Gulf of Mottama Project

Local Ecological Knowledge Assessment to Identify Spawning Areas of Economically Important Fish Species in the Gulf of Mottama

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EXECUTIVE SUMMARY

The Gulf of Mottama (GoM) is facing a concerning decline in fish species catches, which has experienced a significant reduction in abundance since the early 2000s. This decline is attributed to overfishing, illegal practices, and habitat degradation caused by sand mining and infrastructure development along rivers. The urgency of conserving fishery resources has led to the planning on establishment of fish conservation zones or community-based fishery management areas, necessitating comprehensive knowledge of spawning areas and seasons of economically important fish species.

The project aimed to assess spawning areas through interviews with local communities and inform fishery conservation actions in collaboration with them. Fisher responses revealed distinct fishing periods for different fish species, aiding in understanding their reproductive cycles and guiding sustainable fishing practices.

The study interviewed 97 active fishers from eight villages from Mon State in the Gulf of Mottama. The primary fishing periods for Pama croaker and Mango fish were from May to August, while mullets were targeted from October to March. Hilsa shad were targeted from September to February, and Sillago appeared primarily from August to September.

The study identifies key spawning and nursery areas for economically significant fish species in the Gulf of Martaban (GoM) and presents insights into their spawning seasons. In the lower part of the Sittaung River, fisher responses highlight its significance as a vital spawning and nursery ground for economically important fish species, including Hilsa shad, Pama croaker, and Mango fish. Around Koe Tae Su Village, it is noted for its brackish waters and tidal currents, where Pama croaker and Mango fish use the area for spawning. The mudflats around Ma Mauk Village are suggested as feeding and hiding grounds, potentially used by fish on their way from the sea to upstream regions. At the convergence of Sittaung River and Bilin River, it serves as a migratory route for spawning species. The areas around mudflats of Thaton and tidal current along Paung also play roles in fish migration and nursery habitats. In terms of spawning seasons, Pama Croaker and Mango fish exhibited peak spawning in May. Mullet spawning was consistent from January to April, and Hilsa Shad spawning peaked in January. Sillago spawning activity was minimal, with sporadic responses concentrated in August and September. Therefore, the study provides valuable insights into the spawning areas and seasonal patterns of the five important fish species in the Gulf, aiding sustainable fishing practices and conservation efforts.

Overall, the study provides essential information on economically important fish species' spawning areas and seasons in the GoM, supporting evidence-based fishery management and conservation actions with the participation of local communities. The suggestions include conducting a community validation workshop to share research findings and refine understanding of spawning areas and seasons, as well as conducting fish larval surveys in specific regions like the mouth of the Sittaung River and Bilin River to improve knowledge of spawning patterns. The study also advocates for assessing hydrological changes in the Gulf to inform fish migration and conservation strategies. To enhance fishery management, the study suggests establishing community-based mechanisms to counter illegal fishing practices, enforcing closed fishing seasons for sustainable fish populations, creating community-led Fish Conservation Zones (FCZs) in critical areas, and promoting community awareness through accessible information systems to foster local engagement in conservation and sustainable fishing practices. By addressing threats and preserving fishery resources, the research aims to safeguard the livelihoods of small-scale fishers and maintain the ecological integrity in the Gulf of Mottama.

ACKNOWLEDGEMENT

The research project was supported by the Gulf of Mottama Project (GoMP) which is funded by the Swiss Agency for Development Corporation (SDC). Therefore, we would like to provide our sincere acknowledgement to SDC for supporting the research through the GoMP. Most importantly, we would like to appreciate the participants in the communities who involved in the interviews and discussions for their meaningful and valuable contributions. Then, we would like to thank Dr. Bo Sann from IUCN and Dr. Kenneth MacKay for continuous supports through the development of the project. In addition, we want to thank the Fishery Officer, the Township Clusters Coordinators (TCCs) and the Community Facilitators and Monitors (CFMs) of the project for their supports in coordination for field activities. Finally, we would like to appreciate field researchers Myanmar Coastal Conservation Lab (MCCL) @ Point B Design + Training, who actively participated throughout the research process.

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1 INTRODUCTION

The Gulf of Mottama (GoM) is one of the most important and dynamic intertidal wetland systems and has extensive mudflats, sandy beaches, and salt marshes (GoMP, 2019). It is home to critical habitats and species of conservation concern. Furthermore, the GoM area is spawning ground for economically important fish species and wintering ground for migratory shorebirds (GoMP, 2019). Fishery is the major livelihood of communities in the GoM area, and they rely on fishery resources for their family incomes and subsistence uses. Most of the local people are small-scaled fishers who own wooden fishing boats, apply different fishing gears that have been passed down through generations (except trammel net which applied recently in the area) and they sell fishery resources to fish collectors, local markets and wholesalers for export as well as making dried fish (GoMP, 2019). However, fishery resources are now facing varied threats including illegal fishing, unsustainable practices of fishing or overfishing, pollution and weakness in regulations and law enforcement as well as affecting the long-term livelihood for small-scaled fishers. Therefore, the GoM is planning to conserve the fishery resources in the GoM in collaboration with local communities by establishing community-based fishery conservation area in the GoM.

1.1 Critical Knowledge Gap

Despite the significance of fishery resources for small-scaled fishers in the GoM, there has been a substantial decline in the catch of economically important fish species (Hte, Hein, et al., 2022; Hte, Oo, et al., 2022; MacKay & Aung, 2023a). The Hilsa shad, in particular, has experienced a reported 90% reduction in abundance since the early 2000s. This decline has been attributed to overfishing, illegal fishing practices, and the degradation of spawning and nursery areas caused by sand mining and infrastructure development along the rivers. Multiple studies conducted in the GoM, including Hte, Oo et al. (2022), Lunn et al. (2021), and MacKay et al. (2021), have identified these factors as the primary causes of the decline. Similar concerns exist for other fish species, such as Pama croaker and Mango fish, due to their comparable migration and spawning (MacKay et al., 2021). The decrease in fish catch highlights the urgent need for effective fishery conservation measures. Consequently, the project is in the progress of establishing fish conservation zones or community-based fishery management areas, requiring comprehensive information on the spawning areas and seasons of economically important fish species.

Research conducted by Lunn et al. (2021) and Oo et al. (2018, 2019) indicates that the Sittaung River and Bilin River serve as crucial spawning areas for the Hilsa shad. Oo et al. (2018, 2019) also reported the presence of Hilsa shad juveniles in Sut Pa Nu and Kha Wa Chaung during specific months. A study conducted in 2017 (MacKay, 2017) documented the spawning and migration patterns of various fish species in the Gulf. During this period, the Hilsa shad migrated upstream of the Sittaung River from April to May, while Pama croaker were observed spawning above the Sittaung bridge (Moke Pa Lin) in July to August. Mango fish were found above the Sittaung bridge between April and June, and Mullet fish were recorded above the Sittaung bridge from March to June for spawning purposes. The Bilin River and associated creeks were also identified as spawning areas. However, other studies have reported different spawning patterns for the Hilsa shad, with spawning occurring from December to February (Oo et al., 2018, 2019) or January to February (Lunn et al., 2021). Pama fish were observed to undertake migration to the river mouth of the Sittaung River between May and July (MacKay & Aung, 2023b).

In line with previous research, the Sittaung River and Bilin River are vital spawning areas for the Hilsa shad and other economically important fish species. A study in 2021 identified six significant areas for fishery conservation, including the lower part of the Sittaung River and the Bilin River, with a specific focus on the conservation of Hilsa shad (Lunn et al., 2021). However, there has been limited attention given to the spawning of other economically

important fish species such as Pama croaker, Mango fish and mullets, especially in the lower part of the gulf.

