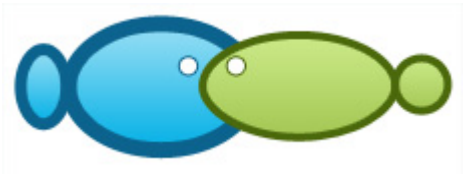

Marine spatial utilization by local fisherman in West Kei Kecil Small Islands Park, Maluku Province, Indonesia

[1]Marvin M. Makailipessy, [1]Imanuel M. Thenu, [2,3]James Abrahamsz

[1] Department of Fishing Technology, Polytechnic of Fisheries, Tual, Indonesia; [2] Department of Aquatic Resource Management, Faculty of Fishery and Marine Science, Pattimura University, Ambon, Indonesia; [3] Learning Center of Ecosystem Approach to Fisheries Management, Pattimura University, Ambon, Indonesia. Corresponding authors: M. M. Makailipessy, mariomarvin.mm@gmail.com; J. Abrahamsz, james.abrahamsz@fpik.unpatti.ac.id

Abstract. Spatial information on fishing such as fishing grounds of local fishermen contributes to the preparation and evaluation of zoning of a marine conservation area. This information is also useful in reducing the potential for space conflicts. The purpose of this study is to analyze the use of sea space by local fishermen based on fishing gear and fishing ground, as well as evaluation of suitability of fishing ground with zonation system in the conservation area of Kei Kecil Island. The research was conducted in May to August 2017, in 3 fishermen ohoi (village), Matwaer, Somlain and Ohoidertutu. Data collection uses interview techniques and participatory mapping. Data is processed and analyzed based on geographic information system (GIS). The results show the utilization of marine space based on the distribution of fishing gear which is dominated by gill net and lines. The use of marine space based on fishing ground, varies seasonally. Local fishermen categorize seasonally fishing ground based on the distribution of fish catches, include: high season from September to December, middle season from May to August, and low season from January to April. There are three types of fishing ground based on the intensity of space use, covering primary, secondary and tertiary fishing ground. Tertiary fishing grounds have wider space use patterns than other types of fishing ground. In the famine season, fishermen tend to enter core zones, sub-zones of tourism and aquaculture for fishing purposes, means that local fishermen have violated the zonation system on TPK Kei Kecil Island.
Key Words: fisherman, fishing ground, marine protected area, zonation system, evaluation.

Introduction. Waters Conservation Area (KKP) according to Government Regulation no. 60 (2007) is a protected waters area, managed by the zonation system, to realize the sustainable management of fish resources and the environment. However, the management of waters conservation areas is inseparable from environmental and resource issues (Halpern 2003; Hiddink et al 2006; Dangeubun et al 2011), fishing pressure (Hiddink et al 2006; Jennings 2009), socio-economic and cultural aspect (Dangeubun et al 2011), as well as governance aspect (Halpern 2003; Jennings 2009; Dangeubun et al 2011). This condition according to Dangeubun et al (2011) will affect the achievement of effectiveness of the management of conservation areas and will be difficult to achieve the purpose of conservation. Christie (2004) states that marine protected areas (MPAs) in Philippines and Indonesia were "biological successes and social failures" through limiting participation, inequitably sharing of economic benefits, and the lack of conflict resolution mechanisms.

Small Island Park (TPK) Kei Kecil as a coastal conservation area and small islands established by Decree of the Minister of Marine Affairs and Fisheries no. 6, 2016, also faced with the problems of space utilization for fishing ground. Therefore, knowledge of those issues must be owned by fishermen, especially local fishermen. Lack of information, socialization and arrangement of fishing zones, marine cultivation and tourism as well as lack of community involvement on space management in TPK Kei Kecil, is a potential trigger of conflicts between fishermen and other stakeholders.

Bennet & Dearden (2014) states that conservation success is often predicated by local support which is strongly influenced by the perception of the impacts that are experienced by local communities and by the management and governance quality. Santoso (2011) states in the planning and determining of conservation areas, the involvement of local fishermen is needed to ensure the safety and sustainability of conservation area management. Spatial and temporal information of fishing activities can be optimized fisheries management as well as economic and biological benefits (Rivai et al 2017), and conservation area management, if space allocation is well laid out to avoid overlapping of space utilization (Rahman & Mansyur 2016).

The development of fishing information systems helps in determining resource utilization patterns, resource conservation activities, and environmental protection of surroundings waters that become fish habitat (Mustaruddin et al 2012). The existence of marine conservation areas provides benefits for increased income and knowledge of fishermen (Randan 2011). Conservation and utilization of Regional Marine Conservation Areas should be supported by fishermen (Rizal 2015). For effective management and a good understanding of fishing activities, information on fishing ground is essential (Rivai et al 2017).

All statements attest the importance of the spatial information need of fishing grounds for local fishermen. The study of space use patterns for fishing is needed in evaluating the zonation system on TPK Kei Kecil. The results are important for knowing potential conflicts of its utilizations and tends. The purpose of the study is to analyze the patterns of sea space utilization for fishing due to the distribution of fishing gears and fishing grounds, and to evaluate their conformity with the established zonation systems.

Material and Method

Description of the study sites. The study was conducted in May - August 2017, at the three "ohoi" (village) in Kei Kecil Barat sub district, covering Somlain, Matwaer and Ohoidertutu. They are the fishing base for local fishermen, with fishing ground in and around TPK Kei Kecil. TPK Kei Kecil has about of 150,000 ha, covering the Core Zone 4,191.27 ha, Limited Exploitation Zone 126,635.34 ha (including fishing, aqua culture and tourism sub-zone), and Other Zones 19,173.39 ha (including other usage sub-zones, customary governance rights and protected forests (Figure 1).

