



Fish Catch-Per-Unit-Effort (CPUE) Analysis in Three Villages in the Gulf of Mottama

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Abstract

The Gulf of Mottama Project (GoMP) has collected fisheries data from the Gulf of Mottama (GoM) since 2016. Initially anecdotal information was collected from fishing villages followed by collection of landing data from two fish buyers in the upper GoM (Kyaikto Township, Mon State). These data have shown an increase in landings and value since 2018 with the exception of a decrease in value in 2021 due to COVID19. In 2020 we initiated data collection directly from fishers from 3 villages from Bilin, Thaton and Paung Townships. Data were collected after each fishing trip via invoices from 5 fishers in each village. The data included catch, species, detailed price information including price for different sizes and gear type. We used the number of fishing days as an indicator of effort allowing us to calculate catch per day as an index of catch-per-unit-effort (CPUE).

The villages in Thaton and Paung Townships fished in the GoM while Bilin fishers fished in the Bilin River and estuary. The GoM fishing villages caught similar species dominated by Flathead Sillago (*Sillaginopsis panijus*), and Pama Croaker (*Otolithoides pama*) and had similar catch, value and catch per day indicators. They also used similar fishing gears and switched gears in July to target Silago.

The Bilin village used smaller-scaled fishing gear and caught different species with Flathead Grey Mullet (*Mugil cephalus*) along with a related Corsula (Fresh Water Mullet) (*Rhinomugil corsula*) comprising 40% of the catch and Pama Croaker an additional 22%. They fished more days but catch per day was about 75% less than the other two villages.

In 2022 there was a considerable difference between villages. The village of Thaton reduced their fishing days by 50% with similar decline in catch and value, while the village of Paung maintained fishing days but catch was reduced. The village of maintained fishing days but had a substantial increase in catch and value. There were also anecdotal reports of a substantial decline in the number of fishing boats in the two GoM villages. These changes indicated the continuing need for detailed data from each village and makes it difficult to generalise across villages.

Fish prices were similar between the villages with prices in 2021 lower for all villages reflecting the disruption in fisheries supply chains due to COVID19. Prices increased considerably in 2022 in spite of the economic and political chaos, reflecting the currency devaluation and increased cost of fishing.

Previously GoMP has shown that Pama Croaker buyers sort fish into eight size categories that are included in the invoices. This allows us to estimate size, weight and age of the catch. The Pama croaker catch from all the villages has been dominated by 2-year-old fish except in 2022 when a large number of larger fish (>5 years old) were caught by the Bilin fishers.

Each individual fisher's data were examined. The Bilin fishers showed considerable consistency between years and each fisher had similar catch and value indices. In the other two villages, 3 out of 5 fishers accounted for most of the catch. There was also a considerable change over the three years with some fishers reducing or stopping fishing necessitating their replacement for data collection.

There is a decline in the CPUE indices from 2021 to 2022 but it is difficult to interpret these trends due to the changes in the economic and political conditions that has affected fishing behaviour. We suggest the collection of additional information to better understand these trends. We conclude by suggesting data collection should continue with the development of a sustainability plan to ensure data collection continues after the project ends in 2024.

1. Background

Fisheries in Myanmar are important for local consumption, income and export earnings (Tezzo et al., 2018). The Gulf of Mottama Project (GoMP)¹ has been working with about 60 coastal villages in the Gulf of Mottama (GoM) since 2015 to develop coastal management plans with a focus on co-management.

The GoM (Figure 1) is a unique ecosystem in the southwest of Myanmar stretching from the Andaman Sea in the south to the mouth of the Sittaung River in the north. It is over 100-km wide at the mouth and narrows to a 1-km funnel at the Sittaung River entrance. The GoM is bounded by Bago Region and Yangon Region on the west and Mon State on the east and has a number of unique features including 7-m diurnal tides that are some of the highest in the world. The GoM is influenced directly by the Sittaung River and in the southeast by the Thalwin River. Additionally, the Ayeyarwady River system contributes sediment due to the west to east oceanic circulation. The end result is that the GoM has a very high suspension load and resultant high turbidity (Ramaswamy et al., 2004). This results in large tidal mud flats that are ecologically important to fish, crabs, and migratory shorebirds, including the highly endangered spoon-billed sandpiper (*Calidris pygmeus*) (Zochler et al., 2014). The Gulf is also very dynamic with frequent changes in the channels and mud flats and severe erosion that has resulted in the loss and relocation of numerous villages (Steijn et al., 2018) particularly on the western coast (Bago Region). The estuary and major rivers are also important spawning and nursery grounds for important fish and crustacean species. These in turn are economically important for small- and medium-scaled fisheries that support numerous coastal villages.

Prior to the project initiation, there was little information available on the fisheries. In order to assist in developing the co-management, a variety of approaches have been used to collect information on the fisheries (MacKay et al 2021). The initial approach was the use of scoping missions, and baseline surveys that assisted in the identification of potential villages. Further information was collected via an Indigenous Fishers Survey in 10 project villages that identified fishing grounds, important species, fishing gear, boats, and threats.

More in-depth information was collected from two fish buyers in Kyaikhto Township. One represents a village fishery from Sut Pa Nu of Kyaikhto in the upper Gulf where data on all species were collected (MacKay et al 2023a). The other one is a larger scale fishery with landings at Mawlamyine (MLM) Holdings Ltd., Kyaikto town, a sub-station affiliated with a cold storage plant freezing fish for export of one commercial species, Pama Croaker (*Otolithoides pama*) (MacKay et al 2023b). This information has shown a substantial increase in landings at both locations since 2016 particularly for Pama Croaker since 2018 and given detailed information on monthly catches and additional ecological data.

While these methods gave an overview of the fishery, we were not able to collect data on effort to show long term trends. Catch-per-unit-effort (CPUE) is used in fisheries to measure the long-term status and sustainability of fishing stocks (Beverton & Holt 1957). The GoMP has also chosen CPUE as one of the indicators to show the effectiveness of fisheries co-management. A decrease in the CPUE may mean a decline in the availability of fish.

In order to obtain data on fisheries effort, we collected data directly from fishers from three villages in Mon State in the lower GoM that included data on fisheries effort. The three villages are Zwe Ka Lar, Bilin Township; Aung Kan Thar, Thaton Township; and Baing Laung, Paung Township (Figure 1). Aung Kan Thar and Baing Laung fishers fish in the GoM from Bilin Township down to southern Paung Township while Zwe Ka Lar fishers

¹ GoMP funded by the Swiss Government through the Swiss Agency for Development and Cooperation (SDC) involves three main partners HELVETAS Swiss Intercooperation (Helvetas), International Union for Conservation of Nature (IUCN), and the Myanmar NGO, Network Activities Group (NAG).

are smaller-scaled and fish in the Bilin River and adjacent areas of the Gulf (Figure 1). We report this information in this paper.

