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# OCTOPUS (*Octopus cyanea)* CATCHING AREA USING HANDLING IN THE BARRANG CADDI ISLAND AREA USING REMOTE SENSING METHOD

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## ABSTRACT

This study aimed to identify potential fishing grounds for the blue octopus *(Octopus cyanea)* around Barrang Caddi Island, Makassar City, by integrating field observations with remote sensing-based oceanographic parameters. A quantitative descriptive survey was employed by accompanying local fishermen during 21 fishing trips using handline *(handline hook)* gear. Geographic coordinates of fishing locations were recorded using a Global Positioning System (GPS), while satellite-derived sea surface temperature (SST), salinity, and chlorophyll-a concentration were obtained from Aqua MODIS and HYCOM datasets. Spatial analysis was performed using Geographic Information Systems (GIS) to delineate potential fishing zones based on the integration of catch distribution and environmental variables. The results revealed that potential fishing grounds were predominantly located in shallow coral reef habitats surrounding Barrang Lompo and Barrang Caddi Islands. Sea surface temperature averaged 29.24°C, salinity reached 30.8 PSU, and chlorophyll-a concentration ranged from 0.6 to 0.8 mg $m^{-3}$, indicating environmentally favorable conditions for Octopus cyanea. Moderate-potential fishing zones occupied the largest spatial extent, whereas high-potential areas were concentrated near structurally complex coral reef ecosystems. These findings demonstrate that remote sensing provides an effective approach for identifying productive octopus fishing grounds and can support sustainable fisheries management, improve fishing efficiency, and provide scientific information for spatial planning and resource conservation in the Spermonde Archipelago.



## INTRODUCTION

Indonesia is recognized as one of the world's largest archipelagic countries, possessing approximately 6.4 million km² of marine waters and one of the richest marine biodiversity resources globally. The fisheries sector plays a strategic role in national economic development through employment generation, food security, and export earnings. According to the Ministry of Marine Affairs and Fisheries, Indonesia's sustainable marine fisheries potential exceeds 12 million tons annually, with cephalopods, particularly octopus, representing one of the most valuable export commodities because of their consistently increasing international demand (Kementerian Kelautan dan Perikanan [KKP], 2023). During the last decade, Indonesian octopus exports have continued to expand toward major international markets, including Japan, China, South Korea, the European Union, and the United States, reflecting the increasing economic importance of sustainable octopus fisheries (Kantun et al., 2023; FAO, 2024).

Among commercially exploited octopus species, *Octopus cyanea* (day octopus) is one of the dominant tropical species distributed throughout the Indo-Pacific region, including

Indonesian coastal waters. This species inhabits shallow coral reefs, rocky substrates, seagrass meadows, and sandy-bottom habitats ranging from the intertidal zone to depths of approximately 40 m (Norman et al., 2019; Rosa et al., 2024). Ecologically, O. cyanea functions as an important benthic predator regulating populations of crustaceans, mollusks, and other invertebrates, thereby contributing significantly to ecosystem stability. Economically, the species commands high market prices because of its desirable flesh quality, high protein content, and increasing consumer demand within both domestic and international seafood markets (Kasim et al., 2021; Kantun et al., 2023).

Octopus also possesses remarkable biological characteristics that distinguish it from many commercially harvested marine organisms. The species exhibits rapid growth, relatively short life spans, and a semelparous reproductive strategy, in which individuals reproduce only once before dying (Boyle & Rodhouse, 2020). Consequently, octopus populations respond rapidly to environmental variability and fishing pressure, making them particularly vulnerable to overexploitation. Environmental factors such as sea surface temperature (SST), salinity, dissolved oxygen, substrate composition, chlorophyll-a concentration, and ocean productivity strongly influence habitat selection, feeding behavior, migration, and reproductive success (Rosa et al., 2024; Sauer et al., 2021). Therefore, understanding habitat suitability and environmental preferences is essential for ensuring sustainable exploitation of octopus resources.

