. This geographical variation might be explained by ecologically driven differences in availability or by access to markets: Maubin is closest to Yangon, where hilsa can fetch higher prices (see Box 2). Nevertheless, the numbers in Maubin and Ngapudaw seem high relative to the overall dependence on fishing in these townships (see Section 5.1). It is likely that there are more 'occasional' fishing households in these townships, that is those who do not depend on fishing for their livelihood, but do take the opportunity to catch hilsa, for example, during spawning runs.

Among survey respondents, the most common gear for fishing hilsa in the region was the trammel net (a type of drift or gill net) with a mesh size between 3 and 4 inches. This is corroborated by BOBLME (2015a), although they also report the use of beach seine nets along river banks to catch juvenile hilsa.

Eighty-five per cent of 'better-off and middle class' households only use the trammel net to catch hilsa, while the 'very poor' households reported using other fishing gear as well. The most likely reason for this difference is that the 'very poor', who tend to have the greatest dependence on fishing (for food as well as income), are less selective in their fishing activities, especially when catches of hilsa are low. Owing to financial constraints and limited understanding of how to use other gear, artisanal fishers tend to use only one or two types of gear, but a survey in another region of Myanmar found fishers to perceive that using a wider range of fishing gear will increase catches (ILO, 2015). Highly dependent fishers may therefore be diversifying their fishing strategies by investing in a range of gear, possibly in reaction to an observed decline in hilsa abundance (see Section 6.2).

4.2 Fishing grounds, effort and timing

PRA participants said that fishers tend to fish in the rivers close to their villages (see Table 4), but also reported travelling further when catch is limited. The fishing boundaries identified through PRA (see Appendix A) are based on trust and mutual understanding and do not necessarily correspond with the official DoF boundaries.

Participants said that they do not engage in large-scale fishing[8] on the coast, unless they do casual labour on large boats. These opportunities are limited owing to the nature of the relationships between the boat owners and the experienced labourers they hire.

Table 4. Fishing grounds by township

TOWNSHIP	RIVER
Labutta	Ywe, Pyamalot
Maubin	Toe
Mawlamyinegyun	Yarzudine, Myingagone
Ngapudaw	Toe, Ngawon (Pathein)

Source: PRAs

Household survey respondents reported a mean of 4.5 hours per day spent fishing (this varies by season). The 'poor' and 'very poor' households reported significantly more time spent fishing than the 'better off and middle class' (see Appendix C), which follows if the latter are more likely to have alternative ways to generate income (see Section 5). Households in Maubin also reported significantly more time spent fishing than households in other townships, even Labutta, which has the most 'very poor' households. Despite Maubin households owning more land, a large proportion of these households are 'poor' and may still be highly dependent on fishing. Other studies have found villages in Maubin to have few alternative livelihood opportunities (Thein et al, 2019).

PRA participants said the timing of fishing in the day depends on the tides and that hilsa fishers tend to fish during high tide. They said they have mutual understanding around fishing time and take turns for fishing, and that some villages even have a raffle system in place to decide who fishes at what time. In contrast, 81% of household survey respondents said they fish at any time of the day, while only a small number of respondents (1–3%) said they only fish at a specific time of day or night. This was significantly associated with social class and with township: the 'better off

[7] Note that NAG targeted the survey towards communities and households that engage in hilsa fishing, so these data are not necessarily representative of the country or region as a whole.
[8] Large-scale fishing includes offshore and inshore activities using powered boats as well as the use of large fixed bag nets in estuaries.

and middle class' households and those in Ngapudaw (which has the greatest proportion of 'better off and middle class' households) were more likely to fish at any time of day (see Appendix C). These households are more likely to have invested in the joint leasing of a tendered fishery where fixed gear is set for long periods of time, whereas 'very poor' households often engage in other activities like casual labour, meaning that they are only able to fish at specific times.

4.3 Seasonality

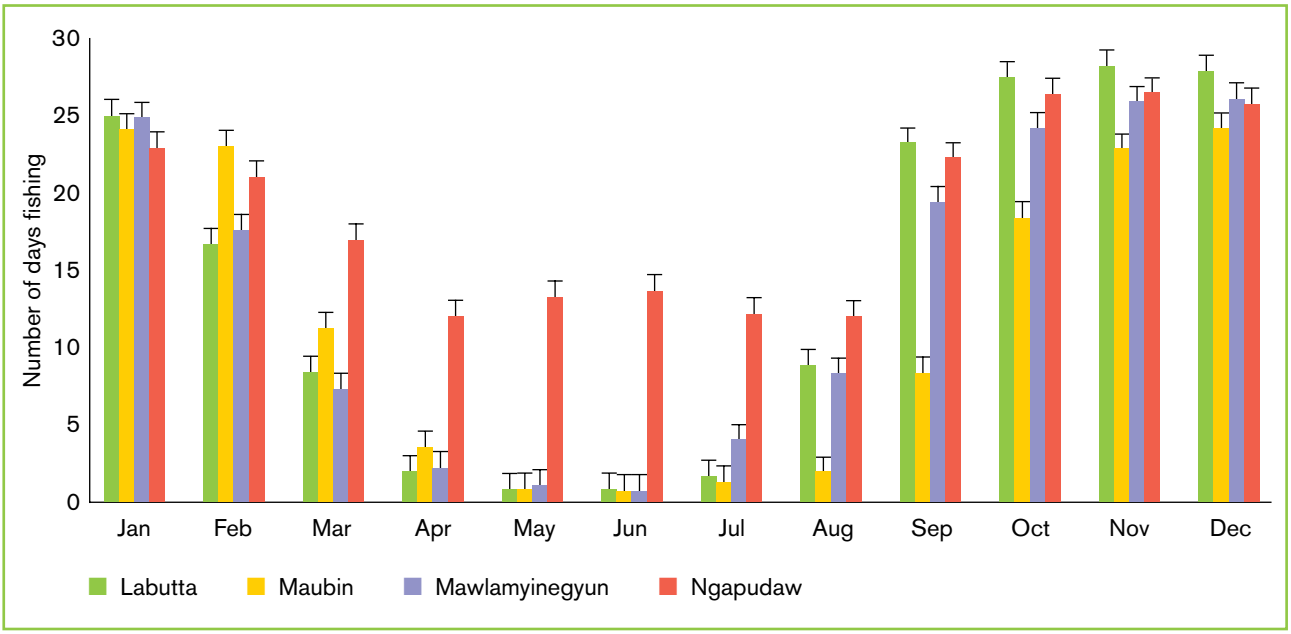
Eighty-eight per cent of household survey respondents said they fished seasonally, rather than all year round. This was significantly associated with the 'better off and middle class', which probably includes more opportunistic fishing households (see Appendix C). The pattern was similar across townships, apart from in Ngapudaw, where households were significantly more likely to fish all year round than those in other townships (see Appendix C). There are many potential reasons for this, such as better enforcement of the closed fishing season (May-July) in other townships, less weather-related disruption to fishing activities or a greater dependence on fishing.[9]

According to household survey respondents, the mean number of days spent fishing per month ranged from a low of four in April to a peak of 26 in November and December. Generally, the period from September to January was the most active fishing period in all townships, although households in Ngapudaw reported an average of 10–15 days of fishing even in those months where households in other townships fished much less (see Fig. 15). This variation corresponds roughly – but not perfectly – with the high season (August to November) and low season (December to April) described by BOBLME (2015c). The 'very poor' households reported spending the most time fishing during the period September to January, whereas the 'better off and middle class' reported more time than other classes spent fishing during other months (see Fig. 16). This indicates that they might be taking the opportunity to catch hilsa during spawning runs.

Respondents reported their monthly catches to be largest from October to January (with a peak of 26.8 viss in November) and smallest from April to July (with a low of 2.2 viss in April). This pattern was similar across all social classes (see Fig. 17) and corresponds roughly with the pattern in effort, indicating that time spent fishing is probably driven by perceptions of abundance. Some survey respondents also mentioned that they catch larger fish with eggs in October, November, and December, which could be another reason for increased effort during these months.

The seasonality in fishing effort and catches does also correspond with the closed season (May-July). PRA participants in each township said that fishing activities cease during these months (see Table 5). However, these answers are likely influenced by concern about the consequences of admitting to an illegal practice. Figures 15 and 16 clearly show that some fishing continues during the closed season, particularly in Ngapudaw.

Figure 15. Mean number of days spent fishing per month, by township (Labutta [n = 292], Maubin [n = 162], Mawlamyinegyun [n = 217], Ngapudaw [n = 162]). Error bars show standard deviation of the mean



[9] Dependence on a resource or occupation implies that there is no equivalent substitute for the resource or occupation without a loss in wellbeing. It is not necessarily reflected by level of use because there may be equally good alternatives.

Figure 16. Mean number of days spent fishing per month, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216]). Error bars show standard deviation of the mean

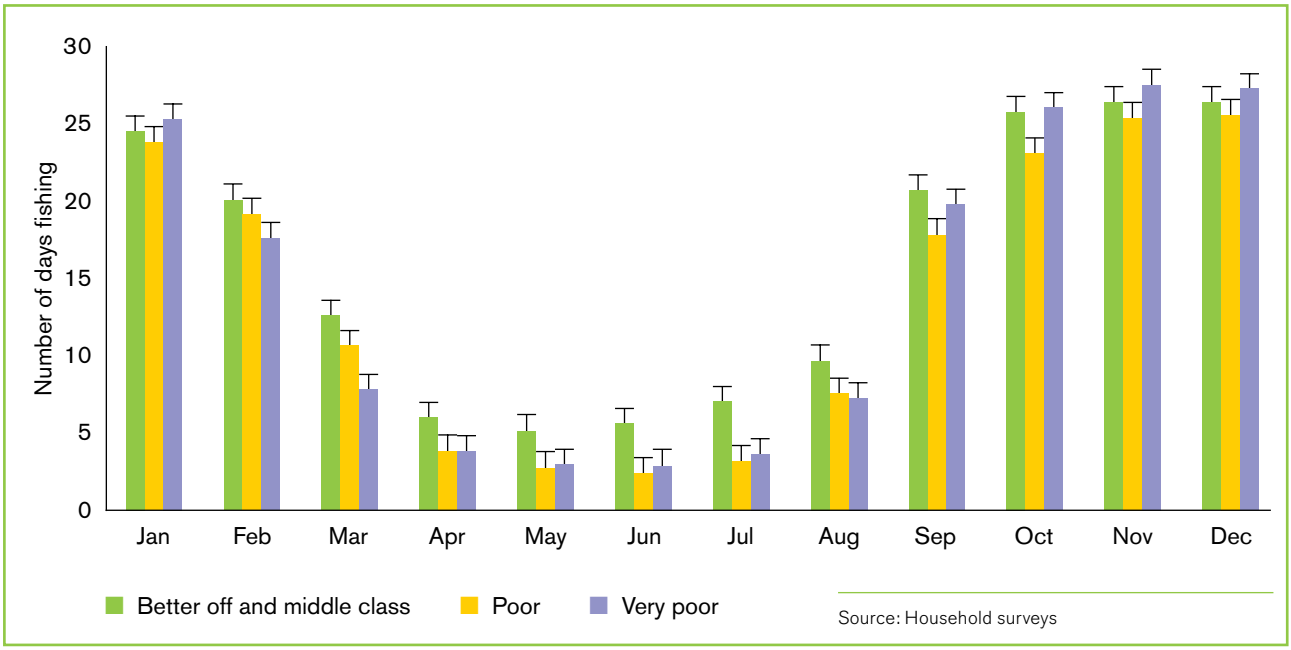


Figure 17. Mean monthly catch volume (viss) by social class
('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