1.2 Application of Local Ecological Knowledge in Conservation

Local Ecological Knowledge (LEK) is a valuable concept encompassing the collective knowledge, practices, and beliefs shared among local resource users concerning ecological interactions within ecosystems (Cook et al., 2014). In the realm of conservation, LEK plays a significant role as a contributor to multidisciplinary approaches and can facilitate transdisciplinary collaborations when local communities are engaged as partners and collaborators. It stands as a crucial component for the successful management of local resources, ensuring their sustainability (Aswani et al., 2018). In specific contexts where data may be limited, especially for assessing stock abundance, historical time series of marine population abundance become vital. LEK can provide essential insights in such cases (Beaudreau & Levin, 2014). However, it is important to recognize that LEK may not always be completely reliable, and validation becomes necessary before implementing experimentation or observations based solely on this knowledge. To validate LEK, researchers often employ a cross-checking and consensus approach, which involves corroborating information from multiple sources. This process is founded on the premise that beliefs or information held by the majority within the local community are more likely to hold merit (Wilson et al., 2006). By combining traditional ecological knowledge with scientific methodologies, a more robust and comprehensive understanding of ecological dynamics can be achieved, fostering effective conservation and management strategies.

Due to declining catch of economically important fish species (Hte, Hein, et al., 2022; Hte, Oo, et al., 2022; MacKay & Aung, 2023a), and limited knowledge on information for spatial management for important fish species, the local fishers play an important role in conservation as well as sharing their ecological knowledge. It has been previously recognized that such information from participation of communities are important to examine state of fisheries especially in data deficient areas (Aswani et al., 2018; Cook et al., 2014; McQuatters-Gollop et al., 2019; Ullah et al., 2023; Veneroni & Fernandes, 2021).

Hte et al. (2023) applied Local Ecological Knowledge (LEK) to study the historical distribution of marine mammals in the GoM. However, beyond this application, there are no prominent direct uses of LEK in fishery management in the region. Thus, the current study aimed to assess the spawning areas of economically significant fish species in the GoM with the following goal and objectives. The results will directly be able to apply in planning and implementation of evidence-based fishery management and conservation actions in the GoM in collaboration with local communities.

1.3 Goal and Objectives

The research aims to investigate the spawning areas of economically important fish species through local ecological knowledge of the fishing communities to contribute to the establishment of fish conservation zones in the GoM. The key objectives of the study are as follow:

1. To identify spawning seasons and locations of economically important fish species (focus on Pama Croaker, Paradise threadfin and Mullets) through LEK of communities,
2. To identify important area for fishery conservation of economically important fish species,
3. To perceive the interest of communities in fishery conservation in identifying potential impact to communities.

2 METHODS

2.1 Study Area and Sample Frame

The research was conducted in seven villages located in the GoM. These target villages were recommended by Mon Fishery Development Association (MFDA) based on their importance for local ecological assessment of spawning grounds for economically important fish species. The selection process was conducted in consultation with the Township Clusters Coordinators (TCCs), and the recommendations were reviewed by Dr. Kenneth Mackey, International Fisheries Advisor. At least 10% of interviewees, primarily fishermen, from the total number of households in the target villages participated in the research. The villages and the sampling frame of the research are shown in Figure 2.1 and Table 2.1.

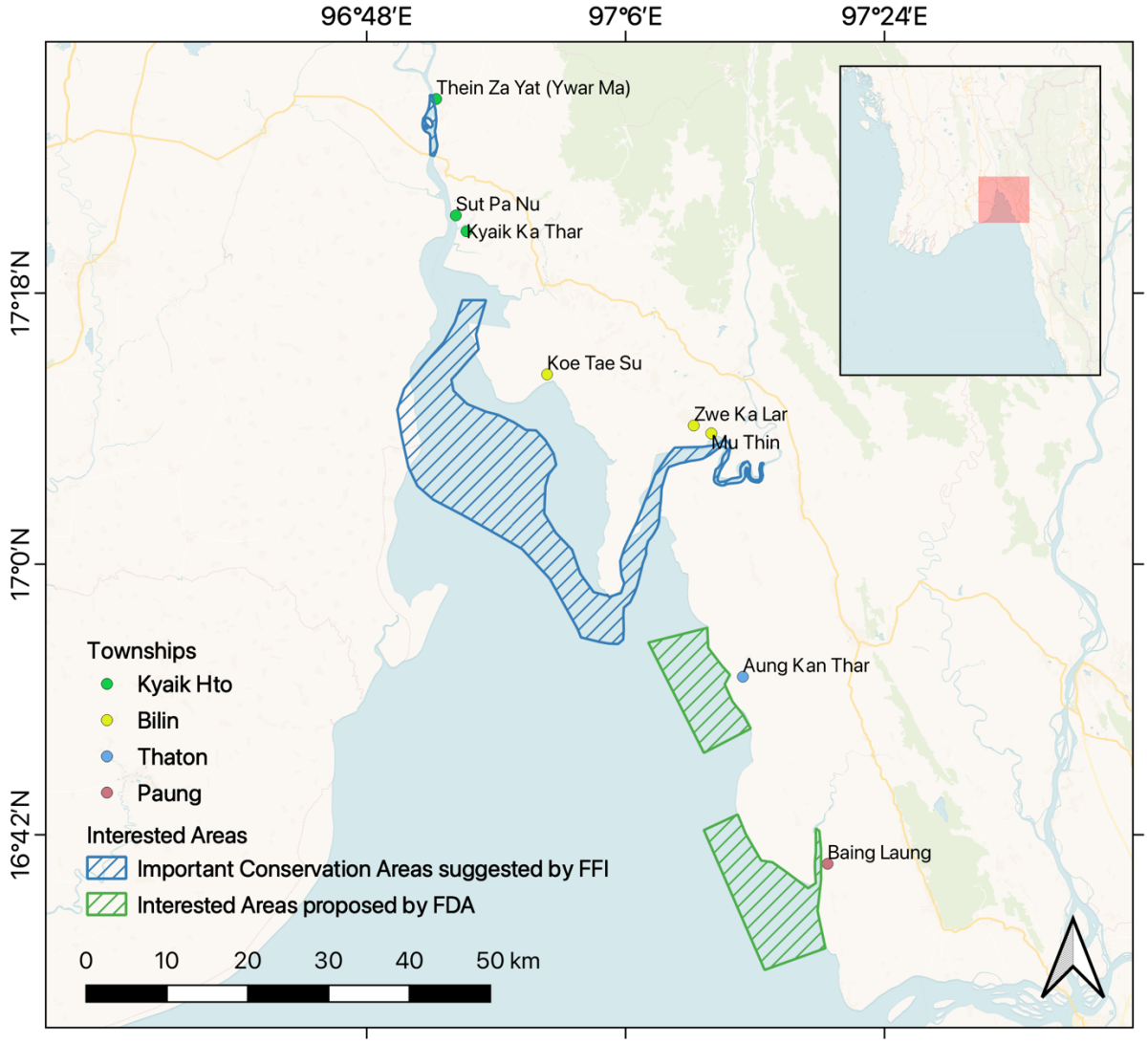


Figure 2.1. The map showing the seven coastal villages which focused on fishing of Pama Croaker, Paradise threadfin and Mullets. The map also showed the confirmed spawning areas and potential spawning area identified as important conservation area for Hilsa shad by FFI in 2022.

Table 2.1. Sampling frame and sample size of individuals participated in the study areas.

