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The prevalence of illegal, unreported and unregulated (IUU) fishing in Mabuhay, Zamboanga Sibugay, Philippines

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Abstract

Illegal, Unreported, and Unregulated (IUU) fishing remains a significant challenge to sustainable fisheries in the Philippines, especially at the municipal level. As of 2023, IUU fishing risk in Mabuhay, Zamboanga Sibugay has not been evaluated yet. This study assessed for the first time the prevalence of IUU fishing in Mabuhay across 16 coastal barangays using the Philippine IUU Fishing Index and Threat Assessment Tool (I-FIT) developed by DA-BFAR and USAID. The IUU fishing prevalence was measured using 10 indicators and a scoring scale of 1-4 (low-very high) with a data quality scoring of 1-3 (low-high). The findings of this study revealed that Mabuhay has a prevalence score of 2.5, indicating a moderate risk to IUU fishing, slightly lower than the national average score of 2.58. The key prevalence factors included very high apprehensions relative to the patrolling effort (62.5%), absence of regular monitoring or reporting of fish catches, low registration of fishers (41.3%) and fishing vessels (4.31%), and most illegal activities were coastal habitat-damaging (97.44%). The data quality of this assessment scored 2.2, denoting medium reliability. This study recommends enhancing enforcement and monitoring in high-risk areas of IUU fishing, increasing and improving the registration of both fishers and fishing vessels, establishing catch reporting and monitoring system, raising awareness on IUU fishing through IEC campaigns, engaging community participation, and conducting an annual assessment of IUU fishing to track changes and improve management strategies to prevent, deter and eliminate IUU fishing in Mabuhay.

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Introduction

Fish is an essential source of food and income for millions of people worldwide, particularly in many coastal communities such as the Philippines (Alvarico *et al.*, 2021). As one of the top fish-producing countries, the Philippines ranks 11th, relying heavily on the rich marine biodiversity to support food security, employment, and economic development (FAO, 2022; Alvarico *et al.*, 2021). However, the sustainability of these crucial resources is increasingly at risk due to the persistent issue of Illegal, Unreported, and Unregulated (IUU) Fishing (Mendoza, 2023).

IUU fishing undermines efforts to conserve marine ecosystems and manage fish stocks sustainably. It includes activities that violate national fisheries laws, such as the use of banned fishing gear, fishing without a permit, or failing to report catches accurately (FAO, 2016).

The challenge to deal with IUU fishing in the Philippines remains at the municipal level, where local government units often face limited enforcement resources, complex jurisdictional overlaps, and weak compliance mechanisms (Khan *et al.*, 2023; Carneiro and Martins, 2022; FMB, 2018). Despite national efforts to combat IUU fishing, such as the enactment of the Philippine Fisheries Code of 1998 (RA 8550 as amended by RA 10654), the implementation remains uneven across municipalities.

In line with the global goals, Sustainable Development Goal (SDG) 14.4 targets that by 2020, there should be effective regulations in harvesting and ending overfishing, illegal, unreported, and unregulated fishing, and destructive fishing practices, and implementing science-based management plans, to restore fish stocks sustainably (DA-BFAR, 2022). However, the Philippines has yet to meet these goals (United Nations, n.d.).

As of the 2023 report, 0% or no assessment has been done on IUU fishing in Zamboanga Peninsula (Region 9), while significant progress has been made in other regions: 95% of Region 13, 87% in Region 6, 85% in Region 3, and 79% in the CAR region have been evaluated (DA-BFAR, 2021). This study generally aimed to assess the prevalence of IUU fishing in the municipal waters of Mabuhay, Zamboanga Sibugay, Region 9, Philippines. The assessment followed the ten standardized indicators of the Philippine Illegal, Unreported, and Unregulated (IUU) Fishing Index and Threat Assessment (I-FIT) Tool developed by DA-BFAR (2022).

Materials and methods

Study area

Mabuhay, Zamboanga Sibugay is a coastal municipality geographically located at 7° 25' North, 122° 50' East, on the northeastern island of Olutanga. It is a 4th-class municipality with a total land area of 82.85 square kilometers, with 37 390 population. The municipality primarily relies on fishing, aquaculture, and agriculture, with coastal waters spanning approximately 27,000 hectares and a shoreline of 65.2 kilometers. It has 16 coastal barangays namely: (1) Abunda, (2) Bangkaw-bangkaw, (3) Caliran, (4) Catipan, (5) Ligaya, (6) Looc-Barlak, (7) Malinao, (8) Pamansaan, (9) San Roque (Pinalem), (10) Poblacion, (11) Punawan, (12) Santo Niño, (13) Sawa, (14) Sioton, (15) Taguisian and (16) Tandu-Comot (Fig. 1).

