

Ethnoconservation of fishery resources in the Sapuka Islands, South Sulawesi Province, Indonesia

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Manuscript received: 7 September 2023. Revision accepted: 15 December 2023.

Abstract. *Massiseng ANA, Daris L, Samawi MF, Jaya J, Irwansyah, Zaenab S. 2023. Ethnoconservation of fishery resources in the Sapuka Islands, South Sulawesi Province, Indonesia. Biodiversitas 24: 6461-6471.* One form of sustainable management of fishery resources is establishing ethnoconservation-based zoning to create a more targeted utilization practice. Therefore, this research aimed to determine the types of ethnoconservation, analyze the distribution of fishery resources, and create ethnoconservation-based zoning in the Sapuka Islands, South Sulawesi Province, Indonesia. The novelty of this research was that it combined regional ethnoconservation-based zoning in the Sapuka Islands community and zoning designated by government regulations. Data was collected through observation, in-depth interviews, Participatory Rural Appraisal (PRA), social mapping and taking coordinate points using the Global Positioning System (GPS) in the waters of the Sapuka Islands. The results showed that ethnoconservation practices related to community culture included restrictions on fishing times and a ban on catching several types of species. Meanwhile, a prohibition based on local regulations restricted fishing gear in certain water areas and prohibited damage to coral reefs. About 18 species of fishery resources were found widespread across the waters of the Sapuka Islands. There is an overlapping area between the ethnoconservation zone of local communities and the conservation zone based on the decree of the Minister of Maritime Affairs and Fisheries with an extent of 2,293.01 ha. This area can be recommended as the conservation zone, which is mutually agreed upon by both local communities and the government.

Keywords: Ethnoconservation, fishery resources, Sapuka Islands, sustainability, zoning

Abbreviations: GIS = Geographic Information System; GPS = Global Positioning System; PRA = Participatory Rural Appraisal

INTRODUCTION

Anthropogenic factors are recognized as a significant contributor to the sustainability of fishery resources, specifically within small island communities in developing countries, where the inhabitants massively rely on these resources for sustenance and livelihoods (Daris 2017; Yamazaki et al. 2018). As stated by Narchi et al. (2014), excessive exploitation of natural resources in tropical islands, driven by local communities to overcome poverty and improve the local economy, resulted in ecosystem damage. Julian et al. (2022) also stressed the relationship between biodiversity loss and human existence, underscoring the need for human participation as an essential component in sustainable management.

To address these challenges, ethnoconservation can be used to manage natural resources sustainably, contributing to improvements in environmental conditions and maintaining biodiversity (Nunes et al. 2021). Ethnoconservation is a method of environmental conservation and rehabilitation that combines natural science with the traditional knowledge and culture of local communities,

incorporating societal perspectives based on biology, ecology, as well as sociology (Hanazaki 2015; Morales et al. 2017). In this context, the availability of natural resources that cannot meet growing human needs may cause societal conflict (Daris et al. 2022; Ma et al. 2022).

In the Sapuka Islands, Pangkajene Islands District, South Sulawesi Province, Indonesia, the increasing population, coupled with limited job opportunities, growing pressure to meet subsistence needs, and the high market demand for fishery commodities, has led to increased exploitation of fishery resources in the coastal areas and small islands of (Massiseng et al. 2022a). Research conducted by Nurhidayat et al. (2019) showed that the condition of coral reefs at 15 observation stations in Liukang Tangaya waters, including the Sapuka Islands, was generally in a damaged condition with an average cover of living coral was only 18.91%.

Effective regulation of small island communities in Pangkajene Kepulauan Regency remains a challenge. The South Sulawesi Provincial Government, through the South Sulawesi Provincial Maritime and Fisheries Service, has created a Zoning Plan for Coastal Areas and Small Islands

(RZWP3K) through the Law No. 27 of 2007 concerning the Management of Coastal Areas and Small Islands and has divided the area waters into several zones, namely: core zone, limited use zone and other zones according to regional needs. However, as stated by Massiseng et al. (2022a), fishermen still carry out fishing activities in the core zone. On the other hand, several rules have been made by local communities, including the system of opening and closing fishing areas and restrictions on fishing gear in certain areas, yet such indigenous wisdom is not necessarily consistent with government zoning policies. This lack of synchronization underscores the need for concerted efforts to empower communities to act both as users and custodians of water resources in the area.

The underutilization of participatory mapping is evident in the determination of area zoning. Nunes et al. (2021) and Renato et al. (2023) recommended the use of participatory mapping in the form of Geographic Information System (GIS)-based zoning, which originates from the knowledge of local communities or fishermen with the participation of critical actors. Therefore, this research aimed to determine the types of ethnoconservation, analyze the distribution of fishery resources, and create ethnoconservation-based zoning in the Sapuka Islands. The findings in this research will contribute to the sustainability of fisheries resources in the waters of the Sapuka Islands by considering ethnoconservation practices in determining water area zoning policies.

MATERIALS AND METHODS

Research area and period

This research was conducted in the waters of the Sapuka Islands, which included nine small islands, from February 2023 to July 2023. The islands are located in Pangkajene Kepulauan District, South Sulawesi Province, Indonesia, as shown in Figure 1. The territorial area of the Sapuka Islands is 14.20 km², consisting of nine small islands, three of which

are inhabited islands (Sapuka Lompo Island, Tinggalungan and Kembang Lemari) (Badan Pusat Statistik Pangkep District 2021). The Sapuka Islands have a population of 4,168 people from various tribes, such as the Bajo, Mandar, Makassar and Bugis. Apart from that, the Sapuka Islands are also inhabited by immigrants from the Bima, Sumbawa, Madura and Lombok areas who have settled and become residents in this region. Most people in the Sapuka Islands work as fishermen. Apart from that, there are other professions, such as traders, government employees, and homemakers.

Data collection

Types and sources of data

This research used primary data obtained from observations, in-depth interviews, Participatory Rural Appraisal (PRA), social mapping, and taking coordinate points using the Global Positioning System (GPS) in the waters of the Sapuka Islands. Secondary data were obtained through documents from various agencies relevant to the research objectives, as well as national and international journal publications, to provide comparisons. The types and sources of data used in this research are presented in Table 1.