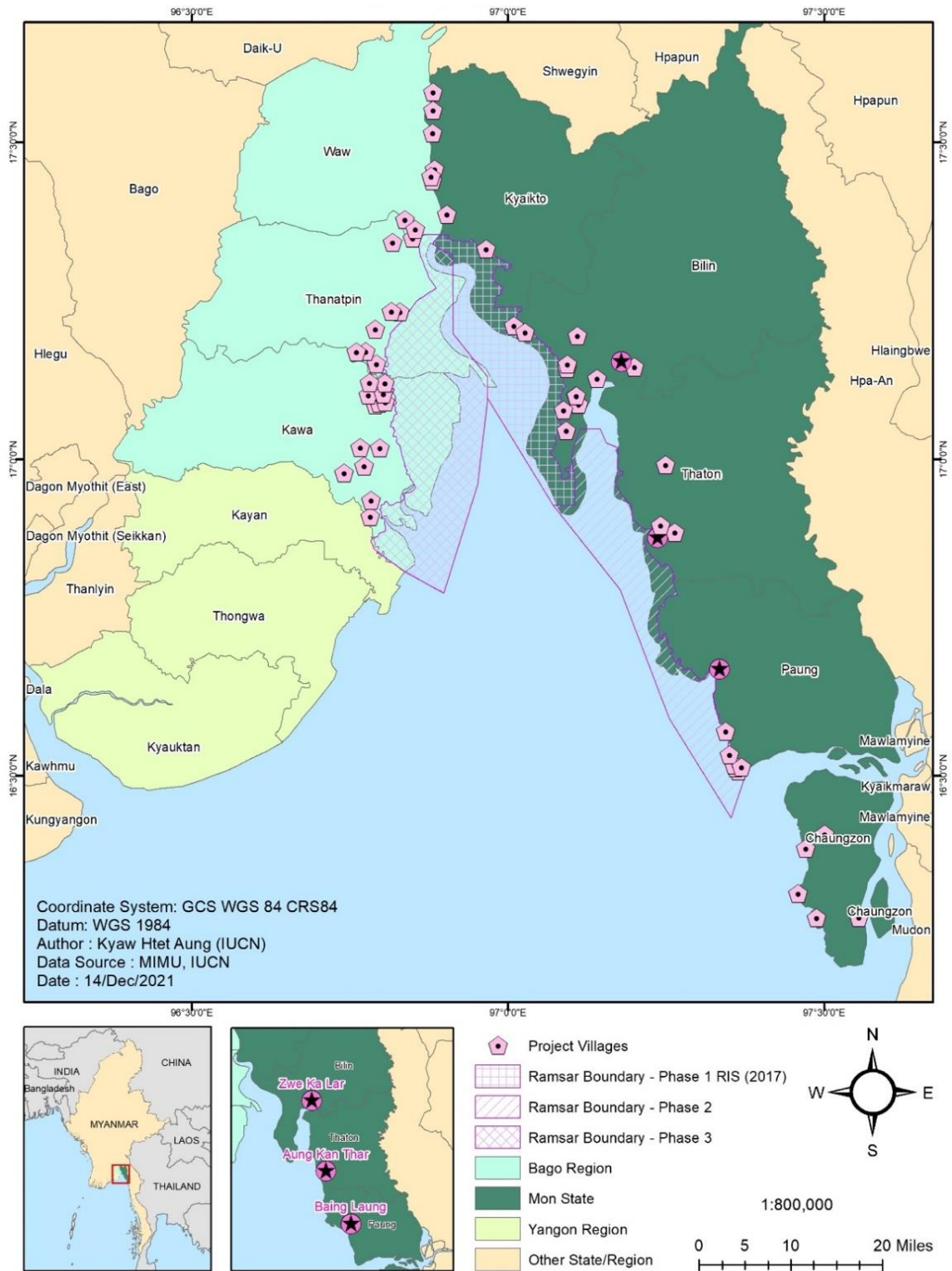


Figure 1: Gulf of Mottama and three villages (Zwe Ka Lar, Aung Kan Thar and Baing Laung) involved in CPUE data analysis

2. Methods

Working through the village fisheries committee, detailed catch data has been collected since 2020 directly from five fishers in each of the three villages in Mon State in the lower GoM (Figure 1). After each fishing trip, the fishers sold their fish to local buyers who prepared an invoice with the catch and value data. These invoices were collected by a local villager and the invoices were sent to GoMP staff who entered the data into excel spreadsheets for analysis. The invoices for each fisher included catch and value by species, subdivided into three to eight size categories, dates of each trip. Additional data was collected on fishing gear from each fisher. All fishers have been cooperative and consistent in the recording of this data.

Initially five fishers from each village were selected for data collection. At Zwe Ka Lar, we were able to collect data from the five fishers for all years. At the other two villages, the situation was more complex due to COVID 19 and the political troubles. Some fishers stopped fishing and thus were replaced with others. This has made analysis more difficult. In spite of this we were able to calculate catch per unit of effort (CPUE) indices. We have used catch per day and catch per fisher as the CPUE indicators. Catch per day was calculated as the total catch divided by the total number of days fishing. Catch per fisher was calculated as the total catch divided by the number of fishers. While the change in fishers made this more complicated but as data was collected from only five fishers for each fishing trip we have used this number. (More details are given in Annex 1). We have used these as indicators to compare the three villages. Additionally, this data will also be useful in monitoring long term changes in both the fish stocks and the fishery.

3. Results

3.1. Fish Catch

A summary of the fisheries data from the three villages is given in Table 1. The time frame for data collection in 2020 was different for each village but the 2021 and 2022 data covered the whole year and allowed us to compare the catches in the three villages.

3.1.1. 2021 Catches

The catches for Aung Kan Thar and Baing Laung were quite similar in total catch, days fishing and the CPUE indices of catch per day (48-56 kg) and catch per fisher (4600-4900 kg). The Baing Laung catches and indicators were slightly higher than those for Aung Kan Thar. The total value of the catch in 2021 was slightly higher for Aung Kan Thar as the value per fisher was MMK 85 Lakhs. Noteworthy was that for Baing Laung where we have complete data for 2020, the catch weight was similar in 2020 and 2021 but the value of the catch was 40% lower in 2021. This was due to a decrease in the catch of the higher priced Pama Croaker (Figure 2) and 40% decline in the croaker price (Table 3) probably reflecting market-related issues due to COVID-19.