The Barrang Caddi Island waters, located within the Spermonde Archipelago, Makassar City, South Sulawesi, constitute one of Indonesia's important small-scale fishing grounds supporting local coastal livelihoods. Fishing activities in this region remain highly dependent on traditional knowledge, particularly for octopus fisheries using hand line (pancing ulur) gear. Hand lines are classified as highly selective fishing gear because they primarily target individual octopus occupying rocky or coral habitats while producing minimal bycatch and causing limited habitat disturbance compared with trawl nets or other active fishing gears (Norman et al., 2019; FAO, 2022). Consequently, hand-line fisheries are increasingly recognized as environmentally responsible fishing practices consistent with ecosystem-based fisheries management principles.

Despite its sustainability advantages, octopus fishing in Barrang Caddi remains constrained by limited scientific information regarding spatial fishing grounds and environmental habitat suitability. Local fishers generally determine fishing locations based on accumulated experience rather than systematic environmental observations. Such dependence on traditional ecological knowledge may reduce fishing efficiency under increasingly variable oceanographic conditions driven by climate variability and anthropogenic pressures. Furthermore, the absence of spatial information regarding productive fishing grounds complicates fisheries management and conservation planning, particularly considering growing export demand and sustainability certification requirements such as those established by the Marine Stewardship Council (MSC) (Kantun et al., 2023).

Recent advances in satellite remote sensing have substantially improved fisheries resource assessment by providing continuous, large-scale observations of marine environmental conditions. Remote sensing enables researchers to quantify essential oceanographic variables, including sea surface temperature, chlorophyll-a concentration, ocean color, turbidity, and salinity, thereby facilitating the identification of productive fishing habitats (Forget et al., 2009; IOCCG, 2020). Satellite-derived oceanographic information has become increasingly valuable because it allows fisheries scientists to monitor dynamic marine ecosystems over extensive spatial and temporal scales that would be difficult to achieve through conventional field surveys alone (Mouw et al., 2017; Hu et al., 2021).

Among remotely sensed environmental variables, sea surface temperature and chlorophyll-a concentration are consistently identified as major predictors of marine species distribution. Sea surface temperature regulates metabolic processes, feeding activity, and habitat preference, whereas chlorophyll-a serves as a proxy for primary productivity that indirectly determines prey availability within marine food webs (Hu et al., 2021; Behrenfeld et al., 2021). Salinity also influences osmoregulatory processes and habitat suitability for benthic cephalopods, particularly in shallow coastal ecosystems where freshwater inputs fluctuate seasonally (Rosa et al., 2024). Integrating these environmental parameters with fisheries catch data has been widely adopted to develop habitat suitability models and identify potential fishing zones for economically important marine species.

Several recent studies have demonstrated the effectiveness of combining remote sensing and Geographic Information Systems (GIS) for fisheries management. Hu et al. (2021) successfully integrated satellite-derived SST and chlorophyll-a data to predict productive fishing grounds for pelagic fisheries, whereas Santos et al. (2023) reported that environmental suitability mapping significantly improved fishing efficiency while reducing unnecessary fishing effort. Similar approaches have been increasingly recommended for small-scale fisheries because they provide decision-support tools that enhance economic productivity without compromising marine ecosystem sustainability (FAO, 2022; Mouw et al., 2017).

Although remote sensing applications have become common for pelagic fisheries, studies focusing on benthic cephalopods, particularly Octopus cyanea, remain relatively limited in Indonesia. Likewise, spatial analyses integrating catch locations, hand-line fishing activities, and satellite-derived oceanographic variables have not yet been comprehensively conducted within the Barrang Caddi Island waters. This knowledge gap limits the development of science-based fisheries management strategies capable of balancing resource utilization and conservation.

Therefore, this study aims to (1) describe the spatial distribution and characteristics of Octopus cyanea fishing grounds using hand-line fishing gear around Barrang Caddi Island, (2) analyze oceanographic conditions, including sea surface temperature, salinity, and chlorophyll-a concentration using satellite remote sensing, and (3) identify the most suitable octopus fishing zones by integrating fisheries catch data with remotely sensed environmental variables through spatial analysis. The findings are expected to provide scientific evidence supporting sustainable octopus fisheries management while improving fishing efficiency and contributing to marine resource conservation in the Spermonde Archipelago.

