ORIGINAL RESEARCH

Catch trends of small-scale fishers near marine protected areas in southeastern Philippines

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ABSTRACT. Fishers are highly dependent on marine resources regarding food and income, which can lead to resource over-exploitation. Coral bleaching, climate change impacts, overfishing, marine pollution, and illegal fishing all pose threats to marine ecosystems, calling for conservation initiatives like the establishment of marine protected areas (MPAs). This study focused on the catch trends of small-scale fishers located nearby to MPAs in Mati, Mabini, San Isidro, and Lupon, southeastern Philippines. It describes the catch trends and fishing effort (CPUE) in the locally managed MPAs in Davao region and some of its implications. Data collection was conducted through actual landed catch surveys based on participatory catch assessment. The fishing gears represented in the study sites included fish traps, spear guns, longline, troll line, hook and line, multiple handlines, and gill net. The catch frequency from the different study sites was quantified (Mati = 2.1-4.0 kg trip^{-1}, Lupon = 10.1-20.0 kg trip^{-1}, San Isidro = 2.1-4.0 kg trip^{-1}, Mabini = 0.1-2.0 kg trip^{-1}) and showed declining trends. Such circumstances call for strict enforcement of the no-fishing zones within the established MPAs to generate greater yields in the long-term and benefits for the local communities. Moreover, there is a need for accurate record-keeping using databases for all the MPAs because documenting MPA recovery relies on credible data sources. Well-protected MPAs have shown abundant fisheries yield and healthy marine ecosystems that foster eco-tourism and enhance awareness on marine conservation. Ecotourism activities within the MPAs may help balance out the spatial and economic displacement of fishers that previously fish in the MPAs sites.

Key words: Fishing gears, fisheries management, marine protected area, monsoon, reef fish.

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Tendencias en la captura de pescadores artesanales cerca de áreas marinas protegidas en el sureste de Filipinas

RESUMEN. Los pescadores dependen en gran medida de los recursos marinos para su alimentación e ingresos, lo que puede llevar a la sobreexplotación de los recursos. El blanqueamiento de corales, los impactos del cambio climático, la sobrepesca, la contaminación marina y la pesca ilegal representan amenazas para los ecosistemas marinos, lo que exige iniciativas de conservación como el establecimiento de áreas marinas protegidas (AMPs). Este estudio se centró en las tendencias de captura de los pescadores artesanales ubicados cerca de las AMPs en Mati, Mabini, San Isidro y Lupon, sureste de Filipinas. Describe las tendencias de captura y el esfuerzo pesquero (CPUE) en las AMPs gestionadas localmente en la región de Davao y algunas de sus implicaciones. La recopilación de datos se realizó a través de censos de captura efectivamente desembarcada, basados en la evaluación participativa de capturas. Las artes de pesca representadas en los sitios de estudio incluyeron nasas, fusiles submarinos, palangre, línea de cacea, línea y anzuelo, líneas de mano múltiples y redes de enmalle. Se cuantificó la frecuencia de captura de los diferentes sitios de estudio (Mati = 2,1-4,0 kg viaje^{-1}, Lupon = 10,1-

20,0 kg viaje^{-1}, San Isidro = 2,1-4,0 kg viaje^{-1}, Mabini = 0,1-2,0 kg viaje^{-1}) y mostró tendencias decrecientes. Tales circunstancias exigen una aplicación estricta de las zonas de veda dentro de las AMPs establecidas para generar mayores rendimientos a largo plazo y beneficios para las comunidades locales. Además, existe la necesidad de un mantenimiento de registros precisos utilizando bases de datos para todas las AMPs, ya que la documentación de la recuperación de las AMPs se basa en fuentes de datos creíbles. Las AMPs bien protegidas han mostrado un rendimiento pesquero abundante y ecosistemas marinos saludables que fomentan el ecoturismo y mejoran la conciencia sobre la conservación marina. Las actividades de ecoturismo dentro de las AMPs pueden ayudar a equilibrar el desplazamiento espacial y económico de los pescadores que anteriormente pescaban en los sitios de las AMP.

Palabras clave: Artes de pesca, manejo de pesquerías, área marina protegida, monzón, peces de arrecife.

INTRODUCTION

Fishers are highly dependent on marine resources for food and income, leading to resource over-exploitation (Bell et al. 2009; Nañola et al. 2011). The coral triangle area in the Philippines, one of the most biodiverse marine regions, hosts over 600 species of corals and 2,000 species of reef fish, supporting the livelihood of more than 120 million people (Read 2014; Muallil et al. 2019, 2020). In this area, about 1.6 million fishers are currently employed in various fishing operations and hold fisheries related jobs in the local markets (Macusi et al. 2020). Unfortunately, marine ecosystems that support these jobs in the fisheries industry are in danger due to contemporary issues such as overfishing, conflicts between commercial and local fisheries, coral bleaching, and marine pollution (Pomeroy and Andrew 2011; Muallil et al. 2015; Abreo et al. 2016; Licuanan et al. 2019; Macusi et al. 2022). Previous assessments of marine fish stocks, both in the commercial and the local fisheries sectors in the Philippines have shown a decline in the current state of marine fisheries resources (Anticamara and Go 2016; Macusi et al. 2022). Both sectors show signs of overfishing and a lack of sustainable management due to governance crisis (Aliño et al. 2004; Nañola et al. 2011; Macusi et al. 2017; Muallil et al. 2019).