The Zwe Ka Lar fishers fished over 200 more days than the other two villages but their total catch was three to four times lower and catch per day was over 5 times lower. As a result, their income per fisher was MMK 30 Lakhs being 2.5 times lower than the other two villages.

3.1.2. 2022 Catches

There was a considerable change in fishing pattern in 2022 probably reflecting the political and associated market problems in Myanmar. In Aung Kan Thar, the number of days fishing decreased by 50% with two fishers reduced their fishing and were partially replaced with two other fishers. This resulted in a decrease of 55% in the catch and 42% in value. While in Baing Laung, the number of fishing days also declined slightly

(5%) resulting in a 27% decrease in the catch but there was a 10% increase in the value of the catch. This increase in value was due to a 90% increase in the price of Croaker to be above the 2020 level (Section 4.2, Table 3).

In Zwe Ka Lar, the situation was completely different. The days fishing and number of fishers remained constant but there was a 52% increase in the catch and over 130% increase in value. As a result, the value of the catch was MMK 70 Lakhs being higher than that at Ang Kan Thar. These changes indicated the need for detailed data from each village and makes it difficult to generalise across villages.

Table 1. Fisheries Data from three GoM Villages in 2020-22

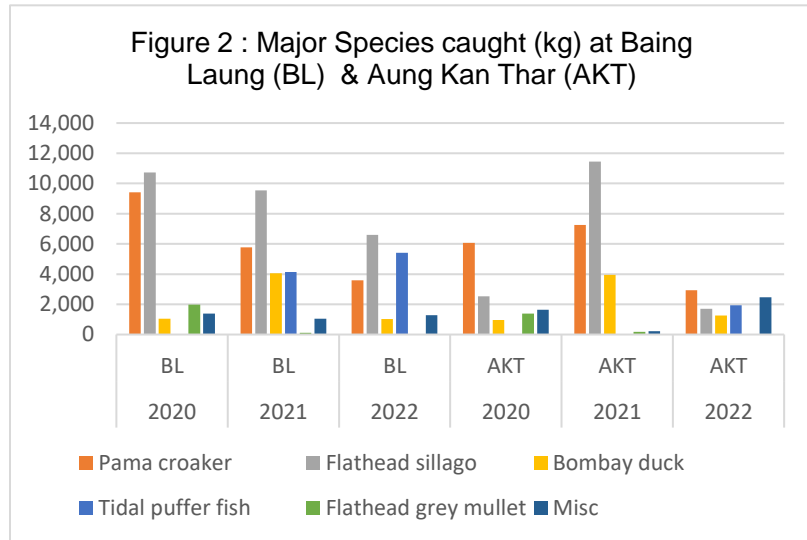
Year	Catch (Viss)	Catch (kg)	Value (MMK)	Days Fishing	Average fishing trip days	Catch /Day (kg)	Catch/ Fisher (kg)	Value/ Fisher (MMK) (US\$ ²)
Zwe Ka Lar, Bilin Township								
2020 Sep-Dec	1,489	2,432	7,357,400	200	4.3	12.2	486	1,548,926 (\$1,191)
2021 Jan-Dec	3,988	6,512	15,415,725	716	6.5	9.1	1,303	3,083,145 (\$1,713)
2022 Jan-Dec	6,088	9,941	35,423,300	721	6.2	13.8	1,988	7,084,660 (\$3,080)
Aung Kan Thar, Thaton Township								
2020 Apr-Dec	7,701	12,575	30,260,640	457	1.3	27.5	2,515	6,052,128 (\$4,655)
2021 Jan-Dec	14,114	23,048	42,836,440	491	1.1	46.9	4,610	8,567,288 (\$4,760)
2022 Jan-Dec	6,300	10,287	24,793,660	229	1.6	44.0	2,057	4,958,732 (\$2,156)
Baing Laung, Paung Township								
2020 Jan-Dec	15,047	24,571	63,644,155	529	2.4	46.4	4,914	12,728,832 (\$9,791)
2021 Jan-Dec	15,105	24,665	37,492,780	441	1.9	55.9	4,933	7,498,556 (\$4,165)
2022 Jan-Dec	10,964	17,904	41,630,255	422	2.0	42.4	3,581	8,326,051 (\$3,620)

² US\$/MMK Exchange has fluctuated 1300 (2020), 1800 (2021), 2300 (2022)

3.2. Species

3.2.1. Catch by Species

The major species captured in Aung Kan Thar and Baing Laung were quite similar (Figure 2 & Table 2). Flathead Sillago (*Sillaginopsis panijus*) and Pama Croaker (*Otolithoides pama*) dominated the catch comprising 60-80% of the catch. Bombay Duck (*Harpadon nehereus*) catches ranged from 9-16% in 2021 and 2022. Flathead Grey Mullet catches were 8-11% in 2020 but catches were very low in subsequent years. At Baing Laung from November 2021 to March 2022, there was a large catch of Tidal puffer fish (*Chelonodon potoca*) that comprised 17% of the total catch in 2021 and 30% in 2022. A similar situation occurred at Aung Kan Thar in 2022 where this species comprised 18% of the catch. Additionally, there were over ten species caught in low quantities reflected in the miscellaneous bar on the graph. This included a mixture of Hilsa and Toli shad (Table 2) that comprise 7-8% of the total with Toli comprising 53 to 73 % of the shad catch.



The Zwe Kar Lar fishery had lower catches (Table 1) with only six major species. The catch profile (Table 2 & Figure 3) was also different from the above two villages. Flathead Grey Mullet (29%) along with the related Corsula (Fresh Water Mullet) (*Rhinomugil corsula*) (11%) comprise 40% of the catch. Pama Croaker comprised 22% of the catch while Flathead Sillago, Seabass (*Lates uwisara calcarifer*), and Paradise Threadfin (Mango Fish) *Polynemus paradiseus* made up 10 to 14% of the catch each.