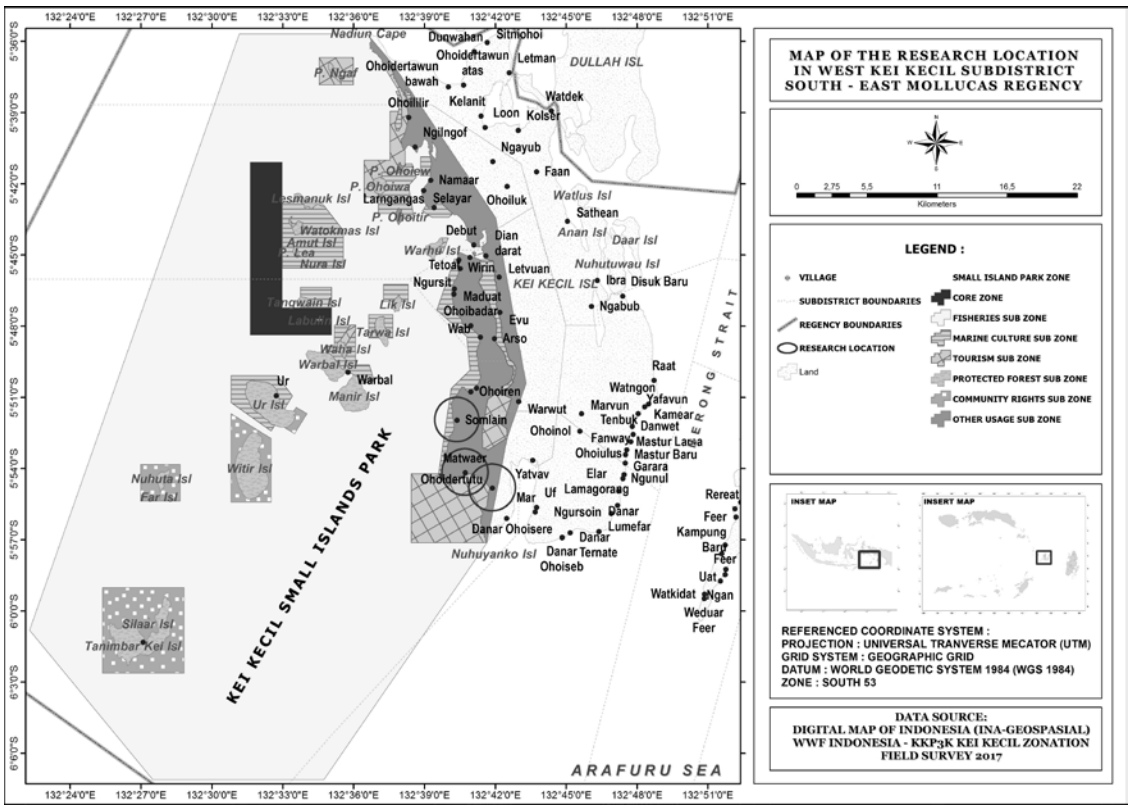

Figure 1. The location of West Kei Kecil Small Island Park (TPK Kei Kecil).

Collection of data. The data of the present study include seasonal fishing activities, fishing grounds, types of fishing gear used, and types of fish catch. Data collection uses interview technique with questionnaire guidance, survey of fishing area, identification of fish catch types, and participative mapping. Interviews and participatory mapping were conducted on 47 respondents as shown in Table 1.

Table 1

Distribution of respondents by type of fishing gear at the research locations

No.	*Ohoi (Village)*	*Type of fishing gear*	*Respondents amount*
1.	Matwaer	Harpoon	3
		Hand Line	7
		Gill Net	7
2.	Ohoidertutu	Net	1
		Gill Net	8
		Hand Line	7
3.	Somlain	Traps	1
		Harpoon	2
		Hand Line	4
		Gill Net	7
Total			47

Data analysis. The analysis technique used in this research is spatial analysis through Geographic Information System (GIS) with ArcGIS software 10. The data that used is data point of fishing grounds. Those points data are then given 3 score per type of fishing gear, while the fishing grounds are rated based on the number of fishermen who access those fishing areas. These two data are then processed in phases.

First, the interpolation method in ArcGIS as inverse distance weighted (IDW) was used. This method is used to find out the value at locations where data is unavailable. Spatial interpolation assumes that data attributes are continuous in space and these attributes are spatially related (Jenisa 2016). The data attribute estimate is based on the surrounding locations and the scores at adjacent points are more similar than those of distant points (Prasasti et al 2005).

Second, reclassify by grouping top data over several classes or categories based on the score of the interpolation process. The classification results are divided into three different categories, and then converted into polygon data to calculate the extent of areas. Interpolation and classification processes based on data on fishing grounds, using natural breaks classification provided by ArcGIS software 10.

Third, intersect to cut a polygon with another polygon on the tangent part (Indarto & Faisol 2012). At this phase, the areas acquried was the result of an intersect between polygon of the fishing area with zones and sub-zones on TPK Kei Kecil.