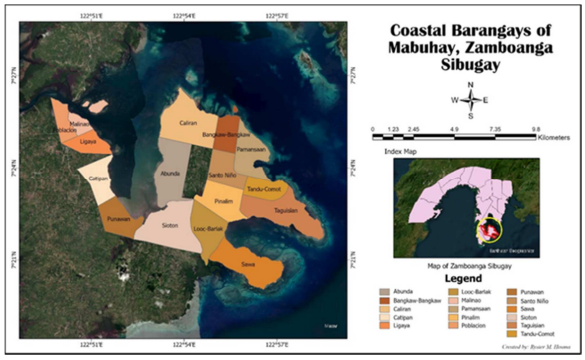

Fig. 1. Map of the study area in Mabuhay, Zamboanga Sibugay

Research design

This study utilized a mixed-method approach integrating both descriptive-qualitative and quantitative research to assess the prevalence of IUU

fishing in the municipal waters of Mabuhay, Zamboanga Sibugay.

Entry protocol

Ethical considerations were fundamental to this research due to the sensitivity of illegal fishing activities. Informed consent was obtained from all participants, ensuring they were fully aware of the study's purpose, their rights as respondents, and their voluntary participation. Ethical guidelines for research involving vulnerable populations were strictly adhered to, and the cultural sensitivities of the study area were respected.

Before data collection, a formal letter was submitted to the municipal officials of Mabuhay, Zamboanga Sibugay, requesting permission and support for the study. Courtesy visits to the mayor and barangay captains through the Municipal Agriculture Office (MAO) were conducted to ensure the safety of the researchers.

Data collection

Measurement of prevalence of IUU fishing using the I-FIT Tool

The research took place over three months, from November 2024 to January 2025, encompassing 16 coastal barangays in Mabuhay, Zamboanga Sibugay. This study employed the Philippine IUU Fishing Index and Threat Assessment Tool (I-FIT) developed by DA-BFAR (2022). Based on the global prevalence vulnerability response framework to IUU fishing. I-FIT is a tool to measure IUU fishing risk in municipal waters. It measures the prevalence of, vulnerability to, and response to IUU fishing. This study only focused on assessing the prevalence of IUU fishing in the municipal waters of Mabuhay using 10 indicators and different methods of data collection of the I-FIT with slight modification (Table 1). The data collection of this study was conducted through social surveys, focus group discussions (FGDs), key informant interviews (KIIs), and secondary data analyses with representatives from enforcement teams, Philippine National Police, Municipal Agriculture Office (MAO), people's organization, academe, and NGO (Table 1). It also used a 4-point rating scale, with 1 being low, 2 moderate, 3 high, and 4 very high IUU fishing risks (Fig. 2).

Table 1. Prevalence measure indicators

Indicators	Methods/Data source
P1. Monthly presence of illegal fishing activities in the municipality in a year	Secondary data/Enforcement teams
P2. Illegal fishing incidence from remote sensing	Secondary data/Oceana Philippines
P3. Number of apprehended violators relative to patrolling efforts in seaborne or other enforcement operations	Secondary data/Enforcement teams
P4. Regular monitoring or reporting of fish catches	Secondary data/MAO
P5. Registration and regulation of fishers and fishing vessels	Secondary data/MAO
P6. Trend in illegal fishing incidence	Focus group discussion/MAO, Enforcement teams, PO, academe
P7. Presence of repeat offenders	Secondary data/Enforcement teams
P8. Amount of fish caught through illegal fishing	Focus group discussion/MAO
P9. Risk of coastal habitat damage due to illegal fishing	Focus group discussion/MAO, Enforcement teams, PO, academe
P10. Violence due to illegal fishing	KII/Enforcement team

Fig. 2. IUU fishing index rating

Data quality

Each indicator is evaluated using a data quality score ranging from 1 to 3, reflecting the reliability and completeness of the data (Fig. 3). A score of 1 denotes low data quality, indicating limited reliability or completeness; a score of 2 represents medium data quality, while a score of 3 signifies high data quality, indicating that the information is both reliable and comprehensive. Information on data quality will guide the local government units in improving their data collection and monitoring.

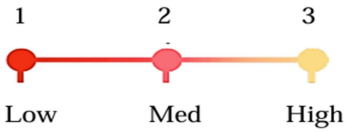

Fig. 3. Data quality score

Population and sample size

A social survey using purposive sampling was employed to collect data on the prevalence of illegal, unreported, and unregulated (IUU) fishing in Mabuhay coastal waters. The respondents were individuals engaged in or impacted by fishing activities, including fishermen, fishing vessel owners, and fish vendors in Mabuhay. Slovin's formula below was used to determine the sample size for the social survey, ensuring representativeness with a 5% margin of error:

$$n = \frac{N}{1 + N\,(e)^2}$$

Where,

n = sample size

N = population size

e = margin of error

The population of fisherfolk is 1,787. Therefore, the sample size for this study is 327.