Table 1 shows that the types and sources of data were taken based on the research objectives. The first objective was to identify the types of ethnoconservation practices in the Sapuka Islands, using data sources obtained from interviews, PRA, and conducting social mapping on three inhabited islands. The second objective was to create a zoning map for fishery resources based on ethnoconservation, with data sources obtained from observations, taking coordinate points using GPS, GIS, and social mapping on nine islands. The third objective was to create a distribution map of fishery resources in the Sapuka Islands by making observations and taking coordinates on nine islands using GPS, GIS, and social mapping.

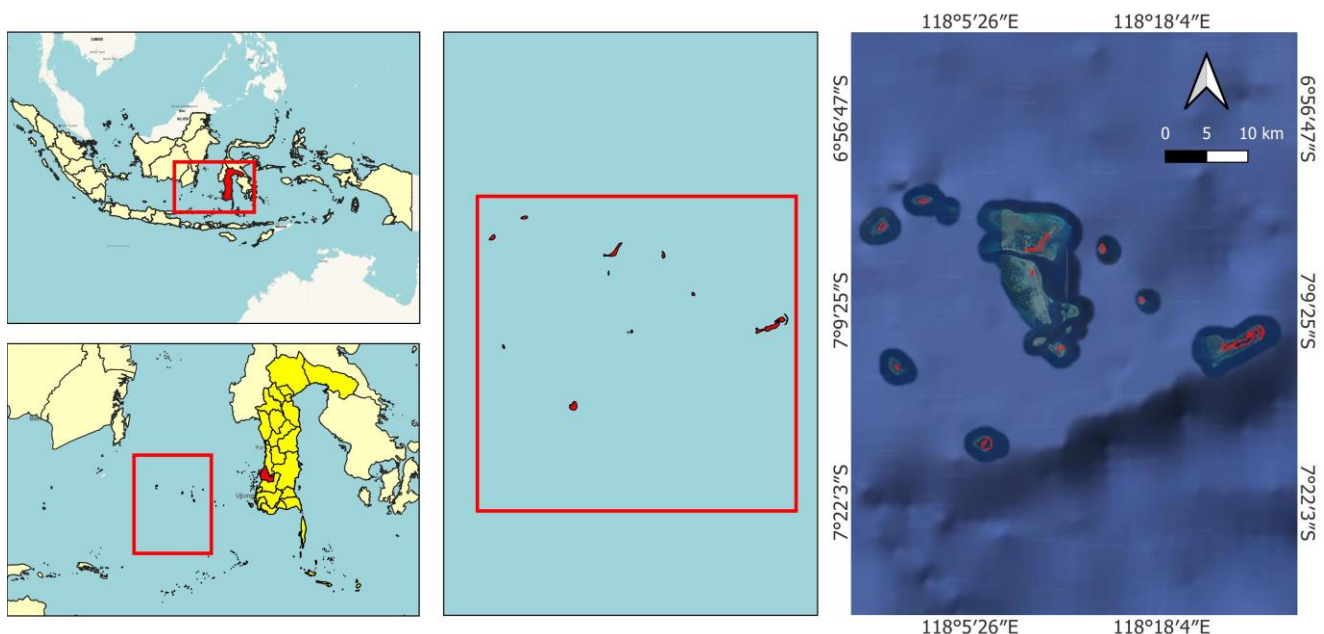


Figure 1. Map of the research area in Sapuka Islands, Pangkajene Islands District, South Sulawesi Province, Indonesia

Table 1. Types and sources of data used in this study

Type of data	Source of data	Location/unit
Types of ethnoconservation in the Sapuka Islands	Interview, PRA, and Social Mapping	3 islands
Zoning map of ethnoconservation-based fishery resource utilization	Observation, GPS, GIS, and Social Mapping	9 islands
Map of the distribution of fishery resources in the Sapuka Islands	Observation, GPS, GIS, Interview, and Social Mapping	9 islands

Tools and materials for data collection

The initial stage of this research commenced with the preparation of equipment and materials adapted to the type of data to be collected. The equipment and materials used in this research included a handphone to record interview activities and documentation; a computer to analyze data; GPS to retrieve coordinate points; a motorboat for observation and locating coordinate points of water areas; a notebook to record research data; permanent markers for writing on banner maps; and banner maps for social mapping during PRA.

Data collection method

Before starting data collection, the Participatory Rural Appraisal (PRA) module was prepared as a guide for implementing PRA according to research objectives and creating guidelines for in-depth interview activities with respondents. Subsequently, a survey or field validation was carried out, comprising activities such as observations regarding the existing conditions of the research location, collection of socio-demographic data from the respondents, and determination of samples to participate in PRA. In this activity, key actors were also determined for conducting in-depth interviews.

The respondent criteria for PRA activities consisted of stakeholders representing fishermen, the community, the government, entrepreneurs, and NGOs (non-governmental organizations) in the Sapuka Islands. The respondents in PRA activities originated from three inhabited islands in the Sapuka Islands, namely Sapuka Lompo (30 respondents), Kembang Lemari (30 respondents), and Tinggalungan Island (30 respondents). The respondents for in-depth interviews consisted of three community leaders, two traditional leaders, one village head, one sub-district head, two fisheries entrepreneurs (locally called *pongawa*), three fishermen, and three housewives. The sample size was determined based on Ferdinand (2006), who recommended a minimum of 30 respondents, resulting in 90 for PRA activities and 15 for in-depth interviews.

The implementation of PRA aimed to obtain data and delve deeper into information by guiding the community to analyze the situation about research objectives. The data collected included aspects related to ethnoconservation, local community institutions, historical flow of fishery resource utilization, potential fishery resources, characteristics of water areas, and fishing seasons. Furthermore, social mapping was carried out to collect data on fishing areas, types of catches obtained, and water areas included in ethnoconservation zones. The method used was in-depth interviews with key actors and stakeholders to identify the types of local wisdom (Sambu and Daris 2019) in the community, as well as regulations applicable to the

research location.