## METHOD

This study employed a quantitative descriptive survey design to identify and map the spatial distribution of *Octopus cyanea* fishing grounds around Barrang Caddi Island, Makassar City, Indonesia. A non-experimental approach was adopted because the study aimed to describe existing fishing-ground characteristics without manipulating environmental conditions or fishing activities (Creswell & Creswell, 2018). Field observations were conducted between November 2025 and January 2026 by accompanying local fishers during ten commercial fishing trips using hand-line (*pancing ulur*) gear. Fishing locations were selected through purposive sampling, involving experienced fishers who routinely targeted *O. cyanea* and possessed extensive knowledge of productive fishing grounds (Etikan et al., 2016; Palinkas et al., 2015). Primary data consisted of Global Positioning System (GPS) coordinates recorded at every successful fishing location, while complementary information regarding fishing time, fishing depth, bait type, fishing gear characteristics, vessel specifications, and operational practices was collected through structured interviews and direct observations. The underlying assumption of the study was that experienced fishers accurately recognize productive octopus habitats and that GPS measurements provide reliable spatial information for mapping fishing grounds (Longley et al., 2021).

Spatial data processing and analysis were performed using Geographic Information System (GIS) software to visualize the distribution pattern of octopus fishing grounds and identify areas with high fishing intensity. GPS coordinates were imported into the GIS environment, georeferenced using the World Geodetic System 1984 (WGS 84), and overlaid

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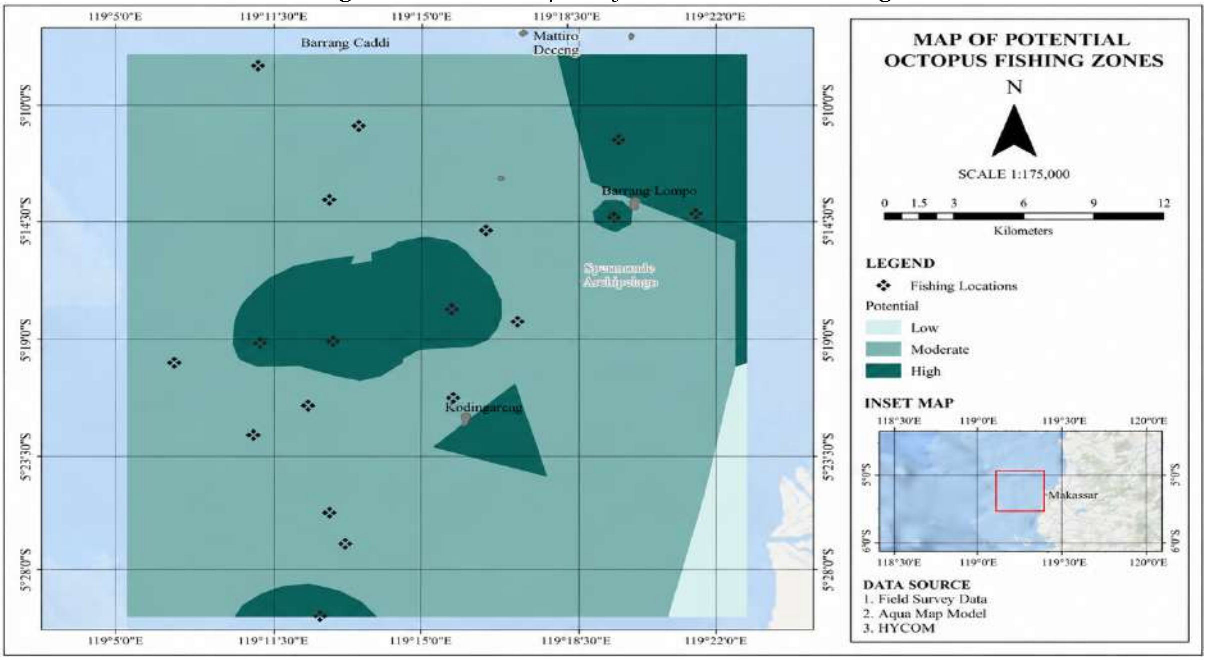
onto the coastal map of Barrang Caddi Island to generate a spatial distribution map (Burrough et al., 2015). Descriptive statistical analysis was subsequently applied to summarize fishing frequency, temporal fishing patterns, and operational characteristics collected through interviews (Field, 2018). Spatial clustering of fishing locations was interpreted to identify potential octopus fishing zones and describe habitat utilization patterns by local fishers. The integration of field-based GPS observations with descriptive spatial analysis provides a practical approach for characterizing traditional octopus fishing grounds and generating baseline information that can support sustainable fisheries management and future integration with remotely sensed oceanographic variables (FAO, 2022; Mouw et al., 2017; Santos et al., 2023).