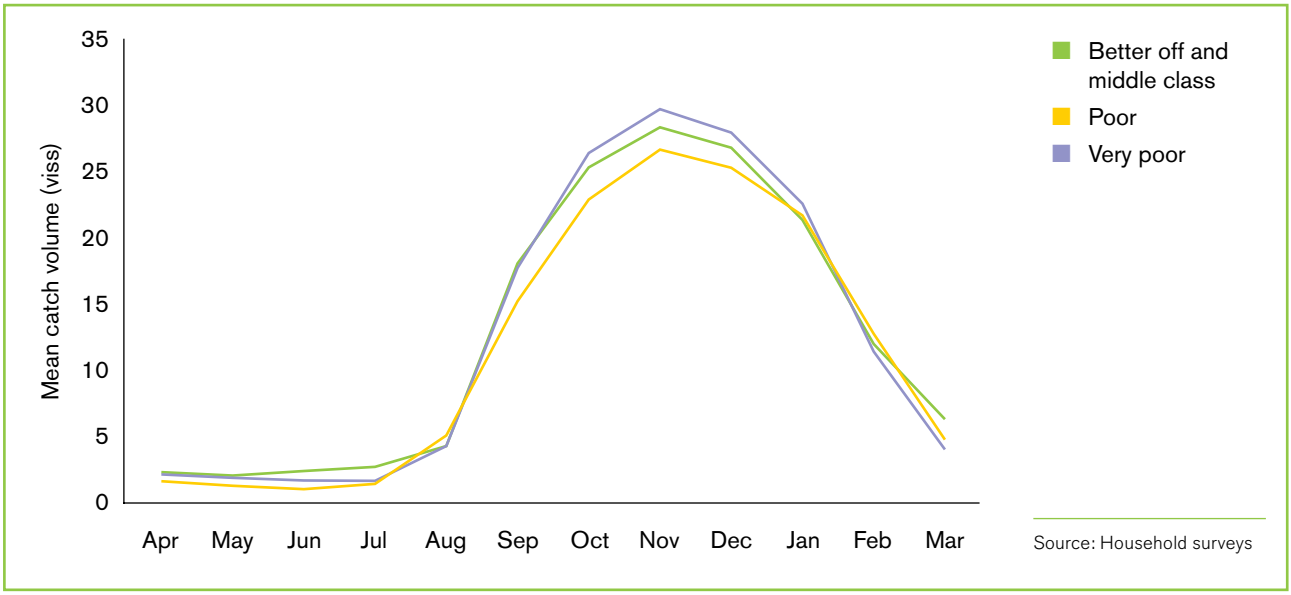


Table 5. Seasonal calendar of hilsa fishing by township

TOWNSHIP	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Labutta												
Maubin												
Mawlamyinegyun												
Ngapudaw												

Source: PRAs

4.4 Hilsa marketing

The hilsa market operates in Myanmar at multiple levels (see Box 2). Access to and preferences for these different levels vary according to social class and gender. Underpinning these differences are the prices offered in different markets, the type of finance required by the households, and the transportation required to access them.

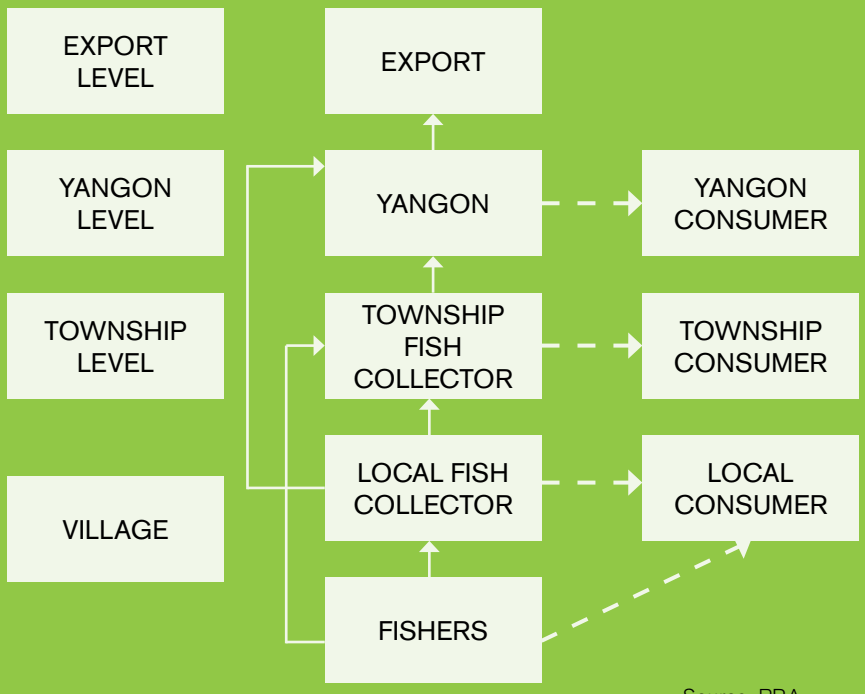
According to the household survey and key informants, households most often sell their fish to local (village) fish collectors (64%). Nineteen per cent said they sell directly to consumers in the village, particularly when they catch small fish, which are not accepted by fish collectors. Other households said they sell fish to township fish collectors, who often pay higher prices than local fish collectors (87% of respondents reported this price difference). Others said that township and local fish collectors pay at a similar rate, but that some fish collectors use inaccurate weighing systems biased in their favour. This is generally accepted as a way of compensating traders for cash advances (Joffre and Aung, 2014; Salagrama, 2015). Twenty-two per cent of household survey respondents said they are not satisfied with how the price of fish is set, probably for this reason.

It is mostly the 'better off and middle class' who sell to township fish collectors, followed by the 'poor' (see Fig. 19). The 'very poor' households are less able to access township fish collectors, probably because these households are more likely to require payment in the form of credit or cash advances (see Fig. 20), which are provided by local fish collectors. The fish collectors offer these loans in exchange for lower-than-market prices or exclusivity over the catch, guaranteeing them a regular supply of fish (Joffre and Aung, 2014). Although this enables 'very poor' households to sustain their livelihoods in periods of no or low catch and to invest in fishing gear or boats (see Section 3.3.3), it also allows a patron-client relationship to develop between fishers and fish collectors, characterised by unequal power distribution and low bargaining power on the side of the fishers (ILO, 2015). Local fish collectors are also the first source of fish price information for most fishers (55%), followed by radio, township fish collectors, and friends or family. Since fishers generally have no access to township market information – particularly in more remote areas – this reinforces their already low bargaining power with local fish collectors (Joffre and Aung, 2014).

BOX 2. MYANMAR'S HILSA VALUE CHAIN

Myanmar's hilsa value chain has four levels: village or local level, township level, Yangon level and international level through exports (see Fig.18). The local or village fish collectors either sell the fish to township fish collectors or directly to consumers at the local level. Then the township fish collectors sell the fish to the central Sanpya fish market in Yangon, where most wholesalers operate. From there, fish is sold directly to consumers, distributed to other regions and exported. The export market was not analysed in this study, but the majority of large-sized hilsa are exported, mostly to India and China (Soe et al, 2018). Marketing relationships in Myanmar are informal and based on trust and personalised economic relations (ILO, 2015).

Figure 18. Myanmar's hilsa value chain



Source: PRA

Figure 19. Fish market usage by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

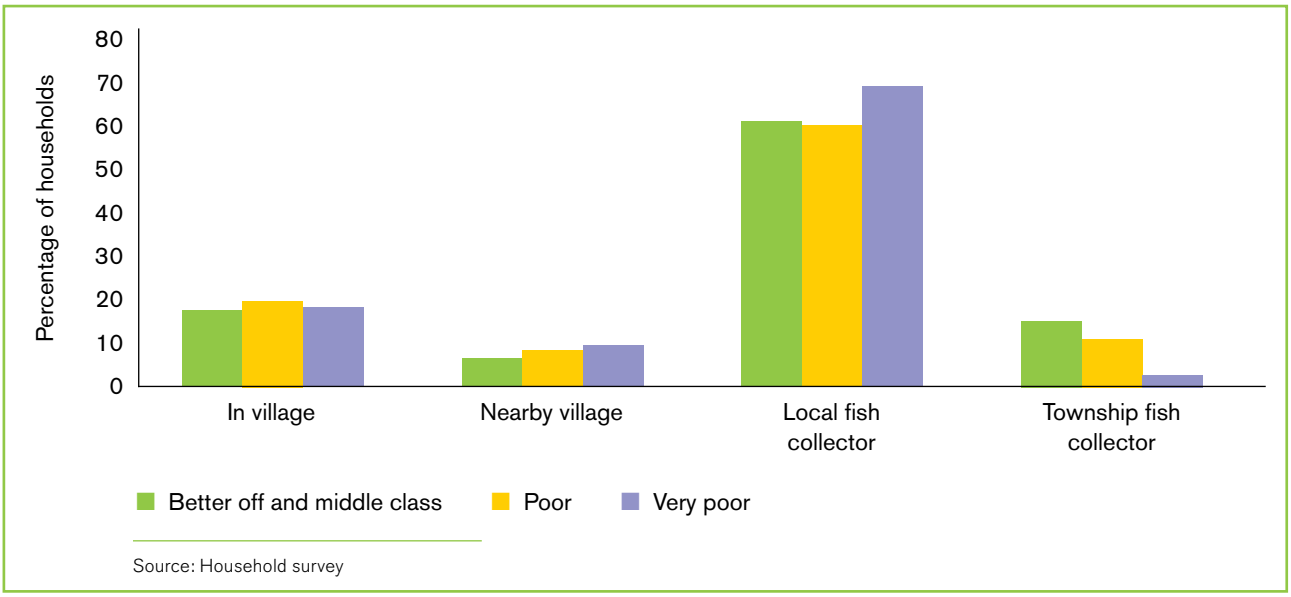
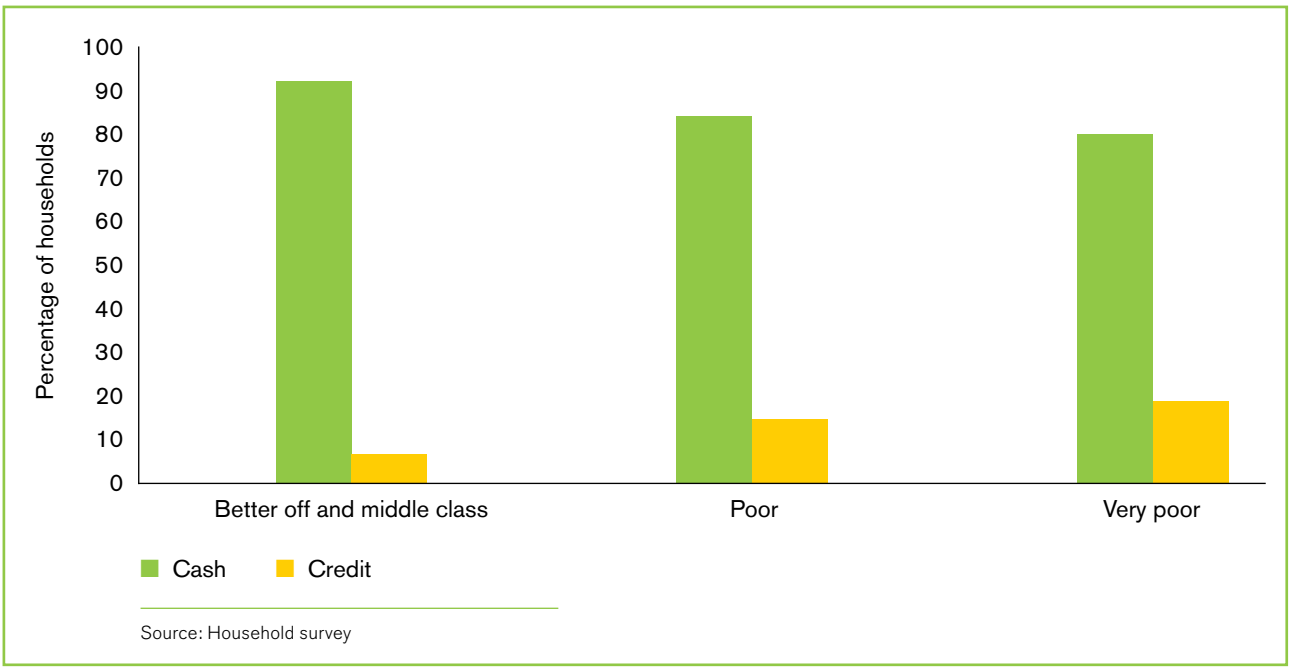


Figure 20. Payment method by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])



Travel time and transportation represent another factor in access to markets. According to the household survey, it takes fishers an average of 30 minutes to reach their market. Local fish collectors generally purchase fish at landing sites (BOBLME, 2015c), but it takes an average of one hour to reach the township fish collectors. Local markets and consumers within villages are mostly reached on foot, while township fish collectors and nearby village markets are accessed by boat (see Fig. 21). Households in these communities do not sell to wholesalers in Yangon, presumably owing to transportation costs and logistics.

