



# The effectiveness of the zoning system in the management of reef fisheries in the marine protected area of Karimunjawa National Park, Indonesia

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**Abstract.** Karimunjawa National Park (KNP) is a nature conservation area which has an original ecosystem and a highly diverse coral reef. The management of fisheries in KNP uses the zoning system and regulation of fishing gear. This article was written to explain the effectiveness of the zoning system in the management of reef fisheries. The study was conducted in KNP in Jepara Regency, Central Java Province between April and September 2015. The data were collected using the survey method, including both primary and secondary data. The respondents were reef fishers who live in Karimunjawa and Kemujan villages, chosen randomly and numbered 94 people. Secondary data were obtained from the Wildlife Conservation Society (WCS) and KNP Authority. The data analysis was done descriptively. The effectiveness of the zoning system was measured from the fishers perception of the zoning, their compliance level, and the number of zoning law violations. The results of this study indicated that most of the fishers (65.95%) state that zone markers are not clearly visible, making it difficult for them to differentiate it. A percentage of 52.13% and 65.96% of the fishers did not reprimand and did not report other fishers who caught fish in the core and protection zones to the KNPA. The fishers compliance level in average was 78.56%. The trend of cases concerning zoning and fishing gear infringements rose linearly between 2002 and 2014. There needs to be more intensive efforts to educate the public about the core and protection zones to build the fishers awareness.

**Key Words:** fishers perception, compliance level, infringement cases, zoning, fishing ground.

**Introduction.** The government of Indonesia has declared a number of coral reef ecosystems as Marine Protected Areas (MPA) in line with the mandate stated in UU (Indonesian Law) No. 5 1990 (Atmaja & Nugroho 2011). The main purpose of declaring MPAs is in accordance to conservation purposes, protecting biodiversity and the ecosystem to ensure the preservation of the function of habitats for fish resources (Nainggolan et al 2013). A number of benefits of the presence of MPAs for local fishers are an increase in fisheries productivity and fish biodiversity, habitat protection, and management of coastal and marine resources (Ulloa et al 2013). MPAs are implemented in phases in the world seas and oceans to protect marine and fisheries resources (Velez et al 2014). All countries develop MPAs due to the concern for the depletion of marine species. However, government each country acts in different ways because of differences in governing systems, public involvement, and role of science (Osmond et al 2010). In the context of the combination between management efforts and regulations, MPAs are an important tool for achieving global coral reef conservation (Allen et al 2011).

The Karimunjawa National Park (KNP), a nature reserve which has an original ecosystem and a richly diverse coral reef, is managed by Karimunjawa National Park Authority (KNPA). The declaration of KNP had a number of purposes: research, knowledge, education, cultural support, recreation, and tourism. At first, the

Karimunjawa area was declared as the Karimunjawa Marine Natural Reserve on April 9, 1986 by the Minister of Forestry (Ministry of Forestry Decree No. 123/Kpts-II/1986) covering an area of 111,625 ha. Then there was a shift in function from a Strict Natural Reserve to National Park, referred to as KNP under the Ministry of Forestry and Plantation Decree No. 78/Kpts-II/1999 on February 22, 1999. In 2001, all marine waters of KNP were designated as a marine conservation area by the Ministry of Forestry Decree No.74/Kpts-II/2001 (KNPA 2014; Campbell et al 2013). The KNP area is divided into nine zones which have different functions and allocations. This zoning system is described in the Director General of Forest Protection and Nature Conservation's Decree Number 28/IV/Set/2012. Those zones are: core zone 444.63 ha; forest zone 1,451.77 ha; marine protection zone 2,599.77 ha; land utilization zone 55.99 ha; marine tourism utilization zone 2,733.74 ha; mariculture zone 1,370.73 ha; religious, cultural, and historical zone 0.86 ha; rehabilitation zone 68.33 ha; traditional fisheries zone 102,899.25 ha (KNPA 2014).

Fishers who live within the KNP who conduct fish catching activities as their main livelihood. In order to create a synergy between the conservation purposes and fishing goals, the KNPA manages the national park using the zoning system to reach ecosystem sustainable. The establishment of a core zone and a protection zone is important in protecting the marine and fisheries resources (Velez et al 2014; Leleu et al 2012). Later, fisheries management developed by including the social aspect the ecological aspect (Caddy 1999). The fishers compliance to the zoning system will determine the success of fisheries management.