Sr.	Village	Township	Total number of fishing households	Sample size	Sample size (%)
1.	Bi Laung	Paung	68	11	16
2.	Aung Kan Thar	Thaton	170	8	5
3.	Koe Tae Su	Bilin	72	19	26
4.	Mu Thin	Bilin	112	12	11
5.	Zwe Ka Lar	Bilin	45	8	18
6.	Sut Pa Nu	Kyaik Hto	76	17	22
7.	Kyaik Ka Thar*	Kyaik Hto	150	11	7
8.	Thein Za Yat (Ywar Ma)	Kyaik Hto	70	11	16

*It is not GoMP project target village

2.2 Household Interviews

The research employed a qualitative methodology to assess the local ecological knowledge of fishers, evaluate the current status of the fishery, determine the catch rate of fish with eggs or fingerlings, and identify the spawning areas of economically important fish species in the GoM. Additionally, the interviews aimed to understand community interest, motivation, and perception regarding collaboration in future fishery conservation efforts.

The primary data collection method utilized in the field survey was household in-depth interviews. This approach involves conducting detailed interviews with individuals to gather comprehensive information. Trained interviewers, accompanied by a notetaker, conducted the interviews, which typically took 30 to 45 minutes to complete the questionnaire. Visual tools, such as participatory spawning area mapping and seasonal maps, were employed by the interviewers to ensure accurate information on spawning times and areas of economically important fish. The field visits were carried out from 15th to 26th March 2023.

2.3 Data Analysis

The field data was entered into Kobo toolbox after data collection. To identify the meaning or pattern of qualitative data, the team applied thematic analysis and coded major theme based on the data. The coding data were analyzed in Excel with a simple Pivot table.

3 RESULTS

3.1 Demographic Information

The study conducted interviewed with 97 active fishers (male = 93 and female = 4 who were accompanied in fishing with their husbands) from eight villages across four townships in Mon State. The majority of the fishers were aged between 36 to 55 years and had more than 10 years of fishing experience. Out of the respondents, 90 of the fishers (ZZ%) had their own fishing boats, while 7 of them worked as wage labors in the fishing boats. However, 5 of them engaged in seasonal fishing with their own boats, and during the low catch seasons, they worked as wage labor in other fishing boats.

3.2 Important Fish Species

In the survey, the villagers were asked their top 5 economically important target fish. The catch frequencies for various fish species across all surveyed villages are summarized in Figure 3.1 as follows: Pama croaker (*Otolothoides pama*) (80), Flathead grey mullet (*Mugil cephalus*) (41), mango fish (*Polynemus paradiseus*) (41), hilsa shad (*Tenualosa ilisha*) (28), Silllago (14), seabass (13), Corsula Mugil (10), and wallago (*Wallago attu*) (5).

Among the surveyed villages, Koe Tae Su had the highest capture frequency for Pama Croaker (17), followed closely by Mu Thin (12). Sut Pa Nu reported the highest frequency for Mullet (15), while Baing Laung recorded 5 individuals. Koe Tae Su had the highest response frequency for Mango Fish (19), with Sut Pa Nu and Thein Zayat (Ywar Ma) each reporting 7 individuals. Similarly, Koe Tae Su reported the highest frequency for Hilsa Shad (19), and Thein Zayat (Ywar Ma) had the second-highest frequency (11).

Mu Thin had the highest frequency for Sillago (7), followed by Baing Laung (6). Sut Pa Nu reported the highest frequency for Seabass (6), while Thein Zayat (Ywar Ma) had the second-highest frequency (2). Zwe Ka Lar had the highest frequency for Corsula Mugil (3), with both Sut Pa Nu and Aung Kan Thar reporting 1 individual each. Aung Kan Thar recorded the highest frequency for Wallago (5), and Thein Zayat (Ywar Ma) reported 1 individual.

Aung Kan Thar did not rank highest in any of the captured important fish species. This could be attributed to the fact that only 5% of the total fishers were interviewed in this study, indicating that the results may not be fully representative of the entire fishing population.

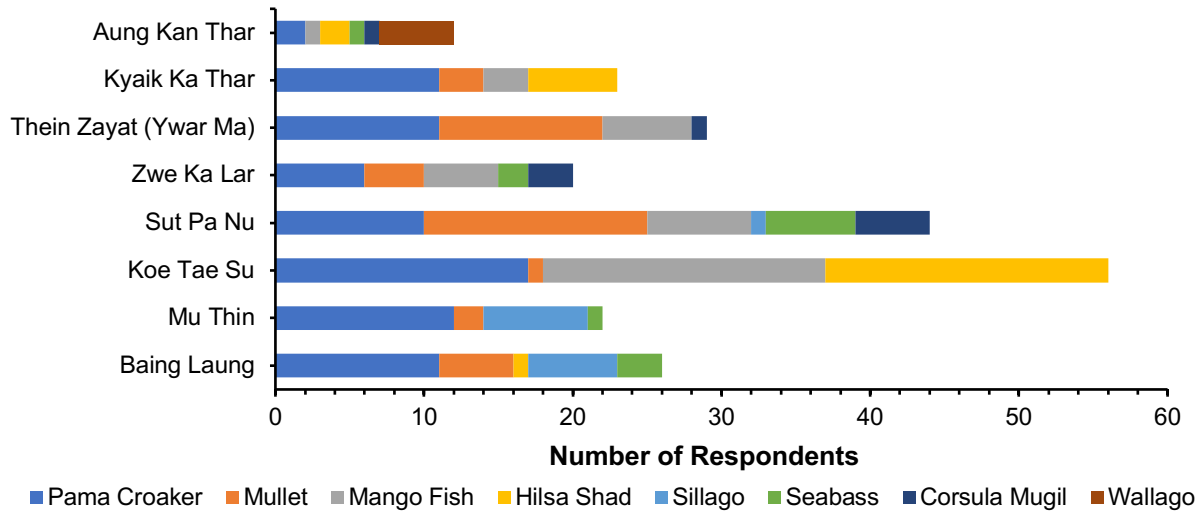


Figure 3.1. Economically important fish of the respondents in the study area

3.2.1 Fishing Months for Economically Important Fish Species

The line graph in Figure 3.2 and the accompanying data in Table 3.1 present the response frequencies of fishers regarding the catch of economically important fish species over the course of the year. The responses from fishers regarding Pama croaker catches ranged from 28 individuals in April to 65 in June, followed by a gradual decline until the end of the year. Mullet catches remained relatively consistent from October to March, with a peak of 35 responses in October. Mango fish catches displayed significant variation, reaching a high of 36 in June before declining. Hilsa shad catches exhibited a similar pattern, with a peak of 24 in January, followed by a gradual decline and subsequent increase in September. Sillago catches were generally low, with a notable peak of 16 in August before decreasing again.

These findings indicate that the primary fishing period for Pama croaker and Mango fish occurs from May to August, while Mullets are primarily caught by fishers from October to March. Hilsa Shad are caught from September to February, whereas Sillago appears to be available primarily in August.

Table 3.1 provides a summary of the fishing months for all the targeted fish species. These data revealed the seasonal fluctuations and variations in fishing efforts for different fish species, offering valuable insights into fishing patterns and dynamics throughout the year.