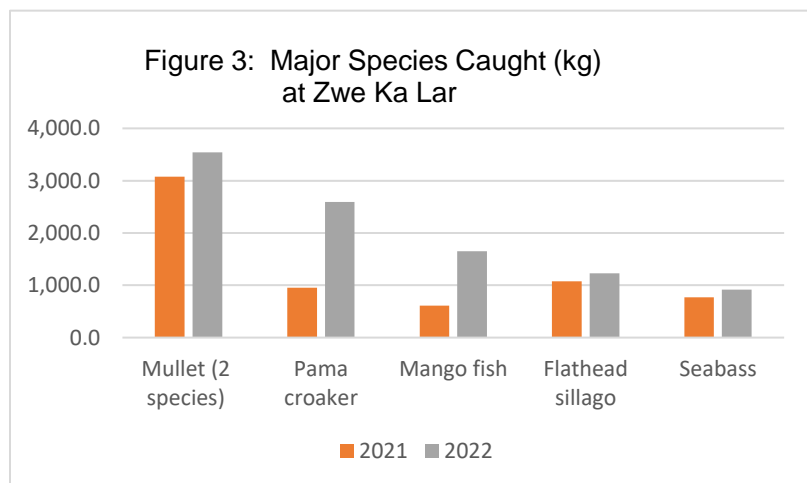


Table 2. Percent catches and value of major species in the three GoM villages

	Pama Croaker	Flat-head Silago	Bom-bay Duck	Tidal Puffer Fish	Flat-head Grey Mullet	Fresh water Mullet	Mango Fish	Sea-bass	Hilsa Shad	Toli Shad	Misc
Baing Laung 2020-22											
% total Catch	28.0%	40.0%	9.1%	14.2%	3.2%	-	-	0.1%	0.7%	2.6%	2.1%
% catch value	46.8%	30.7%	3.1%	9.5%	4.5%	-	-	0.3%	2.0%	0.8%	2.4%
Aung Kan Thar 2021-22											

% total Catch	30.5%	39.5%	15.6%	5.8%	0.5%	-	-	0.1%	0.9%	6.4%	0.4%
% catch value	49.3%	31.5%	5.8%	3.2%	0.8%	-	-	0.3%	2.5%	5.8%	0.5%
Zwe Ka Lar 2021-22											
% total Catch	21.6%	14.0%			29.1%	11.2%	13.7%	10.3%			
% catch value	22.7%	10.8%			23.6%	12.8%	16.7%	13.3%			

Table 3. Prices per kg (MMK) of major species in the three GoM villages

	Pama Croaker	Flat-head Silago	Bombay Duck	Tidal Puffer Fish	Flat-head Grey Mullet	Hilsa Shad	Toli Shad	Sea-bass	Total All³ Species
Baing Laung									
2020	4,026	1,365	784	-	3,072	6,803	864	3,759	2,590
2021	2,283	1,518	611	1,408	2,279	5,266	410	5,074	1,520
2022	4,358	2,236	1068	1,424	3,491	6,253	420		2,325
Average 2020-22	3,556	1,706	821	1,416	2,947	6,107	565	4,417	2,145
Aung Kan Thar									
2020	2,991	1,384	794		2,535	3,069	922	3,694	2,591
2021	2,944	1,538	692	859	3,009	3,688	2,402	4,593	1,859
2022	4,099	2,165	941	1,113	-	5,915	1,826	6,736	2,410
Average 2020-22	3,345	1,696	809	986	2,772	3,202	1,717	5,008	2,287
Zwe Ka Lar									
						Fresh water Mullet	Man-go Fish		
2021	2,588	2,047	-	-	1,943	1,837	3,228	3,556	2,367
2022	3,491	2,671	-	-	3,353	3,758	3,952	4,361	3,563
Average 2021-22	3,040	2359			2648	2797.5	3590	3958.5	3,040

3.2.2. Prices

Prices were collected for all catches based on the price for various size categories. Table 3 indicates that for the individual species prices are quite similar between the three villages. At Baing Laung and Aung Kan Tar, while caught in small quantities Hilsa and Seabass had the highest prices and Bombay Duck had the lowest price. There was also a considerable price difference between the two closely related Shad species with Hilsa Shad being 3 to 10 times more valuable than Toli Shad. At Zwe Kar Lar, Seabass, Mangofish, and Fresh Water Mullet had the highest prices and Silago had the lowest.

Significantly, total prices in 2021 were lower for all villages. The overall prices for Baing Laung declined 41% from 2020 and then increased over 50% in 2022 while Aung Kan Thar prices declined 25% in 2021 then increased 30%. Similarly, Zwe Ka Lar increased 50% from 2021 to 2022. This would appear to reflect the disruption in fisheries supply chains due to COVID 19. The prices in 2022 have increased

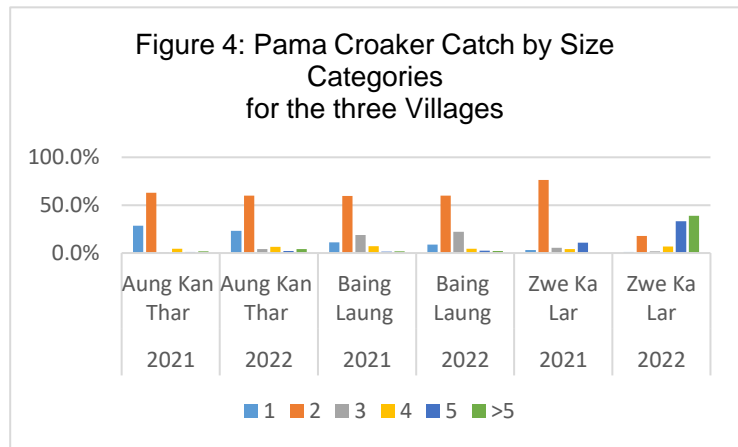
³ The average also includes other species caught in low quantity

in spite of the chaos of the current situation probably due to the economic conditions and devaluation of the MMK.

