INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 26, No. 5, p. 106-118, 2025
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

The vulnerability factors of illegal, unreported, and unregulated (IUU) fishing in municipality of Alicia, Zamboanga Sibugay, Philippines

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Article published on May 09, 2025

Key words: Vulnerability, SDG 14.4, Fisheries management, Region 9

Abstract

Illegal, Unreported, and Unregulated (IUU) fishing continues to seriously threaten the sustainability of marine resources in Alicia, Zamboanga Sibugay, Philippines. However, nothing has been done yet to evaluate the IUU fishing in Alicia. This paper presents the first ever assessment of the vulnerability of coastal waters of Alicia to IUU fishing, using the Philippine IUU Fishing Index and Threat Assessment Tool (I-FIT) developed by DA-BFAR and USAID. The assessment focused on eight indicators with a scaling score from 1 (low vulnerability) to 4 (very high vulnerability) and a data quality score of 1-3 (low -high data quality). Alicia obtained a vulnerability score of 2.63, indicating a moderate risk to IUU fishing. This score is higher than the national average of 2.53. The key vulnerability factors include rich fishing grounds in the municipality that attract legal and illegal fishers, increasing prices of illegally caught fish, and a very low budget allocation for fisheries and coastal resource management. Yet, these are alleviated mainly by other factors such as well-defined jurisdictional borders and a combined enforcement pact with neighboring municipalities, as well as the absence of powerful groups defending illegal fishers. The data quality score is 3, denoting high data reliability. Recommendations include intensifying habitat protection, raising funding allocation, increasing enforcement operations, providing livelihood programs, monitoring, engaging community participation, and conducting regular vulnerability assessments. This study aligns with the Sustainable Development Goal Target 14.4, which seeks to end illegal, unreported, and unregulated (IUU) fishing.

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Introduction

The fishery sector is crucial to economic growth through its contributions to GDP, employment, trade, and livelihoods (Ibrahim *et al.*, 2024). Fisheries is one of the largest and oldest primary industries worldwide, currently, 59.6 million people are being employed in fisheries all over the globe (FAO, 2018). However, one of the pressing problems is Illegal, unregulated, and unreported fishing posing a global threat to food security, maritime livelihoods, and fisheries sustainability, threatening ocean sustainability, national security, and the safety and human rights of fishing communities (Mackay *et al.*, 2020; Auld *et al.*, 2023). It is a very contentious point for the United Nations, as it affects numerous dimensions of the Sustainable Development Goals (Auld *et al.*, 2023). Three UN Specialised Agencies - the Food and Agriculture Organization (FAO), International Labour Organization (ILO), and the International Maritime Organization (IMO) - have developed instruments relating to sustainable harvesting, working conditions, and vessel safety on board fishing vessels (Auld *et al.*, 2023). What is shared among these instruments is the incorporation of port state measures for enforcement.

Illegal, Unreported, and Unregulated (IUU) fishing poses significant challenges in both inshore and high seas ecosystems (Chen *et al.*, 2024), affecting finfish and aquatic invertebrates alike (Temple *et al.*, 2022). This practice has far-reaching economic, social, and environmental consequences (Fujii *et al.*, 2021; Chen *et al.*, 2024), including the depletion of natural resources and the degradation of ecosystems (Setianti *et al.*, 2024). IUU fishing often results in criminal activities and its impact varies from immediate to long-lasting. Key environmental issues linked to IUU fishing include operating without permits, targeting protected species, using prohibited gear, and exceeding catch limits stated in RA 8550, as amended by Republic Act No. 10654 or the Fisheries Code of the Philippines. Estimates suggest that IUU fishing contributes to the annual capture of 11-26 million tons of fish, with a value between USD 10-23 billion (FAO, 2016).

The Philippines is a prime contributor in terms of fish production to the world. In the year 2018, 4.36 million MT had been acquired from aquaculture, municipal, and commercial fisheries productions. The Philippines placed 13th for its fish production and was also in fourth place when it comes to seaweed production in the world (FAO, 2020). Fishery exports earned US $1.6 billion. The Philippine fisheries sector is a significant contributor to the economy, supporting nearly 2 million fisherfolks (TahiLuddiN and Terzi, 2021).

As a member of the UN, the Philippines is committed to attaining the SDGs, including Target 14.4. Moreover, the government has made significant efforts to address this problem through legislative reforms, capacity-building initiatives, and collaboration with international organizations and neighboring countries. Despite various national and local efforts to combat IUU fishing activities, the practice continues to thrive, driven by factors such as regulatory challenges, economic pressures, socio-cultural aspects, and weak monitoring, control, and surveillance (Wilcox *et al.*, 2021). One of the most significant and impactful legislation in terms of Illegal, Unreported, and Unregulated (IUU) fishing is RA 10654, or the Amended Fisheries Code of the Philippines. The Amended Fisheries Code of the Philippines was enacted in 2015 and strengthened the original Fisheries Code, RA 8550, by having heavier penalties against IUU fishing.