Result and Discussion

General findings. The local fishermen at the research location use five types of fishing gear, there are fishing line, net, arrow, fish trap and nets. The dominant fishing gear is fishing rods and nets. Eighteen fishing grounds which was commonly visited by local fishermen are: Witir Island, Manir, Arat, Abovan, Hourlilin, Met Feat, Wirinko, Met Ngalafar, Met Ngane, Watohan, Coastal Waters Ohidertutu and Matwaer, Met Heat, Met Faruk, Ngatun, Ngaur, Nar, Ngurmari, and Laen. The dominant fish species are caught from large pelagic fish groups such as skipjack tuna Cakalan (*Katsuwonus pelamis*), small pelagic fishes such as mackerel (*Rastrelliger* sp), scad (*Selaroides* sp), and redbelly yellowtail fusilier (*Caesio* sp) and demersal fish such as emperor (*Lethrinus* sp), Trevally (*Caranx* sp) and red snapper (*Lutjanus* sp).

Fish catches by fishermen, varies by fishing gear and season. Local fishermen groups fishing season based on the number of catches obtained. There are three different

fishing seasons that are grouped according to the months of the year. First, the peak season is from September to December, this season is where the catches range from 40 to 200 fish. In the second seaso the catches range from 20 to 80 fish; this season runs from May to August. In the third, the low season, the catches only range between 10-50 fish, this season runs from January to April.

Utilization of sea space by means of fishing gears. Spatially, the concentration on the largest use of sea space for fishing activities is fishing rods and nets. From the total area of Kei Kecil Barat subdistrict, on 87,029.00 ha (20.88%) is used fishing line, and on 10.63% net fishing is performed. The concentration on use of sea space by other fishing gear is only 0.01-0.46% (Figure 2).

This condition can be proved by the pattern of sea space utilization through fishing activities with fishing gear and fishing nets. The formed pattern of space use is distributed from the north waters to the south. This pattern is different from the use of sea space for fishing activities with fishing gears like arrow, fish trap and nets.

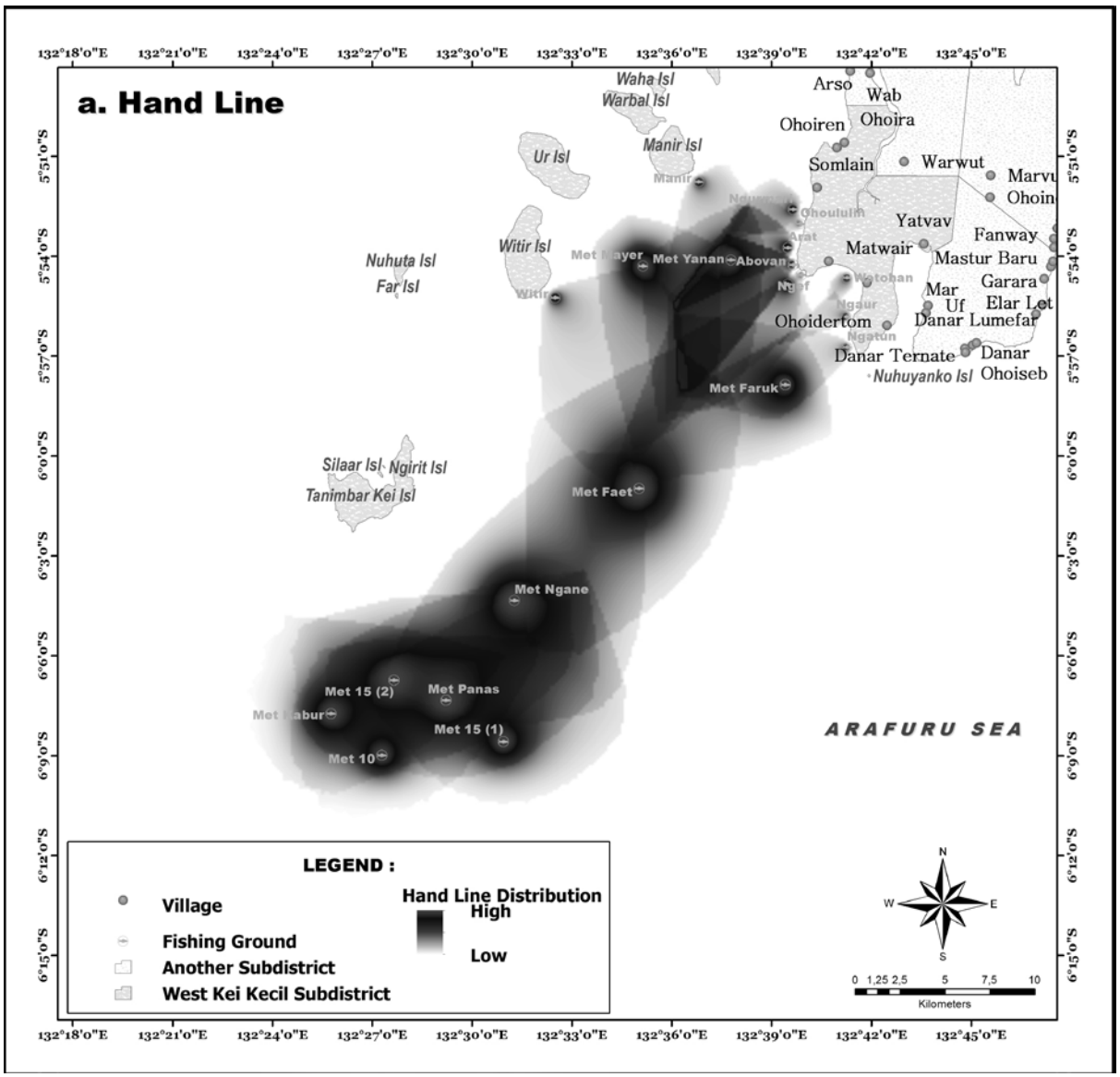

Figure 2a. Map of sea space utilization by means of fishing gears (Hand line).