To prevent further deterioration of the fisheries, establishing marine protected areas (MPAs) has been the policy of the Department of Environment and Natural Resources (DENR), in collaboration with local communities as well as the Bureau of the Fisheries and Aquatic Resources (BFAR), and nongovernmental organizations (NGOs) to protect and preserve marine ecosystems from destruction and overexploitation (Galveia and Macusi 2025). The establishment of MPAs has been implemented since the 1970s in the Philippines, and was initially designed to safeguard biodiversity and critical habitats for their broader role in coastal communities (Alcala and Russ 2006). Protecting critical marine areas can enhance the resilience of ecosystems and allow them to absorb disturbances and continue to provide vital ecosystem services such as production, coastal protection and carbon sequestration (Tan et al. 2018; Añasco et al. 2021). This has been a crucial tool for the conservation of marine ecosystem and fisheries in the Philippines towards securing livelihoods (Pickens et al. 2021). Currently, 90% of the MPAs in the Philippines are considered partially protected, although more attention is needed to assess their effectiveness in protecting the marine environment (Bobiles and Nakamura 2019; Muallil et al. 2019; Galvea and Macusi 2025). However, MPAs alone may not be sufficient to completely halt the decline of fish stocks and address marine habitat degradation (Russ 2002; Arceo et al. 2008). There is a need for concerted efforts to establish and protect a marine habitat from exploitation and restore it through implementation of closures of fishing grounds (Ambal et al. 2012; Rola et al. 2018; Macusi et al. 2021a). These strategies are considered ecosystem-based fisheries management tools that will protect an exposed habitat and species, giving them time to recover (Barboza et al. 2024).

An indicator that is often used and measured for the success of a protected area is the restoration of fish abundance found within the protected area and its adjacent areas (Abesamis et al. 2006a; Higgins et al. 2008). The perception of fish abundance is critical for protected MPAs because fishers often nitice differences between the catch found in their regular fishing grounds and those nearby protected areas (Galveia and Macusi 2025). Fishers associate increased fish abundance with higher catch biomass. Therefore, by measuring fish abundance using catch per unit effort (CPUE), defined as a statistical method to quantify the number of fish caught per unit effort (Harley et al. 2001; Appelman 2015), it can be used as an indicator for the abundance of fish stocks in the area (Zimmerman and Palo 2011). Any increase of CPUE in the area can then indicate an increase of fish stocks in the marine habitat (Burgess and Johns 1999). Moreover, catch rate is sometimes used as an indicator of abundance in the area and any change in the size and the species composition of the catch may indicate the impact of fishing over time (Jennings 2000; Mamauag et al. 2013). The rapid and reliable data gathering on fish captures e.g. CPUE data, and the spatial distribution of fishing activities (location) is vital for fish stock assessments and fisheries management (Meeanan et al. 2023). In previous studies on MPAs that were conducted in Luzon and Central Visayas (Abesamis et al. 2006a; Pomeroy et al. 2010; Horigue et al. 2014), only a handful have been conducted in Mindanao (Nañola et al. 2013; Nanual 2014; Galveia and Macusi 2025). This study aimed to provide additional baseline data to characterize the fisheries communities located near established MPAs in the Davao region and their CPUE.

MATERIALS AND METHODS

Description of the study area

This study was conducted in the Davao region at San Isidro, Lupon, Mabini, and the Mati (Figure 1). These coastal municipalities host rich fishing grounds sustaining their communities. The Davao region is home to 47,000 fishers, most of whom fish in the gulf, which covers an area of 3,087 km^2 (Macusi et al. 2023). The weather and climate in the Davao region are evenly distributed throughout the year, with common disturbances including heavy rains, flooding, and sometimes typhoons that pass the area or affect the Davao Gulf (Macusi et al. 2021b). Estimates show that the Davao Gulf is fished by 13,930 municipal boats and 289 commercial fishing boats (Armada 2002). In the Philippines, any fishing boat weighing over 3 t and operating for commercial purposes is classified as a commercial fishing vessel. These commercial fishing boats operating in the Davao Gulf include ringnets and bagnets.

Tagaliling Marine Protected Area

Tagaliling Marine Protected Area (TMPA), also known as Tamisan MPA, is located off the city of Mati, Davao Oriental, which has a population of more than 147,500 (PhilAtlas 2023). Established in 2011, the TMPA covers a total area of 28.79 ha, encompassing coral reefs, mangroves, and seagrass beds. According to the Bureau of Fisheries and Aquatic Resources (BFAR), this marine protected area had 203 fishers in 2015. Data were collected in the fishing villages of Dahican, Tamisan, and Lawigan.