Women engage in all markets, but findings indicate that women are more likely than men to sell fish directly to consumers in villages (see Fig. 22). As a result, women tend to access the market more on foot than men, who tend to take a boat (see Fig. 23). Local fish collectors are quite equally represented by men and women (see Box 1). Other surveys have also found that women collect fish locally and sell to nearby markets, particularly those operating on leasable floodplain fisheries, and that they are usually head of the household (Søgaard, 2018).

Figure 21. Means of transportation to market by type of market

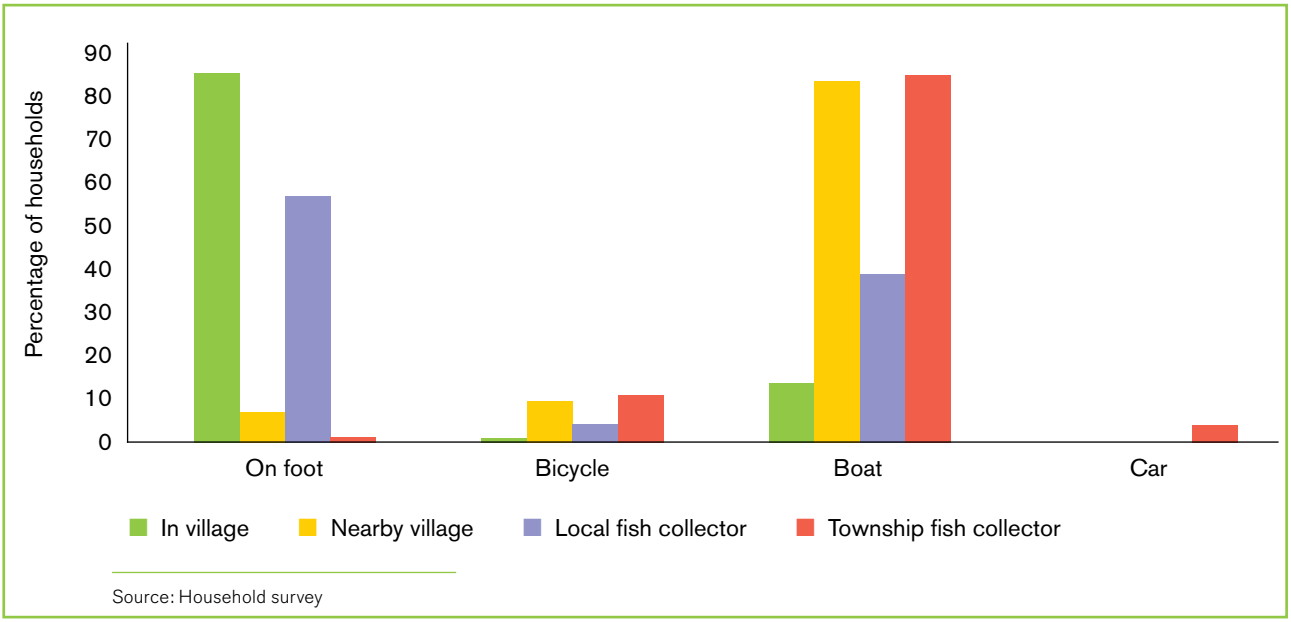


Figure 22. Fish market usage by gender ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

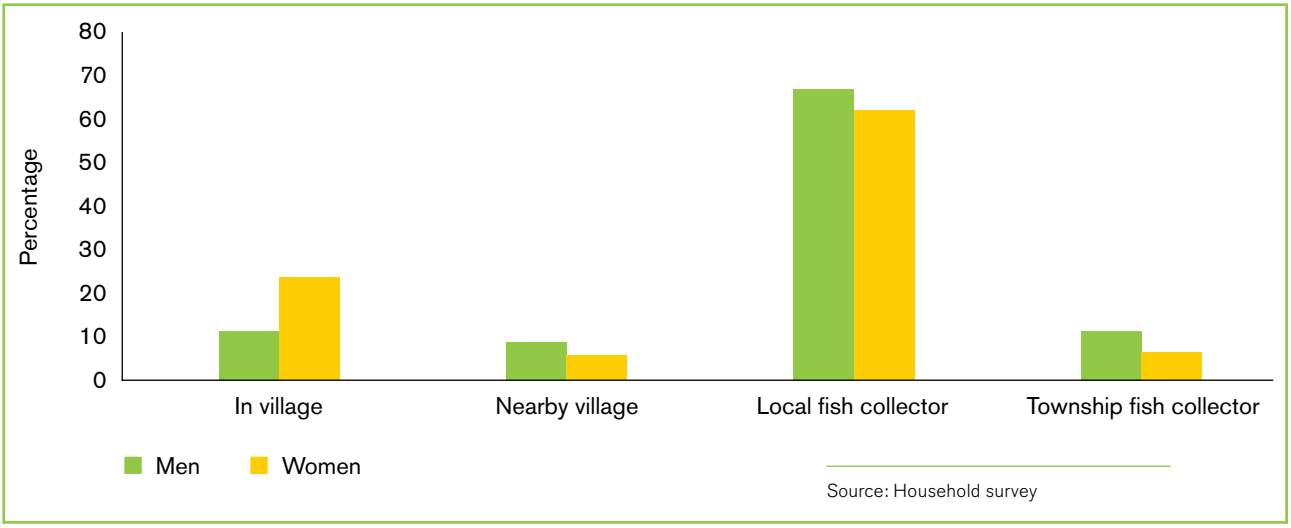
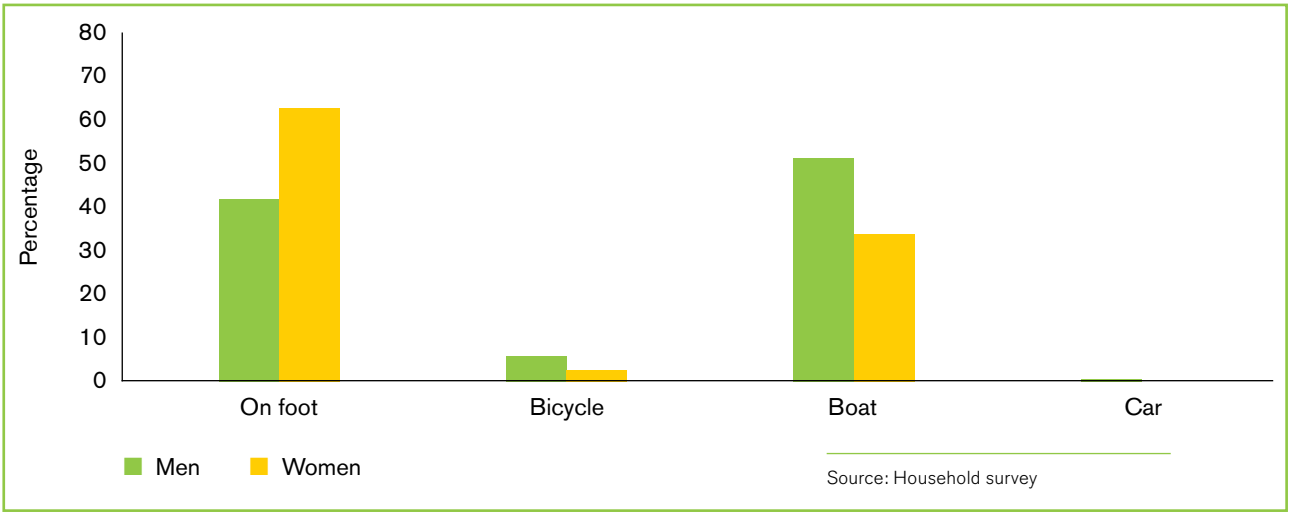


Figure 23. Means of transportation to market by gender



Other livelihoods

5

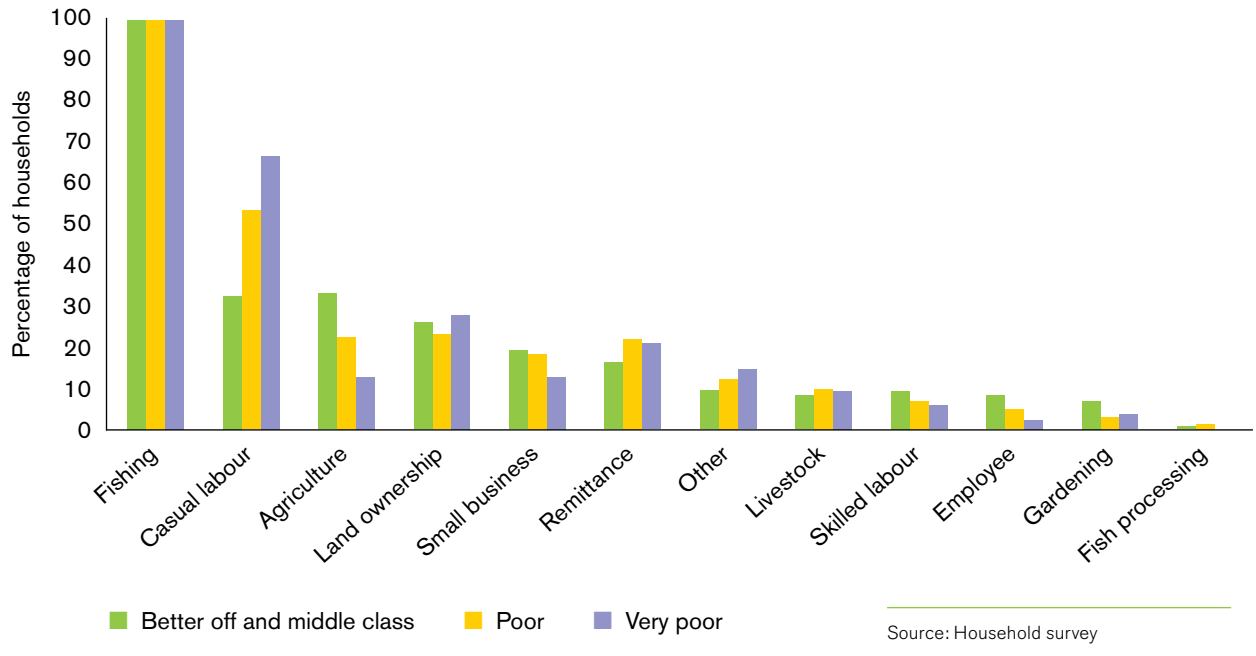
Most fishing households in the region generate some income from activities outside of the fishery sector and many have recently used migration as a livelihood strategy. However, alternative livelihood preferences do not reflect current livelihood options. In order to reduce the hardship imposed by closed fishing seasons, fishing communities require support such as capital investment and training.