3.2.3. Fish Sizes

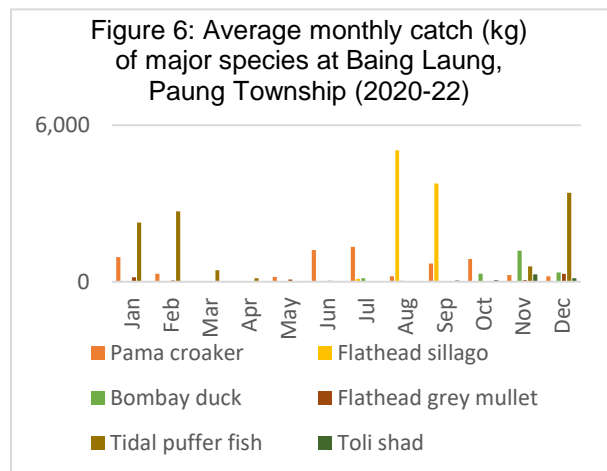
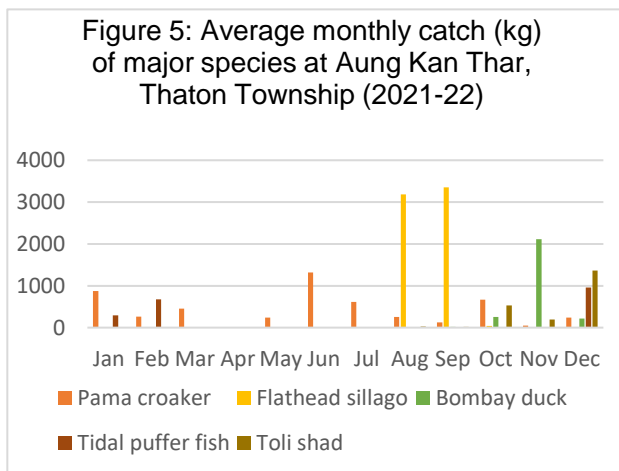
Fish length and weight of individual species are useful parameters to determine the sustainability of a fishery. No detailed length and weight measurements were taken from the landings, however, the invoice data had catch disaggregated into eight size categories. Previous project activities focusing on Pama Croaker showed (MacKay et al 2023b) that the size categories used by buyers gives useful information on size and age distribution of the catch. As such the eight buying size categories are a good indicator of length, weight and ages. The size categories for Pama Croaker thus can be used as an indicator of age such that size 1 = 1-year-old fish, size 2 = 2-year-old fish, etc.

The size distribution of fish caught in the three villages during 2021 and 2022 is indicated in Figure 4. In Aung Kan Thar and Biang Laung the catch was dominated by small sized fish. Size class 2 (2-year-old fish) made up at least 60% of the catch with Size 1 (1-year-old fish) 10-30 % more. In Zwe Ka Lar in 2021, there was a similar pattern with size class 2 fish comprising 75 % of the catch. There was, however, a considerable change in 2022 where larger and older fish of 5-year-old and above comprise about 70% of the catch.



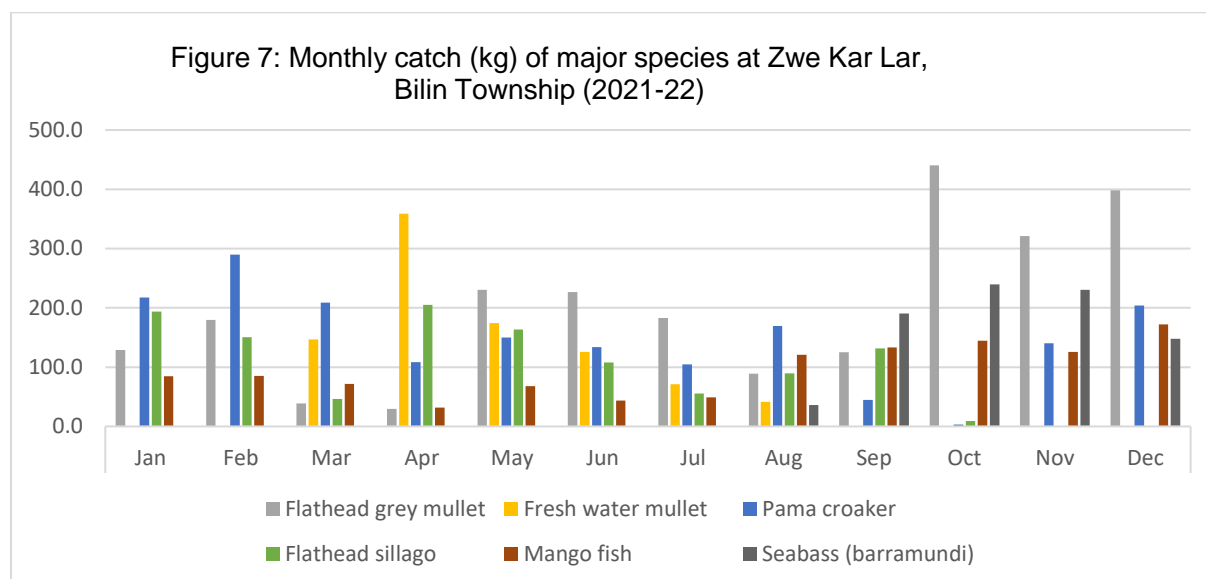
3.3. Monthly Fish Catches

The average monthly distribution of catch of major species for Aung Kan Thar in 2021-22 and Biang Laung in 2020-22 are shown in Figures 5-6.



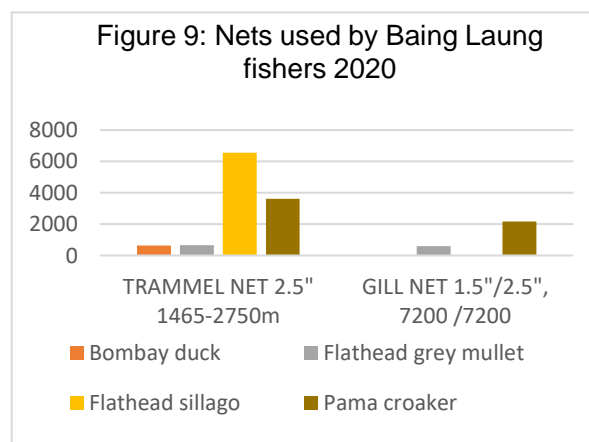
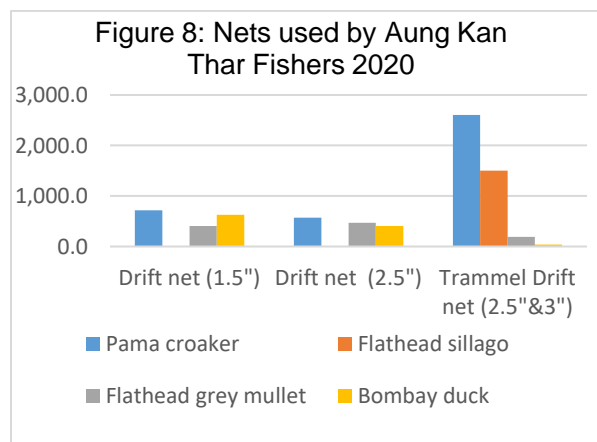
Flathead Silago were only captured in August and September resulting in the highest catches during those months at both villages. Pama Croaker were caught during most other months. Bombay Duck and Toli Shad were captured during October to December. Tidal Puffer fish were captured primarily during December to February while fishing virtually ceased at both villages during March-to May.