Mabini Protected Landscape and Seascape

Mabini Protected Landscape and Seascape (MPLS) is located in the Municipality of Mabini, Davao de Oro, which has a population of 43,552 inhabitants (PhilAtlas 2023), and lies within the Davao Gulf, home to 1,103 fishers (BFAR). Established in 2000, the MPLS spans over six villages and encompasses three types of aquatic habitats: coral reefs (201 ha), mangroves (100 ha), and seagrass beds (62 ha). Data were collected from

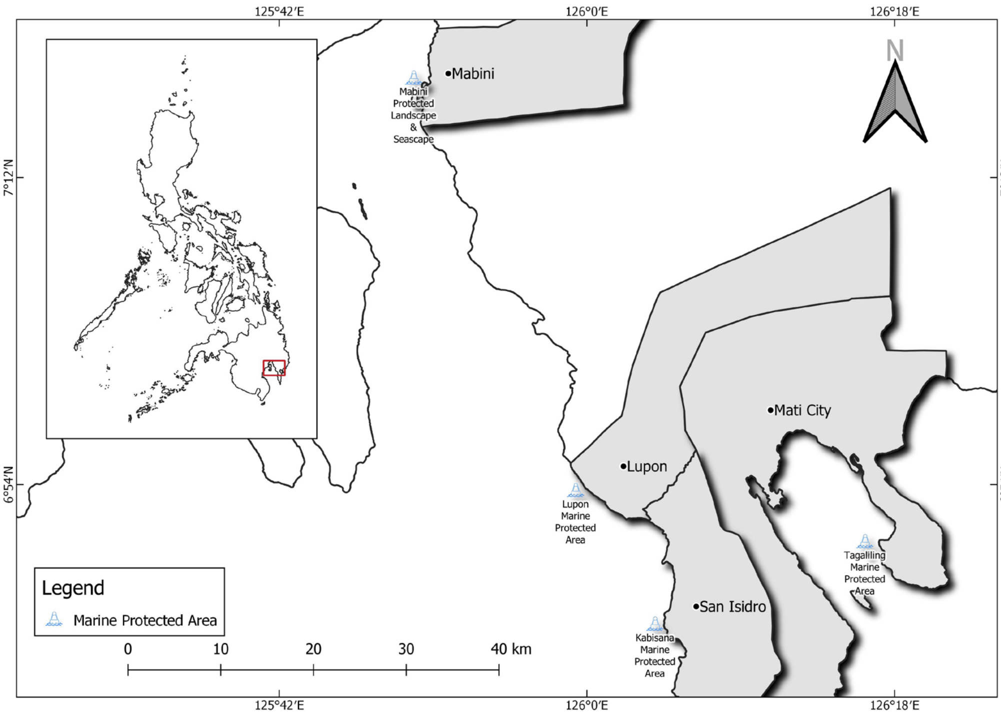

Figure 1. Locations of marine protected areas (blue tagged) in the study site are shown together with the name of the municipality (shaded in grey) in southeastern Philippines.

the fishing villages of Pindasan, Cadunan, and Cuambog.

Kabisanan Marine Protected Area

Kabisanan Marine Protected Area (KMPA) is located in the Municipality of San Isidro, Province of Davao Oriental, which has 33,664 inhabitants (PhilAtlas 2023) and covers a total area of 27,542 ha. Established in 2012 as a 'fish sanctuary' and no-take zone, it has 607 fishers in the study area. Data were collected in the fishing villages of Batobato, Manikling, and Baon.

Lupon Marine Protected Area

Lupon Marine Protected Area (LMPA) is located in the municipality of Lupon, Province of Davao Oriental, which has 66,979 inhabitants (PhilAtlas 2023). Established in 2008, the LMPA covers a total area of 980 ha. In 2019, the LMPA had 511 registered fishers. The protected habitats include coral reefs and seagrass beds. Data for the LMPA were collected from the fishing villages of Poblacion, Ilangay, and Bagumbayan.

Participatory catch assessment

The CPUE data was derived from the catch assessment of fishers conducted at each study site from February to May 2019. Approximately 32 fishers from each municipality participated in the catch assessment (or approximately 120 voluntary fisher for four months). The enrolled fishers identified and provided local names of the fish caught. Additional information collected from the landed catch included the general location of the fishery, time of departure and arrival, weather conditions during the trip, trip dates, and a sample of the catch to determine weight (kg), number and size by fish species.

Data analysis

The CPUE was estimated by dividing the fish catch by the number of fishing hours (Jennings et al. 2001), representing the biomass of the fish catch within the area, as C/E = qN, where C is the catch, E is the fishing effort, and N is the abundance. It is typically used as an index of abundance change over time, assuming that catchability q is constant. All collected fish catch data were standardized and processed using Minitab version 17 (State College, Pennsylvania, USA). The fish catch and the CPUE from different study sites were compared using one-way ANOVA. Additionally, a multiple linear regression analysis was performed to examine the linear relationships between CPUE and various factors potentially influencing the catch. Probability and the quantile plots of the CPUE were checked for deviations from normal distribution and homogeneity.