This article aims to explain the effectiveness of the zoning system in managing reef fisheries by analyzing the application of the zoning system, the fishers perception of the zoning system and fish resources, the fishers compliance level to the zoning system, and the number of infringements.

## Material and Method

**The location and the time of study.** This study was conducted in KNP in Jepara Regency, Central Java Province, Indonesia between July and September 2015.

**Tipes and sources of data.** Data were collected using surveys and observations, and included primary and secondary data. The primary data collected were the fishers characteristics, the fishers perception of the zoning system and fish resources, and the location of fishing grounds. The collection of primary data about the fishers characteristics was done using questionnaires with close-ended questions (Table 1), and the fishers perception was collected using questionnaires with close-ended questions and the Likert scale (Table 2 and 3).

Table 1

The questionnaires using collecting data of fishers characteristics

<i>Questions</i>	<i>Possible answers</i>
How old are you?	a. 21-30 year; b. 31-40 year; c. 41-50 year; d. >50 year
What is your formal education?	a. Elementary school; b. Junior high school; c. Senior high school
What is your position in fishing team?	a. Owner; b. Boat hand
What is number of dependents?	a. 0-2 persons; b. 3-4 persons; c. 5-6 persons
How many years have you been fishing?	a. ≤10 years; b. 11-20 years; c. 21-30 years; d. >30 years
What is your fishing gear?	a. Nets; b. Hook-and-lines; c. Spearguns; d. Traps

Table 2

The questionnaires using collecting data of fishers perception about zoning

<i>Statement</i>	<i>Code</i>	<i>Possible agreement</i>
I understand the zoning division in the KNP	A11	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
I receive information of the zoning division in the KNP from public education	A12	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
The purpose of the zoning is to protect biodiversity and their ecosystems	A13	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
Zoning is beneficial for fishers	A14	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
Zone names and the boundaries are clear	A15	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
I catch fish only in the traditional fishery zone	A17	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
There are other fishers who catch fish in the core and protection zones	A18	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
I reprimand other fishers who catch fish in the core and protection zones	A19	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
I report the fishers who catch fish in the core and protection zones to the KNPA authorities	A110	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree

Table 3

The questionnaires using collecting data of fishers perception about fish resources

<i>Statement</i>	<i>Code</i>	<i>Possible Agreement</i>
The size of the fish caught is decreasing	A21	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
The size of the catch is declining	A23	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
The fishing ground are moving farther away	A24	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
The reef fish need to be conserved so that they can be utilized by the following generations	A210	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree
The health of the coral reef will affect the number of reef fish	A211	1. Strongly disagree; 2. Disagree; 3. Abstain; 4. Agree; 5. Strongly agree

The scores used were 1 = strongly disagree; 2 = disagree; 3 = abstain; 4 = agree; 5 = strongly agree. The instruments were tested on 30 respondents. All respondents were reef fishers who live in Karimunjawa and Kemujan villages, sampled randomly and numbered 94 individuals totally for data collection. The population of fishers was 2,633 individuals (PPP Karimunjawa 2014). To complement questionnaires, the head of the National Park Management Section (SPTN) II Karimunjawa and a number of fisher elders were interviewed. The secondary data were courtesy of the Wildlife Conservation Society (WCS) Indonesia Marine Program in the form of catch and number of trips per zone. The data for the number of zoning and fishing gear infringements were courtesy of the KNPA.

**Data analysis.** The instrument validity and reliability was tested using Pearson correlation and Cronbach Alpha. Furthermore, the confirmatory factor analysis is conducted to measure the questionnaire dominant influence on the perception of respondents about zoning and fish resources. The effectiveness of the zoning system was measured from the fishers perception of zoning, the fishers level of compliance to the

zoning system, and the number of zoning infringements. The fishers perception was analyzed descriptively through the display of tables, graphs, and descriptions. To calculate the fishers compliance level, this equation, which had been used by the KNPA (2013a), was used:

$$KT_{(i/p)} = 100 - \left[ \frac{KZ_{(i/p)}}{TK} \right] \times 100$$

Where:

KT<sub>(i/p)</sub> : compliance level (i = core zone; p = protection zone)

KZ : The number of registered boats operating in the core zone (i) or the protection zone (p) in year

TK : The total number of boats surveyed in year

Furthermore, the level of compliance of fishers and the number of infringement cases were analyzed descriptively, to see trends and changes every year.