The monthly catch profile for Zwe Kar Lar (Figure 7) was very different from the other two villages. Catches were distributed throughout the year including March and April. Flathead Grey Mullet, the major species, was caught during all months with dominant catches during October to December. Fresh Water Mullet was mainly caught from March to June. Pama Croaker were captured in most months. Flathead Silago was caught in all months except October to December as opposed to being captured in only two months (August–September) in the other two villages. Seabass catches were restricted to August to December.



3.4. Fish Catch by Gear Type

Limited data were collected on catches by different gear types (Table 4) for Aung Kan Thar and Baing Laung only 2020 (Figures 8 & 9) and for Zwe Ka Lar January-May 2021-22 (Figure 10)



Aung Kan Thar and Baing Laung fishers used drift trammel nets and gill nets and switch seasonally. In 2020 Baing Laung fishers used gill nets from January - June for 257 fishing days and trammel nets from July to December for 330 fishing days. In Aung Kan Thar, the gill nets fished during April to June (no data available for January- March) and November-December for 296 fishing days. The trammel nets fished from July to October for 170 fishing days.

Fishers from both villages used similar mesh sizes 1.5"-2.5" (3.8-6.4 cm) for gill nets and 1.5" to 3" (3.8-7.6 cm) for trammel nets. The trammel nets were similar in length from 1-2.8 km in both villages. However, Baing Laung used a very long gill nest of 7.2 km compared to 1-1.4 km in Aung Kan Tar. Fishers from both villages caught mainly Flathead Sillago during August-September using trammel nets.

Fishers at Zwe Ka Lar used drift gill nets of both 1.5" and 2.5" mesh and smaller-scaled dragnets and small trammel nets of 1.1 km in length. The species caught in the dragnets and trammel nets were similar for the two gear types (Figure 10).

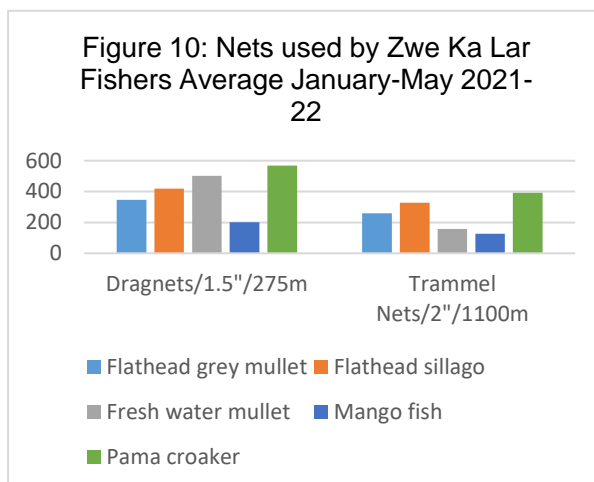


Table 4: Summary of Information on Fishing Gear used in the three villages

Nets	Description	Months	% Fishing days	% Catch	Major Species
Baing Laung					
Drift Gill Nets	1.5"-2.5" mesh 7.2 km length	January-June	43.8	20.9	Pama croaker
Drift Trammel Nets	2.5" mesh 1.5-2.8 km Length	July-December	56.2	79.1	Flathead Silago Pama Croaker
Aung Kan Thar					
Drift Gill Nets	1.5"-2.5" mesh 1-1.4 km length	April-June, Nov-Dec	65.2	48.8	Pama Croaker, Flathead grey Mullet, Bombay Duck
Drift Trammel Nets	2.5"-3" mesh 1.4-2.4 km length	July-October	34.8	51.1	Pama Croaker, Flathead Silago
Zwe Ka Lar					
Dragnets	1.5" mesh 0.275 km length	Data only January- May	61.5	61.6	Pama Croaker, Flathead Silago, Flathead grey Mullet, Mangofish, Fresh Water Mullet
Drift Trammel Nets	2" mesh 1.1 km length	As above	38.5	38.4	As above

3.5. Individual Fishers' Catch

Detailed data were also available for the individual fishers. Annex 1 contains the data for catch, value and days fished in percentages for each fisher using a code⁴. Unfortunately, while five fishers were selected initially from each village in Aung Kan Thar and Baing Laung, some fishers either stopped or

⁴ As the data especially on the value of the catch is confidential it is important that the project not report the data under either the fishers name or initials but use a code know only by the project.

reduced fishing. In order to compensate for that additional fishers were added. The details are explained in Annex 1.

In Aung Kan Thar during 2020-21 (note no data for January- March 2020) the days fishing by the five original fishers (AKT 1-5) varied from 15-25%, while the catch varied from 14-29%, and value for the catch varied from 10-27%. In 2022 two fishers (AKT 1 & AKT 3) decreasing their fishing resulting in them catching 10% and receiving less than 15% of the value. The three replacement fishers (AKT 6-8) combined fished 13%, caught 13% and had 20 of the value. While the other three fishers (AKT 2, 4, & 5) caught considerably higher percentages and received a larger share of the value.

In Baing Laung, the three fishers BL 3 ,5 & 6 who fished all the time accounted for over 75% of fishing days, catch and value with one fisher (BL 6) accounting for 35% of catch and value . In 2022 there was a considerable decrease in fishing effort by the combined fishers (BL 1 & 2, and BL 4 & 7).

In Zwe Ka Lar, all five fishers fished about the same amount of time with each fishing about 20% of time and their share of the catch and value was also about 20%. In addition, there was little change from year to year in effort and catch. Although as was discussed in Section 1 and Table 1 in spite of little increase in fishing effort, the catch and value of the fishery increased considerably in 2022.

3.6. Catch-per-unit-effort (CPUE)

Table 5 summarised the CPUE indicators presented previously in Section 3.1 and adds an additional indicator for Flathead Silago.

Table 5. Catch-per-unit effort indices calculated from data collected from five fishers from each of the three villages

Year	CPUE	Aung Kan Thar	Baing Laung	Zwe Ka Lar
2020 ⁵	Catch/Day (kg)	-	46.4	-
2021		46.9	55.9	9.1
2022		44.9	42.4	13.8
2020	Catch/Fisher (kg)		4,914	
2021		4,610	4,933	1,303
2022		2,057	3,581	1,988
2020 ⁶	Value/ Fisher (MMK) (US\$ ⁷)	-	12,728,832 (\$9,791)	-
2021		8,567,288 (\$5,040)	7,498,556 (\$4,411)	3,083,145 (\$1,814)
2022		4,958,732 (\$2,361)	8,326,051 (\$3,965)	7,084,660 (\$3,374)
2020	Catch Flathead Silago/Day (kg)	37.6	105.8	-
2021		110.1	68.4	-
2022		89.4	58.1	-

The catch/day and catch/fisher for Aung Kan Tar and Baing Laung were similar and both showed a decline in 2022 probably due to the dramatic changes in political and economic environment. The

⁵ Complete year data not available for Aung Kan Thar and Zwe Ka Lar in 2020.