## RESULT AND DISCUSSION

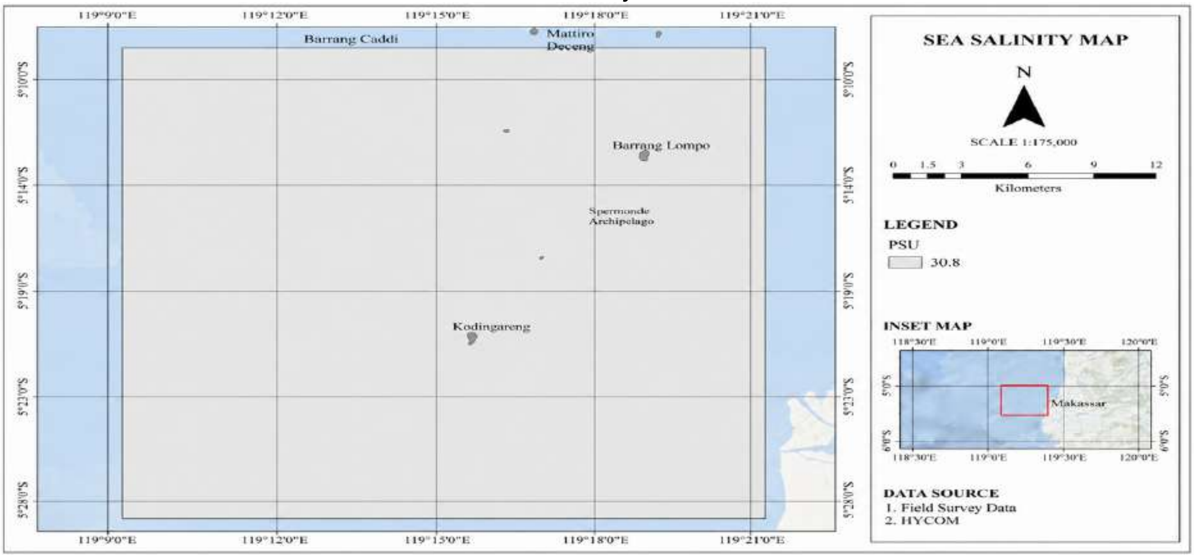
The spatial distribution of *Octopus cyanea* fishing grounds around Barrang Caddi Island demonstrates considerable variation in habitat suitability based on remotely sensed oceanographic parameters and field observations. As illustrated in Figure 1, moderate-potential fishing grounds dominate the study area, indicating that most coastal waters provide suitable environmental conditions for octopus occurrence. High-potential zones are primarily concentrated around shallow coral reef habitats near Barrang Lompo Island, whereas low-potential areas are generally located in deeper offshore waters characterized by relatively simple substrates. This distribution reflects the ecological preference of *O. cyanea* for structurally complex habitats that provide shelter, feeding opportunities, and spawning sites (Estévez et al., 2024; Raberinary & Andrisoa, 2024). The observed pattern also supports the seascape ecology concept, whereby habitat configuration strongly determines the spatial distribution of benthic organisms (Moll et al., 2023).