5.1 Livelihood diversity and preferences

As seen in sections 3.3.1 and 4.1, fishing is the primary livelihood activity of many households in this region. Village administrator key informants estimated that fishing is the main livelihood activity of 42–45% of the total population in Labutta, Mawlamyinegyun and Ngapudaw townships and 35% in Maubin Township, where people are more likely to own land (see Section 3.2) and migrate for work (see Section 5.2). However, 93% of household survey respondents reported income from livelihood activities outside of the fisheries sector, highlighting the versatility of these communities to diversify when necessary (see Fig. 24). After fishing, the next most popular income-generating activities were casual labour (51%), land ownership (25%), and agriculture (23%). The 'very poor' class was much more likely than other classes to generate income from casual labour, whereas the 'better off and middle class' were more likely to generate income from agriculture, skilled labour[10] and gardening.[11] Despite land ownership being rare amongst the 'very poor' households, they were just as likely to generate income from land as the 'better off and middle class' because those who do will almost certainly maximise profit by using their own labour rather than hiring others to irrigate, weed and harvest.

Ninety-seven per cent of survey respondents said they would face difficulties if they had to stop fishing during certain months.[12] Of these respondents, 53% said they would face living difficulties, 28% said their income would suffer and 18% said they would experience both living and income difficulties. These difficulties were reported across each social class (see Appendix C). However, when asked what they actually do during the closed fishing season, 98% of respondents reported livelihoods other than or in addition to fishing. This could be an indication of strategic bias: respondents might have wanted to emphasise the hardship which fishing bans impose, with the hope of influencing policy. Furthermore, livelihood diversity does not necessarily equate to income diversity; while a household might engage in a range of livelihood activities, it may still derive the majority of its income from one livelihood activity (see Fig. 9).

Figure 24. Percentage of household survey respondents reporting income from different activities, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])



[10] Skilled labour includes activities which require much more training than casual labour, such as operating a rice combine harvester or a tractor.
[11] Gardening usually refers to a vegetable garden on the homestead, as opposed to agriculture which takes place on a larger scale.
[12] Although there is a seasonal fishing closure in place, this was a hypothetical question.

The most common livelihood activity in the closed fishing season, particularly for the 'poor' and 'very poor', was casual labour (mostly labour for paddy farmers) (see Fig. 25). Overall, similar numbers of respondents said they engage in agriculture, and net repair and selling, but these were less common among the 'poor' and 'very poor'. Net repair and selling were not mentioned as a livelihood activity when households were asked more generally about their income-generating activities, indicating that although this might be a common activity during the closed season, it does not bring in much income.

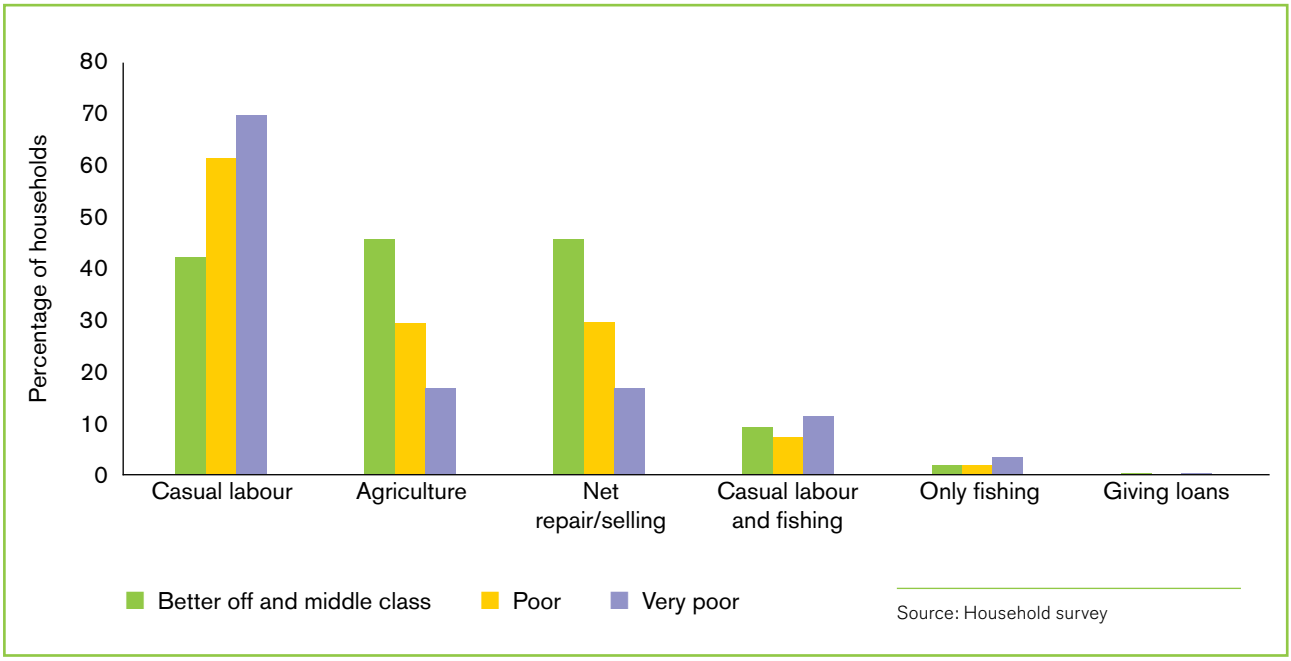
Nine per cent of household survey respondents said they continue fishing in the closed season, 28% said they fish as well as doing casual labour and another 2% said they only fish. Again, these numbers are probably quite conservative, due to the strategic bias that is usually introduced by sensitive questions around illegal resource use. There was also a 10% non-response rate, indicating that additional people did not want to talk about this sensitive behaviour or did not see any alternative livelihood opportunities.

When asked what their preferred livelihood opportunities are during the closed fishing season and what support they would need to make these a reality, the most common answer was small business, such as grocery shops and vendors (43%), agriculture (23%), and job opportunities for skilled workers (16%). These preferences varied by township and social class, probably according to differences in livelihood opportunities in the area and differences in wealth. For example, families from Ngapudaw Township would rather choose to become skilled workers (42%) while other families from Labutta Township (72%) would like to receive more investment for farming. Overall, these preferences did not reflect current income-generating activities, which indicates that there is a desire in these communities to further diversify, but that they need support to do so. Focus group discussion participants asked for more capital investment, vocational training, access to formal education, knowledge of alternative livelihoods, and advanced product processing.

5.2 Migration

Migration appears to be a popular response to the issue of job scarcity in these communities. Forty per cent of survey households had a member who had migrated for work due to job scarcity in the preceding year. Eighteen per cent of these households reported migration within the Ayeyarwady Region, 80% reported migration within Myanmar and 8% reported international migration to countries such as Thailand and Malaysia. Migration was significantly less common among 'very poor' households than others (see Appendix C and Fig. 26). Presumably this is because migration usually requires some initial expenditure, which the poorer households may not have.

Figure 25. Livelihood activities which household survey respondents said they do in the closed season, by social class ('better off and middle class' [n = 202], 'poor' [n = 348], 'very poor' [n = 203]). Respondents were able to give more than one answer



However, migration patterns are complex: the poorest households can also be left with very little choice and might be 'displaced', as they were after Cyclone Nargis (Belton and Filipski, 2019).

Migration did not vary significantly between townships, but Maubin had the highest incidence of migration (see Fig. 27), probably due to its relative proximity to and easy communications with Yangon (Thein et al, 2019). This was confirmed by reports that job availability is very low and that people in Maubin often migrate to other areas when there is low catch in the nearby Toe River.

Other studies have found migrating to take up work in the non-farm sector, usually in Yangon, to be the most common livelihood strategy among the adult children of newly landless households in Maubin (Belton et al, 2015).

Key informant interviews, focus group discussions and PRAs indicated that, although women migrate for skilled and casual labour, the growth of job opportunities elsewhere mostly benefit men because women tend to receive lower wages and face cultural barriers to involvement in industry.

Figure 26. Percentage of household survey respondents with at least one member who has migrated in the last year, by social class ('better off and middle class' [n = 243], 'poor' [n = 374], 'very poor' [n = 216])

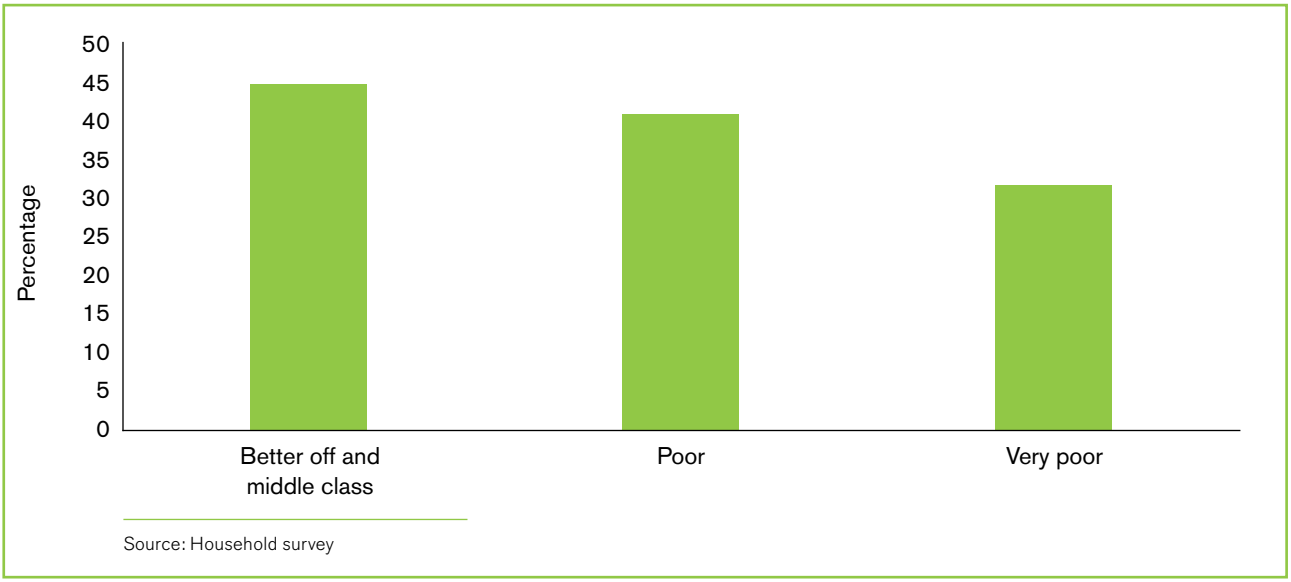
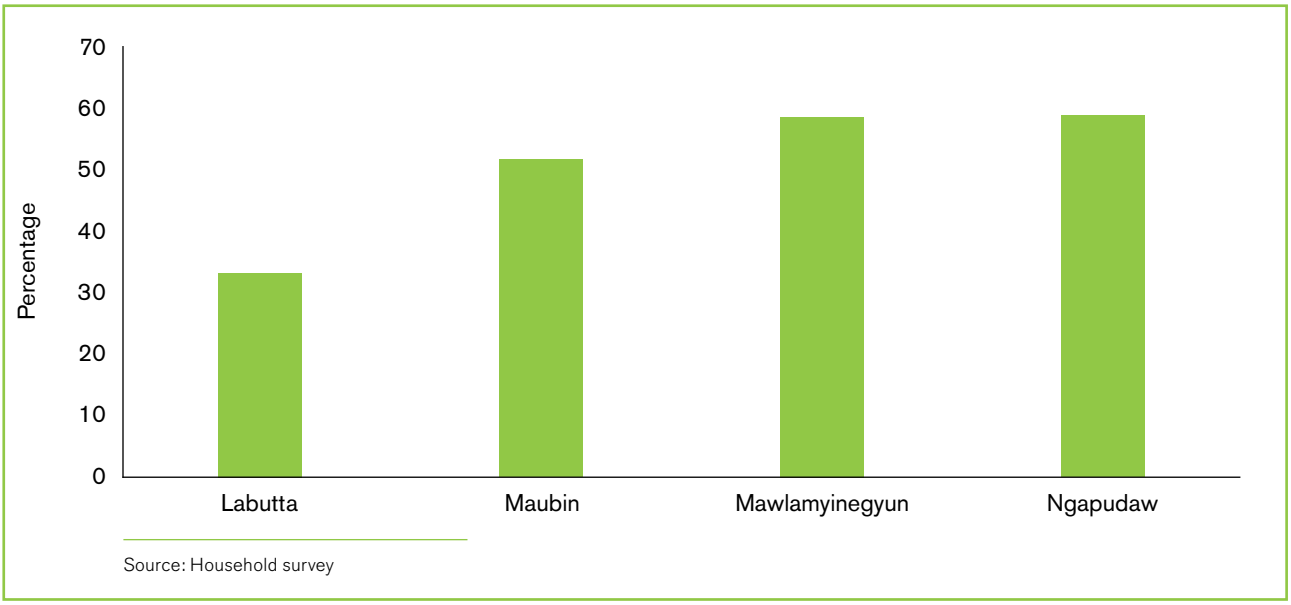