Spatial data collection was also carried out to map the area of fishery resource utilization using GPS navigation to retrieve coordinate points in the waters of the Sapuka Islands. The determination of the coordinate points began with social mapping during data collection through PRA activities and in-depth interviews. Subsequently, image data collection was performed according to the coordinate points of the fishery resource water areas and community ethnoconservation. This was supplemented by observing the fishing points on the nine islands in the Sapuka Islands with the assistance of local fishermen and taking coordinates using GPS. The data obtained were tabulated and analyzed based on the research objectives using descriptive qualitative and spatial data analyses with ArcGIS.

Data analysis

Data analysis methods for types of ethnoconservation

The analysis of data related to the types of ethnoconservation was achieved by using descriptive qualitative analysis methods carried out through the following steps: (i) data reduction, namely re-selecting the data obtained, checking completeness according to the research objectives, and sorting in the right order; (ii) preparing the analysis results related to types of ethnoconservation and then presenting in tables and narratives that could be easily understood; (iii) conclude and verify the data based on the results obtained. The results were verified by confirmation from the respondents and other stakeholders, then necessary conclusions were made.

Methods for analyzing the distribution of fishery resources and zoning based on ethnoconservation

Spatial analysis was used to analyze the distribution and utilization of zoning of fishery resources based on ethnoconservation. Considering the geographical phenomena observed at the research location, spatial dimensions were examined using the Geographic Information System (GIS) analysis tool (Hamid et al. 2020). GIS is often used to analyze and produce thematic spatial data. Morandi et al. (2020) identified two conservation areas using GIS methods, namely ecological corridor (EC) areas and conservation units (CU) in Cerrado, Brazil.

The data obtained by taking coordinates using GPS were then analyzed with GIS, resulting in a collection of spatial data based on the themes examined. Furthermore, overlaying several maps allowed for the visualization of water areas intersecting between restrictions based on government regulations and those predicated on ethnic fishing communities in the Sapuka Islands. Previous

research used spatial data analysis to present marine space utilization and as an indicator in overall management (Prestrelo et al. 2016; Bueno and Schiavetti 2019). Herbst and Hanazaki (2014); Morado et al. (2021); and Hettiarachchi et al. (2022) also used a participatory GIS-based method in Brazil to determine territorial boundaries and the functions to maximize management effectiveness through zoning. Furthermore, Zolkafli et al. (2017) and Eilola et al. (2019) developed a participatory geospatial methodology for local-level land use planning in Tanzania and Malaysia. Beyond generating local spatial data, these results also supported effective community decision-making capacities in formal land-use planning processes. Pita et al. (2019) and Massiseng et al. (2022b) confirmed a growing awareness that conventional conservation methods were no longer effective in dealing with the complexity of socio-ecological problems.

RESULTS AND DISCUSSION

Types and spatial zoning of ethnoconservation in the Sapuka Islands

There are several ethnoconservation practices conducted by communities in the Sapuka Islands.

Ethnoconservation is carried out by communities spread throughout the waters of the Sapuka Islands with zoning, as shown on the map in Figure 2. The ethnoconservation practices conducted by communities in the Sapuka Islands are detailed below.

Ethnoconservation related to Nakasa culture in fishing communities in the Sapuka Islands

Nakasa is a local culture in the form of cultural messages, which means taboo, prohibition, or pemali (in the Bugis language). However, the cultural meaning is intricate, extending beyond simplistic interpretation. When analyzed functionally, Nakasa serves as a tool for cultural goals, strategies, or social control within society. It regulates and determines the behavior and tendencies of individuals in carrying out life activities (Daris et al. 2023). The process of interpreting cultural messages has lasted for a long time interval, resulting in a social action pattern that serves a commonality of beliefs, identification, and origins. Therefore, the value of Nakasa can be integrated within a group, community, and tribe.