Table 3.1. Response frequency for fishing months of economically important fish species in the study area

Fish Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pama Croaker	41	40	37	28	**52**	**65**	**54**	**53**	48	46	43	40
Mullet	**34**	**33**	**32**	23	23	25	18	15	23	**35**	**35**	**34**
Mango Fish	10	10	11	13	**33**	**36**	20	14	11	12	12	12
Hilsa Shad	**24**	**23**	**19**	12	5	4	4	5	14	**19**	**19**	**18**
Corsula Mugil	6	6	7	7	6	4	3	1	2	5	5	6
Seabass	4	4	3	3	3	3	3	1	**7**	**9**	**11**	**7**
Silago	1	1	1	1	1	1	**11**	**16**	**13**	6	2	1
Wallago	4	4	4	2	3	3	3	3	5	4	4	4
Prawn	3	3	3	2	2	3	3	3	3	3	3	3
Indian Threadfin	2	2	3	3	3	2	2	1	2	2	2	2
Mudskipper	2	2	2	2	2	2	1	1	2	2	2	2
Striped Dwarf Catfish	2	1	1	2	1	1	1	1	2	2	2	2
Shrimp	1	1	1	1	1	1	1	1	1	1	1	1
Pangus Catfish	1	1	1	1	1	1	1	1	1	1	1	1
Catla	1	1	1	1	1	0	0	0	1	1	1	1
Sole	0	1	1	1	1	0	0	0	0	0	0	0
Bombay Duck	0	0	0	0	0	0	0	0	0	0	1	1

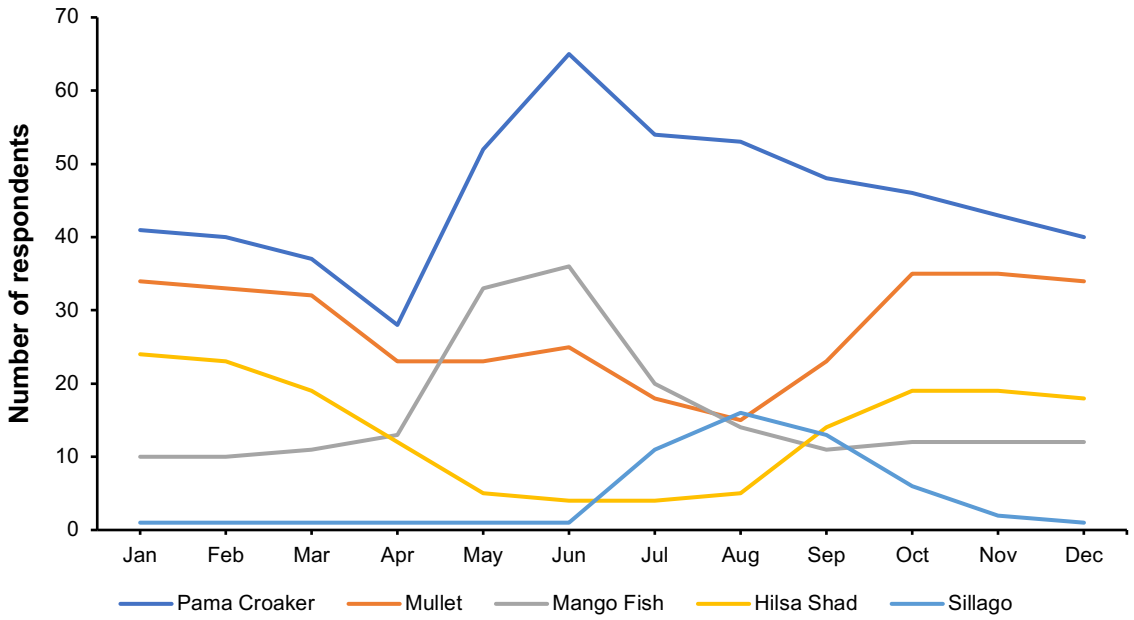


Figure 3.2. Fishing months of five most important fish species indicated by the fishers.

3.3 Spawning Behaviors of Economically Important Fish Species

3.3.1 Spawning Areas

The study has identified nine key areas that are crucial for the spawning, nursing, and migration of economically important fish species. These areas are visually represented in the map provided below (Figure 3.3). However, due to overlapping descriptions from fishers regarding indicators for spawning of different fish species, the study was unable to pinpoint specialized spawning areas or migratory routes for each of the five important fish species. Consequently, the map only depicts potentially significant spawning, nursery areas, and/or migratory routes for these five important fish species in the GoM.

Table 3.2 Response frequency of fishers for the catch of fish with eggs, juveniles or who indicated the spawning of top three target fish in nine identified areas in the Gulf of Mottama

Study Village	Spawning Area (See the Map on Figure 3.3)									Do not Know
	1	2	3	4	5	6	7	8	9	
Baing Laung	0	0	0	0	1	0	0	0	0	11
Aung Kan Thar	0	3	4	2	7	7	1	3	0	6
Mu Thin	4	7	4	0	7	4	2	3	1	8
Koe Tae Su	4	4	4	0	1	0	0	1	0	5
Kyaik Ka Thar	11	0	0	0	5	3	3	5	0	0
Sut Pa Nu	18	2	5	0	1	2	0	0	3	11
Zwe Ka Lar	0	0	0	0	5	2	3	0	0	6
Thein Za Yat (Ywar Ma)	10	3	0	0	0	1	0	0	9	1
Total	**47**	**19**	**17**	**2**	**27**	**19**	**9**	**12**	**13**	**48**