Based on the 2021 assessment on IUU fishing in the Philippines, only 160 municipalities and cities were assessed. The majority of the 160 LGUs fall within the 2.00-3.00 range (DA-BFAR, 2022). Eight LGUs score below 2.00, indicating a lower risk, while two LGUs fall within the 3.50-4.00 range, reflecting a higher risk. Overall, the prevalence scores are closely aligned with the vulnerability scores, indicating that IUU fishing in municipal waters is strongly linked to these areas' susceptibility to such activities. This correlation allows LGUs and their stakeholders to effectively identify and address the risks and vulnerabilities associated with IUU fishing (DA-BFAR, 2022).

As of the 2023 report, no assessment (0%) has been conducted on Illegal, Unreported, and Unregulated (IUU) fishing in the Zamboanga Peninsula (Region 9), in contrast to the significant progress observed in other regions (DA-BFAR, 2021). In response to this gap, the present study was conducted to assess the vulnerability factors contributing to IUU fishing within the municipal waters of Alicia, Zamboanga Sibugay, located in Region 9, Philippines. The assessment employed the eight standardized indicators outlined in the Philippine IUU Fishing Index and Threat Assessment (I-FIT) Tool, developed by the Department of Agriculture–Bureau of Fisheries and Aquatic Resources (DA-BFAR) in 2022.

Materials and methods

Study area

The study was conducted within the municipality of Alicia, located in the southwestern part of Zamboanga Sibugay, approximately 7°30' North and 122°56' East on the island of Mindanao, Philippines. The municipality relies heavily on fishing and aquaculture, with a 98 km coastline. Its fisheries production drives its economy, contributing significantly to economic growth. The study focused on the 20 coastal barangays of the municipality, which include: (1) Bagong Buhay, (2) Bella, (3) Conception, (4) Dawa-Dawa, (5) Gulayon, (6) Ilisan, (7) Kawayan, (8) Lambuyogan, (9) Lapaz, (10) Lapirawan, (11) Litayon, (12) Naga-Naga, (13) Pandan-Pandan, (14) Poblacion, (15) Sta. Maria, (16) Sto. Niño, (17) Talaptap, (18) Tampalan, (19) Tandiong Muslim, and (20) Timbang-Timbang (Fig. 1).

Research design

This study employed a mixed-method approach, using quantitative and qualitative research to objectively assess the vulnerability to illegal, unreported, and unregulated fishing risk in Alicia, Zamboanga Sibugay.

Entry protocol

Ethical considerations were fundamental to this research due to the sensitivity of illegal fishing activities. All participants provided informed consent, 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.

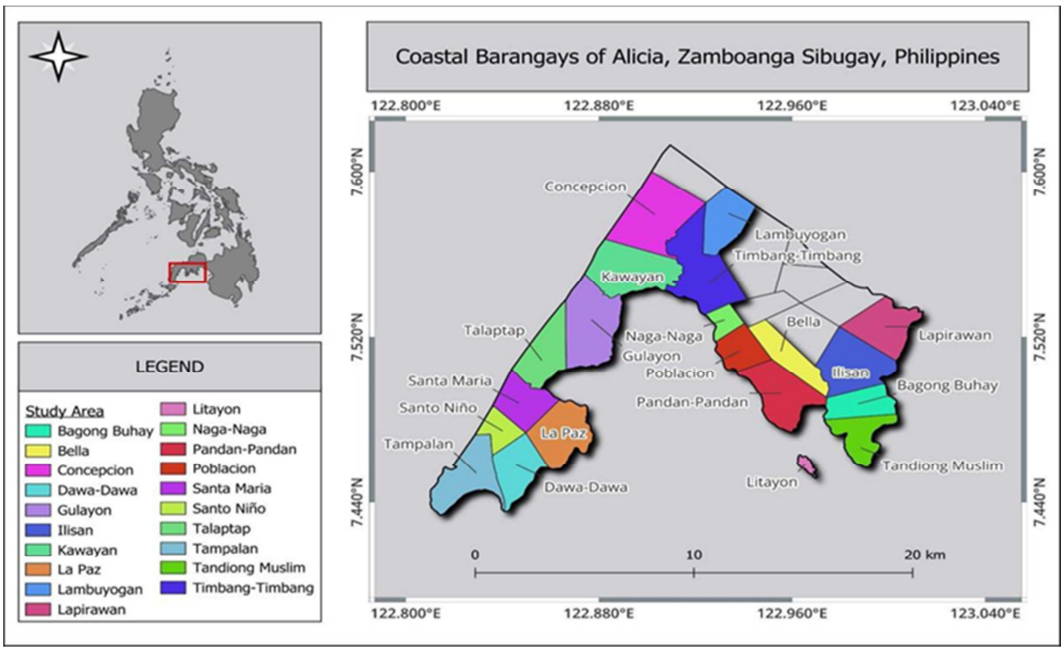

Fig. 1. Map showing the study area comprising 20 coastal barangays in Alicia, Zamboanga Sibugay, Philippines