Data analysis

Descriptive statistical analysis

IUU fishing index score

Participants rated each indicator on a scale from 1 to 4, and the scores were averaged to determine the value for each prevalence indicator. The overall prevalence score was then calculated by taking the average of all 10 indicators (P1-P10).

Monthly presence of illegal fishing activities in the municipality in a year (P1)

The prevalence and data quality scores with corresponding descriptions for P1 are presented in Tables 2 and 3, respectively. The monthly presence of illegal fishing was determined by getting the total number of months where illegal fishing was observed across the total barangays, divided by the total number of barangays × 12 months, then multiplied by 100 to get the percentage.

Table 2. Monthly presence of illegal fishing activities in municipality in a year (P1)

Score	Description
1 (low)	Less than 5%
2 (Moderate)	5 of 15%
3 (High)	16% to 25%
4 (very high)	Greater than 25%

Table 3. Data quality score (P1)

Score	Description
1 (Low)	Data source is reconstructed (i.e., not from monthly meetings) from a one-time workshop with only select people or key informants, not per coastal barangay.
2 (Medium)	Data source is reconstructed from a one-time workshop with a representative per barangay instead of monthly monitoring per barangay
3 (High)	Data is from systematically collected and recorded observations and/or reports

The formula is shown below:

% of observed illegal fishing months={(Total observed illegal fishing months)/(Total Barangays-months)} × 100

Illegal fishing incidence from remote sensing (P2)

The prevalence and data quality scores with corresponding descriptions for P2 are presented in Tables 4 and 5, respectively. The recorded violations from the intrusion of commercial fishing vessels into Mabuhay's municipal waters were detected using remote sensing data from Oceana Philippines.

Table 4. Illegal fishing incidence from remote sensing (P2

Score	Description
1 (Low)	Less than 10 (or no satellite detection of potential violations for 1 year) detections per year
2 (Moderate)	10 to 50 detections per year
3 (High)	50 to 100 detections per year
4 (Very high)	Greater than 100 detections per year

Table 5. Data quality score (P2)

Score	Description
1 (Low)	Data is from one type of remote sensing source;
2 (Medium)	Data is from two remote sensing sources;
3 (High)	Data is from more than two different remote sensing sources of data;

Number of apprehended violators relative to patrolling efforts in seaborne or other enforcement operations (P3)

The prevalence and data quality scores with corresponding descriptions for P3 are shown in Tables 6 and 7, respectively. This indicator was measured by dividing the number of apprehensions by the total number of patrols and operations conducted by the enforcement teams, and expressed as a percentage.

Table 6. Number of apprehended violators relative to patrolling efforts in seaborne or other

Score	Description
1 (low)	Less than 5%
2 (Moderate)	5% to 15%
3 (High)	16% to 25%
4 (very high)	Greater than 25% or if no apprehensions data and/or number of operations is available.

Table 7. Data quality score (P3)

Score	Description
1 (Low)	Data source is from perceptions only;
2 (Medium)	Data is from actual apprehensions and operations data from one law enforcement team;
3 (High)	Data is from actual apprehensions and operations data from multiple fisheries law enforcement teams combined.

Regular monitoring or reporting of fish catches (P4)

The prevalence and data quality scores with corresponding descriptions for P4 are presented in Tables 8 and 9, respectively. The data were collected from the Municipal Agriculture Office (MAO). The percentage of resident municipal or commercial fishers who were reporting catches to MAO was measured.

Table 8. Regular monitoring or reporting of fish catches (P4)

Score	Description
1 (Low)	At least weekly fisher catch reporting or production monitoring is in place, with more than 75% of fishers reporting catches or monitored for catches
2 (Moderate)	51% to 75% of fishers reporting catches
3 (High)	25% to 50% of fishers reporting catches
4 (Very high)	Less than 25% of fishers reporting or being monitored for catches or No catch reporting or fisheries production monitoring by LGU

Table 9. Data quality score (P4)

Score	Description
1 (Low)	The score is based on perception only
2 (Medium)	The score is based on data on catch or fisheries production estimation data
3 (High)	Data is from systematically collected and recorded observations and/or reports

Registration and Regulation of Fishers and Fishing Vessels (P5)

The prevalence and data quality scores with corresponding descriptions for P5 are presented in Tables 10 and 11, respectively. This indicator was only answered by MAO. The percentage of local fishers and fishing vessel registrations with the MAO was computed. The scoring here required that both fishing vessels and fisherfolk were registered with the municipality. The score was derived from the lower percentage of the two (i.e., fisher or fishing vessel registration).