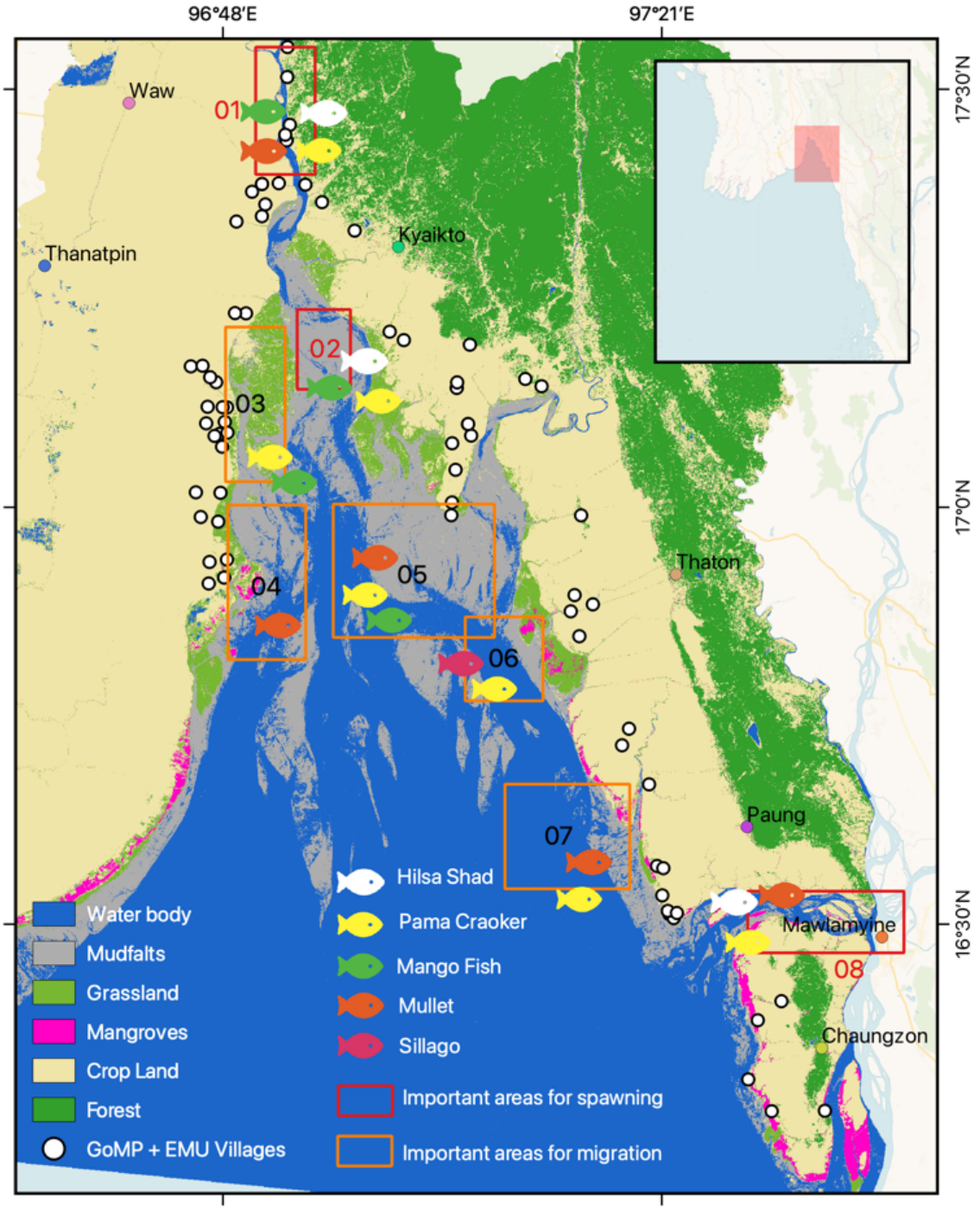


Figure 3.3. Map showing the important areas for spawning and migration of economically important fish species in the GoM according to the local ecological knowledge of the fishers. The Area 9 (upstream of the Sittaung River is not shown in the map). See the detail description in Table 6.1 of the Annex.

3.3.1.1 Area 1: Lower part of the Sittaung River

According to fisher responses, this area serves as the most important spawning and nursery ground for economically significant fish species in the GoM as a total of 47 responses were recorded, including Hilsa shad (14 responses), Pama croaker (23 responses), and Mango fish (13 responses). Fishers expressed that this region represents an estuarine environment influenced by both saltwater from the gulf and freshwater from upstream. The

area comprises sand flats, rocky shores, cliffs, underwater caves, and deep-water pools, which are vital for fish spawning and/or juvenile rearing. A notable indicator observed by fishers during the pre-monsoon months was the visibility of fish with eggs dripping from their abdomens. Post-monsoon, fishers reported the capture of fish with significantly flattened bellies, potentially indicating the release of eggs in the area or upstream.

3.3.1.2 Area 2: Riverine around Koe Tae Su Village

Respondents noted that this brackish area, characterized by strong tidal currents, encompasses caves, deep-water channels, and extensive mudflats. Consequently, fishers (5 responses) reported Pama croaker using this area for spawning due to its accessibility and ease of returning to the sea. Creeks and rivers in the vicinity were also identified as important spawning areas for mango fish (5 responses). Fishers visually detected Hilsa shad with eggs, suggesting that these fish may have spawned in the river's caves and deep-water sections. Mullet juveniles were also reported to be found in nearby inland water bodies and farms.

3.3.1.3 Area 3: Mudflats around Ma Mauk Village

This area features extensive intertidal mudflats and islands with coastal grasslands. Fishers suggest that these areas may serve as feeding and hiding grounds for certain fish species on their way from the sea to the upstream regions of the river. Some fishers also suspect that species such as Pama croaker and mullet may spawn or rear in the western part of Ma Mauk, as well as on the mudflats and in the grassland areas.

3.3.1.4 Area 4: Mudflats and Mangroves around Aung Naing Gyi Village

No visual signs of spawning were observed in this area. However, some fishers from (2 responses) Thaton suspected that the ecosystems, including mangroves, mudflats, and coastal grasslands, may serve as spawning or nursery habitats for certain fish species.

3.3.1.5 Area 5: Mudflats around Kyune Thar Yar Village

This area is located at the convergence of Sittaung River and Bilin River, characterized by extensive mudflats and a deep-water channel. Fishers indicate its importance as a migratory route to the upstream regions of the Sittaung River for spawning of important fish species (27 responses). Some fishers reported fish with mature eggs in the tidal channel around the area. Additionally, some fishers (13 responses) suspected that the mudflats serve as a habitat for mullet juveniles after spawning in the deep-water parts of the sea.

3.3.1.6 Area 6: Mudflats around Crab Island

Fishers clearly identify this area as a migratory route for fish spawning in upstream or deeper parts of the sea (19 responses), as no visual indications of spawning were reported in the surrounding areas.

3.3.1.7 Area 7: Mudflats and Mangroves around Bi Laung Village

Fishers reported that the mangrove areas provide essential nursery grounds for juveniles, although specific species in the area were not clearly identified. However, fishers believe that the ecosystems in the area serve as important stopping sites for migratory fish species.

3.3.1.8 Area 8: Salween River near Mawlamyine

The estuarine environment of the Salween River near Mawlamyine is of particular importance, especially for Pama croaker, as fish with eggs and juveniles are frequently caught by fishers.

3.3.1.9 Area 9: Upstream Areas of Sittaung River

The upstream regions of the Sittaung River are widely recognized as favourable habitats for the spawning and rearing of important fish species such as Pama croaker, mango fish, and Hilsa shad. These areas are characterized by deep-water pools, rocky shores, cliffs, and man-made substrates. However, only 13 responses were recorded from fishers from villages such as Mu Thin, Sut Pa Nu and Thein Za Yat (Ywar Ma).

3.3.2 Spawning Seasons

Based on the fisher responses regarding the spawning season of different fish species, the data reveals distinct patterns. Pama Croaker shows a notable increase in spawning activity from January to May, with the highest response of 32 in May, followed by a gradual decline for the remainder of the year. Mango Fish exhibits a similar trend, with peak spawning activity in May (25 responses) and a subsequent decrease. Mullet spawning remains relatively consistent from January to April, with a decline in subsequent months. Hilsa shad spawning is highest in January (17 responses) and gradually decreases throughout the year. Sillago spawning activity is minimal, with sporadic responses mainly concentrated in August and September. These fisher responses provide valuable insights into the timing of the spawning seasons for these important fish species, aiding in understanding their reproductive cycles and guiding sustainable fishing practices.

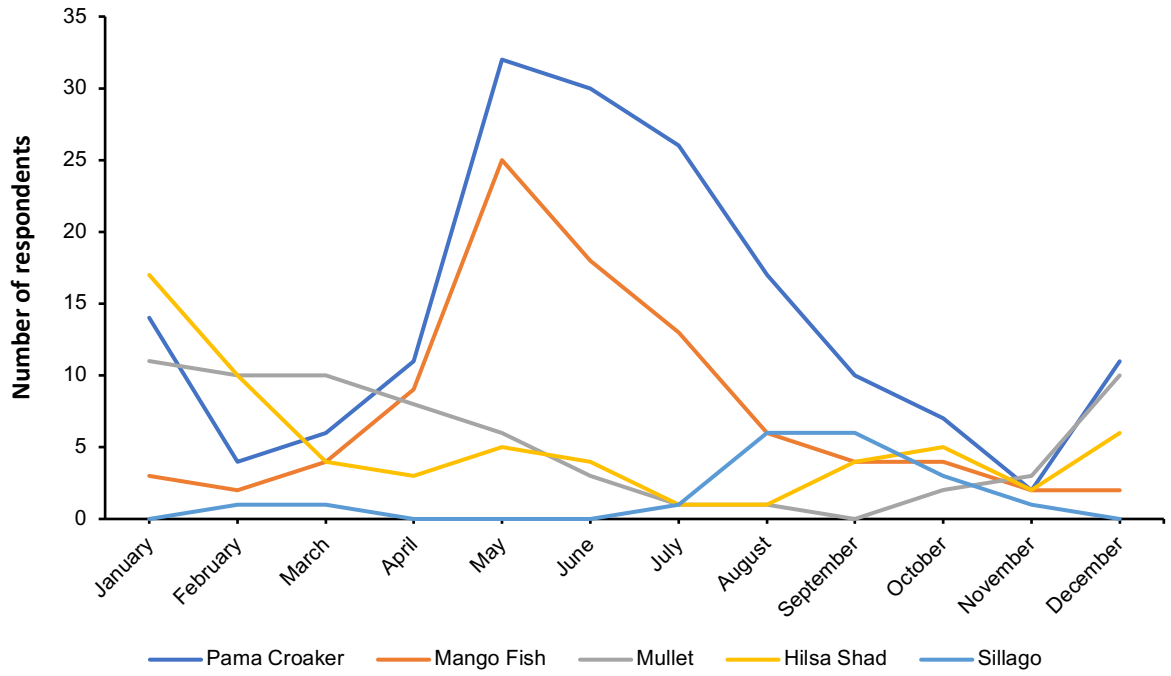


Figure 3.4. The response from the fishers on the catch of five most economically important fish with eggs throughout the year in the Gulf of Mottama