Prior to the study, robust entry processes were implemented to ensure the safety and accuracy of the researchers' data. A request letter was made to the Municipal Agriculture Office for a study permit, and the proposal was presented to the local mayor for approval. Following permission, collaborations with local government officials and stakeholders were also facilitated. A permit to conduct the study was obtained from the municipality.

Data collection

Measurement of vulnerability to IUU fishing using the I-FIT Tool

The study was conducted for three months, starting October 2024 to December 2024, in 20 coastal barangays of Alicia, Zamboanga Sibugay for assessment year 2024. To determine the susceptibility of Alicia's municipal waters to Illegal, Unreported, and Unregulated (IUU) fishing, the Philippine IUU Fishing Index and Threat Assessment Tool (I-FIT) was used in this study. Established by the USAID Fish Right Program and the Department of Agriculture–Bureau of Fisheries and Aquatic Resources (DA-BFAR), the I-FIT tool measures three dimensions: the incidence of IUU fishing, the susceptibility of areas to IUU, and the performance of responses. This research focused only the Vulnerability factors, which are quantified through eight indicators. Each of the indicators is rated on a scale of 1 (Low vulnerability) to 4 (Very High vulnerability), with a composite maximum score of 32, as shown in Fig. 2.

Data for this component were gathered through secondary data from the Municipal Agriculture Office (MAO), key informant interviews with fishers and enforcement teams, and focus group discussions (Table 1).

Table 1. Vulnerability factors indicators

Indicators	Methods/Data source
Fisheries resource availability and coastal habitat quality (V1)	Secondary Data/Municipal Agriculture office
Ex-vessel selling price of species commonly targeted by illegal fishers (V2)	Key informant interview to fishers
Overcapacity of fishers (V3)	Secondary Data/Municipal Agriculture Office
Physical configuration of shorelines and islands (V4)	Focus Group Discussion/Secondary Data/ Municipal Agriculture Office
Weather and ocean condition impacts on seaborne interventions (V5)	Key informant interview and Secondary Data/Enforcement Teams
LGU budget allocation for fisheries and CRM (V6)	Secondary Data/Municipal Agriculture Office
Clear boundaries and jurisdiction for enforcement (V7)	Secondary Data/Municipal Agriculture Office
Illegal fishers are supported by influential third-party people or groups (V8)	Key informant interview/Enforcement teams

Good (low) Bad (Very High)

Fig. 2. IUU fishing index rating

Data quality

A data quality rating precedes every indicator, scored between 1 (low data quality) and 3 (high data quality), that captures the completeness and reliability of the underlying data (Fig. 3). A rating of 1 implies low data quality, meaning that the information available is incomplete or unreliable. A rating of 2 implies moderate data quality, whereas a rating of 3 implies high data quality, with both accuracy and completeness. These ratings are useful inputs for local government units, where gaps in existing data collection activities can be identified and inform the strengthening of monitoring and reporting systems.

Low Medium High

Fig. 3. Data quality score

Population and sample size

A social survey using purposive sampling was used to collect information on the vulnerability factors that lead to illegal, unreported, and unregulated (IUU) fishing in Alicia coastal waters. Respondents were

people directly engaged in or impacted by local fishing operations, including fishers, owners of fishing vessels, and fish vendors. For a representative of the target population, the sample size was calculated using Slovin's formula 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 3,385. Therefore, the sample size for this study is 358.

Data analysis

IUU fishing index score

Each vulnerability factor indicators was given a score of 1 to 4 by the participants. The scores were averaged to get the score for a given indicator. The average of all 8 indicators (V1-V8) was computed to compute the overall vulnerability score.

Table 2. Fisheries resource availability and coastal habitat quality (V1)

Score	Description
1 (low)	Little or no known or perceived ecological richness or limited occurrence of fishing activities in the area.
2 (Moderate)	Known fishing grounds for small pelagic fishes, but the poor condition of coastal habitats
3 (High)	Perceived ecological richness through existing or starting marine protected areas and/ or known/perceived presence of commercially important species in the area
4 (very high)	Existence of thriving marine protected areas, critical habitats, spawning grounds, traditional/ popular fishing grounds, and/ or known perceived presence of commercially important species in the area (e.g., Lapu-Lapu, maya-maya, lobster, Sardinas, Galunggong, etc.)