**Figure 1.**
Potential Fishing Zones for *Octopus cyanea* around Barrang Caddi Island



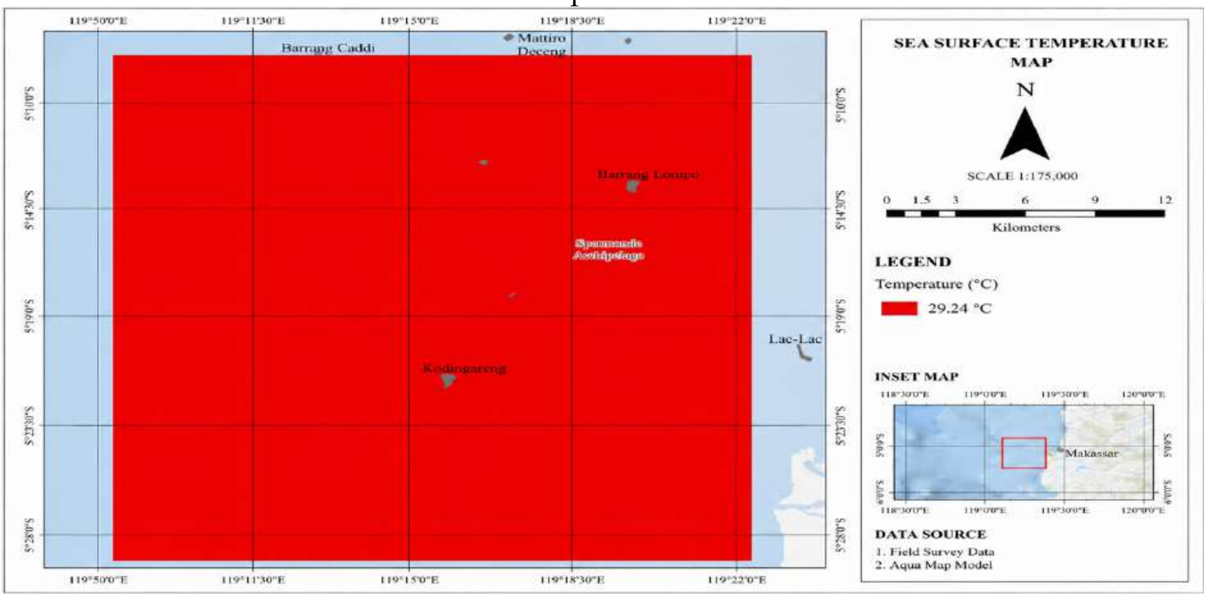

The salinity distribution presented in Figure 2 shows an average value of approximately 30.8 PSU, indicating relatively stable oceanic conditions with minimal freshwater influence. This value falls within the normal salinity range of tropical marine ecosystems and is considered favorable for marine organisms, including benthic cephalopods (Talley et al., 2020). Stable salinity supports physiological adaptation, osmoregulation, and ecosystem productivity, thereby contributing to suitable octopus habitats (Levin et al., 2021). The relatively homogeneous salinity pattern further suggests that the waters surrounding Barrang Caddi are primarily controlled by regional ocean circulation rather than terrestrial freshwater inputs.