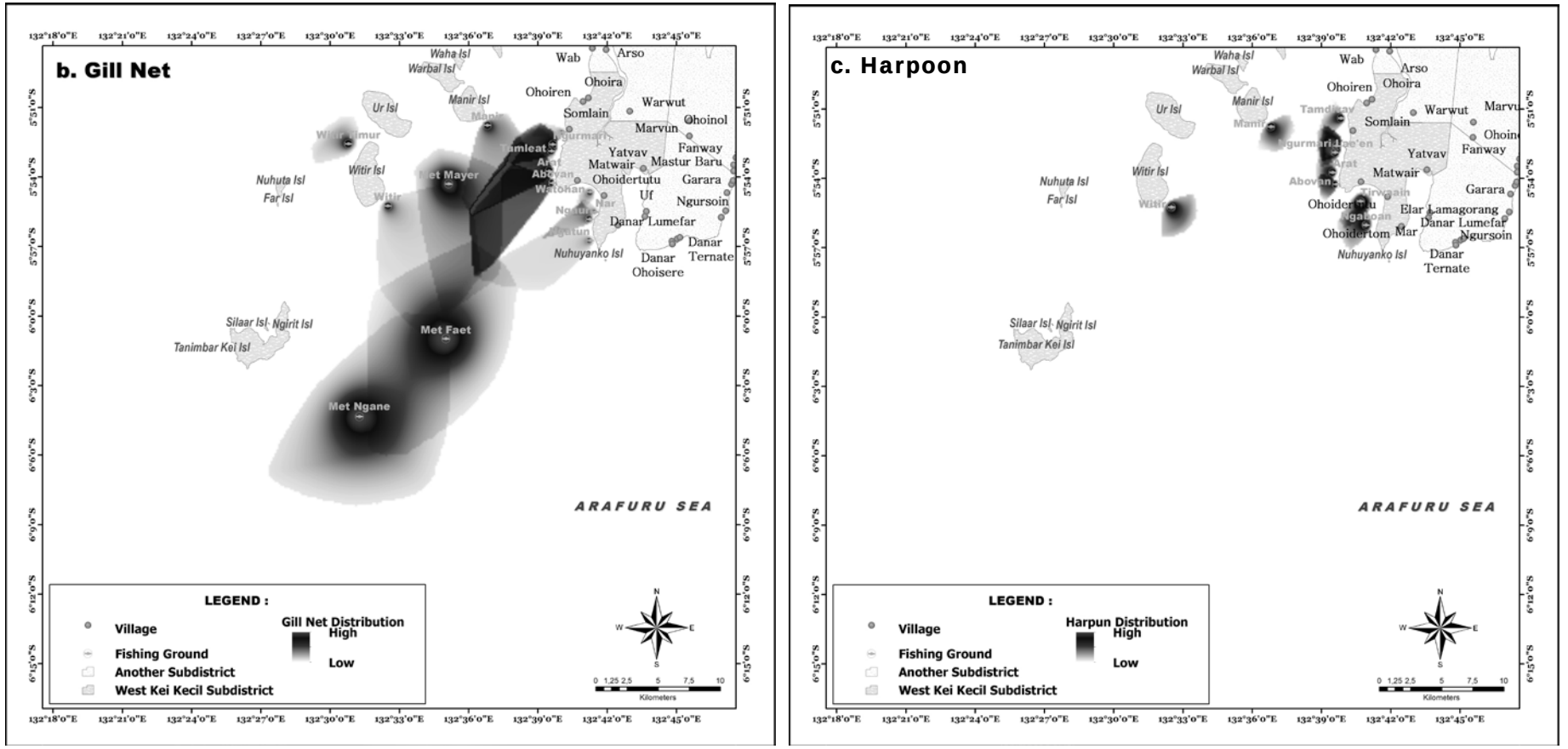

Figure 2b-c. Map of sea space utilization by means of fishing gears (b- Gill net; c- Harpoon).