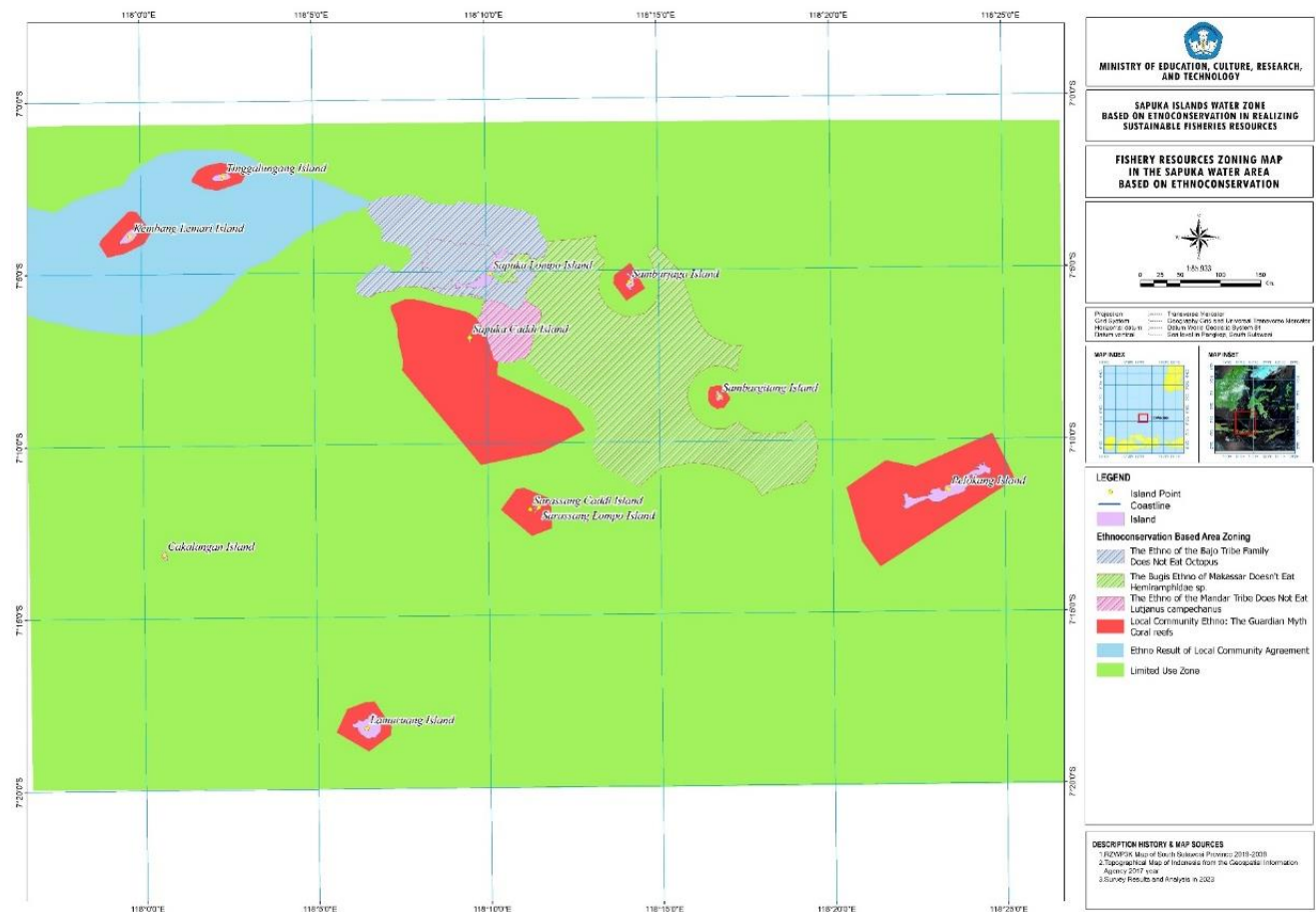


Figure 2. Types and spatial zoning of ethnoconservation in the Sapuka Islands

To comprehend Nakasa as a social system, one must consider its close association with the societal social system, interwoven between different parts. Nakasa is aimed at warding off elements that could disturb or damage, potentially affecting fish catches. For instance, the prohibition of fishing activities every Friday and on the 1st of Muharram (Hijri calendar) is considered Nakasa. This practice has two meanings, namely: (i) preserving capture fishery resources by providing opportunities for marine biota, including fish, to spawn and reproduce, ensuring sustainability, and (ii) a religious aspect, as Friday is a day of mandatory prayers for the predominantly male Muslim fishermen in the Sapuka Islands. In addition, the fishermen also believe in a three-month Nakasa where fishing activities are prohibited for a day every three months of the Hijri calendar, as shown in Table 2.

Table 2 shows that Nakasa day in the first three months (Dzul Hijjah, Muharram, Shofar) is on Thursday, while in the second three months (Robi’ul Awal, Robi’ul Akhir, Jumadil Awal), it is on Tuesday. In the third three months (Jumadil Akhir, Rojab, Sya’ban), Nakasa Day falls on Saturday, and in the fourth three months (Romadhon, Shawwal, Dzulqo’dah), it is on Sunday. Based on this phenomenon, it is concluded that Nakasa, as one of the local cultures in the Sapuka Islands community, could be integrated with the context of exploiting capture fishery resources. It can also function as a means of controlling excessive fishing activities to maintain sustainability. Every week, there are at least two Nakasa days, which prevent the communities from carrying out fishing activities, thereby providing opportunities for fish to spawn and reproduce. For example, in the month of Dzul Hijjah, the fishing community does not catch fish every Friday and Thursday, which are considered Nakasa days.

Ethnoconservation related to the prohibition of catching certain species by fishing communities in the Sapuka Islands

The ethnoconservation is based on the local culture of the community who live in the Sapuka Islands, with the majority being fishermen from the Bugis, Makassar, Mandar, Bajo, and Bima tribes. Each tribe has a culture of conservation in carrying out fishing activities. Based on the results, the culture of conservation or ethnoconservation carried out at the research location is shown in Table 2.

Table 2. Nakasa quarterly fishing community in the Sapuka Islands

Hijri month	Nakasa day (Prohibition to sea)
Dzul Hijjah	Thursday
Muharram	
Shofar	
Robi’ul Awal	Tuesday
Robi’ul Akhir	
Jumadil Awal	
Jumadil Akhir	Saturday
Rojab	
Sya’ban	
Romadhon	Sunday
Syawal	
Dzulqo’dah	

Prohibition of catching red snapper (*Lutjanus campechanus* Poey 1860) in the Mandar tribes. The fishing community of the Mandar tribe refrains from eating red snapper, considering it a sacred fish. This practice stemmed from the belief that eating Red Snapper could bring bad luck in the form of skin disease attacks for the family. Consequently, the prohibition is beneficial in conserving fish resources in the waters of Sapuka Caddi Island. The area of the sea used as a conservation zone by the community was approximately 811.61 hectares (Figure 2).

Prohibition of catching tendro fish (*Hemiramphidae* sp.) among the Bugis and Makassar tribe. The Bugis and Makassar fishing communities refrain from eating tendro fish (*Hemiramphidae* sp.) due to a historical event where the fish saved the lives of their ancestors during a sea mishap. This cultural prohibition is aimed at avoiding disasters and bad luck associated with tendro fish. The area of the Sapuka Islands waters, used as a conservation zone for the fish, reached 10,068.20 hectares (Figure 2).

Prohibition of catching octopuses (*Octopoda* sp.) in the Bajo tribe. The Bajo fishing community on the Sapuka Islands has banned eating octopuses, believing in the myth that associated octopuses with their ancestors. This prohibition is very beneficial for efficient growth, reproduction, and interference from Bajo fishermen. The area of water used as a conservation zone by the community for octopus habitat was approximately 3,923.66 hectares (Figures 2 and 3).

Ethnoconservation related to local rules agreed upon by the fishing community in the Sapuka Islands

Restrictions on using fishing gear in Kembang Lemari and Tinggalungan Island waters can be interpreted as ethnoconservation. The fishing communities in these locations have made a joint agreement refraining fishermen from using compressor machines to carry out diving, anesthesia, bombing, or catching coral fish and sea cucumbers. The only fishing gear permitted included those considered environmentally friendly. Sanctions for fishermen who violate these rules are in the form of burning the boats and confiscating catches. This prohibition stemmed from the fact that compressor machine users generally use bombs and anesthesia when diving, causing damage to coral reef ecosystems and fish resources. The water area in the seas of Kembang Lemari and Tinggalungan Island, used as a conservation zone by the community, was 10,633.60 hectares (Figure 2).

Ethnoconservation related to the preservation of coral reef ecosystems by fishing communities in the Sapuka Islands.