**Figure 2.**
Sea Surface Salinity Distribution



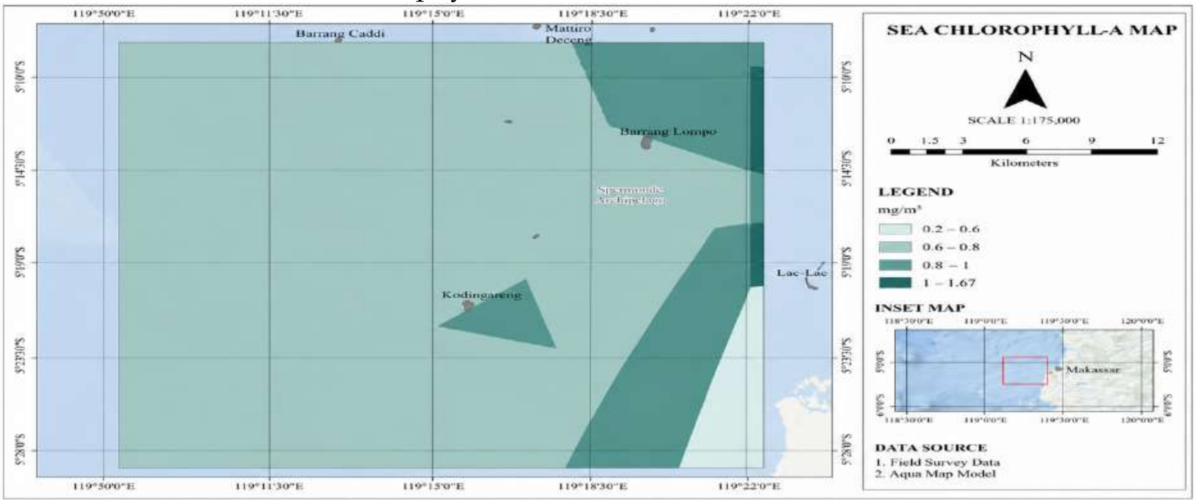

Sea surface temperature (SST) averaged 29.24°C across the study area (Figure 3), representing typical tropical marine conditions. This temperature lies within the optimal physiological range reported for *O. cyanea* and is expected to enhance feeding activity, growth, and habitat utilization (Pörtner et al., 2021; Rosa et al., 2022). SST also influences nutrient dynamics and primary productivity, making it one of the most important variables used in satellite-based fisheries habitat assessment (Brewin et al., 2023). The relatively stable SST observed in this study indicates favorable environmental conditions for sustaining octopus populations throughout the coastal ecosystem.

**Figure 3.**
Sea Surface Temperature Distribution




The chlorophyll-a distribution (Figure 4) ranged from 0.6 to 0.8 mg m$^{-3}$ across most coastal waters, with localized areas reaching 1.67 mg m$^{-3}$, indicating moderate to high primary productivity. Higher chlorophyll-a concentrations generally corresponded with productive reef environments where increased phytoplankton biomass supports greater prey availability for benthic predators such as octopus (NOAA, 2023). Conversely, areas exhibiting lower chlorophyll-a concentrations (<0.6 mg $m^{-3}$) were associated with reduced biological productivity and lower habitat suitability. Similar relationships between chlorophyll-a concentration and productive fishing grounds have been reported in previous studies using satellite remote sensing (Hanintyo & Jatisworo, 2021; Prayitno et al., 2021).

**Figure 4**.
Chlorophyll-a Concentration Distribution




Overall, the integration of GPS observations and remotely sensed oceanographic variables demonstrates that the occurrence of *O. cyanea* is primarily associated with shallow coral reef habitats characterized by stable salinity, optimal sea surface temperature, and moderate-to-high chlorophyll-a concentrations. These findings confirm that habitat complexity, environmental stability, and biological productivity collectively determine the distribution of productive octopus fishing grounds. The study further demonstrates the value of combining remote sensing with field observations to support ecosystem-based fisheries management and improve the spatial identification of sustainable octopus fishing areas in the Spermonde Archipelago (FAO, 2022; Rosa et al., 2024).