Table 3. Data quality score (V1)

Score	Description
1 (Low)	Data source is based only on perception
2 (Medium)	Mixed data source from perceptions and some from scientifically-collected survey / monitoring data
3 (High)	Score is based on fisheries and coastal habitat survey data collected using scientific methods

Fisheries resource availability and coastal habitat quality (V1)

The vulnerability and data quality score with corresponding descriptions are shown in Tables 2 and 3. The data used for this indicator were derived from the fisheries production reports of the Municipal Agriculture Office (MAO) and further cross-checked by focus group discussions (FGD).

Ex-vessel selling price of species commonly targeted by illegal fishers (V2)

Vulnerability and data quality scores with descriptions of this indicator are presented in Tables 4 and 5. These ex-vessel selling prices were the prices that illegal fishers received directly for their catch. The price of commonly targeted species by illegal fishers were computed from price monitoring of illegal fishers through key informant interviews.

To calculate the percentage change for each species:

1. $Percentage\ Increase = \left(\frac{Price\ in\ 2024 - Price\ in 2023}{Price\ in\ 2023}\right) x100$
2. $Total\ Average\ Percentage = \left(\sum \frac{Percentage\ Increase}{Number\ of\ targeted\ species}\right) x100$

Table 4. Ex-vessel selling price of species commonly targeted by illegal fishers (V2)

Score	Description
1 (Low)	Less than 2 % increase in the average ex-vessel price of fish or a decrease in price
2 (Moderate)	2% to 5% increase in ex-vessel price
3 (High)	6% to 10% increase in ex-vessel price
4 (Very high)	The average ex-vessel price of fish is more than 10% higher than last year.

Table 5. Data quality score (V2)

Score	Description
1 (Low)	Data source is based only on perception
2 (Medium)	Mixed data source from perceptions and some from scientifically-collected survey /monitoring data
3 (High)	Score is based on price monitoring data

Overcapacity of fishers (V3)

The vulnerability and data quality scores with the corresponding descriptions for V3 are shown in Tables 6 and 7. The fishers' density in the

municipality was employed as a proxy to estimate the overcapacity of fishers. It is computed using the estimated fisher population in the municipality divided by the estimated length of the coast in kilometers, as indicated by the formula below.

Total Fisher Density=(Estimated number of fisheers)/(Total length of coastal area (km))

Table 6. Overcapacity of fishers (V3)

Score	Description
1 (low)	Less than two fishers per km of coastline
2 (Moderate)	3 to 30 fishers per km of coastline
3 (High)	31 to 70 fishers per km of coastline
4 (very high)	More than 70 fishers per km of coastline

Table 7. Data quality score (V3)

Score	Description
1 (Low)	Based only on rough estimates of number of fishers and coastline length
3 (High)	Based on actual number of fishers and measured length of coastline from GIS or other means

Physical configurations of shoreline and islands (V4)

Coastal areas with continuous and simple coastline are easier to patrol over areas with complex geological characteristics. This indicator scores the physical configuration of shoreline and islands in Alicia. The vulnerability scores with the corresponding descriptions are presented in Table 8. The score was calculated based on the existing maps and accessible information of Alicia's municipal waters, consisting of a large mainland with two outlying islands.

Table 8. Physical configurations of shoreline and island (V4

Score	Description
1 (Low)	Single, continuous, and simple coastline
2 (Moderate)	Single coastline with complex features (i.e., large embayment
3 (High)	Large mainland with some smaller outlying islands
4 (Very high)	Multiple small islands with no known large islands

Weather and ocean condition impacts on seaborne interventions (V5)

The success of seaborne enforcement operations is sometimes impacted by the weather and ocean conditions. This indicator gauges the percentage of unsuccessful operations due to unsafe weather or sea conditions for the assessment year 2024. This is estimated using the formula below:

Patrol abortion Rate (%)={(Number of aborted seaborne operations)/(Total number of scheduled and unscheduled operations)} × 100

The vulnerability and data quality scores with corresponding descriptions are presented in Tables 9 and 10. If there were no enforcement operations or no active enforcement team, a score of 4 (very high) was assigned.

Table 9. Weather and ocean condition impacts on seaborne interventions (V5)

Score	Description
1 (Low)	Less than 5% of enforcement operations were cancelled due to weather conditions.
2 (Moderate)	5% to 25% of enforcement operations were cancelled due to weather conditions
3 (High)	26% to 50% of enforcement operations were canceled due to weather conditions
4 (Very high)	More than 50% of enforcement operations were canceled due to weather conditions.