RESULTS

Fish catch composition

The following 11 fish species were present in all the study sites: Ambon emperor (*Lethrinus amboinensis*), lunar tail snapper (*Lutjanus fuscescens*), mackerel (*Rastrelliger faughni*), grouper (*Epinephelus guttatus*), giant trevally (*Caranx tille),* red snapper (*L. malabaricus),* goatfish (*Terapon theraps*), daggertooth (*Muraenesox cinereus*), rabbithfish (*Siganus canaliculatus*), ornate thread bream (*Nemipterus hexodon*), and bigeye scad (*Selar crumenopthalmus*) (Table 1). Nine other fish species were only present in three sites (Table 1). In total, 20 species were caught in Lupon and Mabini, 16 species in San Isidro, and 15 species in Mati. These fish species were captured using various fishing gears e.g. spearfishing, gillnet, fish trap, fish corral, hook and line, troll line, longline, and multiple handlines. Generally, small-scale fishers tend to catch most of these fish species in the study sites utilizing various fishing gears. The design and methods applied to utilize these fishing gears are described in greater detail by Balisco et al. (2019).

Catch frequency

Total catch in all the study sites, ranged from 0.1 to 2.0 kg trip^{-1} (Figure 2). The highest total catch was from Mati (Figure 2 A), which ranged from 2.1 to 4.0 kg trip^{-1} (25% of fishers), followed by 4.1 to 6.0 kg trip^{-1} (23%) and 6.1 to 8.0 kg trip^{-1} (15%). In Lupon, fishers typically catch between 10.1 to 20.0 kg trip^{-1} (Figure 2 B), followed by 2.1 to 4.0 kg trip^{-1} (25% of Lupon fishers), with the least frequent catch range (4%) being 40.1 to 50.0 kg trip^{-1}. The catch range of Lupon fishers from 10.1 to 20.0 kg trip^{-1}was higher compared to those from Mati or other sites. For San Isidro (Figure 2 C), the most frequent catch range (51%) was 2.1 to 4.0 kg trip^{-1}, which, though low, was viable. In Mabini (Figure 2 D), the most frequent catch range (39%) was from 0.1 to 2.0 kg trip^{-1}, followed by a catch range of 2.1 to 4.0 kg trip^{-1} (39%), and 10.1 to 20.0 kg trip^{-1} (0.8%).

CPUE by fishing gear

The most frequent CPUE for fish traps (62%) was 0.5 kg trip^{-1} (Figure 3 A). The most frequent CPUE for fish corrals (42%) was less than 0.5 kg trip^{-1} (Figure 3 B), while a few fishers (1%) catch 3.6 kg trip^{-1}. Moreover, the most frequent CPUE with hook and line (62%) was less than 0.5 kg trip^{-1}, while only a few fishers (1%) catch between 3.6 and 4.0 kg trip^{-1} (Figure 3 C). For gillnet (Figure 3 D), the most frequent CPUE (46%) was also 0.5 kg trip^{-1}, followed by 37% between 0.6-1.0 kg trip^{-1}, and only 1% with 2.6 to 3.0 kg trip^{-1}.

For troll line, 38% of fishers had a CPUE of 0.5 kg trip^{-1}, followed by 31% with a CPUE of 0.6 kg trip^{-1} (Figure 4 A). Lastly, a few fishers (3%) had a CPUE of around 3.6-4.0 kg trip^{-1}. For

Table 1. Species commonly caught using various fishing gear in Mati, Lupon, San Isidro, and Mabini in southeastern Philippines. Presence (+) or absence (-) of species in the site.

Name	Scientific name	Mati	Lupon	San Isidro	Mabini
Ambon emperor	*Lethrinus amboinensis*	+	+	+	+
Lunar tail snapper	*Lutjanus fuscescens*	+	+	+	+
Island mackerel	*Rastrelliger faughni*	+	+	+	+
Red hind grouper	*Epinephelus guttatu*s	+	+	+	+
Giant trevally	*Caranx tille*	+	+	+	+
Red snappers	*Lutjanus malabaricus*	+	+	+	+
Goatfish	*Terapon theraps*	+	+	+	+
Daggertooth pike conger	*Muraenesox cinereus*	+	+	+	+
Rabbit fish	*Siganus canaliculatus*	+	+	+	+
Sleek unicornfish	*Amanses scopas*	-	+	+	+
Blackbar soldierfish	*Myripristis jacobus*	+	+	-	+
Moontail bullseye	*Priacanthus hamrur*	-	+	+	+
Blue swimming crab	*Portunus pelagicus*	-	+	+	+
Golden threadfin bream	*Nemipterus virgatus*	-	+	+	+
Ornate threadfin bream	*Nemipterus hexodon*	+	+	+	+
Bigeye scad	*Selar crumenophthalmus*	+	+	+	+
Great barracuda	*Sphyraena barracuda*	+	+	-	+
Scarlet snapper	*Etelis carbunculus*	+	+	-	+
Rainbow runner	*Elagatis bipinnulata*	-	+	+	+
Giant trevally	*Caranx ignobilis*	+	+	-	+
Total		15	20	16	20