## Results and Discussion

**Zoning system.** In order to educate the Karimunjawa communities, KNPA has conducted intensive socialization of zoning and benefits (Widyatmoko et al 2012). However, based on interviews with fishers, not all of fishing activities have been conducted in the right zone. The fishing grounds based on the results of interviews with the fishers can be seen in Figure 1.

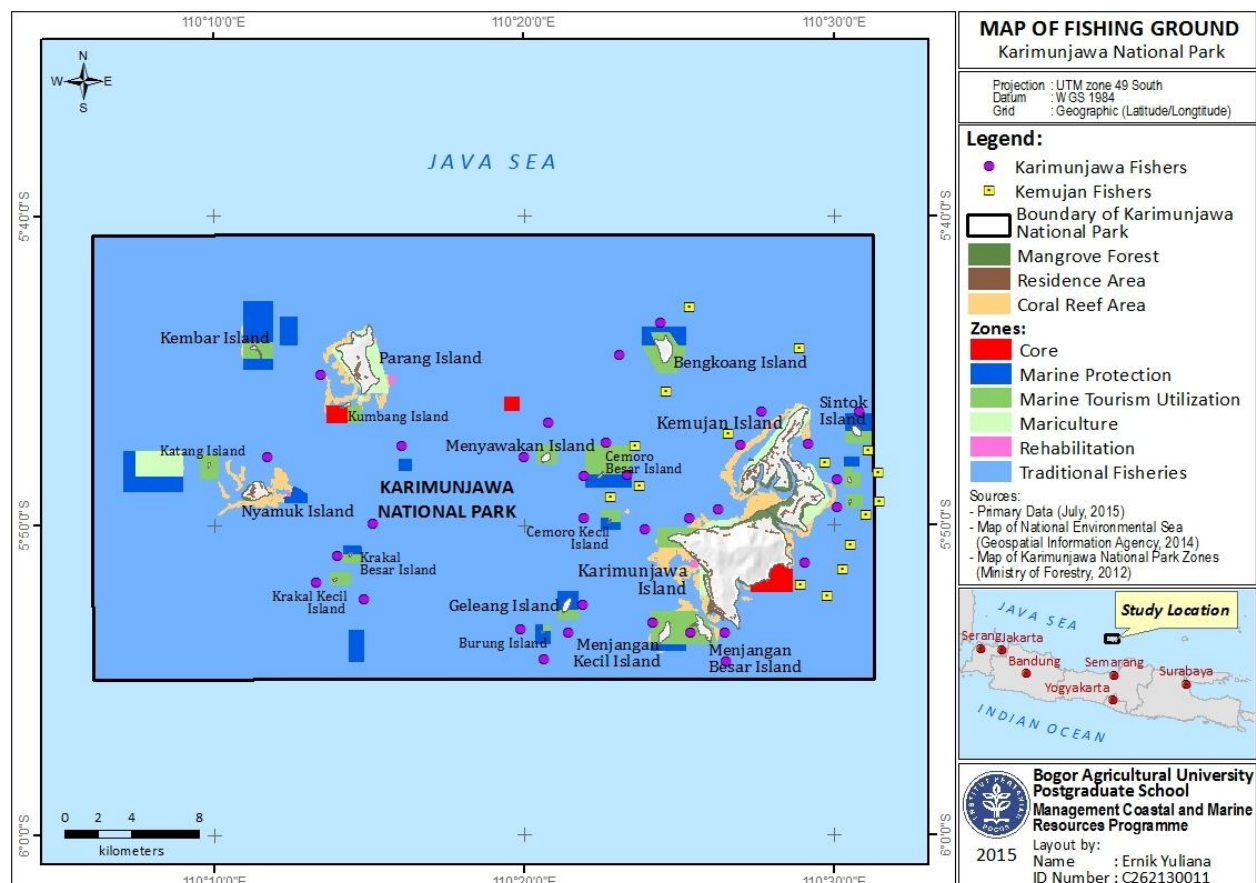


Figure 1. The fishers of Karimunjawa and Kemujan villages fishing grounds.