Table 10. Data quality score (V5)

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)	Seaborne operation/fisheries law enforcement operation records and reports

LGU budget allocation for fisheries and CRM (V6)

The vulnerability and data quality scores with corresponding descriptions for this indicator are shown in Tables 11 and 12. Recognizing that larger budget allocations is crucial for providing more response measures to combat IUU fishing, this indicator was measured by the total budget allocation for fisheries and coastal resource management (CRM) divided by the total municipal water area in $km^{2,}$ as presented in the formula below:

Total budget per km²= (∑Budget for fisheries and CRM)/(Area of Municipal water in km²)

Table 11. LGU budget allocation for fisheries and CRM (V6)

Score	Description
1 (Low)	Higher than P100,000/km² of municipal waters
2 (Moderate)	P50,000-P100,000/km² of municipal waters
3 (High)	P1,000-P49,999/km² of municipal waters
4 (Very high)	Less than P1,000/km2 of municipal waters

Table 12. Data quality score (V6)

Score	Description
1 (Low)	The data source is from rough estimates (not based on a document)
2 (Medium)	Mixed data sources (i.e., from official documents and some estimates)
3 (High)	Computed mostly from financial documents

Clear boundaries and jurisdiction for enforcement (V7)

This vulnerability indicator examines the status of the delineation of municipal waters and/or agreements with adjacent LGUs on access to fishing or water boundary jurisdiction. Its vulnerability and data quality scores with corresponding descriptions are shown in Tables 13 and 14. The data for this indicator refers to the adopted municipal boundary delineation from NAMRIA. In addition, the LGU Alicia has a joint agreement with the adjacent three LGUs (Talusan, Olutanga, and Mabuhay) to address IUU in their municipal waters.

Table 13. Clear boundaries and jurisdiction for enforcement (V7)

Score	Description
1 (Low)	Municipal waters officially delineated (NAMRIA Approved) and/ or fishing agreements with adjacent municipalities reached (e.g., with joint resolution or ordinance)
2 (Moderate)	Unofficial boundaries (i.e., no ordinance or resolution), but the boundaries are recognized by adjacent fishers (i.e., no conflicts with fishers from adjacent LGUs)
4 (Very high)	No boundary delineation attempts or agreements with adjacent municipalities, but with conflicts with fishers from adjacent LGUs (e.g., illegal fishing by fishers from adjacent LGUs)

Table 14. Data quality score (V7)

Score	Description
1 (Low)	Data source is from perceptions only
3 (High)	Score is backed up by official documentation (e.g., ordinance or resolution)

Illegal fishers supported by third-party influential people or groups (V8)

The vulnerability and data quality scores with corresponding descriptions are outlined in Tables 15 and 16. Data were gathered by interviewing enforcement teams about the presence or absence of incidents in which someone or influential people groups intervened, resulting in the release without due process during the assessment year in 2024 This indicator is measured using only two choices: 1 for no incidents or 4 for at least one case during the assessment year.

Table 15. Illegal fishers supported by third-party influential people or groups (V8)

Score	Description
1 (Low)	No, there have been no incidents during the assessment year when someone intervened after an apprehension or enforcement operation that resulted in the release of the apprehended vessel and/ or fisherfolk without due process
4 (Very high)	Yes, there was at least one case during the assessment year when someone intervened after an apprehension or enforcement operation that resulted in the release of the apprehended vessel and/ or fisherfolk without due process.

Table 16. Data quality score (V8)

Score	Description
1 (Low)	Based only on perceptions or experience without any documentation
3 (High)	Based on experience with some documentation of the incident and the intervention

Results and discussion

Fisheries resource availability and coastal habitat quality (V1)

The municipality of Alicia has established the Tantanang Bay Marine Fish Sanctuary, located in Tangalay, Kawayan. It is a growing marine protected area managed by the Municipality of Alicia. Fish sanctuaries (known as 'no-take zones')