fishers using longline (Figure 4 B), about 51% had a CPUE of less than 0.5 kg trip^{-1}, followed by 32% with a CPUE of 0.6-1.0 kg trip^{-1}, and 7% with a CPUE of 1.1 to 1.5 kg trip^{-1}. Regarding the CPUE of spearfishing, the most frequent (57%) was 0.5 kg trip^{-1} (Table 2), followed by 25% with a CPUE of 0.6-1 kg trip^{-1}, and 1% with CPUE of 3.6 to 4.0 kg trip^{-1} (Figure 4 C). Most fishers (35%) using multiple hooks (handline) had a CPUE of 0.5 kg trip^{-1} (Figure 4 D; Table 2). Another 30% had a CPUE of 0.6-1.0 kg trip^{-1}. Then 16% had a CPUE of 1.1-1.5 kg trip^{-1}, followed by about 3% with a CPUE of 2.1-2.5 kg trip^{-1} and 3.6-4.0 kg trip^{-1}, while the least number of fishers (1%) had a CPUE of 3.1 to 3.5 kg trip^{-1}.

There were highly significant differences in the CPUE of different fishing across all study sites (df = 7, MS = 2.94, F = 14.49, P < 0.001). The post-hoc analysis showed differences in CPUE of the various fishing gears: the CPUE of fish corral (1.11 kg trip^{-1}) was equal to that of multiple handline (0.97 kg trip^{-1}) and longline (1.011 kg trip^{-1}), and greater than those of gillnet (0.80 kg trip^{-1}), troll line (0.74 kg trip^{-1}), fish trap (0.66 kg trip^{-1}), spearfishing (0.64 kg trip^{-1}) and hook and line (0.58 kg trip^{-1}). Additionally, the result of the one-way ANOVA for the pooled data of catches from Lupon, Mabini, Mati, and San Isidro also showed highly significant differences (df = 3, MS = 21.41, F = 116.52, P < 0.001). The post-hoc analysis

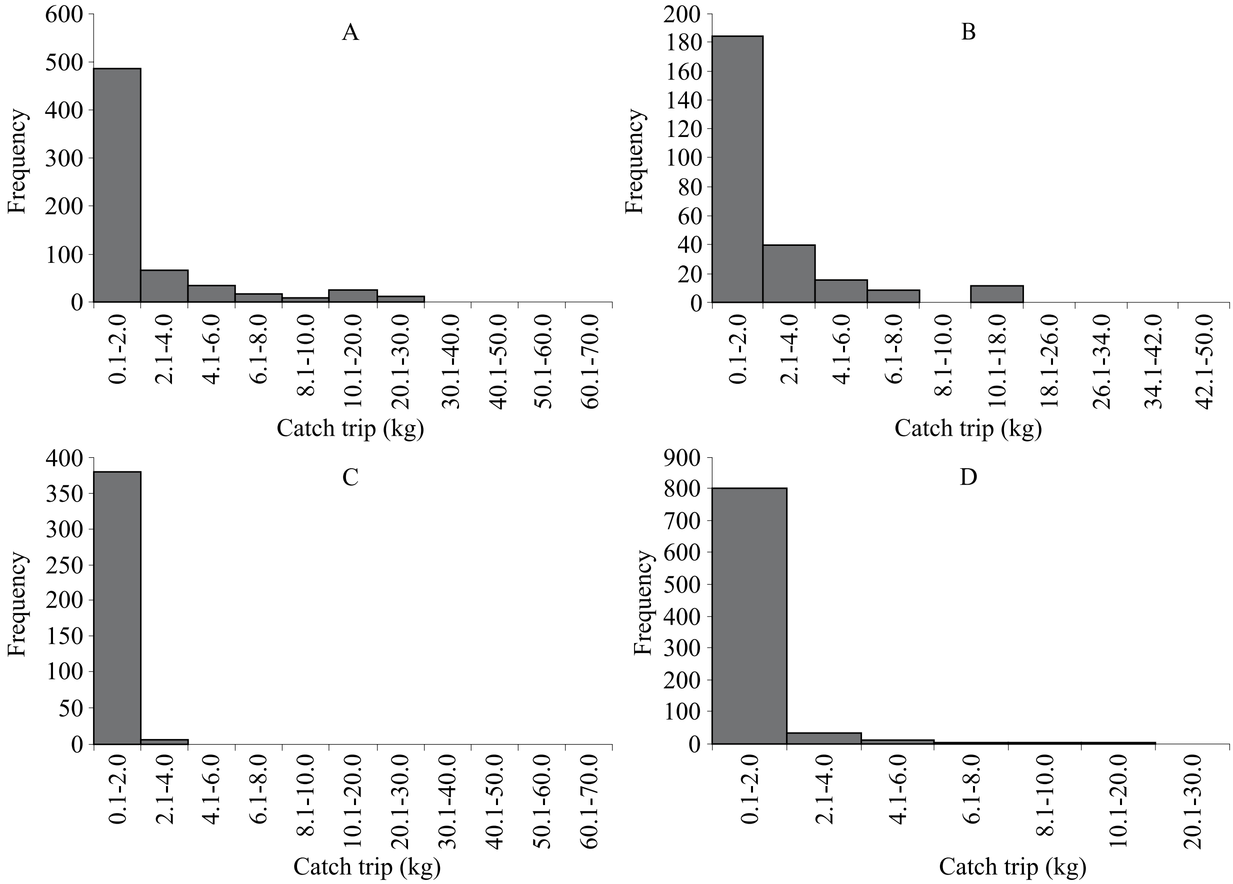

Figure 2. Frequency of total catch per fishing trip in different sites: Mati (A), Lupon (B), San Isidro (C), and Mabini (D) in southeastern Philippines.

indicated that fishers from Mati had the highest catch rate (12.36 kg trip^{-1}) among all the study sites, followed by Lupon (8.72 kg trip^{-1}), San Isidro (8.37 kg trip^{-1}) and then Mabini (4.93 kg trip^{-1}), although catch rates between Lupon and San Isidro were not significantly different from each other.