It can be seen in Figure 1 that the fishing grounds of the fishers from Karimunjawa village are more wide-spread than those of the fishers from Kemujan Village. This is because the fishers from Kemujan Village mostly use non-motorized boats, limiting their reach to the waters immediately surrounding Kemujan and Karimunjawa islands. In

contrast, the fishers from Karimunjawa already use motorized boats, at least with one motor, allowing them to go further into the KNP, and even outside of the national park. Some fishing grounds are very close to and even being inside the protection zone, for example on the Sintok Island, Geleang Island, and Bengkoang Island.

**The fishers characteristics.** The fishers are those who interact the most with the sea; therefore, their involvement in the conservation of KNP is of utmost importance. The involvement of fishers will be maximum if the fishermen have a good perception of zoning and MPA. Bennett & Dearden (2014) demonstrated that the success of a conservation area is strongly affected by the involvement of the local people and the management of the MPA. The fishers perception and knowledge of the zoning system is closely related to the fishers characteristics (Kincaid et al 2014). A complete description of the respondents characteristics is presented in Table 4.

Table 4

Characteristics of the respondent individuals

<i>The respondents characteristics</i>	<i>Number (persons)</i>	<i>Percentage (%)</i>
Age (years)		
a. 21-30	30	31.91
b. 31-40	28	29.79
c. 41-50	27	28.72
d. >50	9	9.57
Education		
a. Elementary school	75	79.79
b. Junior high school	2	18.09
c. Senior high school	17	2.13
The fishers' position		
a. Owner	70	74.47
b. Boat hand	24	25.53
Number of dependents		
a. 0-2 persons	41	43.62
b. 3-4 persons	51	54.26
c. 5-6 persons	2	2.13
Experience as a fisher (years)		
a. ≤10	27	28.72
b. 11-20	30	31.91
c. 21-30	25	26.60
d. >30	12	12.77
Fishing gear		
a. Nets	8	8.51
b. Hook-and-lines	47	50.00
c. Spearguns	27	28.72
d. Traps	12	12.77

It shows in Table 4 that the majority of the respondents are less than 40 years old (61.70%). This is within the productive age, because the profession requires physical fitness to be able to catch fish at sea. Most of the respondents (79.79%) had only attended elementary school, a common finding in fishers. Also, most of the respondents (70%) are the owners of their own vessels with a majority of 3-4 dependents (54.26%), and the majority has had 11-20 years experience as fishers. Half of the respondents (50.00%) are hook-and-line fishers.

The fishers should already have a good perception and knowledge of the fisheries management system in KNP, including the zoning system. They were involved as one of the parties in the planning of the zoning system (2003-2005) which produced the changes in zoning (2012) and policies in KNP (Campbell et al 2013). Analysis of the

fishers perception could be used as an indicator of the fishers social acknowledgement of a national park zoning and management (Leleu et al 2012).

**Instrument analysis.** The results of validity and reliability test of the instrument are presented in Table 5. All of 9 statements to identify the perceptions of respondents about zoning were valid and reliable. Also all of the 5 statements to identify respondents perception of the fish resources were tested as valid and reliable, too.

Table 5

The results of validity and reliability test of the instrument

Statement code	Validity		Reliability	
	<i>r</i> -count > <i>r</i> -table (0.361)	Conclusion	Cronbach Alpha > 0.6	Conclusion
A11	0.739	Valid		
A12	0.620	Valid		
A13	0.615	Valid		
A14	0.689	Valid		
A15	0.597	Valid	0.802	Reliable
A17	0.479	Valid		
A18	0.729	Valid		
A19	0.682	Valid		
A110	0.468	Valid		
A21	0.805	Valid		
A23	0.729	Valid		
A24	0.734	Valid	0.623	Reliable
A210	0.531	Valid		
A211	0.366	Valid		

**The fishers perception of zoning and fish resources.** The results of confirmatory factor analysis on instruments of fishers perception about zoning are presented in Figure 2.