Table 10. Registration and regulation of fishers and fishing vessels (P5)

Score	Description
1 (Low)	More than 90% of resident fishers and fishing vessels are registered, and registration is updated periodically (not just done once)
2 (Moderate)	51% to 90% of fishers and fishing vessels are registered
3 (High)	Only 25% to 50% of fishers and fishing vessels are registered
4 (Very high)	Less than 25% of fishers and fishing vessels are registered in the municipality, Or No fisherfolk and/or fishing vessel registration is ongoing.

Table 11. Data quality score (P5)

Score	Description
1 (Low)	The percentage is based on perception only on the estimated total number of fishers and fishing vessels in the area
2 (Medium)	The percentage is based on an inventory of fishers and fishing vessels done more than 5 years ago
3 (High)	The percentage is based on an inventory of fishers and fishing vessels done less than 5 years ago

Trend in illegal fishing incidence (P6)

The prevalence and data quality scores with corresponding descriptions for P6 are presented in Tables 12 and 13, respectively. The data for this indicator were gathered through focus group discussions. The

trend of each type of illegal fishing activity was rated based on the year 2023 versus the 2024 trends.

Table 12. Trend in illegal fishing incidence (P6)

Score	Description
1 (Low)	No change; no more or very few IUU fishing incidents (i.e., a score of 1 for both the P1 and P2)
2 (Moderate)	Most illegal fishing activities have decreasing trends
3 (High)	Mixed trends (i.e., some IUU activities are increasing while others are decreasing) or no change, but with at least a score of 2 or more for either VBD/year
4 (Very high)	Most illegal fishing activities have increasing trends

Table 13. Data quality score (P6)

Score	Description
1 (Low)	Data source is from perception of key informants in a one-time workshop
2 (Medium)	Data is from monthly or more frequent tracking of illegal fishing occurrences per barangay
3 (High)	Data is from systematically collected and recorded observations and/or reports and not just from perceptions.

Presence of repeat offenders (P7)

The prevalence and data quality scores with corresponding descriptions for P6 are presented in Tables 14 and 15, respectively. Based on the apprehension records from the enforcement teams, the presence of repeat offenders was determined by checking whether any vessel or violator apprehended during the assessment year was also caught in previous years. If at least one repeat offender is confirmed, the score for this indicator is 4 (very high).

Table 14. Presence of repeat offenders (P7)

Score	Description
1 (Low)	No
4 (Very high)	Yes

Table 15. Data quality score (P7)

Score	Description
1 (Low)	No documented information on apprehensions (perception only)
2 (Medium)	Current apprehension record available but no past recorded apprehension data available (i.e., based only on recollection or memory recall of certain individuals)
3 (High)	Score is supported by documented multiple apprehensions for the same violator(s)

Amount of fish caught through illegal fishing (P8)

The scores for prevalence and data quality for indicator P8 are shown in Tables 16 and 17, respectively. This indicator was computed by getting the annual catches of illegal fishers within the municipal waters of Mabuhay in metric tons per square kilometer of municipal water annually. The formula is presented below:

Estimated Annual Catch (MT)=Usual Incidence per Month × Usual Catch per Incidence × 12/1000

Table 16. Amount of fish caught through illegal fishing (P8)

Score	Description
1 (Low)	less than 0.25 MT/km²
2 (Moderate)	0.25 to 0.5 MT/km²
3 (High)	0.5 to 1.0 MT/km²
4 (Very high)	greater than 1.0 MT/km²

Table 17. Data quality score (P8)

Score	Description
1 (Low)	Data source is from perception of less than 2 people
2 (Medium)	Data is from more than 2 people and perceptions derived from a systematic survey or focused group discussion
3 (High)	Data is from systematically collected and recorded observations and/or reports of illegal fishing incidents

Risk of coastal habitat damage due to illegal fishing (P9)

The prevalence and data quality scores are shown in Tables 18 and 19, respectively. For each type of illegal fishing gear, the extent of habitat damage per incident was rated 1 to 4 (1 no damage, 4 extensive damage). This indicator was calculated by multiplying the sum of the usual incidents and the rate of the extent of habitat damage per incident of each illegal fishing activity or gear to get the total damage rating. To calculate the % weighted proportion of habitat-damaging illegal fishing incidents, the total of all the damage ratings of 2 to 4 (excluding the rating of 1) was added and divided by the total damage rating overall, then multiplied by 100 as shown in the formula below:

% Weighted Proportion={(Total Damage Rating of Violations)/(Total Damge Rating Overall)} × 100

Table 18. Risk of coastal habitat damage due to illegal fishing (P9)