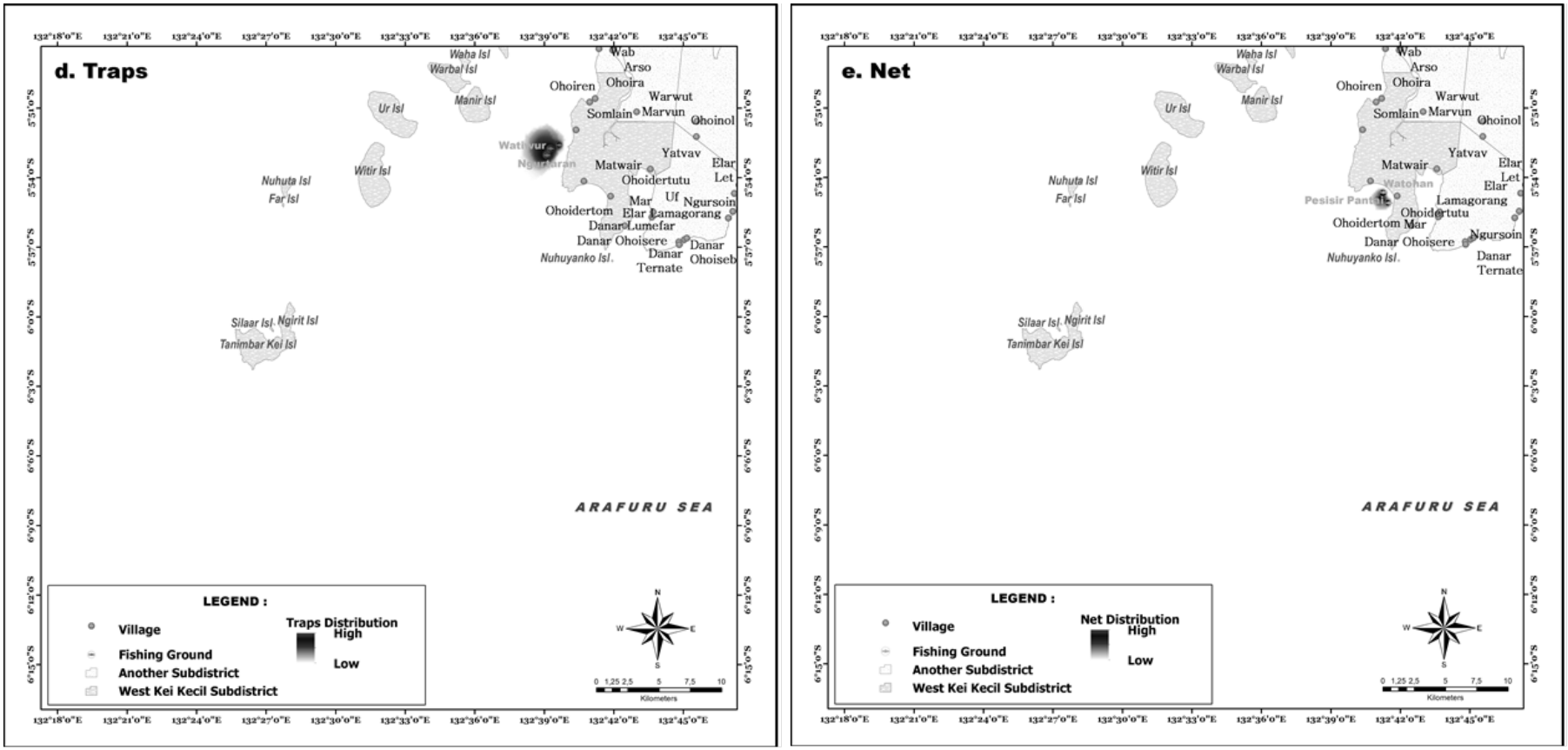

Figure 2d-e. Maps of sea space utilization by means of fishing gears (d – Traps; e – Net).

The pattern of space use is affected by the distribution on the number of fishermen who operate each type of fishing gears. The more fishermen who use a type of fishing gear, the wider of sea space that is used for the operation of the fishing gear. The distribution of fishing activities is also influenced by other factors, such as fishing habits and strategies in fishing, fish behavior, and population dynamics (Jennings 2009 Fulton et al 2005).

Utilization of sea space by means of fishing ground types. The use of marine space based on fishing grounds, varies seasonally. Fishermen in these three locations of the research categorize fishing ground on a seasonal, in accordance with the distribution of fish catches, includes: high season from September to December, middle season from January to April (Figure 3). Spatial analysis of the intensity of space use, found three types of fishing grounds, consist of: primary, secondary and tertiary fishing areas.