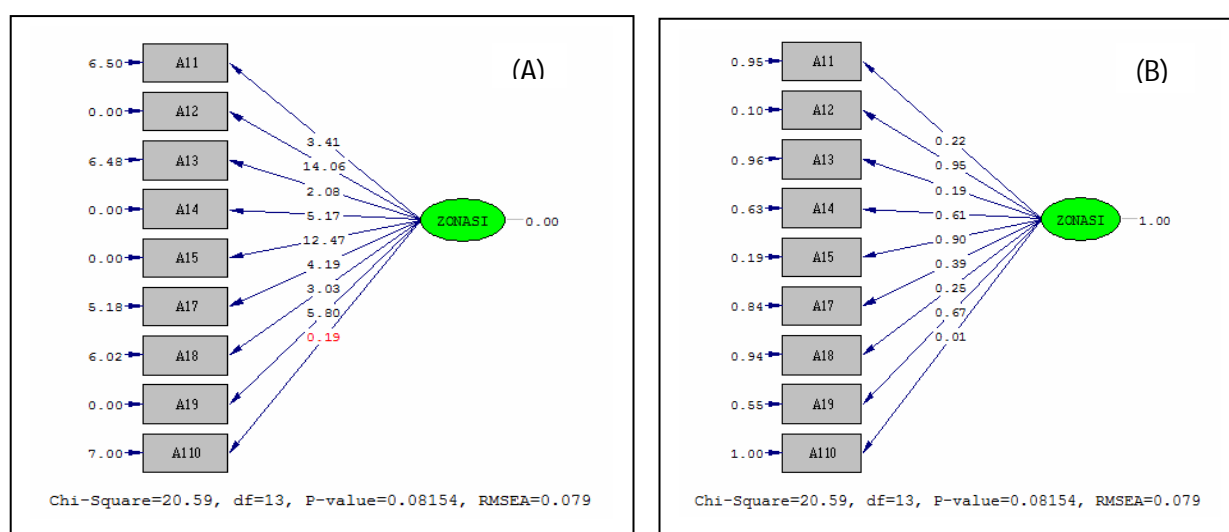


Figure 2. The tests result of confirmatory factor analysis of the respondents perception about zoning.

Eight statements are significant ( $t\text{-count} > t\text{-table } 1.96$ ) to describe the perceptions of respondents about zoning, but statements A110 (Reporting the fishers who catch fish in the core and protection zones to the KNPA authorities) not significant with  $t\text{-count } 0.19 < t\text{-table } 1.96$  ( $\alpha = 0.05$ ) (Figure 2A).

Among them, the statement that has the greatest effect on the respondent's perception of zoning is A12 (the fishers received information of the zoning division in the KNP from public education). Meanwhile the statement that has the lowest loading factor value is A110. Extension of TNKJ to fishers is important, as evidenced by the high value of loading factor of the statement about it. The tests result of goodness of fit of the model produces good criterion for  $RMSEA < 0.08$  and  $P\text{-value} > 0.05$  (Figure 2B).

The results of descriptive analysis of the fishers perception about zoning are presented in Table 6. There is 81.91% of the fishers are aware of the zone divisions in KNP, mostly from public education efforts (63.83%).

Table 6

The fishers perception of the KNPs zoning system

<i>Statement</i>	<i>Strongly disagree (%)</i>	<i>Disagree (%)</i>	<i>Abstain (%)</i>	<i>Agree (%)</i>	<i>Strongly agree (%)</i>	<i>Total (%)</i>
Understand the zoning division in the KNP	2.13	10.64	5.32	64.89	17.02	100
Received information of the zoning division in the KNP from public education	8.51	20.21	7.45	48.94	14.89	100
The purpose of the zoning is to protect biodiversity and their ecosystems	2.13	8.51	14.89	58.51	15.96	100
Zoning is beneficial for fishers	4.26	13.83	10.64	63.83	7.45	100
Zone names and boundaries are clear	31.91	34.04	6.38	18.09	9.57	100
Catching fish only in the traditional fishery zone	3.19	21.28	5.32	61.70	8.51	100
There are other fishers who catch fish in the core and protection zones	3.19	22.34	13.83	56.38	4.26	100
Reprimand other fishers who catch fish in the core and protection zones	0.00	52.13	24.47	21.28	2.13	100
Report the fishers who catch fish in the core and protection zones to the KNPA authorities	3.19	62.77	10.64	20.21	3.19	100

The results were in line with the statement of the head of the SPTN II Karimunjawa during interview, that public education about the core and protection zones has been conducted by the KNPA through various media, i.e. leaflets, banners, and songs recorded on compact discs (CDs), mobile phone short messages, direct lectures and discussions through visits to the fishers. After 2010, the extension was also done by the KNPA to fishers outside of Karimunjawa, fishers in Rembang, Jepara, Tegal, and Kendal regencies. As mentioned by Campbell et al (2013), the KNPA has done much to build the fishers awareness of fishery regulations and also their perception of fish resources as a result of the tourism industry and other industries.