Score	Description
1 (Low)	No habitat-damaging illegal fishing
2 (Moderate)	Less than 10% weighted proportion of habitat-damaging illegal fishing incidents
3 (High)	11% to 50% weighted proportion of habitat-damaging illegal fishing incidents
4 (Very high)	More than 50% weighted proportion of habitat-damaging illegal fishing incidents

Table 19. Data quality score (P9)

Score	Description
1 (Low)	Data source is from perception of less than 2 people
2 (Medium)	Data is from more than 2 people, and perceptions derived from a systematic survey or focused group discussion
3 (High)	Data is from systematically collected and recorded observations and/or reports

Violence due to illegal fishing (P10)

The scores for prevalence and data quality with corresponding descriptions for indicator P10 are shown in Tables 20 and 21, respectively. This indicator was measured based on the occurrence of direct harm to fishers, law enforcement personnel, and other people from records or reports, apprehensions, and blotters. Given the severity of the threat and the effect of IUU fishing, the score has been multiplied by 2.

Table 20. Violence due to illegal fishing (P10)

Score	Description
1 (Low)	There is no perceived threat of harm to people from illegal fishers
2 (Moderate)	Yes, there is a threat, but no physical harm yet (e.g., illegal fishers carry firearms)
3 (High)	Yes, there have been cases of physical harm during the assessment year(s) covered, but no deaths
4 (Very high)	Yes. Someone was killed during the assessment year, which was possibly related to illegal fishing.

Table 21. Data quality score (P10)

Score	Description
1 (Low)	Based on perceptions or second-hand knowledge
2 (Medium)	Based on first-hand knowledge of responders/ participants
3 (High)	Based on official records, blotters, resolved cases, or other documentation

Mapping IUU fishing threats

Threat maps were developed to identify the location and frequency of IUU fishing activities. A color-coded system was used to classify violations based on their frequency: blue means uncommon violations; yellow means occasional violations; green means frequent but limited violations; and red means frequent and widespread violations. Each violation type was assigned a specific code to facilitate analysis and representation in the threat maps. A code of 1-3 letters was assigned for every illegal activity.

Results and discussion

Monthly presence of illegal fishing activities in the municipality in a year (P1)

Illegal fishing activities were recorded in six out of 16 barangays (Table 22). There were 26 barangay-months with illegal fishing presence across all six barangays. By dividing 26 barangay-months by 192 barangay-months (16 barangays × 12 months), the percentage of this indicator is 13.54%. This percentage earned a score of 2, indicating a moderate prevalence of illegal fishing in Mabuhay coastal waters. The data quality was from systematically collected and recorded observations and reports. Therefore, it falls under 3, denoting high-quality data.

Table 22. Presence of illegal fishing

Coastal Barangay	Months with illegal fishing
1. Abunda	0
2.Bangkaw-bangkaw	6
3. Caliran	7
4. Catipan	0
5. Ligaya	0
6. Looc Barlac	0
7. Malinao	1
8. Pamansaan	9
9. Poblacion	0
10. Punawan	0
11. Sioton	0
12. Santo Niño	0
13. San Roque	0
14. Sawa	0
15. Taguisian	1
16. Tandu-Comot	2
Total	26

Illegal fishing incidence from remote sensing (P2)

Satellite-based vessel monitoring enhances situational awareness and prioritizes enforcement efforts where they are most needed (Kroodsma *et al.,*

2021). According to Oceana Philippines, Mabuhay exhibited a significant decrease in detected illegal fishing vessels in 2024 compared to 2023, despite ranking third in the province of Zamboanga Sibugay for the number of commercial fishing vessel visits. There were 11 illegal entries of commercial fishing vessels in the municipal waters of Mabuhay (Table 23). The findings show that the prevalence of illegal fishing in Mabuhay falls under 10 to 50 detections per year, with a prevalence score of 2 (moderate level). The data quality is 1 (low) as the data were collected from a single remote sensing data satellite.

Table 23. Monthly illegal fishing incidence from remote sensing

Months	Incidence
January	0
February	0
March	1
April	4
May	1
June	0
July	1
August	0
September	0
October	0
November	2
December	2
Total	11

Number of apprehended violators relative to patrolling effort in seaborne or other enforcement operations (P3)

Mabuhay has an estimated total of 104 seaborne operations conducted in 2024, resulting in 65 apprehended violators (Table 24). The ratio is 65/ 104 = 0.625 or 62.5 %. This result is greater than 25%, garnering a score of 4 (very high risk to IUU fishing). The very high prevalence of apprehensions requires more comprehensive strategies, including better community engagement, alternative livelihood, stricter prosecution, not just arrest (FAO, 2016). The data quality score is 3 (high) as the data were from real operations and apprehension reports from law enforcement teams.