The fishing community from the Bugis, Makassar, Mandar, Bajo, and Bima tribes living in the Sapuka Islands believe in the myth that most of the coral reef ecosystems have marine guards who often appear on Friday and Monday nights. This marine guardian is believed to protect the coral reef ecosystem and is known as Prophet Khaidir. According to the myth, Prophet Khaidir is the ruler of the water and ocean, protecting the coral reef ecosystem from intruders during the day and night. The community

believes that anyone who disturbs and injures the coral reef ecosystem will experience disaster and hardship in life. These disasters and difficulties can take the form of accidents, such as the sinking of boats, damage to ships, lack of catches, and even sudden deaths. The beliefs and myths are beneficial to preserving the coral reef ecosystem in the waters of the Sapuka Islands.

Previous research showed that the advancement of science and technology in sustainable fishery resource management was influenced by many factors. For example, Rasekhi et al. (2022) examined the knowledge of local fishermen regarding fishing behavior, practices, and climatic conditions in priority coastal ecosystems of the Caspian Sea. The results underscored the importance of incorporating both modern knowledge and exogenous factors for accurate marine resource conservation. To achieve this, it is crucial to supplement information from traditional fishermen and the cultural practices of local communities.

A holistic ethnoconservation method can integrate various aspects of local community life, such as cultural,

social, economic, and environmental. This requires the active participation of local communities, NGOs, local government, private sectors, as well as paying attention to social changes in the community (Fulton et al. 2018). The culture of fishing communities on coasts and small islands can be used as a program that supports conservation and conflict management (Daris et al. 2023; Massiseng et al. 2022a), resulting in the term ethnoconservation. This concept not only considers culture but also local rules resulting from community agreements regarding the utilization of fishery resources and treatment of water areas (Silva and Lopez 2015; Sjostrom et al. 2021). Therefore, it is believed to be more successful in regulating local communities and acting as a supervisor.

Distribution of fishery resources in the Sapuka Islands

Fishermen in the territorial waters of the Sapuka Islands catch various types of fish with high economic value. Fishery resources across the waters of the Sapuka Islands are presented in Figure 3 and Table 3.

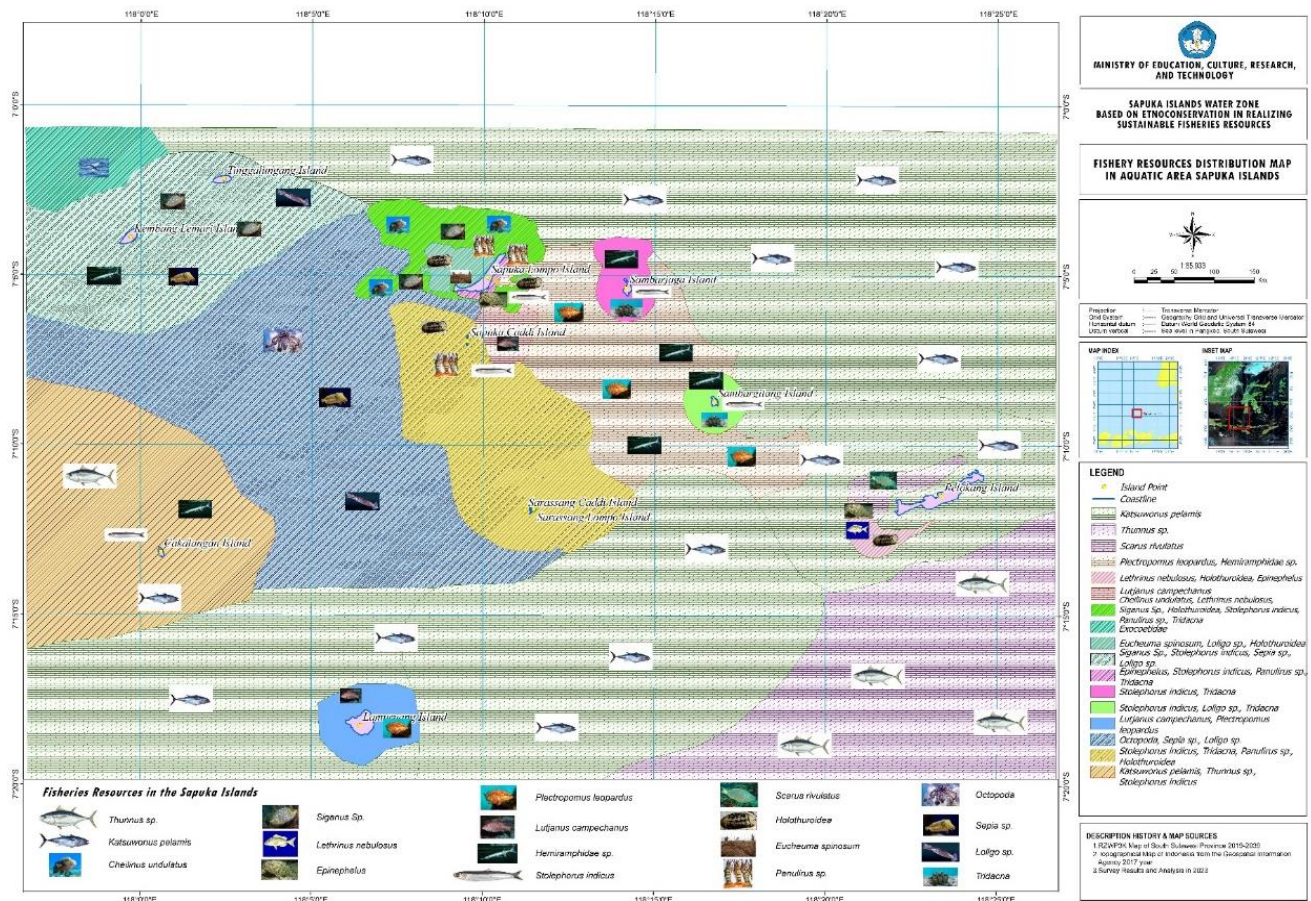


Figure 3. Distribution map of fishery resources in the Sapuka Islands waters area