are critical for creating marine conservation programs since they can conserve and grow fish stocks in tropical artisanal and temperate industrial fisheries (Solandt *et al.*, 2022). The fisheries production in Alicia indicates the existence of commercially important species such as groupers, big-eyed scad, Crevalle, garfish, hardtail, milkfish, threadfin breams, round scad, sardines, rabbitfish, skipjack, slipmouth, snapper, spanish mackerel, sting ray, striped mackerel, trevalle, and tuna and other assorted fishes, including parrotfishes, juvenile rabbitfish, Mackerel Scad, Big eye Scad, Lobster, Mullet (Table 17). The total fish production amounted to 1,163,038.04 kilograms in Alicia, and the species abundance as shown in Table 17. Other aquatic products include seaweeds, shells, sea cucumbers, lobsters, octopuses, squids, shrimps, mud crabs/blue crabs, and cuttlefish. The Philippines' rich marine resources and expansive coastlines make it an ideal environment for a thriving seafood industry (Galang, 2024). However, the abundance of marine resources in 6 fishing grounds in Alicia attracts legal and illegal fishers to adopt faster and profitable methods, specifically using destructive fishing methods, potentially leading to coral bleaching in the southern Mindanao, where Alicia is located, particularly in the Zamboanga and Sibuguey Bay (NOAA, 2025) which may lead to the degradation of marine species and the deterioration of the marine ecosystem. This indicator has a score of 4, indicating a very high vulnerability to IUU fishing due to rich fisheries resources and presence of marine protected area).This also implies that IUU fishing is driven not only by poverty, low registration of fishers and fishing vessels, repeat offenders, lack of patrols and surveillance, but also by economic opportunities for the fishers survival and consumption (Widjaja *et al.*, 2020; Lubchenco and Haugan, 2023). Because this information is supported by secondary data from MAO and verified using FGD, the data quality is rated 3 (high). The score is based on data acquired through scientific surveys of fisheries production and coastal habitats.

Table 17. Monthly production of fish catch

Months	Monthly production (kg)
1. January	157,793.13
2.February	111,829.01
3. March	149,550.73
4. April	91,624.20
5. May	84,936.39
6. June	85,338.05
7. July	83,668.16
8. August	109,219.91
9. September	57,030.84
10. October	94,387.19
11. November	64,330.43
12. December	73,330
Total	1,163,038.04

Ex-vessels selling price of species commonly targeted by illegal fishers (V2)

Data on the fish species commonly targeted by illegal fishers were obtained through a focus group discussion (FGD) with the Municipal Agriculture Office (MAO). According to the MAO, illegal fishing practices are generally indiscriminate, capturing various fish species without selection. Meanwhile, ex-vessel selling price data for these species were collected through key informant interviews (KII) with local fishers. Data from 2023 and 2024 were compared across 25 fish species frequently targeted by illegal fishers to assess price changes (Table 18). The analysis revealed an average percentage increase of 33.59% in ex-vessel prices. This significant price increase falls under the score of 4 (very high), as it exceeds the threshold of over 10% higher than last year. Since this score is based on mixed data source from perceptions and some scientifically-collected survey/ monitoring data.

Table 18. Species prices usually targeted by illegal fishers

Targeted species	2023 price	2024 price	% change
1. Rabbitfish	80	100	2
2. Grouper	180	200	11.1
3. Ornate Emperor	170	200	17.6
4. Parrotfish	80	100	2
5. Whiteleg shrimp	40	60	50
6. Goatfishes	70	80	14.2
7. Unicorn fishes	70	80	14.2
8. Slipmouth	20	30	5
9. Squid	150	200	33.3
10. Indian Mackerel	180	200	11.11
11. Big-eyed scads	180	200	11.11
12. Snapper	170	200	17.65
13. Fusilier	70	100	42.86

14. Acetes	160	200	2
15. Rabbitfish	100	170	70
16. Lobster	900	1700	88.89
17. Shortfin scad	100	100	0
18. Triggerfish	60	80	33.33
19. Moray eel	20	40	100
20. Surgeonfish	80	90	12.5
21. Butterfish	50	70	40
22. Threadfin	60	100	66.6
23. Silverside	50	70	40
24. Milkfish	100	120	20
25. Bali Sardinella	25	30	20
Total average percentage			33.59

Overcapacity of fishers (P3)

In Alicia's 98-kilometer coastline, 1,773 fishers depend on the sea as the main source of their livelihood, bringing the fisher density of 18 individuals per kilometer. This places Alicia's municipal waters at a moderate level of fishing pressure with a score of 2, an evident balance between use of resources and sustainability. Yet, with increasing population and increased demand for fish, the region is highly susceptible to overfishing and exploitation, especially without strict regulation. Several studies have confirmed that fishery overcapacity increases competition among fishers for declining stocks and tends to lead them into illegal practices to maintain their catch (Nedumpara *et al.*, 2024). The quality of data for assessing overcapacity of fishers is high with a score of 3 as this was computed based on the actual number of fishers and the measured length of coastline from GIS or other means. This data indicates the reality today and is an urgent early warning, calling stakeholders to take proactive and adaptive management approaches to preserve Alicia's abundant marine environment for future generations.

Physical configurations of shorelines and islands (V4)

Alicia remains vulnerable to (IUU) fishing due to its complex coastal geography, which presents significant challenges for monitoring and enforcement. The municipality comprises a large mainland and two smaller outlying islands locally known as Sinking Island, a tourist destination, and Litayon Island, inhabited by local communities as illustrated in Fig. 4. Based on these geographic characteristics, Alicia is classified under category of high vulnerability to IUU fishing with a score of 3, indicating a large mainland with some smaller outlying islands that increases the difficulty of effective fisheries management and surveillance.