Regular monitoring or reporting of fish catches (P4)

Pauly and Zeller (2016) emphasized that global fishery catches are substantially underreported, with Philippine small-scale fisheries largely absent from official statistics. In Mabuhay, the 2024 assessment revealed no regular and active fish catch monitoring due to the absence of designated fish landing sites, allowing local fishers to sell the catch directly into neighboring municipalities (e.g., Municipality of Margosatubig), bypassing any reporting system. Given the situation, this indicator has a score of 4, falling under the very high risk of IUU fishing, where less than 25% of fishers report their catch, or no monitoring happens at all. The data quality score is 1 (low) based on perception only.

Table 24. Number of apprehended violators

Months	Apprehended violators
January	8
February	2
March	3
April	10
May	18
June	5
July	11
August	1
September	2
October	0
November	5
December	0
Total	65

Registration and regulation of fishers and fishing vessels (P5)

Proper registration of fishers and vessels is essential for effective fisheries management and the reduction of IUU fishing (FAO, 2018). Without this information, the authorities have no clear starting point to track and control fishing pressure (Sumaila *et al.*, 2019). The fisher registration rate in Mabuhay was at 41.3%, out of an estimated 1,787 fishers, 738 were registered across the 16 coastal barangays. However, vessel registration is significantly lower, at only 4.31%, as out of the estimated 1,437 boats, only 62 were registered. Since the score requires that both fishers and fishing vessels are registered and uses the lower percentage, Mabuhay receives a score of 4, a very high prevalence of IUU fishing due to the low vessel registration rate. The data quality for this indicator is rated high (3) because the inventory of fishers and fishing vessels was done less than five years ago.

Table 25. Trend of illegal fishing

Types illegal fishing	Trends
Hulbot-hulbot (Danish seine)	Decreased
Tapsay	Decreased
Unregistered fishing vessel	Decreased
Fishing without a permit	Decreased
Dumbol (Bobo fish trap)	Decreased
Sinsuro	Decreased
Compressor	Decreased
Likum-likom	Decreased
Tare-tare	Decreased

Trend in illegal fishing incidence (P6)

The analysis of illegal fishing in Mabuhay revealed a downward trend according to the FGD participants (Table 25). This decline in activity resulted in a moderate prevalence of IUU fishing with a score of 2, meaning most illegal fishing activities have decreasing trends. The moderate risk score signifies that despite the continued presence of illegal fishing, noticeable progress has been made. The data quality for this indicator is 1 (low) because the data source was derived from a one-time workshop.

Presence of repeat offenders (P7)

Based on the apprehension data from the enforcement teams, this study confirmed the absence of repeat offenders across all coastal barangays in Mabuhay (Table 26). The zero recurrence of violators in IUU fishing coming from 6 out of 16 coastal barangays earned a score of 1 (low). This signifies that Mabuhay has an effective enforcement and each coastal barangay has an active community involvement between fisherfolk and the local government unit to curb illegal fishing (PIDS, 2021; FAO, 2002). In areas with small coastal communities, people usually go back to illegal fishing due to poverty, which heavily relies on fishing to survive while expecting fewer catches (Friedman *et al.*, 2018). On the other hand, some barangays have no repeat offenders, likely because of a stronger community patrol, better teamwork through FARMCs, and more active support from the LGU (Pomeroy *et al.*, 2017a; Pomeroy *et al.*, 2017b). The data quality score is 3 (high) because it is supported by documented multiple records from the enforcement teams.

Table 26. Presence of repeat offenders

Illegal fishing		Vicinity	Yes/ No
1.	Hulbot-hulbot	Barangay Pamansaan	No
2.	Hulbot-hulbot	Barangay Bangkaw-bangkaw	No
3.	Hulbot-hulbot	Barangay Caliran	No
4.	Hulbot-hulbot	Barangay Taguisian	No
5.	Tare-tare	Barangay Pamansaan	No
6.	Tapsay	Barangay Bangkaw-bangkaw	No
7.	Tapsay	Barangay Pamansaan	No
8.	Tapsay	Barangay Tandu-Comot	No
9.	Likum-likom	Barangay Pamansaan	No
10.	Compressor	Barangay Bangkaw-bangkaw	No
11.	Unregistered fishing boat	Barangay Caliran	No
12.	Unregistered fishing boat	Barangay Bangkaw-bangkaw	No
13.	Unregistered fishing boat	Barangay Malinao	No
14.	Fishing without a permit	Barangay Caliran	No
15.	Fishing without a permit	Barangay Malinao	No
16.	Sinsuro	Barangay Caliran	No
17.	Dumbol	Barangay Pamansaan	No