Table 3. Types and distribution of fishery resources in the Sapuka Islands

Types of fishery resources	Fishing ground waters territory and seaweed cultivation
Tuna fish	Cakalangan Island, Pelokang Island
Cakalang fish	Cakalangan Island, Lamuruang Island, Pelokang Island, Tinggalungan Island
Napoleon fish	Sapuka Lompo Island, Tinggalungan Island
Baronang fish	Kembang Lemari Island, Tinggalungan Island
Katamba fish	Pelokang Island
Grouper fish	Sapuka Lompo Island, Sapuka Caddi Island, Pelokang Island
Sunu fish	Lamuruang Island, Sambargitang Island, Sambarjaga Island
Red snapper fish	Lamuruang Island, Sapuka Caddi Island
Tendro fish	Kembang Lemari Island, Cakalangan Island, Sambarjaga Island, Sambargitang Island
Anchovies fish	Sapuka Lompo Island, Sapuka Caddi Island, Sambarjaga Island, Sambargitang Island
Cockatoos fish	Pelokang Island
Sea cucumbers	Sapuka Lompo Island, Sapuka Caddi Island, Pelokang Island
Seaweed	Sapuka Lompo Island
Lobster	Sapuka Lompo Island, Sapuka Caddi Island
Octopus	Kembang Lemari Island, Cakalangan Island
Cattlefish	Cakalangan Island, Kembang Lemari Island
Squid	Tinggalungan Island, Kembang Lemari Island
Giant clam	Sambargitang Island, Sambarjaga Island

Based on Figure 3 and Table 3, there are 18 types of potential fishery resources in the Sapuka Islands, consisting of tuna, cakalang, napoleon, baronang, katamba, grouper, sunu, red snapper, tendro, anchovies, cockatoos, sea cucumbers, lobster, octopus, cuttlefish, squid, giant clam and seaweed. The potential of this fishery resource spread over the territorial waters, which consist of nine islands. Specifically, seaweed cultivation is only carried out on Sapuka Lompo Island and the types of fish produced included reefs with high economic value, as well as protected fish, namely parrot, napoleon, clams, and sea cucumbers. In this location, three large collectors buy catches of fishermen at market prices and then bring them to Makassar City for further reselling to exporters.

The allocation of fishery resources in an area can serve as an indicator of the management and utilization pattern (Ameyaw et al. 2021; Daris et al. 2022). Analyzing the spatial and temporal utilization pattern of fishery resources (Castro et al. 2017), as exemplified in the research by Nessa et al. (2020), plays a crucial role in determining areas for seed sources.

Zoning for the utilization of fishery resources based on ethnoconservation

The fishermen in the Sapuka Islands engage in fishing activities with a sense of responsibility, following cultural norms and local agreements with the governments. This adherence to rules directly impacts water conservation, reflecting community ethnoconservation. We overlaid the map of the ethnoconservation zone with a map of fishery resources (Figure 4), while the details on ethnoconservation practices in the Sapuka Islands region regarding the utilization of fishery resources are presented in Table 4. These practices are then translated to designated water areas, underscoring the positive impacts of ethnoconservation on the overall health and sustainability of fishery resources.

Table 4. Zoning the utilization of fishery resources based on ethnoconservation

Types of ethnoconservation	Conservation tribe
Prohibition of catching red snapper	Mandar Tribe
Prohibition of catching Tendro fish	Bugis Tribe and Makassar Tribe
Prohibition of catching octopuses	Bajo Tribe
Restrictions on the use of fishing gear	The community of Kembang Lemari Island and Tinggalungan Island
Ethnoconservation of coral reef ecosystems	The Sapuka Islands Community

Note: Primary data 2023

Table 4 shows that determining conservation zones based on local community culture facilitates government supervision of illegal fishing. Local communities proactively manage these zones, incorporating their existence into cultural and collective agreement rules known to the provincial government. The tribes inhabiting the Sapuka Islands have different cultures in fishery resource utilization activities. For example, the Mandar tribe has a culture of not catching red snapper due to the belief that the fish can bring disease to the community. On the other hand, the Bugis and Makassar tribes refrain from eating tender fish, primarily due to a historical event where the fish once helped the ancestors from a sea mishap. Other conservation zones apply to the two islands in the Sapuka Islands, namely Kembang Lemari and Tinggalungan. Communities on these two islands apply stringent rules related to restrictions on fishing gear. Only fishing gears considered environmentally friendly are permitted, and the community has imposed sanctions in the form of burning ships/boats for fishermen who violate these rules. Another type of ethnoconservation practice was observed in the

culture of the Bajo Tribe. This tribe has a culture of not catching octopuses due to the reported fraternal link with the ancestors.

The ethnoconservation practice that applies to all fishing communities in the Sapuka Islands is related to preserving coral reefs, covering a water area of 9,146.76 hectares (Figure 1). This area includes the waters of Pelokang, Sarassang, Lamuroom, Sapuka Caddi, Jauhungan, and Kembang Botol Island. It is believed that the seas covering these six islands have a guard in the waters, named Prophet Khaidir, resulting in strict prohibitions to avoid damaging the coral reef ecosystem. This collective belief, spanning all the tribes in the Sapuka Islands, contributes to the conservation of 9,146.76 hectares of coral reef ecosystem. However, Nurhidayat et al. (2019) reported that the condition of coral reefs in Liukang Tangaya waters, including the Sapuka Islands, was generally in a damaged condition, with an average live coral cover of only 18.91% at 15 observation stations. The leading cause of damage was attributed to fishing activities that lacked environmental friendliness. Agaton and Collera (2022) and Schutter et al. (2023) suggest the importance of designating rehabilitation zones within conservation areas to address these concerns.

Alignment of zoning between ethnoconservation and government regulation

We also overlaid the map of the ethnoconservation zone with the map of the conservation zone designated by the Minister of Maritime Affairs and Fisheries (Figure 5). After comparing the conservation zone based on the 2022 Minister of Maritime Affairs and Fisheries Regulation with those grounded in community ethnos, an overlapping zone measuring 2,293.01 hectares was obtained (Table 5). This overlapping zone might serve as a potential compromise, representing a mutual agreement between the government and the Sapuka Islands community.