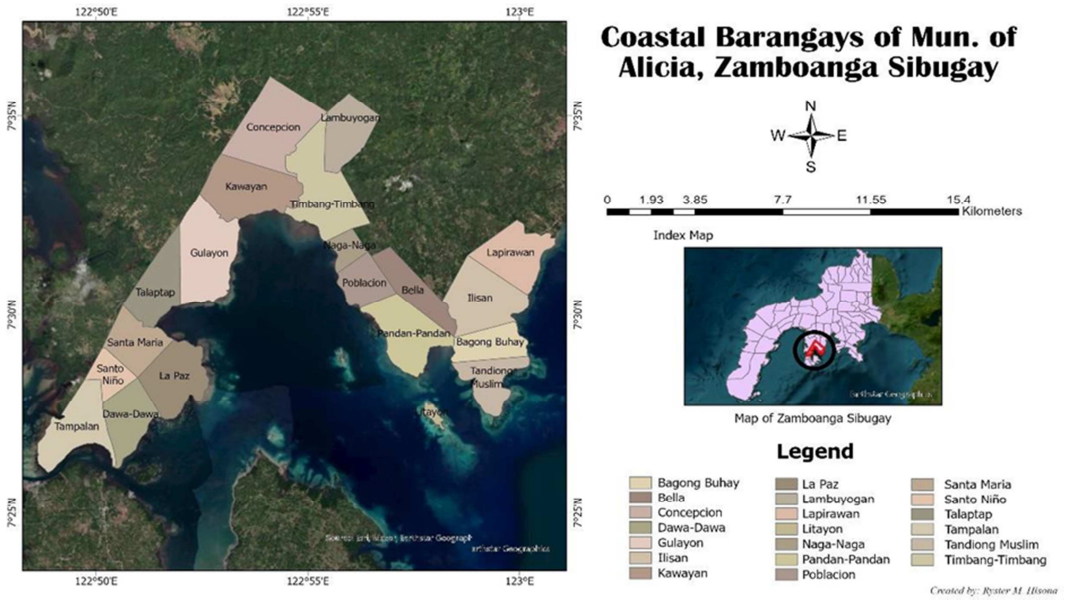

Fig. 4. Physical configurations of shorelines and islands in Alicia

Weather and ocean condition impacts on seaborne interventions (V5)

During the assessment year, seaborne enforcement operations in Alicia were scheduled once a week with a total of 52 in 2024. However, due to rough sea conditions, seven operations were canceled, representing 13.47% cancellations of all planned activities. According to the assessment criteria, this percentage falls within the 5% to 25% threshold for score of 2, denoting a moderate vulnerability due to weather-related disruption. These cancellations highlight the operational challenges posed by unpredictable sea conditions. This result is based on official records and reports from seaborne and fisheries law enforcement teams. Therefore, the data quality is rated 3, with high accuracy and reliability.

Table 19. Allocated budget for fisheries and CRM

Line item	Total estimated budget of cost (PhP)
Fuel, oil & lubricants	350,000.00
Food provision	83,600.00
CAA fishery warden honorarium	48,000.00
Sea craft repair & maintenance	139,953.00
Atom alliance subsidy	200,000.00
Meals & snacks	30,000.00
Fisherfolk capability Building	30,000.00
Supplier	5,000.00
Monitoring	25,000.00
Miscellaneous	1,697.00
Total	913, 250.00

LGU budget allocation for fisheries and CRM (V6)

In the assessment year 2024, the Local Government Unit (LGU) of Alicia, Zamboanga Sibugay, allocated a total of PHP 913,250.00 budget for fisheries and coastal resource management (Table 19). Covering an area of approximately 980 km², Alicia's municipal waters reflect a budget allocation of only PHP 931.89 per square kilometer. Based on established assessment criteria, this falls into the score of 4 (very high vulnerability), which is below the PHP 1,000/km² threshold deemed necessary for effective management. This finding shows a huge budget gap concerning the extent of marine resource governance required, underscoring the need for more investment in protecting and long-term managing Alicia's coastal waters. The budget data was derived from official and verified financial records from the Municipal Agriculture Office, thereby garnering a data quality score at 3 (high).