Amount of fish caught through illegal fishing (P8)

The assessment conducted in 2024 estimated that a total of 0.633 metric tons (MT) of illegal catch originated from the 270 km² municipal waters of Mabuhay (Table 27). This resulted in a catch density of approximately 0.0023 metric tons per square kilometer per year, equivalent to 2.3 kilograms per square kilometer per year. This falls below the 0.25 MT/km² threshold, resulting in a score of 1 (low). The largest volume of illegal fishing is attributed to hulbot-hulbot (Danish Seine), accounting for 0.18 metric tons, primarily conducted by fishers from outside Mabuhay (specifically from Alicia, Margosatubig, and Malangas). The combined annual illegal catch of both Mabuhay fishers and outside fishers is estimated at around 633 kilograms, valued at ₱31,650.00 based on the BFAR-set price of ₱50 per kilogram. The data quality for this indicator is 3 (high) because the data were from systematically collected and recorded reports of illegal fishing incidents.

Table 27. Amount of fish caught through illegal fishing

Illegal fishing/ Gear	Residence of violator	Incidence per month			kilograms per incidence			Average catch per year (kg/year)
		Min. incidence	Max. incidence	Usual incidence	Min. catch	Max. catch	Usual catch	
Hulbot-Hulbot (Danish Seine)	Outsiders	1	9	5	1	5	3	180
Tapsay	Local	1	2	1.5	2	3	2	45
	Outsiders	1	5	3	1	4	2.5	90
Unregistered	Local	1	1	1	2	2	2	24
Fishing Vessel	Outsider	1	4	2.5	2	2	2	60
Fishing without a	Local	1	1	1	2	2	2	24
permit	Outsider	1	4	2.5	2	2	2	60
Dumbol	Local	1	3	2	2	2	2	48
Air compressor	Outsider	1	1	1	2	2	2	24
Likum-likom	Outsider	1	1	1	2	5	3.5	42
Sinsuro	Outsider	1	1	1	1	2	1.5	18
Tare-tare	Outsider	1	1	1	1	2	1.5	18
Total		12	33	22.5	20	33	26.5	633

Risk of coastal habitat damage due to illegal fishing (P9)

Illegal fishing has severely compromised marine habitats in Mabuhay, accounting for 97.44% of the total weighted habitat damage (Table 28). This is based on the computation below:

Total weighted habitat damage = $\frac{936-(12+12)}{936}\ x\ 100 =$ 97.44%

The finding represents more than 50% of the weighted proportion. Based on the scoring criteria, this signifies a high prevalence of IUU fishing, with a corresponding score of 4.

Illegal fishing practices like Hulbot-hulbot (240), Tapsay (216), fishing without a permit (168), and the use of unregistered fishing vessels (168) are among the activities with the highest damage ratings, posing severe and often irreversible threats to marine ecosystems.

Studies have emphasized that despite enforcement efforts to ban Hulbot-hulbot under the Philippine fisheries law (Republic Act 10654 amending RA 8550), this practice continues in different coastal communities, causing physical damage to coral reefs and seagrass beds, which are vital ecosystems that support coastal fisheries (Pomeroy *et al.*, 2017a; Muallil *et al.*, 2015). Tapsay fishing, along with the absence of registration and licensing, weakens monitoring and enforcement efforts, allowing small-scale fishing activities to proceed without regulation (Jacinto *et al.*, 2020). Even practices with lower damage ratings, such as Compressor and Likum-likom, continue to threaten marine sustainability (Leopold *et al.*, 2019; Anticamara and Go, 2016). The data quality rating is 2 (medium) based on perception derived from focused group discussion.

Violence due to illegal fishing (P10)

The findings revealed no recorded data on violence due to illegal fishing. This indicator garnered a low prevalence of IUU fishing with a score of 1, indicating low or no observed occurrence within the study area. This was based on the absence of official records, such as blotter reports and documentation. Moreover, participants from KII and focus group discussions did not recall any incidents of violence due to illegal fishing. The data quality is 2 because it is based on the first-hand knowledge of participants and testimonies from local enforcement personnel, even though no formal written documentation was available during the data collection.

Average prevalence and data quality scores

The prevalence score of each indicator (P1 to P10) with data quality score is summarized in Table 29. The average prevalence score of Mabuhay coastal waters is 2.5, indicating a moderate risk to IUU fishing. The average data quality score is 2.2, signifying a medium reliability.