DISCUSSION

Catch trends of fishers living close to the MPAs

Trends in the CPUE of the small-scale fishers based on their fishing gears in Mati, Lupon, San Isidro, and Mabini exhibited a decreasing trend. Reduced and declining catches (0.1-2.0 kg trip^{-1}) were frequently observed across all study sites and fishing gears (0.5 kg trip^{-1}suggesting that target species were overexploited. Our findings regarding the CPUE using various fishing gears were consistent with previous publications which also assessed MPAs in the Davao Oriental area (Nanual 2014; Rapiz 2014) and Davao Gulf (Nañola et al. 2013; Macusi et al. 2021a, 2021b). These decreasing trends in CPUE were exacerbated by extreme weather disturbances, climate change impacts, illegal fishing practices such as compressor and poison fishing, and marine pollution (Abreo et al. 2016; Macusi et al. 2020, 2023, 2025). These

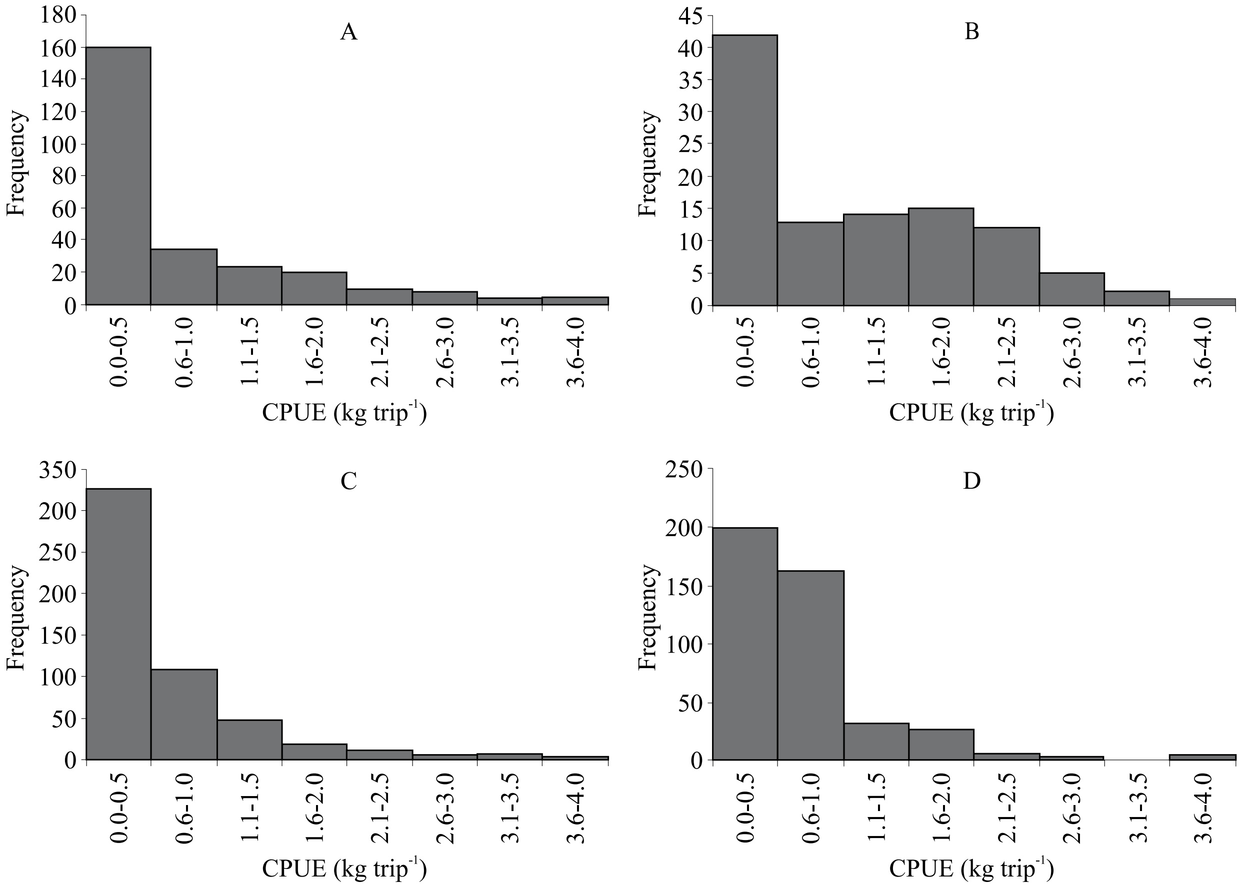

Figure 3. Plot of catch frequency and catch per unit effort (CPUE) of various fishing gears in the study sites in southeastern Philippines: fish trap (A), fish corral (B), hook and line (C), and gillnet (D).