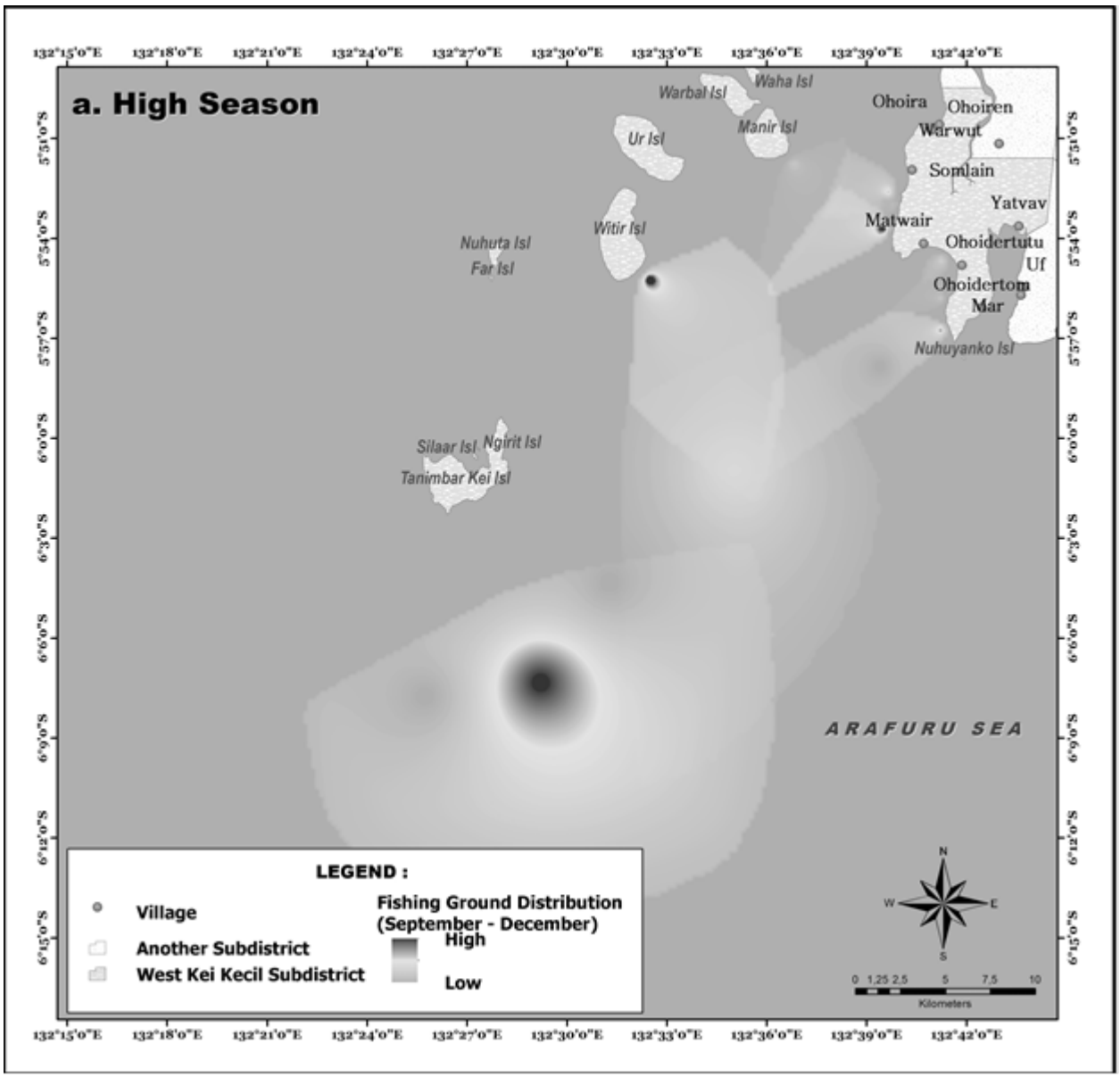

Figure 3a. Map of seasonal fishing ground distribution in the high season.

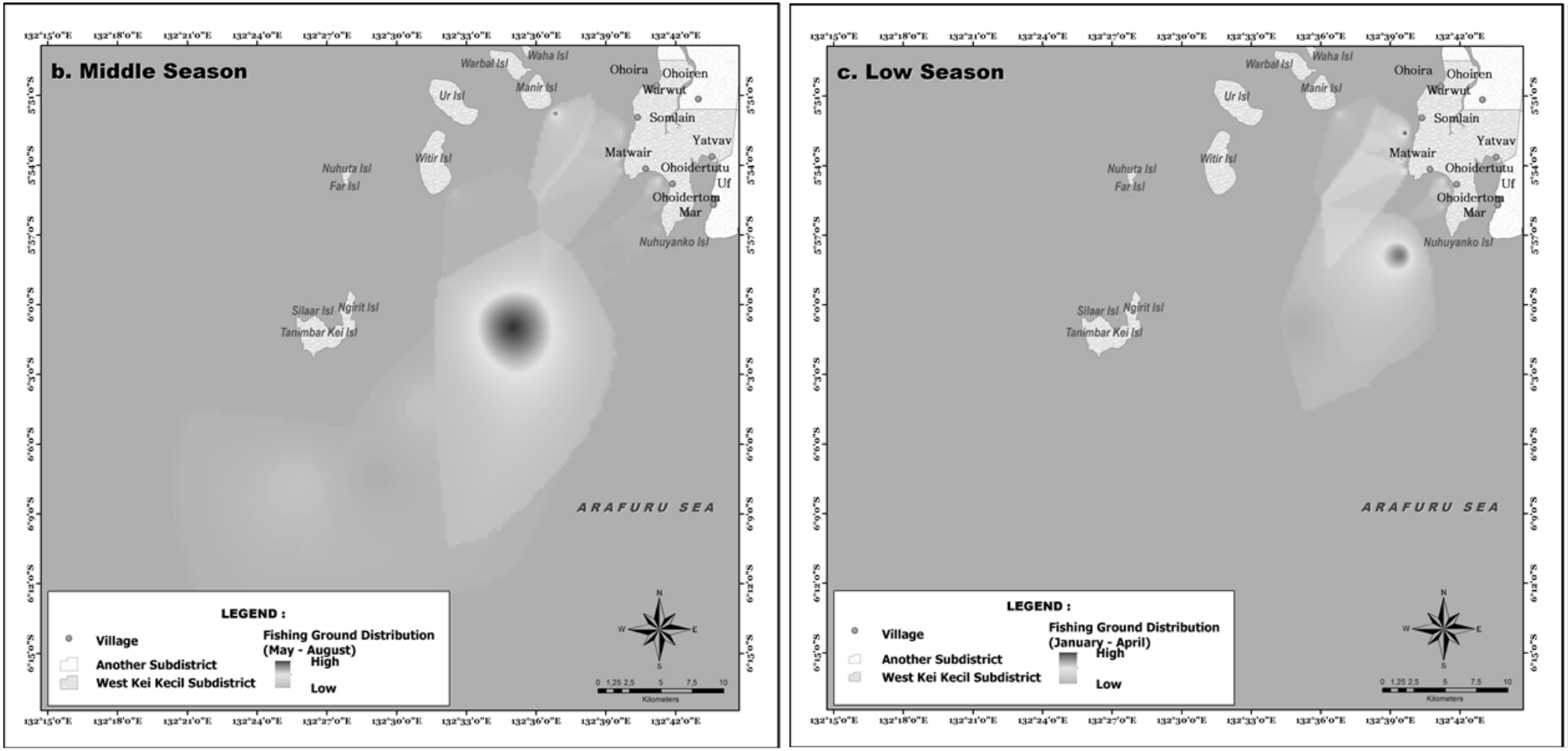

Figure 3b-c. Maps of seasonal fishing grounds distribution: b - middle season, c - low season.

The extent of each fishing ground levels vary seasonally (Table 2). First, the primary fishing ground contributes to the use of sea space between 5.16-6.01% of the total sea area in Kei Kecil Barat sub district, and the highest in low season. Second, in the secondary fishing ground, sea space utilization varies between 8.82-46.51%, the highest in peak season. Third, on the contrary of both, in tertiary fishing areas, the utilization of marine space ranges between 48.27-85.17%, the highest in the low season.