Figure 27. Percentage of household survey respondents with at least one member who has migrated in the last year, by township (Labutta [n = 292], Maubin [n = 162], Mawlamyinegyun [n = 217], Ngapudaw [n = 162])



Perceptions of hilsa fishery management and sustainability

6

Although these fishing communities have some knowledge of hilsa spawning and migratory behaviour and perceive a decline in abundance, in the face of livelihood hardship, conservation is not a priority for them. Effective implementation of co-management systems could provide an opportunity to build awareness and a more sustainable and inclusive fishery.

6.1 Hilsa spawning and migration

Biological studies have demonstrated spawning peaks in March-July and October-November in freshwater and brackish zones, and in February and November in coastal zones (Ei et al, 2018). Key informants, including DoF officials, were able to roughly describe hilsa spawning areas. However, only one township DoF officer could provide information on water conditions and seasonality of spawning. According to this officer, June-July is the main spawning season, with another peak in January-February, while clear and shallow water around a meander bend is the best place for hilsa spawning and growth of fry before they travel downstream.

Fifty-seven per cent of household survey respondents said they know where hilsa spawns, based on their own experience. Twenty-eight per cent of respondents identified spawning months, mostly referring to April (24%) and May (29%), which do fall within one of the peaks identified by biological studies. Twenty-three per cent of respondents said they could describe the ecosystem in which spawning occurs. Fifty-four per cent of these said spawning occurs in freshwater and brackish water near to sand banks and 26% said it occurs in streams under stones and leaves. These answers varied with township, probably due to their respective ecological differences: 96% of respondents in Maubin and 43% in Labutta said spawning takes place in fresh and brackish waters, while 54% of Ngapudaw households said it takes place in streams under stones and leaves. Respondents from Mawlamyinegyun gave a range of answers, but 12% said spawning takes place in mangroves. These answers, which make reference to a range of traditional spawning habitats, indicate a general perception of fish spawning in the region (Akester, in press) rather than specific knowledge about hilsa.

PRA perceptions of spawning seasonality were slightly different and varied more clearly between township (see Table 6). The PRA respondents identified spawning peaks between April and June or August, depending on the township, but the second and third peaks identified in the biological studies were not observed by PRA participants. Neither were participants able to mark spawning grounds or migratory routes on a map. However, the limited overlap between perceived spawning season and fishing activity (see Tables 5 and 6, which were derived from the PRAs) indicates an awareness of the closed fishing season and of conservation needs, even if fishing activities do in fact tend to take place all year round (see Section 4.3 and figures 15–17, which were derived from the household surveys).

Thirty-six per cent of household survey respondents said they knew that hilsa migrates, mainly based on their experience (79%). Only 7% of respondents said that that they knew the direction of migration, either along the river (55%) or near to sand banks (23%). According to survey respondents, the upstream migration starts in October-November (30% said this) or March-April (25%). Respondents said that upstream migration of hilsa stops in March (20%) or February (16%). These correspond roughly with the timings reported by BOBLME (2015a): one migration in the dry season and one in the wet season.

Patterns in perceptions of downstream migration were less clear: 21% of respondents said downstream migration starts in September, 18% in May and 14% in July, while 19% said it stops in July, 12% in January and 12% in March. BOBLME (2015a) reported two periods of downstream migration: in the dry season from April to May and during the wet season from July to September,

Table 6. Seasonal calendar of hilsa spawning by township

TOWNSHIP	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Labutta												
Maubin												
Mawlamyinegyun												
Ngapudaw												

Source: PRAs

but these are still not well understood. The survey results did not vary by township or social class, possibly due to the sample size: around 80% of respondents could not identify any spawning month.

6.2 Hilsa abundance and threats

Most household survey respondents (91%) were aware of a decline in hilsa stocks, perceptions that are reflected in other studies (Joffre and Aung, 2014; Salagrama, 2015). The major reason that fishers provided for this was large-scale fishing activities, which include offshore and inshore activities using powered boats, as well as the use of large fixed bag nets (stow nets) in estuaries. For example, PRA participants in Labutta said that juvenile hilsa are overfished as bycatch by larger-scale fishers and discarded. They also said that use of stow nets to target other species in coastal areas can destroy hilsa fry and juveniles, because they often use very small sized mesh.

Fishers also mentioned that fish abundance can increase when there is a storm in the delta because large-scale fishing will usually have stopped in the mouth of the river during that period. Other studies in Myanmar indicate that local fishers tend to blame large trawlers, the use of illegal fishing gear, lack of fishery regulation enforcement, and environmental factors, such as climate change, for declining fish stocks (Joffre and Aung, 2014; Salagrama, 2015).

6.3 Environmental awareness and motivation

Focus group discussions identified several factors considered harmful to natural resources in the area: fishing during the spawning season, use of fishing nets with mesh size less than four inches, and use of illegal fishing gear. In Maubin Township, fishers also mentioned problems relating to plastics and use of pesticides, forest depletion, and river bank erosion, which contribute to changes in fish migration, habitat degradation, loss of fishing nets,[13] and resettlement of people.

Most survey respondents (67%) said they do not conserve natural resources, but a significant number (59%) said they had planted mangroves or other trees. Those who do not conserve resources said that a good approach to conservation would be restricting the cutting of trees and encouraging more tree-planting (52%), along with enforcement of regulations by the government (30%), such as the banning of refuse dumping into rivers.

In some focus group discussions, we heard that communities in Mawlamyinegyun and Ngapudaw have an agreement to use a minimum mesh size of trammel net and share a common understanding on resource conservation. However, some people in these communities also admitted that sometimes environmental conservation is not a priority and that they fish during the closed season or use illegal fishing gear in order to maintain their livelihoods. The reasons given largely related to family size, lack of job opportunities, health and education expenses, and other livelihood difficulties, indicating that dependence on fishing can impede sustainability. Respondents who said they have respected the fishery closure did so because of low abundance of hilsa during those times, not only due to environmental awareness.

6.4 Co-management

Very few fishery or fisheries management associations were identified during the focus group discussions. In Ngapudaw, respondents reported two associations, which were set up to manage the payment of fishing gear license fees. In Mawlamyinegyun, two fishery associations apparently work with the DoF to provide information and awareness to fishers on taxation and conflict resolution, with the main purposes being environmental conservation, social development, and regulation of illegal fishing. Despite the lack of experience in working collectively, focus group respondents said they thought that fishery associations or committees could strengthen fishery stakeholders' involvement in fishery management and fisher community development.

Most household survey respondents (71%) did not know about any fishery association, except for those in Maubin Township, where 70% of respondents knew of a fishery association. This is as expected, since fishers in Myanmar generally work individually (ILO, 2015). When asked about the goals of fishery associations, 34% of respondents said the goal is to issue licenses and solve problems, 27% said the goal is fishery development and 25% said it is to secure access to capital from NGOs. In Labutta and Mawlamyinegyun, the perceived goal was mainly capital access (61% and 50% respectively), while in Maubin and Ngapudaw it was issuing licenses (33% and 89% respectively). Perceptions also varied with social class: the 'very poor' households perceived the role of fishery associations as being to facilitate access to capital from NGOs and tender for bids, while 'better off and middle class' households perceived their role as being to issue licenses. It is true that to access credit from some local NGOs, fishers have to be members of a legally constituted fishery association. However, the rest of these perceptions reflect a lack of understanding about the reasons for associating

[13] When river banks collapse, fixed barrier nets are buried and lost.

and demonstrates that the new *Ayeyarwady Regional Freshwater Fisheries Law* (2018) is being implemented slowly with a degree of resistance from Union-level promoters of 'business-as-usual'.

Most household survey respondents (97%) were not familiar with the concept of co-management, but around 84% said they would be interested in participating in such a system. This interest was positively associated with poorer households; 92% of 'very poor' households showed interest, as opposed to 77% of 'better off and middle class' households. Similarly, more households showed interest in Labutta (67%) and Maubin (79%) townships than elsewhere. Those who expressed no interest were not opposed to the idea, but said that they lacked the time to devote to such an initiative. A study of hilsa fisheries in Bangladesh produced similar findings: even though participation of fishers in management was scarce, there was interest and willingness to participate (Islam et al, 2018).

Conclusions and recommendations

7

The majority of hilsa fishing households in the Ayeyarwady Region live in challenging socioeconomic conditions and are extremely vulnerable. However, they use a range of coping strategies, such as taking informal loans, livelihood diversification, and migrating, in order to manage food insecurity and other shocks. Each of these strategies highlights further opportunities for socioeconomic improvement and for a more sustainable and inclusive fishery (see Table 7).

One of the major constraints for fishing households is insufficient and irregular income. Not only does income tend to be lower than expenditure, the seasonal and unpredictable nature of fishing as a livelihood activity results in seasonal and unpredictable flows of income. Given the limited access of most fishing households to formal credit, they mostly use social capital to obtain informal loans from moneylenders, fish collectors, and relatives to meet their basic needs during periods of low catch. They also take these loans for capital investment in fishing and in other livelihood activities. Myanmar has one of the least developed financial systems in the world and so these informal systems will continue to play a crucial role for some time yet (GIZ, 2013). However, many struggle to pay these loans back and this can sometimes lead to accumulated debt.