**Figure 5.**
Daily Octopus (Octopus cyanea) Catch During Three Weeks of Fishing Operations

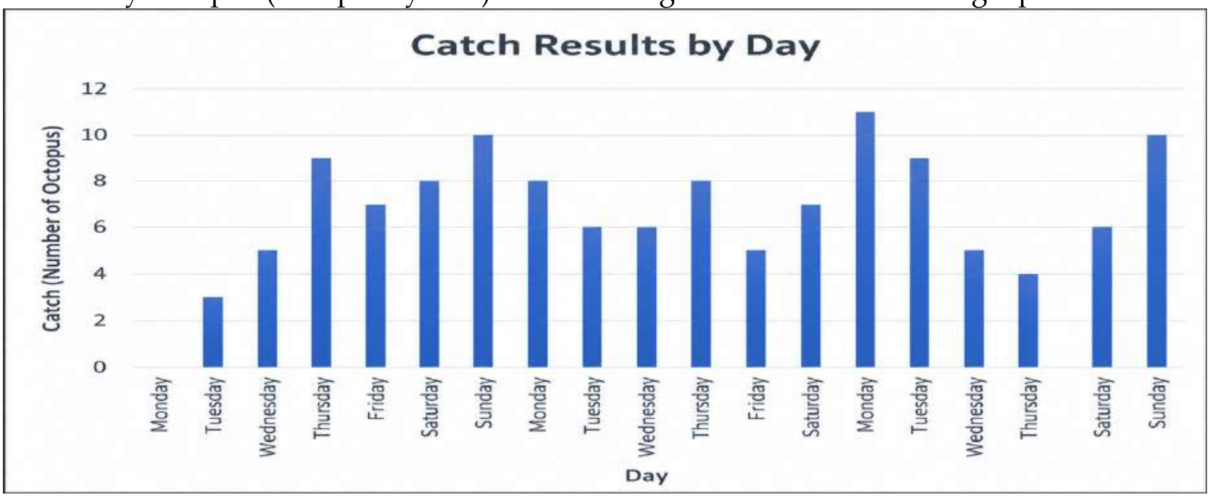



Figure 5 illustrates the variation in daily Octopus cyanea catches recorded during three consecutive weeks of fishing operations around Barrang Caddi Island. Overall, catch production fluctuated considerably throughout the observation period, ranging from approximately three to eleven individuals per fishing trip. The highest catches were consistently recorded during weekend fishing operations, whereas lower catches generally occurred at the beginning of the fishing week.

The temporal variability observed in Figure 5 suggests that octopus availability is strongly influenced by short-term environmental variability rather than remaining constant throughout the fishing season. Daily differences in sea surface temperature, local current dynamics, tidal conditions, and prey availability may influence octopus foraging activity and consequently affect catch success. Similar temporal fluctuations have been reported in tropical small-scale octopus fisheries, where environmental conditions directly regulate predator movement and feeding behavior (Raberinary & Andrisoa, 2024; Rosa et al., 2022).

The relatively higher catches observed during several fishing trips correspond well with the distribution of high-potential fishing zones identified through remote sensing analysis. These productive areas were characterized by shallow coral reef habitats, moderate chlorophyll-a concentrations, and stable oceanographic conditions that provide suitable shelter and abundant prey for O. cyanea. Consequently, integrating satellite-derived environmental variables with field catch observations improves the reliability of identifying productive fishing grounds.

Conversely, lower catches were generally associated with fishing operations conducted outside the most productive habitat patches or during periods of less favorable environmental conditions. Although fishing effort remained relatively consistent among trips, natural variability in octopus behavior and habitat utilization likely contributed to differences in catch rates. This finding supports previous studies indicating that catch variability in cephalopod fisheries is primarily driven by habitat quality and environmental dynamics rather than fishing effort alone (Boyle & Rodhouse, 2007; Estévez et al., 2024).

Overall, the catch pattern presented in Figure 5 confirms the effectiveness of combining remote sensing information with field observations for identifying productive octopus fishing grounds. The correspondence between environmental suitability and actual catch production demonstrates that satellite-derived oceanographic parameters can provide valuable support for sustainable fishing operations in the Spermonde Archipelago.

## CONCLUSION

This The integration of field survey data with remote sensing successfully identified the spatial distribution of potential Octopus cyanea fishing grounds in the waters surrounding Barrang Caddi Island. Moderate-potential fishing zones dominated the study area, while high-potential zones were concentrated in shallow coral reef habitats characterized by favorable environmental conditions. Oceanographic parameters, including a sea surface temperature of 29.24°C, salinity of 30.8 PSU, and chlorophyll-a concentrations ranging from 0.6 to 0.8 mg $m^{-3}$, indicated suitable habitat conditions for octopus occurrence and fishing activities. The spatial correspondence between productive fishing locations and environmentally suitable habitats demonstrates that remote sensing can effectively support the identification of octopus fishing grounds. This approach offers a practical decision-support tool for improving fishing efficiency, reducing search time and operational costs, and promoting ecosystem-based and sustainable fisheries management in the Spermonde Archipelago. Future studies should incorporate additional environmental variables, seasonal observations, and species distribution modeling to improve the accuracy and long-term applicability of octopus fishing ground prediction.

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