3.4 Changes in Fishery

3.4.1 Changes in the Past 10 Years

A total of 74% of fishers reported a significant decrease in the fish population, attributing this decline primarily to an increase in illegal fishing practices utilizing stake nets (Than Zakar Pike). In contrast, 43% of fishers indicated that the size of fish remained unchanged, with many of them expressing uncertainty about the underlying cause. However, 50% of fishers noted a substantial increase in fish prices, which they attributed to elevated commodity prices,

inflation and a decline in fish availability which potentially created higher market demands. Furthermore, 40% of fishers reported a significant reduction in the number of fishers actively engaged in the industry, citing the decline in fish stocks and insufficient income resulting from limited catches. Consequently, many fishers opted to migrate abroad in search of alternative sources of income. These represent the notable changes observed in the fishery sector over the past decade.

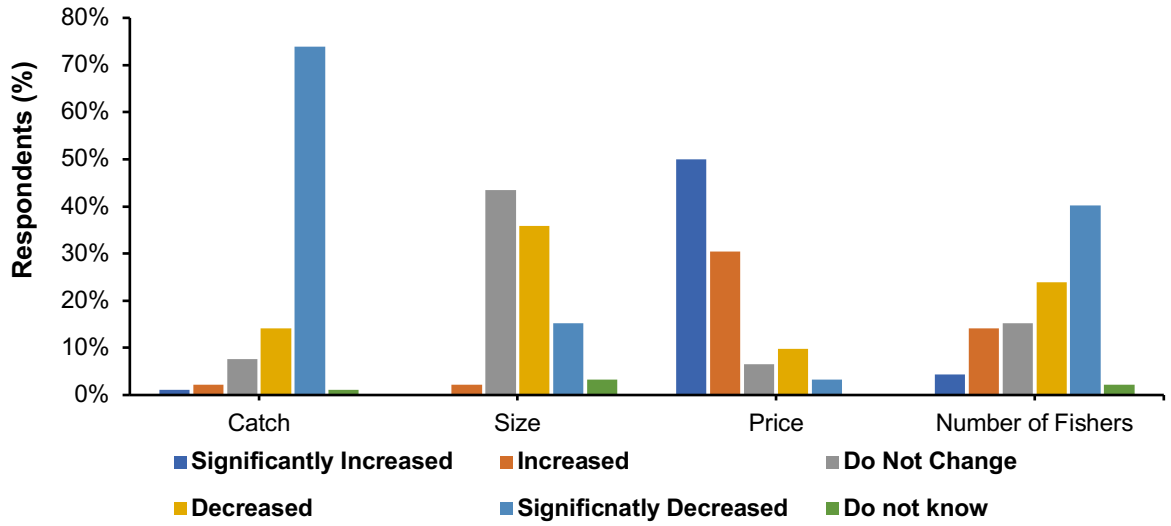


Figure 3.5. Frequency of reported changes in fishery in the past 10 years (2010 - 2020)

3.4.2 Changes after the COVID 19 Pandemic

About 40% of fishers reported a significant decrease in the fish population, stating increasing illegal fishing activities and the capture of fish carrying eggs and fingerlings as the primary reasons. Subsequently, 33% of fishers observed a decrease in the size of fish, factoring it to natural phenomena such as seasonal variations in fish size and the absence of adult female fish, as smaller fish are responsible for carrying eggs. Additionally, 35% of fishers noted an increase in fish prices, which they attributed to high commodity prices. Moreover, 38% of fishers reported a notable decrease in the number of fishers engaged in the industry, primarily as a result of dwindling fish stocks and the subsequent migration of fishers to other countries in search of employment opportunities.

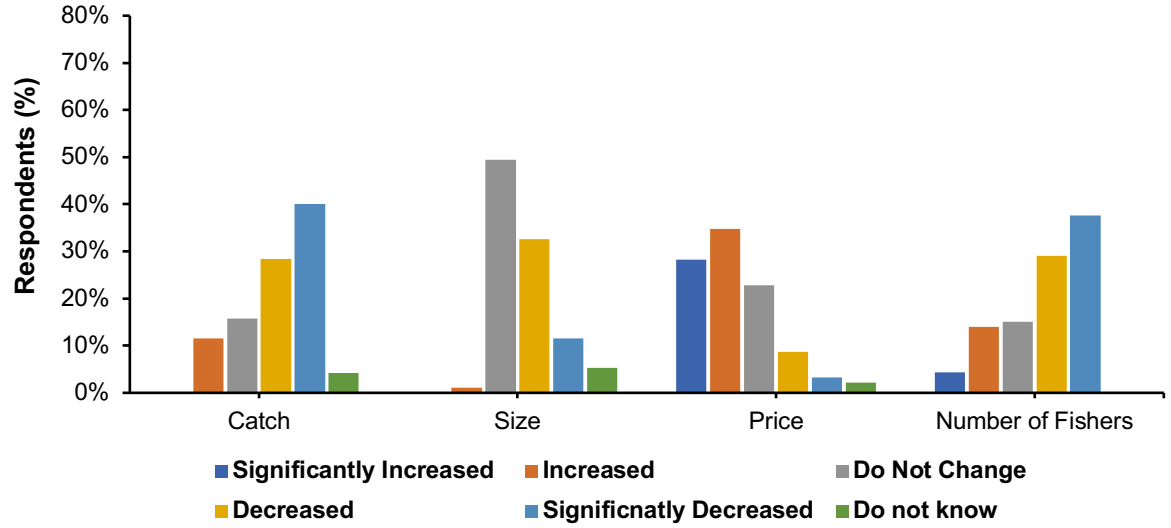


Figure 3.6. Frequency of reported changes in fishery after COVID 19 pandemic (2020 – 2022)

3.5 Fishery Conservation in the Gulf of Mottama

3.5.1 Community Interest in Conservation

The majority of respondents, accounting for 93%, argued that fishery conservation activities are necessary in the Sittaung River. The primary reason for conserving fish is the prevalence of illegal fishing practices utilizing illegal fishing gears such as Than Zakar Pike, poisoning fishing, electrofishing, and small mesh sizes, which target both large and juvenile fish, leading to exploitation of fish resources in the current situation. Additionally, respondents highlighted that conservation efforts would not only benefit the well-being of families but also future generations and the entire community.

Regarding conservation activities, 54% of respondents suggested that the most effective solution would be to restrict the use of illegal fishing gears, including Than Zakar Pike, poisoning fishing, and electrofishing. Among them, 11% recommended enforcing a closed fishing season during spawning time, while 8% expressed the need to establish seasonal closures for certain fishing gears. Furthermore, 8% suggested the creation of fishery conservation zones in spawning areas to protect fish abundance.

3.5.2 Stakeholder Participation in Conservation

A total of 81% of fishers expressed interest in participating in fishery conservation, driven by their desire to restrict the use of illegal fishing gears to prevent fish extinction and support the well-being of their families when fish populations are abundant. Only 4% of respondents stated no interest in involvement.