⁶ 2020 January to March data not available for Aung Khan Tar

⁷ US\$/MMK Exchange has fluctuated 1300 (2020), 1700 (2021), 2100 (2022)

indices for Zwe Ka Lar were about four to five times lower. This is, as indicated previously by the nature of their fishery as they use smaller nets and fish mainly in the Bilin River and estuary rather than the main GoM. Surprisingly at Zwe Ka Lar, the two indices increased in 2022.

We have also determined the value per fisher for the five fishers from each village. This can give some indication of the value of the fishery to the community. In Baing Laung where we have a full year's data for 2020 there is a 41% decrease in value/fisher in 2021 even though the catch rate increased. This probably reflects the impact of COVID19. There was a slight increase in value in 2022 in spite of the catch rate decreasing. In Aung Kan Thar from 2021 to 22 the catch and days fishing (Table 1) decreased by around 50% and is reflected in a 42% decline in value per fisher. Zwe Ka Lar presented a completely different situation as the value per fisher actually increased by 130% in 2022 from 2021. The change in US\$ is reflective of the above changes but also due to the devaluation of the Myanmar Kyat. This would also be incorporated in increased prices for imported fisheries inputs fuel, nets and motors that has made fishing more expensive.

CPUE is mainly used in fisheries to determine the sustainability of the fishery usually calculated for single species or a stock. In our case we have looked at the whole mixture of 6-10 species. Unfortunately, the data did not allow us to determine fishing days for each species. However, one species, Flathead Silago was caught almost exclusively in August-September (Figure 5 & 6) and we had catch and fishing days for those months. The catch per day for this species (Table 5) suggests a decline over the three years at Baing Laung and from 2021 to 2022 at Aung Kan Thar.

While the CPUE indices have declined, it is difficult to interpret this as a decrease in the abundance of the fishery stocks. There had been major changes in the fishery since we started data collection. Anecdotal information suggests the number of boats fishing has declined by 50% (Kyaw Thu Aung, Pers. Comm.). Some fishers have left fishing while others have decreased their days fishing. Markets and prices have been greatly affected by COVID19 with fish prices declining in 2021 (Table 3) but have increase in 2022. Prices of fishing inputs have also increased. All of this has affected fishing behaviour and makes it very difficult to interpret trends. We suggest the collection of additional information is needed to assist in interpreting trends.

4. Follow-up Activities

Collection of fish catch data from the three villages had two purposes: The first one was to support and supply information to the fishers, the village fisheries committee, the VDC, the Township FDA and other stakeholders to assist in their fishery management. The second one was to supply information to GoMP in terms of monitoring the effectiveness of the interventions. The following is a suggestion of potential follow up to strengthen these objectives.

Data sharing:

- a. The data must be shared and discussed (at least annually) with village fishers, the Village Development Committee and the Township Fishers Development Association as a means of strengthening the commitment to data collections and fishery management. The presentation should allow feedback to discuss the data, confirm or correct conclusions.
- b. In order to accomplish the above objectives, the data needs to be summarised using a format developed by the Fisheries Officer. The International Fishers Advisor could assist in this format. A suggested report to present to individual fishers is shown in Annex 2.
- c. Reports should respect the confidentiality of the data from individual fishers. Names or initials should not be used but a code developed for individual fishers.

- d. Data sharing with Department of Fishery and other Government agencies should occur when appropriate.

Additional Data: As indicated in Section 3.6, it is difficult to interpret changes in the CPUE as there had been major changes in the number of fishing boats and other fishing practices in the past two years. Additional information should be collected on the following.

- e. GoMP staff should determine annually the number of boats fishing including those fishing full time and those part-time.
- f. The data collection is based on invoices that report only fish sold to buyers. Previous discussion with fishers indicated some fish were consumed in the fisher's household. Interviews with Baing Laung villagers (especially women) indicated, in contrast to many fishing villages, the fish consumption was of fresh and high-quality fish with about 1 kg/day/household. In addition, some fish may be sold unofficially and some may be dried or used for fish paste. There may be a separate market for croaker swim bladders rather than being sold with the whole fish. A fisheries survey could be carried out in each village to determine the value and importance of the informal fishery and changes due to COVID19 and the political difficulties. This could be done with assistance of Point b.
- g. Tidal puffer fish were not caught in 2020 but in 2021 and 2022. Is this a new fishery or have they always caught them?
- h. The fishery at Zwe Ka Lar is quite different from the other two villages. Additional information is needed to better understand the differences. This includes:
 - They had longer trips than the other villages yet they appeared to fish closer to their village;
 - The invoices showed fewer fish species than the other villages. Do they catch other species that they consume or locally process? (See f).
 - Hilsa and Toli catches were not reported yet there are reports of Hilsa spawning in the Bilin River. Do they catch these shad species, and if so, what do they do with them?
 - In 2022, ZKL reported catches of large-sized Pama Croaker (Figure 9) that were not reported in other years or at the other villages. Any explanation?
 - In 2022 the catch and value of the fishery increased considerably (Table 1) in Zwe Ka Lar while it declined at the other villages.
- i. There is little information on Mulletts and Flathead Sillago and the role of the Bilin Rivers for Hilsa, Croaker and Mullet spawning and nursery habitats. If feasible FFI, Point B, individual researchers and other research organisations could be involved in assisting in research on these topics.

We conclude that data collection should continue including the incorporate of the above suggestions. The GoMP should also explore with other organisations working in the GoM the possibility of the data collection continuing and sustained after the project has ended. It will be important that GOMP staff assist in the development of user-friendly software and efficient data collection system for this.