Table 5 shows that the area of waters included in the conservation zone based on the 2022 Regulation of the Republic of Indonesia is 11,439.76 hectares, spanning Sambarjaga, Pelokang, Sapuka Caddi, and Lamuruang Island. Meanwhile, the community ethnoconservation zone is 9,146.75 hectares, covering all waters of the Sapuka Islands, including Sambargitang, Sarassang, Tinggalungan, and Kembang Lemari Island. This disparity underscores the importance of incorporating ethnoconservation areas as indicators in the determination of conservation regulations in the Sapuka Islands region, promoting expansion and harmonization.

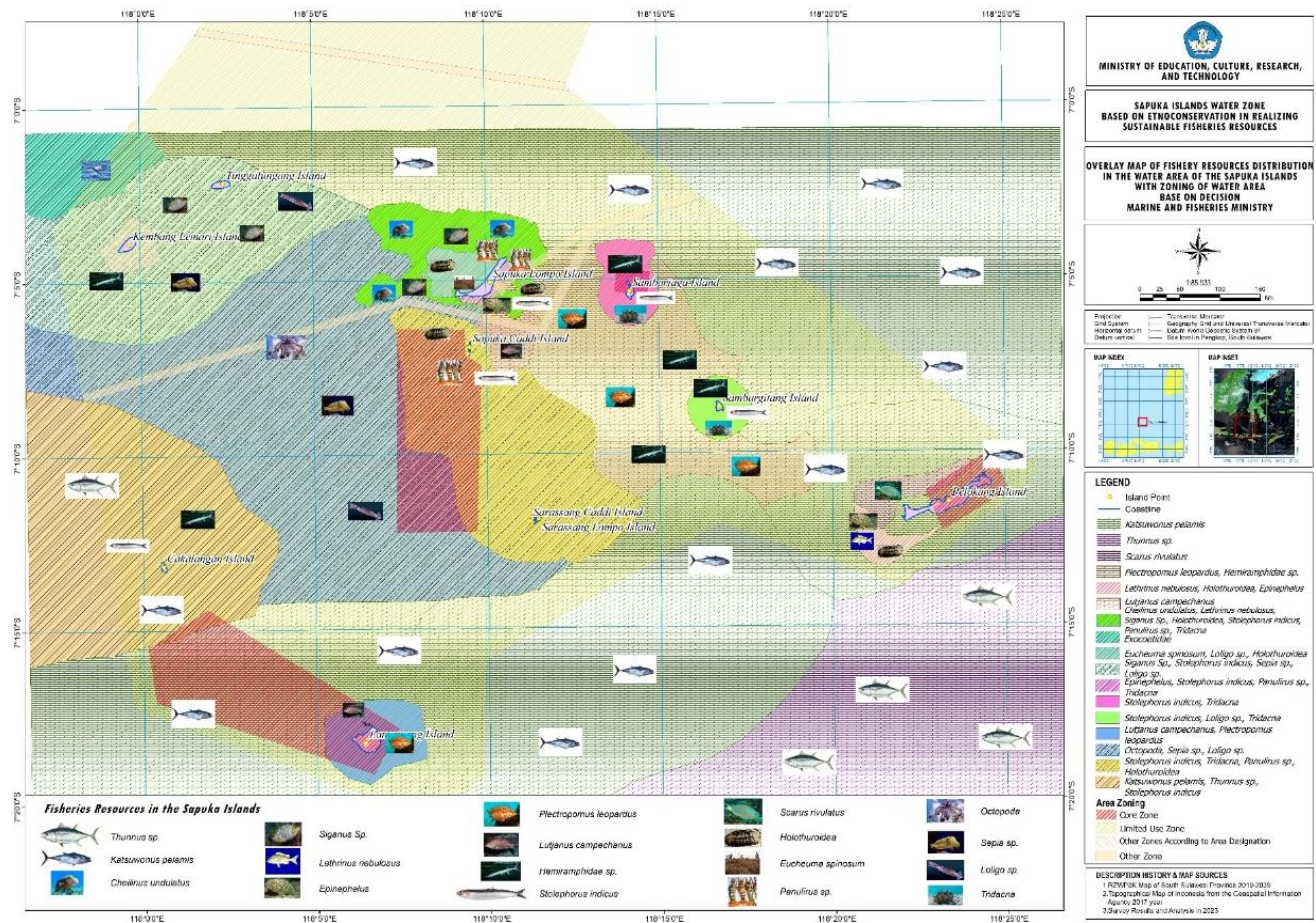


Figure 4. Overlay of ethnoconservation zoning map with fishery resources distribution in the Sapuka Islands waters areas

Table 5. The overlapping areas between ethnoconservation zone of local communities in the waters of the Sapuka Islands and conservation zones based on the decree of Minister of Maritime Affairs and Fisheries

Waters/Island Areas	Area (Ha)		
	Marine and fisheries government regulation conservation zone	Ethnoconservation zone	Overlay zone (Marine and Fisheries Government Regulation & Ethno)
Sambarjaga Island	229.66	169.12	60.54
Pelokang Island	952.89	2991.3	2038.41
Sapuka Caddi Island	4634.33	4453.67	180.66
Lamuruang Island	5622.88	370.62	5252.26
Sambargitang Island	0	93.29	93.29
Sarassang Island	0	448.05	448.05
Tinggalungan Island	0	265.59	265.59
Kembang Lemari Island	0	355.11	355.11
Total area	11439.76	9146.75	2293.01