As for the main participants in fishery conservation, 30% of fishers argued that fisher groups should take the lead. Additionally, 22% and 11% of respondents suggested involving the Department of Fishery (DoF) and General Administrative Department (GAD), respectively, especially in patrolling and enforcing rules and regulations against illegal fishing. Moreover, 13% discussed the participation of village administrators, while 4% mentioned the involvement of non-governmental organizations (NGOs).

3.5.3 Opportunities and Challenges for Conservation

Regarding potential challenges, 40% of respondents stated that they would face negative impacts on their family's livelihoods and might incur debt when they stop fishing during the closed season, as they have limited job opportunities and depend solely on fishing. Moreover, 26% discussed the risks associated with community participation in these activities, as local fishermen may face harm during patrols, given that illegal fishermen often operate in large groups, possess weapons, and have connections with the current regime in certain political situations. Consequently, 10% of respondents expressed concerns that conservation activities may not be effective under such circumstances. Additionally, 5% expressed difficulty in ensuring fishers' compliance with rules and regulations for effective fishery management.

The respondents of the 16% strongly discussed that the fish stock will be increased through fishery conservation actions. Therefore, 33% stated that the income will increase, and the family wellbeing will be comfortable. And 32% also said that the fish resources will become sustainable and support not only the whole community but also for the future generation. Only 5% did not know about this.

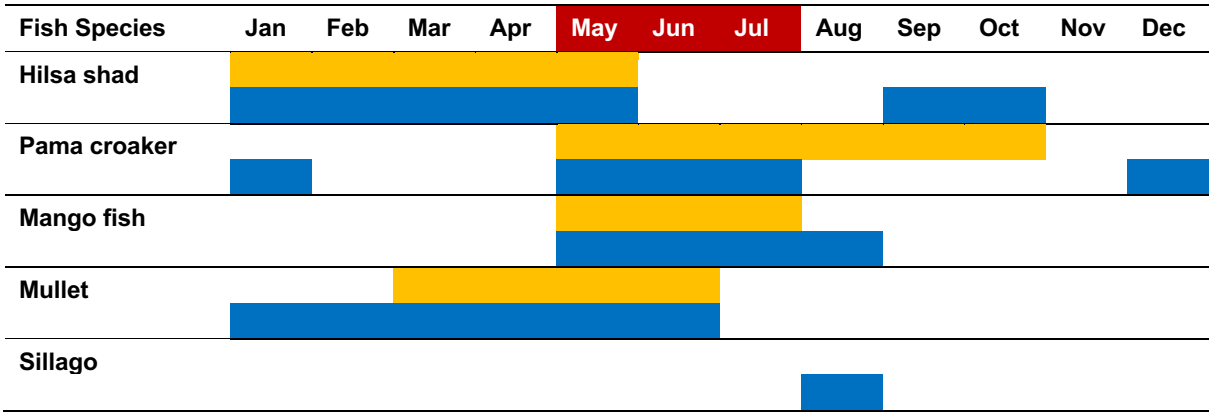
4 DISCUSSION

Through the local ecological knowledge of fishermen from eight villages across four townships in Mon State, the study identified the spawning areas and seasons of economically significant fish species in the GoM, along with their trends over the past ten years and the synergistic impacts of the COVID-19 pandemic and the political changes after 2021.

The study also identified key spawning areas, namely the mouth of the Sittaung River, upstream of the Sittaung River, and the mouth of the Bilin River, which encompass extensive mudflat areas. These findings are consistent with previous studies conducted in the GoM, as indicated in Table 6.2 of the Annex. Additionally, areas indicated on the map (Figure 3.3) that were not previously studied are believed to be important migratory routes, with the ecosystems adjacent to these areas serving as crucial migratory stops for the identified important fish species. However, the study does not explicitly differentiate which areas are predominantly important for specific fish species.

Furthermore, the study unveiled the spawning seasons of the important fish species, which mostly align with previous key findings presented in Tables 4.1 and 4.2. The Hilsa shad was found to spawn from January to May, with the peak season likely occurring in January. The study also suggested that Hilsa shad may spawn in September and October, which has not been previously documented in research and studies. However, similar responses were reported during community consultation meetings held for the establishment of fish conservation zones in five villages near the two bridges of the Sittaung River. Both Pama croaker and mango fish exhibited similar spawning seasons, with peak spawning occurring in May, consistent with previous research findings. While Pama croakers are known to spawn throughout the year (Bhakta et al., 2021), the study also recorded December and January as spawning seasons in the GoM. Limited information is available regarding the spawning time of other species such as Mullets and Sillago. However, the local ecological knowledge indicated that mullets spawn from January to June in deeper parts of the water, and they migrate extensively across the entire GoM. Fishermen believe that Sillago do not spawn in the gulf; however, based on the fish catch, the spawning season is estimated to occur around August. Therefore, the study provides valuable insights into the spawning areas and seasonal variations for the five most important fish species in the Gulf.

Table 4.1. Comparison of the spawning months of economically important fish species indicated by previous research tabulated in Table 4.2 in GoM (yellow box) and by current research (blue box). The red boxes are the close season regulated by the DoF.



4.1 Limitations of the Study

During the field visits, conducting interviews with fishers posed significant challenges due to their busy livelihood activities, leading to difficulties in achieving a consistent percentage of fishing households and resulting in variations in sample sizes. To address this issue, the research team validated the recorded data and key findings by consulting the Fishery Officer of the GoMP and members of Fishermen Development Associations. The goal was to ensure that the local ecological knowledge regarding fish species spawning was standardized and reliable. The study relied on the Local Ecological Knowledge (LEK) of the fishers. However, it is important to acknowledge potential biases inherent in using LEK, such as uncertainties in indicating changes, memory losses, bandwagon effects (influence of others' opinions), and limitations in precisely navigating locations on maps. To mitigate these biases, the study cross-referenced its key findings with previous research conducted in the region. By aligning these findings with established knowledge, the study demonstrated that any potential biases introduced by the use of LEK were deemed negligible.

4.2 Key Recommendations

Recommendations for effective fishery management in the GoM, focusing on economically important fish species, are provided based on the study's key findings:

4.2.1 Further Research and Assessment:

- Conduct a community validation workshop to share research findings, gather feedback, and refine knowledge on spawning areas and seasons.
- Conduct fish larval surveys in the specified areas, especially the mouth of the Sittaung River and Bilin River, to enhance understanding of spawning locations and periods.
- Study hydrological changes in the Gulf to assess their impact on fish migration and inform fishery conservation areas and management strategies.

4.2.2 Effective Fishery Management:

- Establish community-based mechanisms to combat illegal fishing practices, which were identified as a significant threat. It includes the establishment of a system for community members to actively monitor fishing activities in their area. This could involve regular patrols, reporting suspicious activities, and documenting evidence of illegal fishing practices. Community members can act as "eyes and ears" on the water, reporting any violations they observe.
- Enforce closed fishing seasons effectively to ensure sustainable fish populations, especially for Hilsa shad conservation. However, the effective enforcement of these regulations largely falls under the jurisdiction of the Department of Fisheries (DoF) or relevant governmental bodies. In addition to regulatory enforcement, it's imperative to consider the provision of alternative livelihood opportunities for fishing communities during these close seasons. By offering viable alternatives, such as training in other income-generating activities or financial supports, these communities can continue to support themselves while simultaneously contributing to the recovery of fish populations.
- Establish community-led Fish Conservation Zones (FCZs) in critical areas like the mouth of Sittaung River and Bilin River.
- Enhance community awareness through accessible information sharing systems to empower local communities in conservation efforts and promote sustainable fishing practices.