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Annex 1: Detailed Catch per fisher

Table A1: Catch, value (MMK) and days fished as proportion (%) of total for Aung Kan Thar, Thaton Township

Fisher	AKT 1			AKT 2			AKT 3			AKT 4			AKT 5		
Year	Catch (%)	Value (%)	Days (%)	Catch (%)	Value (%)	Days (%)	Catch (%)	Value (%)	Days (%)	Catch (%)	Value (%)	Days (%)	Catch (%)	Value (%)	Days (%)
2020	24.3	24.0	20.6	28.7	25.7	18.8	24.4	23.4	20.4	9.2	10.2	17.3	13.3	16.6	19.4
2021	25.1	26.8	21.4	14.4	16.4	13.8	20.8	20.3	20.4	17.9	16.0	20.4	21.8	20.5	24.4
2022	6.5	10.9	20.1	43.7	34.1	27.8	3.3	3.5	2.2	16.7	17.3	23.1	17.0	13.8	16.7
Average	20.7	21.9	20.8	24.9	23.8	19.3	17.9	17.0	16.8	15.3	14.6	19.1	18.4	17.6	21.3
Fisher	AKT 6, 7, & 8														
Year	Catch (%)	Value (%)	Days (%)												
2020	0.0	0.0	0.0												
2021	0.0	0.0	0.0												
2022	12.8	20.3	10.0												
Average	2.9	5.2	3.8												

Initially at Aung Kan Thar five fishers were selected for data collection. In 2020-21 they fished most months except for March-April. In 2022 there were considerable changes in fishers and fishing effort AKT 1 stopped fishing at the end of July. AKT 3 fished only in August & September. AKT 6 fished only January & February, AKT 7 fished only in October and AKT 8 fished during October –November. We have combined the data for AKT 6, 7 & 8 they represent less than 15% of the fishing effort in 2022.

Table A2: Catch, value (MMK) and days fished as proportion (%) of total for Baing Laung, Paung Township

Fisher	BL 1 & 2			BL 3			BL 4 & 7			BL 5			BL 6		
Year	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)
2020	19.62	17.09	17.01	16.19	15.67	20.79	12.65	10.46	14.93	23.93	27.41	24.76	27.62	29.37	22.50
2021	11.20	10.21	15.87	13.82	13.06	16.55	12.02	8.96	11.34	28.2	27.28	26.53	34.72	40.49	29.71
2022	6.95	7.76	7.58	17.90	18.61	30.33	6.38	7.52	6.87	25.37	24.57	26.54	43.40	41.55	28.67
Average	13.15	12.56	13.79	15.78	15.84	22.60	10.74	9.21%	11.35	25.90	26.55	25.86	34.44	35.84	26.65

Annex 1: Detailed Catch per fisher

At Baing Laung initially five fishers were selected. Two were brothers using the same boat if one could not fish the other did fish. We are considering them as a single fisher (BL 5). Data was collected from alternate fishers BL 1 when BL 2 could not fish and similarly from BL 7 when BL 4 could not fish. In both cases we have consider them as one fisher.

Table A2: Catch, value (MMK) and days fished as proportion (%) of total for Zwe Kar Lar, Bilin Township

Fisher Years	ZKL 1			ZKL 2				ZKL 3			ZKL 4			ZKL 5		
	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)	Catch (%)	Value (%)	Days Fishing (%)	
2020	18.11	19.69	15.50	21.34	18.72	22.00	22.21	24.00	22.50	22.85	18.29	22.00	15.48	19.31	18.00	
2021	19.51	19.81	20.39	17.81	18.69	20.67	20.36	20.18	18.58	22.81	22.32	20.67	19.52	19.00	19.69	
2022	20.54	20.61	20.53	18.67	18.84	18.59	18.01	17.70	18.86	21.92	22.04	20.80	20.85	20.82	21.22	
Average	19.87	20.28	19.85	18.7	18.78	19.91	19.36	19.15	19.18	22.35	21.64	20.89	19.70	20.14	20.1	

At Zwe Kar Lar the original selected fishers have all remained fishing.

Annex 2: Suggested report to Fisher

Here is the example for one fisher from Aung Kan Tar in 2021

1) Summary Catch of all Fishers in AKT Village

Month	# of fishing days	# of fishers	Total Catch (Viss)	Total Catch (kg)	Total Value (MMK)	Catch (kg) /day	Catch (kg) /Fisher	Value (MMK) /Fisher
Jan	22	4	647.2	1,056.8	2,553,745	48.0	264.2	638,436
Feb	36	5	536.8	876.5	2,028,175	24.3	175.3	405,635
May	29	5	350.8	572.8	1,661,130	19.8	114.6	332,226
Jun	97	5	1,337.1	2,183.4	6,894,310	22.5	436.7	1,378,862
Jul	58	5	668.5	1,091.6	3,254,550	18.8	218.3	650,910
Aug	76	5	3,783.2	6,177.6	10,210,480	81.3	268.6	2,042,096
Sep	64	5	3,626.4	5,921.7	9,330,600	92.5	92.5	1,866,120
Oct	27	4	522.3	852.8	2,848,800	31.6	213.2	714,075
Nov	51	4	2,416.0	3,945.2	2,728,550	77.4	986.3	682,138
Dec	31	3	226.3	369.5	1,318,600	11.9	123.2	439,533
Year Total	491	4.5	14,114.3	23,047.7	42,828,940	46.9	4609.5	9,150,031

Summary of AKT 1 catch in Jan-Dec 2021

Month	# of fishing day	Total Catch (Viss)	Total Value (MMK)
Jan	7	202.0	863,470
Feb	7	158.8	611,000
May	5	88.0	382,550
Jun	21	310.5	1,859,760
Jul	9	157.7	771,150
Aug	15	1,017.4	2,753,420
Sep	13	759.0	1,947,650
Oct	4	213.7	1,115,950
Nov	12	535.5	599,650
Dec	12	100.4	578,500
Grand Total	105	3,542.9	11,483,100
% of Total	21.4%	25.1%	26.8%

Annex 2: Suggested report to Fisher

Species Catch by AKT 1 Jan-Dec 2021

Species	Total Catch (viss)	Total Value (MMK)
Total 2021	3,542.9	11,483,100
Ka Ba Lu	17.0	81850
Ka Ku Yan 9(Suu)	5.4	30150
Nag Lake Kyaut	3.7	14800
Nga Nhut	535.5	599650
Nga Pa Lway	1,712.0	4409060
Nga Poke Tin	1,216.7	6209170
Nga Pon Narr / Nga Mway	1.0	5250
Nga Pu Tin	7.1	9960
Nga Tha Lauk	13.2	69200
Nga Tha Lauk Yauk Pha	1.7	7050
Nga-pyar	1.3	1300
Nga-yaung (Suu)	28.3	38160
Pin Lal Nga Pyin Ma		
Ka Ka Tit		