Table 2

Percentage distribution of sea space utilization used, based on fishing ground types by means of fishing season

Fishing ground types	*High season (ha)*	*%*	*Medium season (ha)*	*%*	*Low season (ha)*	*%*
Primary fishing ground	4,539.64	5.22	4,489.69	5.16	5,234.05	6.01
Secondary fishing ground	40,477.07	46.51	24,195.25	27.80	7,672.12	8.82
Tertiary fishing ground	46,551.93	48.27	62,833.75	67.04	79,356.88	85.17

In general, the results of spatial analyzes describing tertiary fishing grounds have wider space use patterns than other types of fishing grounds. This pattern occurs because of the habits of fishermen in the selection of fishing grounds in each fishing season. The habit of fishing in the same location is evidence of good local knowledge of the fishermen (Tidd et al 2015), so that the habitual approach, knowledge or experience of the fisherman is very important (Salas & Gaertner 2004).

Spatially, there is a shift fishing ground based on fishing season, whereas in peak season the fisherman has the farthest fishing ground distances from their village compared to the other season. This pattern gradually decreases until the low season where the fishing ground is relatively close to *ohoi* (village) location. The shift of the fishing ground is due to the seasonal factors, in the dry season (May to July) the waters of West Kei Kecil sub-district are calmer and less bumpy than in the rainy season (November to January).

Another finding is the determination of fishing ground by fishermen using the traditional way that is based on instinct or experience that is hereditary and also by the observation of the waters condition. The determination of fishing areas is also determined by the moon, rain and season (Limbong et al 2017). The spatial information of the fishing ground is important as well as information on fishing behavior and spatial fish distribution, also useful in improving fisheries management (Mundy 2012), and planning of fishing centers (Abrahamsz 2012).

Fishing activities, sea space utilization and zonation system of West Kecil Small Islands Park. Spatially, the utilization of space by fishermen has violated zonation in the conservation area of TPK Kei Kecil. Especially in the sub zone of tourism in TPK Kei Kecil island is the main fishing ground of the village fishermen of Matwair and Ohoidertutu. It does not differ much on the sub zone of the aquaculture and the core zones where both are also the main fishing ground of the Matwair and Somlain villagers. The result of the analysis shows that the largest use of sea space for fishing ground is in January - December in sub zone of tourism which is about 209.63-1,211.45 ha or around 7-40% of the sub zone of tourism. In January - August, fishermen even have their main fishing areas within the core zone of 3.85-4.26 ha or 25-27% of the core zone area. The extent of space use of fishing ground in each seasons is interconnected with the zonation of TPK Kei Kecil area (Table 3).

Table 3

Area Capture fishing area per season within zone and sub zone of region

Fishing season	*Core zone (15.67 ha)*		*Tourism sub zone (2,999.45 ha)*		*Mari-culture sub zone (1,244.16 ha)*	
	Space utilization (ha)	*%*	*Space utilization (ha)*	*%*	*Space utilization (ha)*	*%*
High season	0.00	0%	588.84	20%	1.02	0.1%
Medium season	4.26	27%	209.63	7%	1.31	0.1%
Low season	3.85	25%	1.211,45	40%	3.65	0.3%

Only 36% of respondents are aware that there is the conservation area in their village (ohoi) coastal and marine areas, while 64% of the respondents were unaware of any conservation areas in their coastal and marine areas. Several factors that influence the understanding of fishermen about conservation areas include the lack of conservation area boundaries, lack of community involvement in the formation of conservation areas and lack of socialization also contribute to the lack of public knowledge about conservation areas. The involvement of fishing communities and stakeholders in the establishment and determination of zoning of conservation areas is very important. Elliott et al (2001), Pollnac et al (2001) suggested that in determining the zonation system, it is necessary to involve all stakeholders. Santoso (2009) states that the steady management of a region requires the steadiness prerequisite of the status / legality of the region, includes the certainty of physical boundaries in the field, clearly on the map, legal and also known and recognized by the parties.

Conclusions. The utilization of sea spaces based on the distribution of fishing gear is dominated by gill and lines. The use of marine space based on fishing grounds, varies seasonally. Local fishermen categorize seasonal fishing areas based on the distribution of fish catches, includes: high season from September to December, middle season from May to August, and low season from January to April. There are three types of fishing areas based on the intensity of space use, covering on primary, secondary and tertiary fishing areas. Tertiary fishing areas have wider space use patterns than other types of fishing areas. In the low season, fishermen tend to enter core zones, sub-zones of tourism and aquaculture for fishing purposes, means that local fishermen have violated the zonation system on TPK Kei Kecil Island.

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References

Abrahamsz J., 2012 Spatial dynamic model of fishery system: case of small pelagic fisheries area development at Central Mollucas Regency. Dissertation, Bogor Agricultural University, Bogor, 375 p. [In Indonesian].

Bennet N. J., Dearden P., 2014 Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. Marine Policy 44:107–116.

Christie P., 2004 Marine protected areas as biological successes and social failures in Southeast Asia. American Fisheries Society Symposium 42:155–164.

Dangeubun F. D. W., Wiryawan B., Mustarudin, Purbayanto A., 2011 [Management and impact of conservation in the southeast Aru]. Jurnal TRITON 7(2):49-60. [In Indonesian].

Elliott G. P., Merton D. V., Jansen W. P., 2001 Intensive management of a critically endangered species: The Kakapo. Biological Conservation 99:121-133.