results provide additional evidence supporting the need for stakeholders and financial support in the management of these MPAs. Accurate records of changes and transformations in fish resources abundance within well-protected MPAs are noted for their potential to foster tourism and conservation areas. Conversely, a lack of proper records and monitoring in MPAs can lead to false hopes and misconceptions about the condition of the marine ecosystem (Galveia and Macusi 2025). Unmonitored MPAs, though legitimate, may fail to properly document and record the expected benefits of protection due to insufficient monitoring. On the other hand, properly documented and monitored MPAs with proactive community programs can lead to better conservation partnerships between government agencies, local stakeholders and NGOs (Cabral et al. 2014; Rapiz 2014). Moreover, the collaborative efforts between coastal communities and local governments contribute to a sustainable future, which implies a beneficial impact on local communities (Dangan-Galon et al. 2016).

Fishing gears and well-managed MPAs

Among the local fishers, the use of various fishing gears or multiple fishing gears is an adaptation towards finding more fish to catch and take home (Behivoke et al. 2021; Macusi et al. 2023). For instance, handlines are commonly used by all fishers,

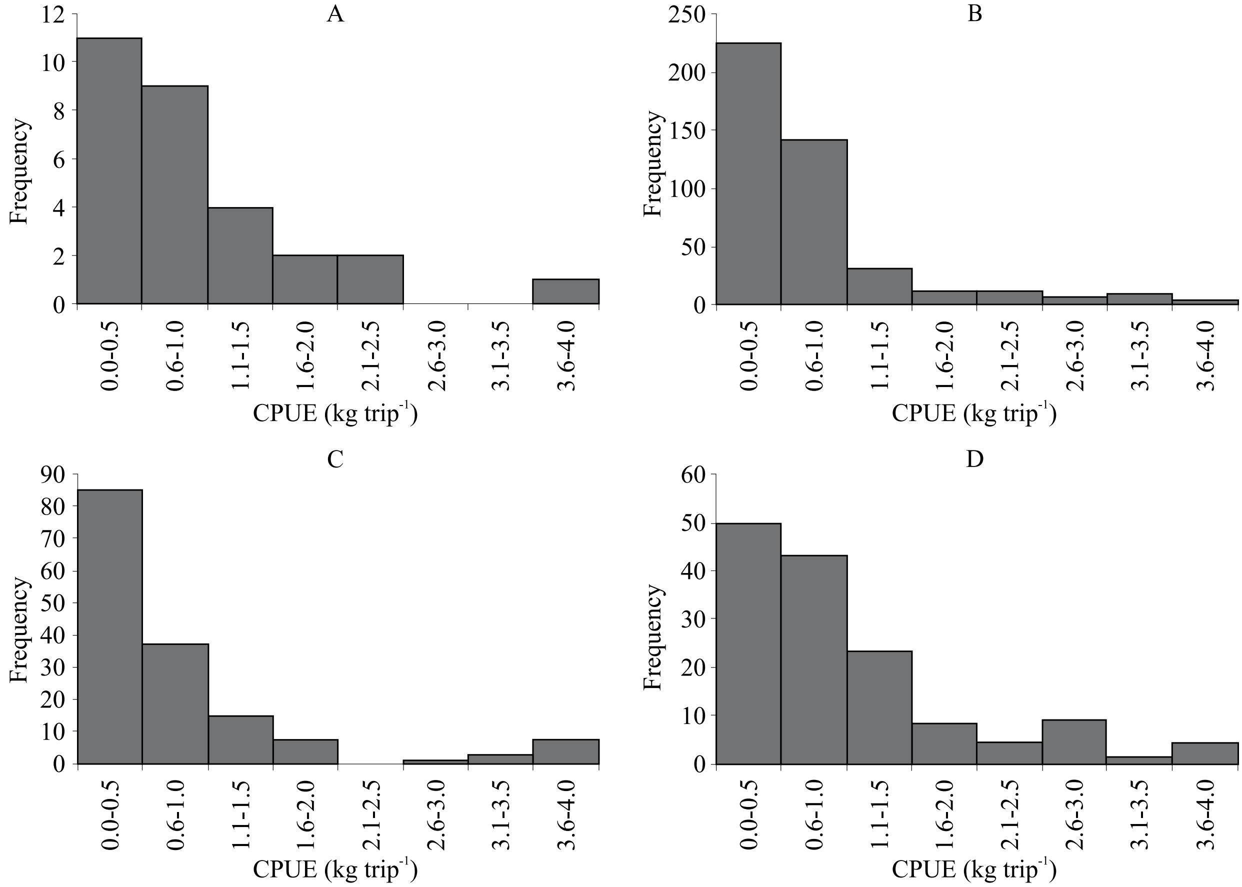

Figure 4. Catch frequency of additional fishing gears: troll lines (A), longline (B), spear fishing (C), and multiple handline (D) in all study sites in southeastern Philippines.