By implementing these recommendations, stakeholders can work collaboratively to ensure the sustainable management of fishery resources and safeguard the ecological balance in the GoM.

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6 ANNEX

Table 6.1. The evidence of spawning of five economically important fish species in nine identified areas based on the local ecological knowledge of the fishers in the Gulf of Mottama

Location	Pama croaker	Mango fish	Hilsa shad	Mullet	Silago
Area (1)	- Found fish with dripping eggs from the abdomen, - Found juveniles on the sand flat, - Fish caught on the sand flat along the area had dripping eggs, - Heard the croaking noise in deep water channel, - Caught fish with eggs which are migrating to the upstream. Then, after a few months fish were caught without eggs (flattened abdomen).	- Found and caught fish with dripping eggs, - Caught fish with eggs near Kyaik Ka Tar and Su Pa Nu. After the monsoon, the fish in the area were caught without eggs (which may indicate the fish are spawning in the upstream and then back to the sea).	- Found fish with dripping eggs during January and February then did not see fish with eggs anymore as they released eggs and the abdomens were flat, - According to the catch, the fish spawned in December and January were about 2 inches in size, the one spawned in September and October were about 3 inches.	- Found the trail of mullet on the mudflat because they laid eggs by digging the mud with their mouths. - In the mid December, fish were caught with eggs and got fish with egg with unique gonad in the mid-December. - Caught fish with eggs.	- No evidence of spawning or migration reported from the interviewees.
Area (2)	- Notice the colour of the fish is changing in yellow, - Found and caught fish with eggs everywhere in the spawning time (May and June). In January and February,	- Found and caught fish with immature eggs in March and got fish with dripping eggs in May and June.	- Found and caught fish with dripping eggs, - Found and caught fingerlings.	- Fish with eggs and fingerings were caught in deep water areas, - Found fish with eggs and fingerings in the farming areas and then they went back to the river with no eggs,	- No evidence of spawning or migration reported from the interviewees.

Location	Pama croaker	Mango fish	Hilsa shad	Mullet	Silago
	the eggs were not mature yet, - In March, found and caught fish with eggs and after that, their abdomens became flat.			- The fish caught during the spawning time had bigger abdomen and gonad.	
Area (3)	- Heard croaking sound from the fish, - Found and caught fish with eggs near the mouth of the Sittaung River.	- No evidence of spawning or migration reported from the interviewees.	- No evidence of spawning or migration reported from the interviewees.	- Found the juveniles on mudflat around Ma Mauk, - Caught and found fish with dripping eggs, - During spawning time, mullet migrated to the deep-water channels as the fishers saw mullets around the areas of deep-water channels.	- No evidence of spawning or migration reported from the interviewees.
Area (4)	- No evidence of spawning or migration reported from the interviewees.	- No evidence of spawning or migration reported from the interviewees.	- No evidence of spawning or migration reported from the interviewees.	- Found juveniles in the grassland	- No evidence of spawning or migration reported from the interviewees.
Area (5)	- Fish with eggs were mostly found at the mouth of Bilin River during the rainy season, - Heard croaking sound from the fish. The sound gets louder as more fish gather for spawning.	- Heard croaking sound from the fish in the river channel.	- No evidence of spawning or migration reported from the interviewees.	- Caught more fish with eggs and fingerings, - Spawning ground can be around the mudflats because mullet always feed on mudflats, - Found the school of fish in the surrounding farming areas during the spawning time.	- No evidence of spawning or migration reported from the interviewees.

Location	Pama croaker	Mango fish	Hilsa shad	Mullet	Silago
				Mullet stayed in the farms for about 15 days to spawn during spawning time and left a lot of juveniles. - The eggs were dripping on the mudflats, - Noticed that the abdomens of fish got flat after they laid eggs.	
Area (6)	- Juveniles were found in the grasslands, - Heard croaking sound in the deep-water channel as they travelled up the Bilin river, - Found and caught fish with eggs.	- No evidence of spawning or migration reported from the interviewees.	- No evidence of spawning or migration reported from the interviewees.	- No evidence of spawning or migration reported from the interviewees.	- Juveniles were found on the mudflat. - During spawning time, we could hear the bubbling sounds from the Westcoast
Area (7)	- Eggs were found in the roots of mangroves, - Heard the croaking sound of the fish, - During November and December, fingerings can be found in the grasslands, - Fish with eggs were found.	- No evidence of spawning or migration reported from the interviewees.	- No evidence of spawning or migration reported from the interviewees.	- Fingerings were found in grasslands, - Found fish which are hiding on the mudflats at spawning time, - During the spawning time, the fish with eggs are less active.	- No evidence of spawning or migration reported from the interviewees.
Area (8)	- Found juveniles on the mudflat,	- No evidence of spawning or migration	- Found fish with dripping eggs.	- Found the trail of mullet on the mudflat because it laid eggs by digging	- No evidence of spawning or migration

Location	Pama croaker	Mango fish	Hilsa shad	Mullet	Silago
	- Found the changing colour of eggs and heard the croaking sound.	reported from the interviewees.		the mud with their mouths.	reported from the interviewees.
Upstream of Sittaung River	- Heard croaking sound around the rocky areas along the river, - Laid eggs in the deep-water pool of the river and near the rocky shores, cliffs, and the bridge.	- Laid eggs in the deep-water pool of the river and near the rocky shores, cliffs, and the bridge, - In the raining season, fish with eggs migrated to the upstream then fish went back to the sea without eggs, - Fish with eggs were found, - Fish made noises during spawning time and fish became thinner after spawning in May.	- Found fish with eggs migrated to the upstream then fish went back to the sea without eggs, - Fish laid eggs in estuarine environment of the upstream of Sittaung River, - Heard noises from the fish while they are spawning in the rocky areas along the river, - Caught more fish with eggs in the upstream areas.	- No evidence of spawning or migration reported from the interviewees.	- No evidence of spawning or migration reported from the interviewees.

Table 6.2. Studies conducted from 2017 to 2023 in the GoM on spawning of economically important fish species. Adapted from (Whitty, 2023)

References	Hilsa shad	Pama croaker	Mango fish
MacKay (2017) *	• Spawn in April-May • Spawn in freshwater above the bridge on the Sittaung River	• Spawn in July-August • Spawn in the area where fresh and saltwater meet above the bridge on the Sittaung River	• Spawn in April-June • Spawn above the bridge of Sittaung River
Oo, et al., (2018, 2019)	• Larvae/ juveniles were recorded in March near Kha Wa Chung • Larvae were recorded in January and juveniles were recorded in March near Sut Pa Nu	• Larvae/ juveniles were found near Kha Wa Chaung and Sut Pa Nu in July • Juveniles were found near Sut Pa Nu in September-October	• Larvae were recorded in March-July in both Kha Wa Chaung and Sut Pa Nu • Juveniles found in July-November
San, et al., (2020)	• Recorded the catch of larvae and juveniles in stow net in the villages above Sittaung old bridge.	• N/A	• N/A
Lunn, et al., (2021)	• Spawning season was between January and February • Juveniles were found in March-May • Smaller size (80 g) ovary matured fish were caught around Sut Pa Nu and Ta Naw Kyun in Sittaung River • Larger sized (320 g) were found in Bilin River • Large, matured females (> 800 g) were caught along the Sittaung River until Zay Ya Thein village, and Bilin River	• N/A	• N/A
MacKay & Aung (2023a)	• N/A	• Suggested that Pama Croaker undertake a migration from May to July to the mouth of the Sittaung River where they spawn.	• N/A

*The study also indicated that Mullets spawn from March to June above the bridge of Sittaung River, Bilin River and associate creek