A majority of the respondents (74.47%) understood the purpose of the zoning and 71.28% of the respondents acknowledged that the zoning is beneficial for them. This is supported by the results of the study by Leleu et al (2012) which found that fishers admit there are economic benefits they received as a result of the establishment of the core

and protection zones. However, the majority of the respondents (65.95%) claimed that the zone boundaries were not clear, making it difficult to differentiate between the core and protection zones and other zones. The ambiguity of the zone boundaries has triggered zone trespassing and fishing gear infringements. At the other hand, only 70.21% of the respondents claimed that they catch fish purely in traditional fishing zones; the others said that they also fishing in another zones. This is surprising because the head of the SPTN II Karimunjawa stated that the traditional fishing zones cover 92% of the KNP; therefore, local fishers can catch fish in these zones without disturbing the core and protection zones.

Self-surveillance among fishers is still not effective. This is apparent by the fact that the majority of respondents (52.13%) do not reprimand and 65.96% of the respondents do not report other fishers who catch fish in the core and protection zones. There is still need many efforts to build the fishers awareness in marine surveillance. Once the fishers awareness of surveillance is improved, collaborative surveillance (Rees et al 2013) between KNPA and the people could be established; because the surveillance is not only KNPA's responsibility but also a shared responsibility between the KNPA and the local people.

To understand the fishers perception of zoning, an analysis of the fishers perception of fish resources was conducted. The tests results of confirmatory factor analysis on instruments of fishers perception about fish resources are presented in Figure 3.

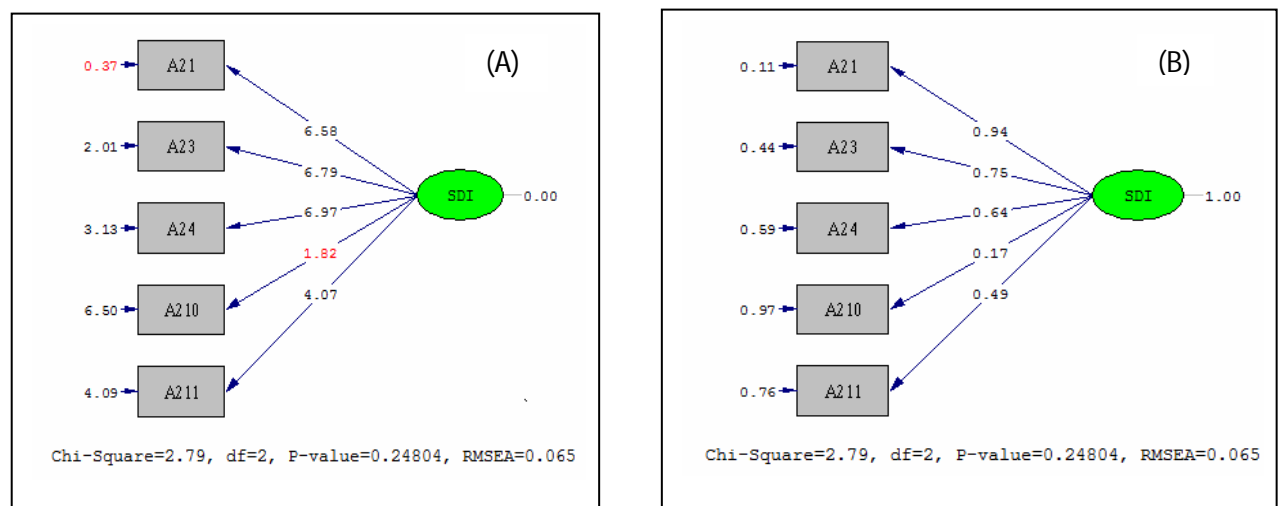


Figure 3. The tests results of confirmatory factor analysis on instruments of fishers perception about fish resources.