Table 28. Potential habitat overall damage

Type of violation	Incidents per year	Damage rating per incident	Total damage rating
1. Hulbot-hulbot (Danish seine)	60	4	240
2. Tapsay	54	4	216
3. Unregistered fishing vessel	42	4	168
4. Fishing without a permit	42	4	168
5. Dumbol (Bobo fish trap)	24	3	72
6. Sinsuro	12	2	24
7. Compressor	12	1*	12
8. Likum-likom	12	1*	12
Tare-tare	12	2	24

*1 is no damage; 4 extensive damage

Table 29. Prevalence index score

Indicator	Scores	Data quality
P1. Monthly presence of illegal fishing activities in the municipality in a year	2	3
P2. Illegal fishing incidence from remote sensing	2	1
P3. Number of apprehended violators relative to patrolling efforts in seaborne or other enforcement operations	4	3
P4. Regular monitoring or reporting of fish catches	4	1
P5. Registration and regulation of fishers and fishing vessels	4	3
P6. Trend in illegal fishing incidence	2	1
P7. Presence of repeat offenders	1	3
P8. Amount of fish caught through illegal fishing	1	3
P9. Risk of coastal habitat damage due to illegal fishing	4	2
P10. Violence due to illegal fishing	1	2
Average	2.5	2.2

IUU fishing threat map

The map in Fig. 4 illustrates the distribution of illegal activities throughout Mabuhay's coastal waters. The identified IUU fishing activities for the 2024 assessment year were based on findings from the social survey, reflecting both the observations of respondents within their respective coastal areas and documented reports from enforcement agencies. The frequency of illegal fishing practices was categorized to reflect varying levels of prevalence.

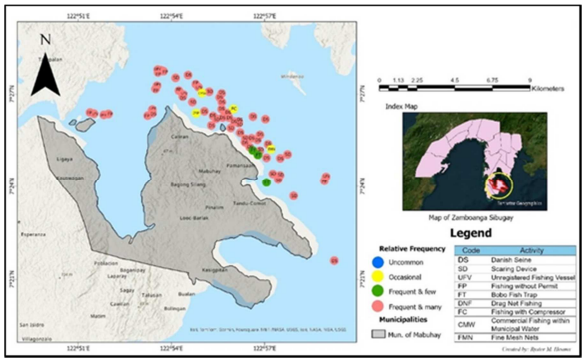

Fig. 4. IUU fishing threat map

Areas classified as "frequent and many" (red) denote the highest density of IUU fishing, indicating established hotspots characterized by activities such as the use of Danish Seine (Hulbot-hulbot), Scaring devices (Tapsay), operation of unregistered fishing vessels, and fishing without a permit. The category "frequent and few" (green) corresponds to the presence of Bobo fish traps (Dumbol), while the "occasional" category (yellow) captures less frequent practices, including the use of Tare-tare, commercial fishing within municipal waters, Likum-likom, compressor fishing, and Sinsuro.

Coastal barangays of Mabuhay, such as Caliran, Bangkaw-bangkaw, and Pamansaan, have the highest concentrations of IUU fishing activities, characterized by frequent and widespread IUU fishing practices based on the spot reports from the enforcement teams.

Conclusion

The study aimed to assess the prevalence of illegal, unreported, and unregulated (IUU) fishing in the municipal waters of Mabuhay. The results show a prevalence score of 2.5, indicating a moderate risk of IUU fishing. This is slightly below the national

average prevalence score of 2.58. Key indicators attributed to the moderate prevalence of IUU fishing include the absence of repeat offenders, a small amount of fish caught through illegal fishing, and the absence of violence due to illegal fishing. However, Mabuhay is facing threats and challenges due to a very high apprehension rate, the absence of regular monitoring or reporting of fish catches, a very low vessel registration rate, and a very high risk of coastal habitat damage due to illegal fishing. The IUU fishing threat map highlights hotspots in Caliran, Bangkaw-bangkaw, and Pamansaan, where illegal fishing practices, like Hulbot-hulbot and Tapsay, were dominant. The overall data quality scored an average of 2.2, reflecting a medium data reliability.

Recommendations

This study highly recommends enhancing enforcement and monitoring, because there are coastal areas in Mabuhay that are high-risk zones for the prevalence of IUU fishing, such as Caliran, Bangkaw-bangkaw, and Pamansaan. Moreover, registration and licensing of both fishers and fishing vessels should be increased by providing easier access to the registration and licensing process to help reduce IUU fishing. A regular catch reporting system should be established. Data transparency and accuracy through better reporting systems and technology for more effective decision-making should be enhanced. Education campaigns to raise awareness of IUU fishing's environmental impact and promote sustainable practices should be launched. Collaboration between local governments, fisheries agencies, NGOs, and communities to improve enforcement efforts should be strengthened. Enforcement teams should be capacitated on how to handle confrontations and reduce violence related to IUU fishing. Regular assessment of IUU fishing should be conducted to track changes, evaluate, and improve management strategies to combat IUU fishing.

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