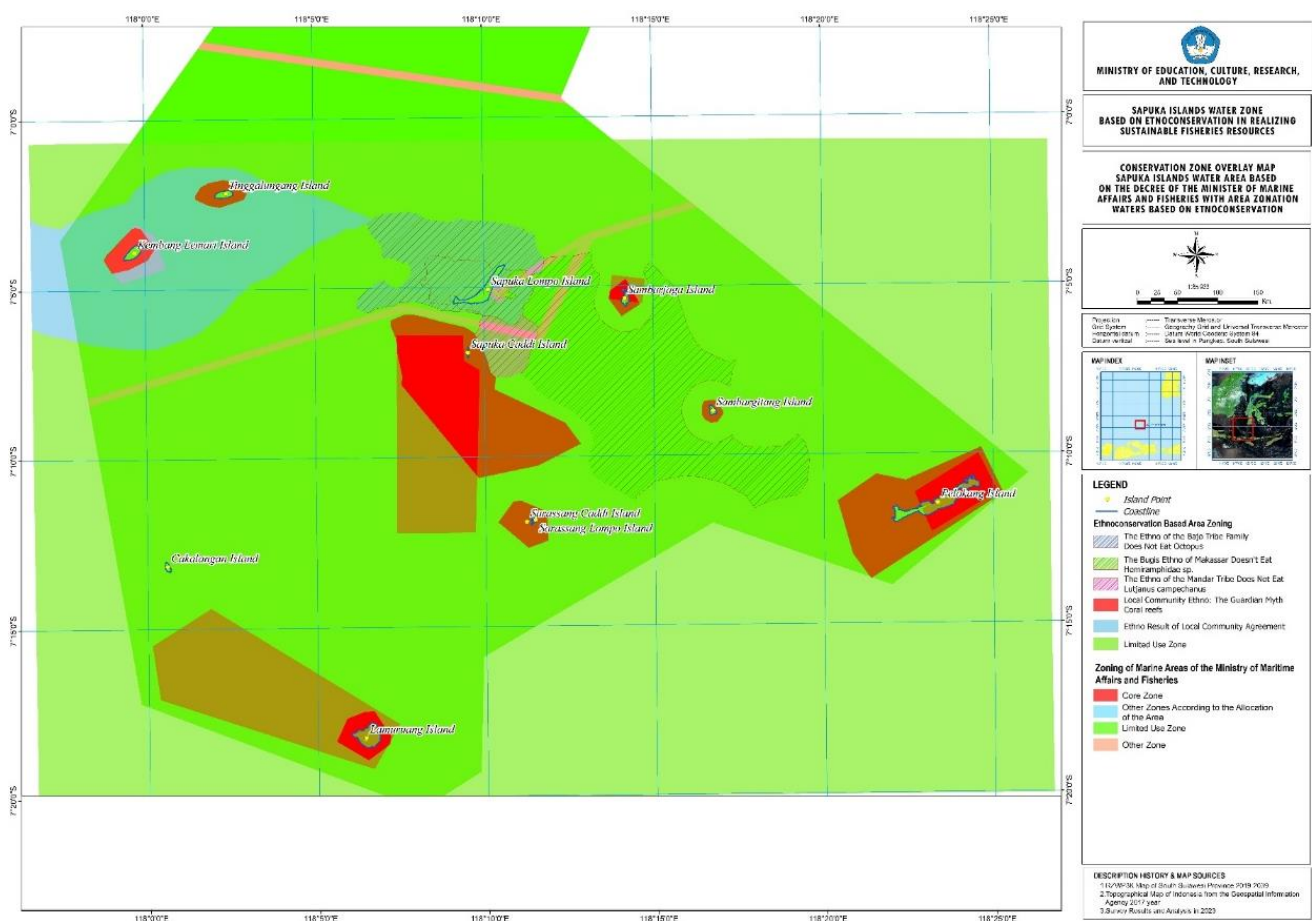


Figure 5. Overlay map of zoning between community-based ethnoconservation in Sapuka Islands and the decree of the Minister of Maritime Affairs and Fisheries

The variation between community-desired conservation zones and those designated by the government occurs due to a lack of community participation in the decision-making process. Despite the existence of long-standing cultural practices and local rules governing marine resource utilization within the community, these practices are often not consistent with government-defined conservation zones. Acknowledging the significance of community

participation, the management of Marine Protected Areas (MPA) should actively indulge the local population (Restrepo et al. 2022). The established culture in the Sapuka Islands includes the prohibition of catching red snapper, Tendo fish, and octopuses, restrictions on the use of fishing gear, and the ethnoconservation of Coral Reef ecosystems (Table 4).

Fu et al. (2017), Feng et al. (2021), and Qi et al. (2023) underscored the importance of functional zoning within an area to manage relationships between various stakeholders, reconcile and eliminate conflicts, as well as focus on patterns of sustainable community development. Based on the results, a combination of conservation and human activity was recommended to create sustainable, functional zoning. This is because ecological conservation with a total ban on human activity is not the best strategy. An effective solution entails making humans maintainers and actors in conservation efforts.

In conclusion, ethnoconservation related to fishery resource management in the Sapuka Islands consisted of two types, namely the culture of each ethnic group and local regulations related to the utilization of fishery resources. The cultural aspect included restrictions on fishing time, as well as the prohibition of catching several types of species, namely red snapper, tendro fish, and octopuses. Meanwhile, prohibitions based on local regulations were in the form of limiting fishing gear in certain water areas to prevent damage to coral reefs. About 18 species of fishery resources were found scattered in the waters of the Sapuka Islands, including tuna, skipjack, napoleon, baronang, katamba, grouper, sunu, red snapper, tendro, anchovy, cockatoo, sea cucumber, seaweed, lobster, octopus, cuttlefish, squid, and giant clam. Furthermore, the conservation zone designated by the Regulation of the Minister of Maritime Affairs of the Republic of Indonesia in 2022 was approximately 11,439.76 Ha. The community ethno (culture) conservation zone, on the other hand, amounted to 9,146.75 Ha, and the overlapping zone was 2,293.01 Ha. Based on the results, the conservation zone that can be correctly implemented by fishing communities is the overlay zone. The agreement between the government and local communities on its location and area makes the overlay zone highly suitable for ethnoconservation efforts. The ethnoconservation practices undertaken by the community have yielded positive impacts on fishery resources. These impacts included restrictions on catching certain species, regulations on fishing areas, and limitations in fishing times. Failure to base policies on these principles could lead to inadequate management of fishery resources, resulting in a decline in the potential.

ACKNOWLEDGEMENTS

The authors are grateful to the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia for providing funding through the 2023 Domestic Collaborative Research (PKDN) program. The authors are also grateful to the Regent of Pangkejene and Islands, and the Head of the Maritime and Fisheries Service, who facilitated the research activities. In addition, appreciation goes to the Chancellor of Universitas Cokroaminoto Makassar and all stakeholders who have helped in the successful completion of this research.

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