Fulton E. A., Smith A. D. M., Punt A. E., 2005 Which ecological indicators can robustly detect effect of fishing? ICES Journal of Marine Science 62:540-551.
Halpern B. S., 2003 The impact of marine reserves: Do reserves work and does reserve size matter? Ecological Applications 13(1):117–137.
Hiddink J. G., Hutton T., Jennings S., Kaiser M. J., 2006 Predicting the effects of area closures and fishing effort restrictions on the production, biomass, and species richness of benthic invertebrate communities. ICES Journal of Marine Science 63:822–830.
Indarto, Faisol A., 2012 [The basic concept of spatial analysis]. Andi Publisher, Yogyakarta, Indonesia, 180 p. [In Indonesian].
Jennings S., 2009 The role of marine protected areas in environmental management. ICES Journal of Marine Science 66:16–21.
Jenisa F., 2016 [Geographic information system application practicum]. Faculty of Social Science, State University Padang, Padang, pp. 1-2. [In Indonesian].
Limbong I., Wiyono E. S., Yusfiandayani R., 2017 [Factor affecting the production of purse seine unit in fishing base Sibolga Fishing Port, North Sumatera]. Albacore 1(1):89-97. [In Indonesian].
Mustaruddin, Simbolon D., Handoyo K., 2012 [Development of management information system of fishery capture resources and environment in Padang Pariaman Regency, West Sumatra]. PSP Bulletin 20(2):143-154. [In Indonesian].
Prasasti I., Wijayanto H., Christanto M., 2005 [The analyzes of application of Krigging and Inverse Distance Method for interpolation of temperature, precipitable water, atmospheric stability index Using NOAA-TOVS Data]. MAPIN XIV Annual Scientific Meeting, Sepuluh Nopember Institute of Technology, Surabaya, pp. 316-322. [In Indonesian].
Pollnac R. B., Crawford B. R., Gorospe M. L. G., 2001 Discovering factors that influence the success of community-based marine protected areas in the Visayas, Philippines. Ocean and Coastal Management 44:683–710.
Rahman A., Mansyur A., 2016 [Conformity utilization of waters for aquaculture development in the Staring Bay Area Konawe Selatan District]. Fisheries Business Journal FPIK UHO 3(1):31-48. [In Indonesian].
Randan N., 2011 [Impact analysis of marine conservation areas establishment on the fishers socio economic condition. Essay, Bogor Agriculture Institute, Indonesia. [In Indonesian].
Rivai A. A., Siregar V. P., Agus S. B., Yasuma H., 2017 [Potential fishing ground mapping based on gis hotspot model and time series analysis: a case study on lift net fisheries in Seribu Island]. Journal of Tropical Marine Science and Technology 9(1):337-356. [In Indonesian].
Rizal S. L., 2015 [Perception of fishermen society on regional marine conservation area (KKLD) Gili Sulat - Gili Lawang Sambelia District, East Lombok Regency]. GaneÇ Swara 9(1):192-195. [In Indonesian].
Salas S., Gaertner D., 2004 The behavioral dynamics of fishers: management implications. Fish and Fisheries 5:153–167.
Santoso P., 2009 [The importance of the limits of the conservation area of Indonesian waters and the preparation of human resources]. Pp. 1-9. [In Indonesian].
Santoso D., 2011 [Fisheries based marine watershed management model (KKP) to improve fisherman's catch results - A theoretical approach]. Proceedings of the National Seminar on the Development of Small Islands 2011, pp. 111-118. [In Indonesian].
Tidd A. D., Vermard Y., Marchal P., Pinnegar J., Blanchard J. L., Milner-Gulland E. J., 2015 Fishing for space: fine-scale multi-sector maritime activities influence fisher location choice. PLOS ONE 10(3): e0121498. https://doi.org/10.1371/journal.pone.0121498.
*** Centre Bureau of Statistics of South East Maluku District, 2016 [Kei Kecil Barat Subdistrict in Figures]. [In Indonesian].
*** Decree of The Minister of Marine and Fisheries Number 6/KEPMEN-KP/2016 Coastal conservation regions and small islands, Kei Kecil Islands, Islands, and their

arrangements In The Maluku Tenggara Regency, Maluku Province. Jakarta. Pp. 1-5. [In Indonesian].
*** Government Regulation Number 60, 2007 Regulation concerning conversation of fish resources. State Gazette of the Republic of Indonesia 2007 No. 134. State Secretariat, Jakarta. [In Indonesian].

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Authors:
Marvin Mario Makailipessy, Fisheries of Polytechnic, Department of Fishing Technology, Indonesia, Tual, Jl. Raya Langgur – Sathean, Km 6 Kabupaten Maluku Tenggara, 97611, e-mail: mariomarvin.mm@gmail.com
Imanuel Musa Thenu, Fisheries of Polytechnic, Department of Fishing Technology, Indonesia, Tual, Jl. Raya Langgur – Sathean, Km 6 Kabupaten Maluku Tenggara, 97611, e-mail: i.m_thenu@yahoo.com
James Abrahamsz, Pattimura University, Faculty of Fishery and Marine Science, Department of Aquatic Resource Management, Indonesia, Jl. Mr. Chr. Soplanit Kampus Poka Ambon, 97233; Pattimura University, Learning Center of Ecosystem Approach to Fisheries Management Indonesia, Jl. Mr. Chr. Soplanit Kampus Poka Ambon, 97233, e-mail: abrahamsz_amq@yahoo.com; james.abrahamsz@fpik.unpatti.ac.id

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