but they can also set traps in coastal areas to catch more fish after leaving the traps overnight or for two days (Obar et al. 2020). The combined use of fishing gears enables the local fishers to increase their catch, preventing them from returning home empty-handed (Macusi et al. 2017; Behivoke et al. 2021). As shown in the study results, more fish are caught using hook and line, gillnet, longline, fish trap and spearfishing. While there are more frequent low catches registered by fishers, there are also bigger catches that they get from time to time, and the use of other fishing gears enables these fishers to obtain a catch without staying for a week in distant areas. Increasing the distance from the shoreline to fish indicates that nearshore fishing grounds are depleted, forcing fishers to venture farther into more pristine areas (Daw 2008). When MPAs are well-managed and protected, local fishers benefit from restored fish stocks and population spillover to other habitats, making fish more accessible (Abesamis et al. 2006a, 2006b; Barboza et al. 2024). In the study sites, MPA protection leads to better fisheries as stocks reproduce and replenish. This protection allows fish to grow and increase in abundance, due to the protection implemented in the area, and most local fishers will benefit from the fish stock recovery (Muallil et al. 2015, 2019). Moreover, when the MPAs are well protected, this can be tapped for sustainable tourism resulting in a better financial provision and well-being of

Table 2. Percentage of catch per unit effort (CPUE) (kg trip^{-1}) ranges by different fishing gear in southeastern Philippines.

CPUE	Spear	Multiple hooks	Long line	Troll line	Gillnet	Hook and line	Fish trap	Fish corral	Average
0.0-0.5	57	35	51	38	46	62	62	40	49
0.6-1.0	25	30	32	31	37	21	13	13	25
1.1-1.5	10	16	7	14	7	9	9	13	11
1.6-2.0	5	6	3	7	6	3	8	14	6
2.1-2.5	0	3	3	7	1	2	3	12	4
2.6-3.0	1	6	1	0	1	1	3	5	2
3.1-3.5	2	1	2	0	0	1	1	2	1
3.6-4.0	1	3	1	3	1	1	2	1	2

communities in the area (Rapiz 2014; Jimenez et al. 2015).

Law enforcement problems

Activities within an MPA may depend on its size, i.e. the larger the MPA, the greater the area available for tourism activities such as diving, strolling and camping. Moreover, the size of an MPA is thought to influence the magnitude of its effect. For example, a larger and well managed MPA can result to more fish stocks, marine life being protected and authorized fishing activities in the mixed-use zone (Muallil et al. 2019, 2020). Diffusion models have shown that MPAs with radii smaller than 2,000 m^2 had significantly lower fish abundances within their boundaries compared to larger-sized MPA (Pérez-Ruzafa et al. 2008). In areas where large-scale commercial fishing has been banned, artisanal or small-scale fishers may be granted limited access to fish in the buffer and mixed-used zones (Barboza et al. 2024). There are also instances when law enforcers apprehend illegal fishers in no-fishing zone areas, but these offenders are released after political negotiation takes place (Galveia and Macusi 2025). Although there are fish wardens who can file cases, violators often return home unscathed and without paying any penalty. Consequently, the least enforced governance aspect in the Philippine's MPAs and small-scale fisheries is the lack of evidence for charging illegal fishers (Macusi et al. 2023; Galveia and Macusi 2025). Many cases are dismissed or settled even before formal charges are filed, leading to a lack of progress in case filings. Absence of legal action by local governments in terms of the penalties imposed on illegal fishers remains a debacle in the MPA governance with negative consequences on fisheries depletion. According to Lester and Halpern (2008) highly protected or restrictive MPAs yield greater benefits for communities.

CONCLUSION

The result of this study has provided additional evidence supporting the need for various stakeholders to continue their support in the management of MPAs in the Davao region. Moreover, the accurate keeping of records using databases is highly recommended for all the MPAs studied because documenting MPA recovery relies on credible data sources. Certainly, well-protected MPAs are noted for their abundance of fisheries and healthy marine ecosystems which can then foster eco-tourism and enhance awareness on marine conservation. The converse is also true, unmonitored MPAs, though legitimate, may fail to properly document and record the expected benefits of protection due to insufficient monitoring. Activities within MPAs may depend on their size, the larger the MPAs, the greater the area available for tourism activities such as diving, strolling and camping. For example, a larger and well managed MPA can result in more fish stocks, marine life protected and authorized fishing activities in the mixed-use zones. The displacement of fishers from their original fishing grounds can be compensated when the MPAs are well-protected, because fish stocks start to recover in the fishing grounds and there is real enforcement conducted by the local government and maritime police. In the end, preserving the MPAs not only by protecting them with legal measures but also by replicating their boundaries with buoy markers and observation houses can bring benefits to the whole community and raise awareness for marine conservation.

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Declaration of competing interest

The authors declare that no competing financial interests or personal relationships could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Author contributions

Reyuof P. Manuel: conceptualization, and conduct; data visualization; writing of first draft. Edison D. Macusi: statistical analysis; supervision; fund acquisition.

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