Table 20. Summary of vulnerability indicator and data quality scores

Indicator	Vulnerability score	Data quality score
Fisheries resource availability and coastal habitat quality (V1)	4	3
Ex-vessel selling price of species commonly targeted by illegal fishers (V2)	4	3
Overcapacity of fishers (V3)	2	3
Physical configurations of shorelines and islands (V4)	3	-
Weather and ocean condition impacts on seaborne interventions (V5)	2	3
LGU budget allocation for fisheries and CRM (V6)	4	3
Clear boundaries and jurisdiction for enforcement (V7)	1	3
Illegal fishers supported by third-party influential people or groups (V8)	1	3
Average	2.63	3

Clear boundaries and jurisdiction for enforcement (V7)

According to the Municipal Agriculture Office (MAO), Alicia's proposed municipal water boundary map is still pending approval and has not been officially delineated by the Department of Environment and Natural Resources - National Mapping and Resource Information Authority (DENR-NAMRIA). Pending the official approval, the Alicia Local Government Unit (LGU) has already adopted the proposed boundary for its fisheries management and enforcement activities. The LGU of Alicia has pursued a collaborative approach to coastal governance by entering into a Memorandum of Agreement (MOA) under Sangguniang Bayan Resolution No. 00264, authorizing the municipal mayor to represent the municipality in the ATOM Alliance. This alliance includes the neighboring municipalities of Alicia, Talusan, Olutanga, and Mabuhay and outlines their respective municipal water boundary jurisdictions, and a contribution of ₱200,000.00 for the joint

management of environmental and natural resources within their jurisdictions. The creation of the ATOM Alliance reinforces cooperative enforcement and supports inter- municipal fishing agreements, thereby enhancing the region's capacity to manage its shared marine resources. In light of these coordinated efforts, the score for this indicator is 1 (low), indicating minimal vulnerability to IUU fishing. The data quality is rated as 3 (high), supported by official documentation and records from the LGU and MAO.

Illegal fishers supported by third-party influential people or groups (V8)

Data provided by the enforcement teams show that illegal fishers were not supported by any influential people or groups. External interventions for their release during apprehensions were not recorded and reported within the assessment year. This means there were no official records, reports, or credible testimonies indicating that any individuals intervened to release apprehended illegal fishers or vessels without following due process. As such, this indicator is rated a score of 1 (low), signifying that no unauthorized interference occurred in enforcing fisheries laws. Furthermore, since the information is based on the first-hand experience of the enforcement team and is supported by documented incident reports, the data quality is assessed as high (score 3). This finding reflects the integrity of enforcement operations in Alicia and highlights the absence of political or unauthorized influence in fisheries law enforcement during the period under review.

Average vulnerability and data quality scores

The IUU fishing vulnerability score of each indicator, with its quality data score, is summarized in Table 20. The vulnerability assessment indicates that the municipal waters of Alicia, Zamboanga Sibugay are at a moderate risk to illegal, unreported, and unregulated (IUU) fishing, with an average vulnerability score of 2.63, higher than the national average score of 2.53 (DA-BFAR, 2021). The average score for data quality for this assessment is 3, denoting a high reliability.

Conclusion

The vulnerability assessment reveals that the municipal waters of Alicia, Zamboanga Sibugay, indicates a moderate risk of Illegal, Unreported, and Unregulated (IUU) fishing with a rating of 2.63, higher than the national average of 2.53. IUU fishing is still occurring in the coastal waters Alicia due to the top vulnerability factors which include having rich fishing grounds in the municipality with high ecological potential that draw in legal and illegal fishers, increasing prices of illegally caught stocks, and having a very inadequate budget for coastal resource management and fisheries. Yet, these are alleviated by low vulnerability factors such as well-defined jurisdictional borders, a combined enforcement pact with neighboring municipalities, the absence of influential groups supporting illegal fishers. With a score of 3, representing high data quality, the survey offers a firm basis for fruitful decision-making towards solving IUU fishing in the region.

Recommendations

This study strongly recommends enhancing habitat protection measures, increasing funding allocation for effective law enforcement, capacity-building activities for Bantay Dagat and other enforcement units, and long-term livelihood programs for fishermen, improving the monitoring and documentation of fish capture reporting to enable accurate data collection and effective management of commercially significant species. In addition, active community participation in fisheries management and marine conservation should be promoted to foster local stewardship and raise awareness about sustainable fishing practices. Lastly, it is recommended to institutionalize regular vulnerability assessments to track evolving IUU fishing dynamics and evaluate the effectiveness of management strategies over time.

Acknowledgements

The first author wants to extend her heartfelt thanks to all the persons and institutions involved in making this study successful. I sincerely thank the Mindanao State University-Iligan Institute of Technology Department of Environmental Science for their academic inputs. We appreciate Hon. Alvie Musa, Mayor of Alicia, and

municipal officials' assistance and cooperation during the data-gathering process. We acknowledged the assistance of the Municipal Agriculture Office, Bantay Dagat, PNP-Maritime, and the fisherfolk community, whose inputs strengthened this study. The first author appreciates the support of the Department of Science and Technology - Accelerated Science and Technology Human Resource Development Program for its financial support.

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