Although most of these households derive the majority of their income from fishing, many of them have one or more other livelihood activities through which they try to support themselves during closed seasons and throughout the year. Agriculture is an important secondary livelihood activity for many, while casual labour allows the landless households to supplement their fishing income. Many households also use migration as a livelihood strategy when local jobs are scarce and this generates remittance income for family left at home.

Low income and a strong dependence on fishing nevertheless impede the ability and willingness of fishers to comply with current and future regulations that impose a short-term cost, for instance by limiting access to the hilsa fishery or requiring investment in specific types of fishing gear. The introduction of a monetary or in-kind incentive system, such as the food compensation scheme in Bangladesh, might improve the socioeconomic condition of fishing households and ultimately improve their ability and willingness to comply with regulations (Bladon et al, 2016). However, incentives must be carefully designed with proper stakeholder participation so that they are appropriate for the social and institutional context and so that negative unintended outcomes are minimised. Compensation schemes for artisanal fishers in Bangladesh and Brazil have both generated some perverse incentives, where people have actually entered the fishery in order to receive benefits (Corrêa et al, 2014; Islam et al, 2016).

A negative unintended outcome of the practice of taking credit from local fish collectors is that it locks households into cycles of debt and relationships which

Table 7. Major challenges faced by fishers in the Ayeyarwady Delta and opportunities for socioeconomic improvement and a more sustainable and inclusive hilsa fishery

CHALLENGES	OPPORTUNITIES
Irregular and insufficient income	Incentives for compliance with fishing regulations Alternative livelihood support Community savings schemes
Dependence on hilsa fishing	Diversification strategies Migration Alternative livelihood support Incentives for compliance with fishing regulations
Debt dependency and lack of access to formal credit	Inclusive financing Social capital
Limited market information and bargaining power	Inclusive financing
Limited knowledge of fishery status and conservation needs	Awareness-raising campaigns Co-management systems
Limited participation of fishing communities in fisheries management	Co-management systems

require them to continue selling fish at the local level, without the flexibility to negotiate on price or sell at the township level where prices are higher. Any incentives for compliance with fishery regulations would need to be designed with these challenges in mind. In Bangladesh, although food compensation provides a short-term boost to food security, many fishers do not comply with the fishing bans because they still need to pay interest on their loans during these periods (Islam et al, 2016). Similarly, traditional microfinance schemes have largely failed to lift small-scale fishers out of their cycles of debt because they have not been designed with seasonal fishers in mind (Uraguchi and Mohammed, 2016). More inclusive financing, such as the provision of low-interest loans to fishing households with no requirement for repayment during closed seasons, should reduce debt dependency and help to create the enabling conditions for an incentive system to be effective. A conditional loan or even cash transfer could help to lower opportunity costs and provide an entry point into an incentive scheme (Porras et al, 2016).

Alternative livelihood preferences in this survey did not reflect current income-generating activities and fishing households specifically asked for training in skilled labour and capital for investment in small businesses and farming. Provision of alternative livelihood support by the DoF and NGO partners could improve socioeconomic conditions by reducing dependence on fishing, particularly during times when the hilsa requires protection. For example, in addition to food compensation, some fishing communities in Bangladesh are provided with support such as rickshaws, vans, livestock, and small-business grants (Islam et al, 2016). But in order to be effective, this kind of support requires rigorous needs assessment and there is evidence to caution against the use of alternative livelihood support to incentivise sustainable behaviour, since it does not necessarily reduce the need or desire to exploit resources (Wright et al, 2016).

Although understanding was limited, fishing households in this survey were mostly supportive of the concept of co-management. While fisheries co-management projects are underway in some areas, participation of Ayeyarwady Delta fishing communities in fisheries management is still very limited (Soe et al, 2018; Thein et al, 2019). Familiarity with the concept was low in this study and respondents associated fishery associations mainly with license fee collection and fishery development. But rights-based co-management is generally understood to be the best opportunity for the sustainable development of inland and delta fisheries in Myanmar (Gregory et al, 2016). Co-management systems have great potential to improve the long-term sustainability of incentive-based approaches, particularly when capacity for top-down monitoring and enforcement is low (Begossi, 2014; Sarkki and Karjalainen, 2015). Where community-level institutions exist, individuals can work together to agree on the design of the incentive system and participate in monitoring and enforcement (Clements et al, 2010; Sommerville et al, 2010). Even if active community-based enforcement is not possible, compliance with regulations would be expected to improve through the social norms that emerge from collective action.

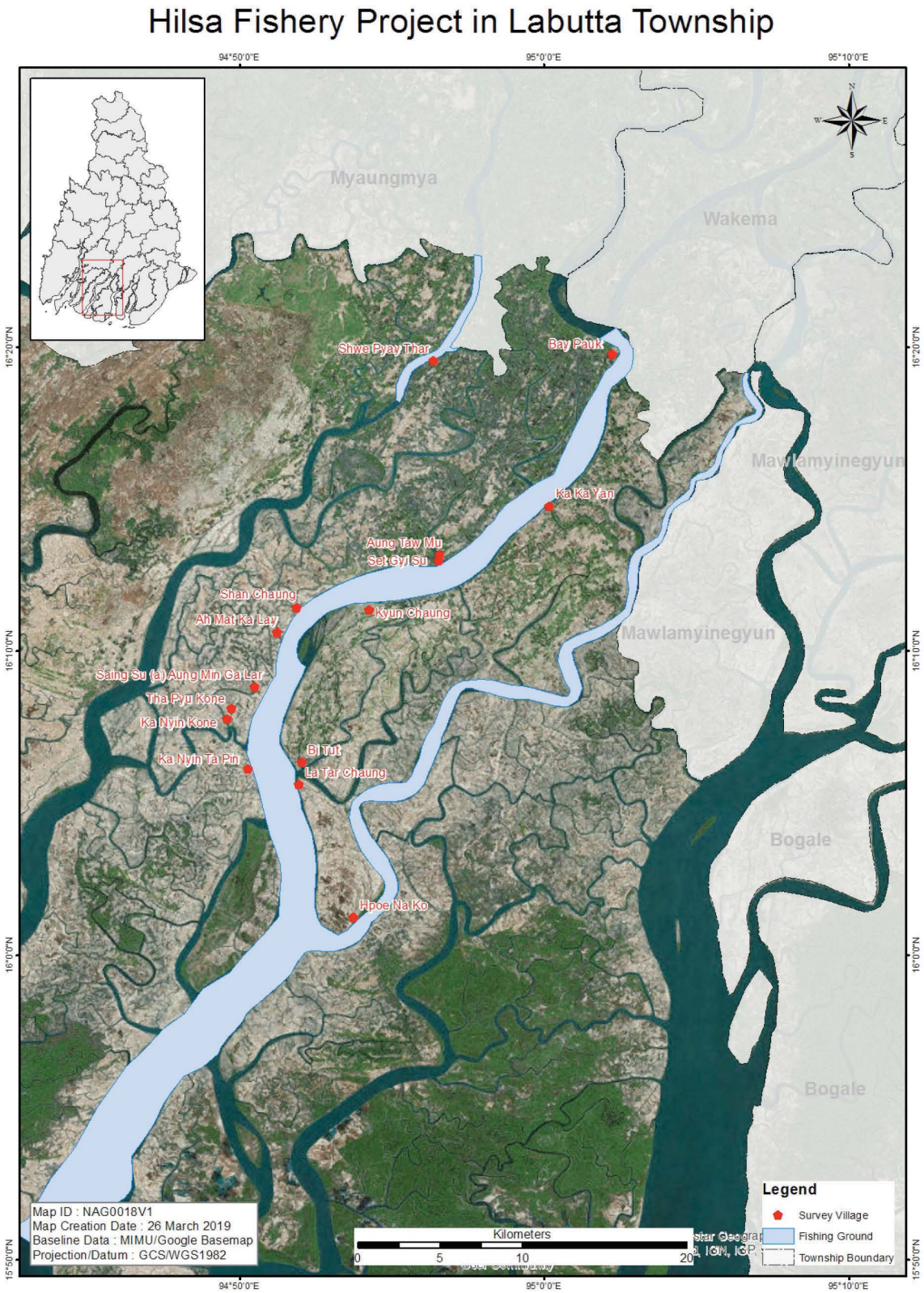
Another potential component of this co-management approach is community savings groups, such as those which have been established in hilsa fishing villages in Bangladesh (Dutton et al, 2018). Some village revolving funds and savings groups do exist in Myanmar (GIZ, 2013), but as co-management infrastructure improves, community savings groups may provide another opportunity to address the seasonality of fishing income and enable households to reduce their debt dependency.

Awareness of a decline in hilsa abundance was high among survey respondents. They blamed this mostly on large-scale fishers, small mesh sizes, and illegal fishing gear, and seemed aware of the impacts of habitat degradation on hilsa populations. Yet they did not seem so aware of the potential impacts of their own actions, such as fishing for juvenile hilsa and fish about to spawn, and using nets that block river channels. Moreover, environmental conservation was not a priority for most households, mostly because they are focused on overcoming their day-to-day socioeconomic challenges. Efforts to raise awareness on the importance and status of the hilsa fishery and how specific regulations can benefit stocks have great potential to improve compliance with (and acceptance of) fishing regulations and spatial closures (Velez et al, 2014). Fishery associations could also help to raise awareness at the community level.

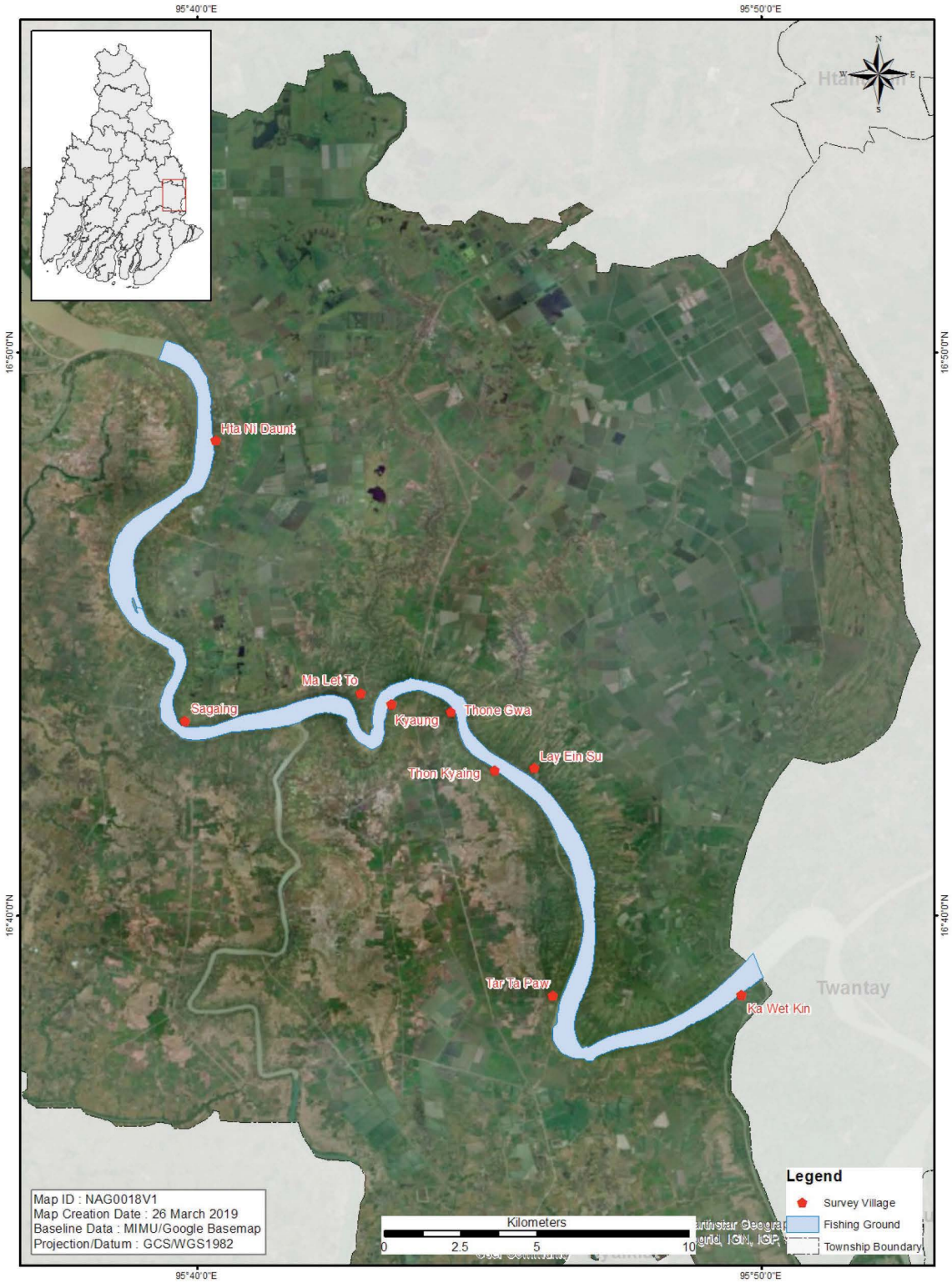
Socioeconomic conditions varied significantly between surveyed townships, which means that not all of these solutions will be equally suitable or effective in all communities. For example, in Ngapudaw, hilsa fishing appears to be much less seasonal than in other townships and so any attempts to incentivise compliance with closed fishing seasons will need to be carefully tailored to the context. Finally, it should be noted that for any of these socioeconomic interventions to have an impact on hilsa stocks, fishing regulations and sanctuary delineations must have a rigorous ecological foundation.

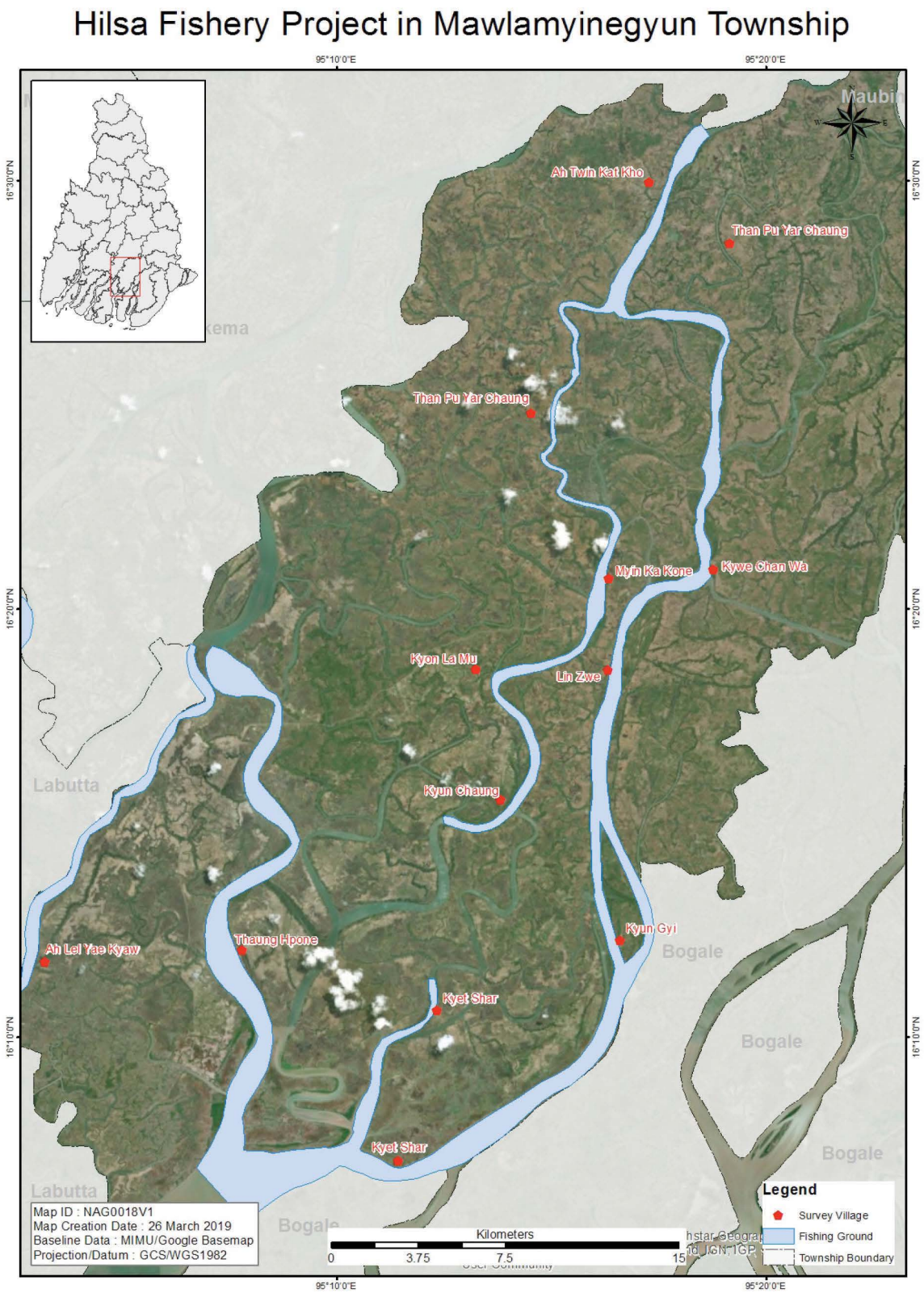
Appendices

Appendix A. Maps of villages in each township surveyed, with fishing boundaries identified through PRA.

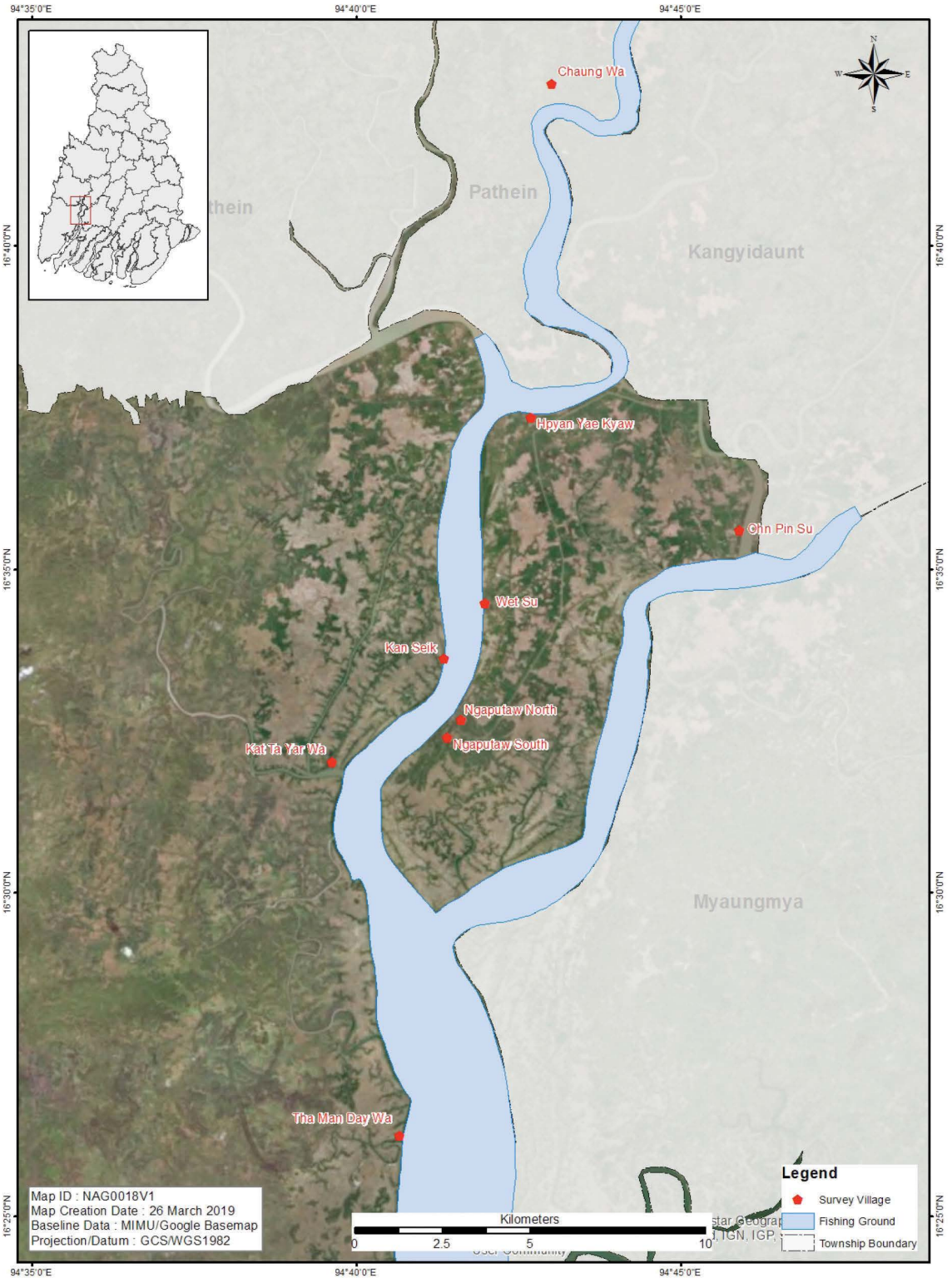


Hilsa Fishery Project in Maubin Township




Hilsa Fishery Project in Mawlamyinegyun Township
95°10'0"E
95°20'0"E
16°30'0"N
16°20'0"N
16°10'0"N
Ah Twin Kat Kho
Than Pu Yar Chaung
Than Pu Yar Chaung
Myin Ka Kone
Kywe Chan Wa
Kyon La Mu
Lin Zwe
Kyun Chaung
Kyun Gyi
Ah Lel Yae Kyaw
Thaung Hpone
Kyet Shar
Kyet Shar
Labutta
Bogale
Legend
Survey Village
Fishing Ground
Township Boundary
Map ID : NAG0018V1
Map Creation Date : 26 March 2019
Baseline Data : MIMU/Google Basemap
Projection/Datum : GCS/WGS1982
Kilometers
0
3.75
7.5

Hilsa Fishery Project in Ngapudaw Township



Appendix B. Sample size calculation

Design Effect	*deff*	2
Population Size	*N*	298925
Percentage of success (value of indicator)	P	50%
Significance level	Alpha	5%
Standard normal value for 5% sig. level	$z_{Alpha/2}$	1.96
Margin of error	D	0.05
Required at risk per study wave (n)	N	767
Cushion (% of non-respondents)		9%
Required at risk per study wave (n1)	n1	833
% of Population at risk		100%
Prevalence rate		100%
Final Sample Size	n2	833

$$n = \frac{NZ^2_{\alpha/2}p(1-p)}{(N-1)d^2 + Z^2_{\alpha/2}p(1-p)}$$

Appendix C. Household survey summary statistics and results of significant associations of socioeconomic characteristics with social class ('better off and middle class', 'poor', and 'very poor') and township (Labutta, Mawlamyinegyun, Maubin, and Ngapudaw).

VARIABLE	SUMMARY STATISTICS	SIGNIFICANT ASSOCIATIONS WITH SOCIAL CLASS	SIGNIFICANT ASSOCIATIONS WITH TOWNSHIP
Household size	Mean = 4.6, median = 4.0, SE* = 0.06%	Not significant	Maubin had significantly larger households than other townships (Kruskal-Wallis $\chi^2 = 9.42$, df = 3, $p < 0.05$)
Dependency ratio	Mean = 50%, median = 58%, SE = 2%	'Better off and middle class' had a lower dependency ratio than other classes (Kruskal-Wallis $\chi^2 = 18.30$, df = 2, p = <0.001)	Not significant
Assets (number of different productive and non-productive assets)	Mean = 2.0, median = 2.6, SE = 0.06	Significant differences were found between each class: number of assets increased from 'very poor' to 'better off and middle class' (Kruskal-Wallis $\chi^2 = 42.03$, df = 2, p = <0.0001)	Households in Ngapudaw and Maubin have significantly more assets (Kruskal-Wallis $\chi^2 = 63.364$, df = 3, $p < 0.0001$)
Land ownership (1 = land, 0 = no land	1= 19%, 0 = 81%	Land was positively associated with higher social classes ($\chi^2 = 27.60$, df = 2, $p < 0.0001$)	Significantly more households in Ngapudaw owned land ($\chi^2 = 14.81$, df = 3, $p < 0.01$)
Annual income (MMK)	Mean = 3,500,000, median = 3,987,770, SE = 88,450	Significant differences were found between each class: income increased from 'very poor' to 'better off and middle class' (Kruskal-Wallis $\chi^2 = 24.74$, df = 2, p = < 0.0001)	Households in Mawlamyinegyun had a significantly lower income than most other townships (Kruskal-Wallis $\chi^2 = 37.07$, df = 3, $p < 0.0001$)
Income dependence on fishing (percentage of total income from fishing)	Mean = 63%, median = 66%, SE = 0.88	The 'better off and middle class' had a significantly lower income dependence on fishing than other classes (Kruskal-Wallis $\chi^2 = 18.54$, df = 2, $p < 0.0001$)	Households in Ngapudaw had a significantly higher income dependence than those in other townships, whereas those in Labutta had higher incomes (Kruskal-Wallis $\chi^2 = 16.751$, df = 3, $p < 0.001$)
Income from alternative livelihoods (1 = yes, 0 = no)	1 = 93%, 0 = 7%	Not significant	Not significant

*SE=standard error of the mean

VARIABLE	SUMMARY STATISTICS	SIGNIFICANT ASSOCIATIONS WITH SOCIAL CLASS	SIGNIFICANT ASSOCIATIONS WITH TOWNSHIP
Alternative livelihoods (1 = yes, 0 = no)	1 = 98%, 0 = 2%	Not significant	Not significant
Annual expenditure (MMK)	Mean = 4175284, median = 3583500, SE = 1.78	'Very poor' households had significantly lower expenditure than other classes (Kruskal-Wallis $\chi^2 = 11.16$, df = 2, $p < 0.01$)	Households in Mawlamyinegyun had a significantly higher total expenditure than those in Labutta and Maubin, whereas those in Labutta had higher expenditure than those in Ngapudaw (Kruskal-Wallis $\chi^2 = 21.225$, df = 3, $p < 0.001$)
Debt (1 = in debt, 0 = no debt)	1 = 76%, 0 = 25%	Debt was positively associated with lower social class ($\chi^2 = 14.82$, df = 2, $p < 0.0001$)	Not significant
Migration (1 = migrated, 0 = no household member migrated)	1 = 40%, 0 = 60%	Migration was negatively associated with poorer social class ($\chi^2 = 8.45$, df = 2, $p < 0.05$)	Not significant
Difficulty in obtaining clean water over the last year (1 = difficulty, 0 = no difficulty)	1 = 30%, 0 = 71%	Not significant	More households in Maubin (98%) have experienced difficulty in obtaining water than in the other townships, and many fewer households in Ngapudaw (49%) have experienced difficulty ($\chi^2 = 97.705$, df = 3, $p < 0.0001$)
Latrine (1 = sanitary, 2 = unsanitary, 3 = none)	1 = 74%, 2 = 16%, 3 = 9%	Not having a latrine and having an unsanitary latrine were significantly associated with the 'very poor' class ($\chi^2 = 16.38$, df = 4, $p < 0.01$)	Households in Labutta are the least likely to have a latrine, while households in Maubin are most likely to have a sanitary latrine. Households in Ngapudaw are the most likely to have a latrine, but also the most likely to have an unsanitary one ($\chi^2 = 61.107$, df = 6, $p < 0.0001$)
House condition (1 = good, 2 = medium, 3 = poor)	1 = 28%, 2 = 61%, 3 = 11%	Poor and medium conditions were significantly associated with the 'very poor' class ($\chi^2 = 42.95$, df = 4, $p < 0.0001$)	Significantly fewer households in Ngapudaw were in poor condition than other townships, and significantly more were in a medium condition, while Maubin had significantly more houses in a good condition ($\chi^2 = 81.515$, df = 6, $p < 0.0001$)
House type (1 = reinforced concrete, 2 = wooden, 3 = bamboo)	1 = 2%, 2 = 67%, 3 = 31%	Bamboo houses were significantly associated with the poorer classes, while wooden houses were associated with the better off ($\chi^2 = 47.56$, df = 4, $p < 0.0001$)	NA

VARIABLE	SUMMARY STATISTICS	SIGNIFICANT ASSOCIATIONS WITH SOCIAL CLASS	SIGNIFICANT ASSOCIATIONS WITH TOWNSHIP
House size (1 = large, 2 = medium, 3 = small)	1 = 10%, 2 = 62%, 3 = 28%	Smaller houses were significantly associated with the poorer classes ($\chi^2 = 29.92$, df = 4, $p < 0.0001$)	Maubin and Ngapudaw had significantly larger houses than other townships ($\chi^2 = 28.785$, df = 6, $p < 0.0001$)
Social class (1 = 'better off and middle class', 2 = 'poor', 3 = 'very poor')	1 = 29%, 2 = 26%, 3 = 45%	NA	The 'better off and middle class' was significantly associated with Ngapudaw township, whereas 'poor' was associated with Maubin, and 'very poor' with Labutta ($\chi^2 = 184.76$, df = 6, $p = <0.0001$)
Fishing time (1 = whole day, 0 = specific times of day)	1 = 81%, 0 = 19%	Poorer households are more likely to fish at specific times of day ($\chi^2 = 9.07$, df = 2, $p <= 0.05$)	Households in Ngapudaw are significantly more likely to fish throughout the whole day ($\chi^2 = 37.57$, df = 3, $p < 0.0001$)
Hours spent fishing in a day	Mean = 4.5, median = 3.0, SE = 0.13	Poorer households spend significantly more time in a day fishing (Kruskal-Wallis $\chi^2 = 22.76$, df = 2, $p < 0.0001$)	There were significant differences between each township apart from Mawlamyinegyun and Ngapudaw (Kruskal-Wallis $\chi^2 = 104.47$, df = 3, $p < 0.0001$). Households in Maubin spent the most time fishing in a day.
Seasonality of fishing (1 = always fishing, 0 = seasonal fishing)	1 = 12%, 0 = 88%	'Better off and middle class' are significantly more likely to fish all year around than seasonally ($\chi^2 = 7.10$, df = 2, $p < 0.05$)	Households in Ngapudaw are significantly more likely to fish throughout the whole day ($\chi^2 = 100.95$, df = 3, $p < 0.0001$)

Abbreviations and acronyms

BOBLME	Bay of Bengal Large Marine Ecosystem
DoF	Department of Fisheries
DoP	Department of Population of the Ministry of Labour, Immigration and Population
FAO	Food and Agriculture Organization of the United Nations
MKK	Burmese Kyat
MoALI	Ministry of Agriculture, Livestock and Irrigation
NAG	Network Activities Group
PRA	Participatory Rural Appraisal

Glossary

Aquaculture: farming of fish, crustaceans, molluscs, aquatic plants, algae, and other organisms.

Co-management: flexible and cooperative partnerships in fisheries management between various entities including governments, agencies, NGOs, and local people dependent on fisheries for their livelihoods.

Drift net: a fishing gear consisting of one or more panels of webbing fastened together. These nets are left free to drift with the current, usually near the surface or not far below it.

Enumerator: person responsible for collecting field data.

Exclusive Economic Zone: a sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources, within 200 nautical miles from its coast.

Fixed bag net (stow net): a stationary fishing gear made from netting, usually in the form of a cone or pyramid. These nets are fixed by means of anchors or stakes, placed according to the direction and strength of the current. The mouths are sometimes held open by a frame, which may or may not be supported by a boat. They can be fixed for a long time at the same place in rows.

Gill nets: a common fishing net used by commercial and artisanal fishers in marine and some freshwater and estuary areas. Gill nets are composed of vertical panels of netting that hang from a line with regularly spaced floaters that hold the line on the surface of the water.

Inland waters: permanent water bodies inland from the coastal zone and areas whose properties and use are dominated by the permanent, seasonal, or intermittent occurrence of flooded conditions.

Inland capture: harvesting of naturally occurring organisms from surface waters inland of the coastline.

Marine capture: harvesting of naturally occurring organisms from ocean and coastline, including bays and estuaries.

Purposive sampling: a nonprobability sampling technique based on the characteristics of a population and the objective of the study.

Beach seine net: a fishing net that hangs vertically in the water with its bottom edge held down by weights and its top edge buoyed by floats, deployed from the shore.

Recruitment: the number of fish surviving to enter the fishery or to some life history stage such as settlement or maturity.

Revolving fund: a fund or account that is continually replenished as withdrawals are made.

Rights-based fisheries management: management regimes based on the allocation of property rights or user rights to fishers.

Snowball sampling: a nonprobability sampling technique where research participants recruit other participants from among their acquaintances, introducing numerous biases.

Stow net: see fixed bag net.

Trammel net: fishing net consisting of two/three layers of netting with a slack small mesh inner netting between two layers of large mesh netting within which fish will entangle. These nets are most common as stationary gear, usually to catch fish at or near the bottom in inland and marine waters, but they can also be used drifting

Tube well: a type of water well in which a long, 100–200 millimetres-wide, stainless steel tube or pipe is bored into an underground aquifer. The lower end is fitted with a strainer, and a pump lifts water for irrigation. The required depth of the well depends on the depth of the water table.

Venn diagram: a diagram that shows all possible logical relations between a finite collection of different sets.

Village tract: a fourth-level administrative subdivision of Myanmar's rural townships.

Viss: Myanmar's unit of weight measurement based on the weight of a single copper coin called a tical (3.6 pounds or 1.6 kilos).

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The Darwin-HilsaMM project is developing an incentive-based system of hilsa fisheries management in Myanmar's Ayeyarwady Delta. This study uses a mixed-methods approach to assess the socioeconomic status of local fishing households. Many are extremely vulnerable, owing to the seasonal nature of fishing and unpredictable flows of income. Coping strategies include informal loans, livelihood diversification, and migration, while many flout fishing restrictions to cover costs and repay loans. Given these household characteristics, we recommend monetary or in-kind incentives for compliance with regulations, more inclusive access to suitable financial products, skills training and small-business investment, more co-management institutions, and awareness-raising campaigns.

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