It can be seen at Figure 3 that four statements are significant ( $t\text{-count} > t\text{-table } 1.96$ ) to describe the latent variables, namely the fishers perception about fish resources, except the statement A210 (the reef fish need to be conserved so that they can be utilized by the following generations) that has  $t\text{-count} < t\text{-table}$  (Figure 3A). From the results of the identification of fishers perceptions, most respondents considered that the fish resources do not need to be saved, because it is a gift from God that should be utilized as much as possible. This was in line with the result of study by Winata & Yuliana (2010) that fishers had a low perception on fisheries resources conservation. The statement that has the greatest loading factor value is A21 (the size of the fish caught is decreasing), with the value of 0.94, the statement that has the lowest loading factor is A210. The value of RMSEA model  $< 0.08$  and  $P\text{-value} > 0.05$ , that means the model meets the criteria of goodness of fit (Figure 3B).

The results of descriptive analysis of the fishers perception about fish resources are presented in Table 7. It can be seen that most of the respondents (86.17%) have noticed that the size of the reef fish caught nowadays has become smaller, as the fish



size is an indicator for determining fish biomass (Sparre & Venema 1999), such result shows that the reef fish biomass in the ocean has decreased. This discovery was supported by the confessions of the respondents (84.05%) that the size of their catches has decreased and that the fishing grounds have moved farther away (41.49%). The fishers perception is in line with the results of the study by Campbell et al (2013) who suggested that there has been a decrease in reef fish biomass between 2005 and 2009 as a result of the fishers weak compliance in the zoning due to their poverty.

The fishers knowledge of reef fish resources conservation is quite good, because 58.51% of the respondents are aware that the resources need to be conserved for the sake of the future generations (Table 7). However, this knowledge is not realized by fishing practices that consider zoning (KNPA 2013a). Most of the respondents (89.36%) also admit that the health of the coral reef affects the abundance of reef fish and reef fish resources. These two findings were in line with the results of the study by KNPA (2013a) which suggested that the increase in the fishers knowledge did not have a positive correlation with the fishers compliance level to the zoning system, because the increase in their knowledge was not followed by not catching fish in the core and protection zones.

Table 7

The fishers perception of fish resources

<i>Statement</i>	<i>Strongly disagree (%)</i>	<i>Disagree (%)</i>	<i>Abstain (%)</i>	<i>Agree (%)</i>	<i>Strongly agree (%)</i>	<i>Total (%)</i>
The size of the fish caught is decreasing	1.06	9.57	3.19	62.77	23.40	100
The size of the catch is declining	2.13	11.70	2.13	57.45	26.60	100
The fishing ground are moving farther away	7.45	31.91	19.15	27.66	13.83	100
The reef fish need to be conserved so that they can be utilized by the following generations	7.45	25.53	8.51	51.06	7.45	100
The health of the coral reef will affect the number of reef fish	2.13	6.38	2.13	45.74	43.62	100

**The fishers compliance level to the zoning system.** The analysis of the fishers compliance level to the zoning system based on the number of fishing trips in core and protection zone and the number of zoning law violations handled by the KNPA, both those processed by the law and by counseling. The numbers of fishing boats and trips in 2013 are presented in detail in Table 8.

Table 8

The number of fishing boats and trips in KNP in 2013 (Source: KNPA 2013a)

<i>Aspect</i>	<i>Zone</i>		
	<i>Core</i>	<i>Protection</i>	<i>Utilization</i>
Average number of trips per day	3.25	12.25	-
Number of boats operating per day	35	39	839
Catching equipment	Hook-and-line Trap	All fishing gear	All fishing gear

The KNPA surveillance report (2013a) presented in Table 8 explains that some boats still catch fish in the core and protection zones. From the average number of boats operating daily (839 boats), there were 24 boats which used trawl nets.

The fish catches in each zone is presented in Figure 4. It can be seen that there are fish-catching activities in the core and protection zones between 2010 and 2014. All fishing activities are prohibited in these two zones because the core and protection zones play an important role in exporting eggs and larvae from spawning and exporting fish biomass (spill over) to areas outside of the core and protection zones (Leleu et al 2012). There is a concern that fish-catching activities in the core zone will damage the coral reef which should be protected as nursery, feeding, and spawning grounds (Kenchington & Day 2011; Naingolan et al 2013).

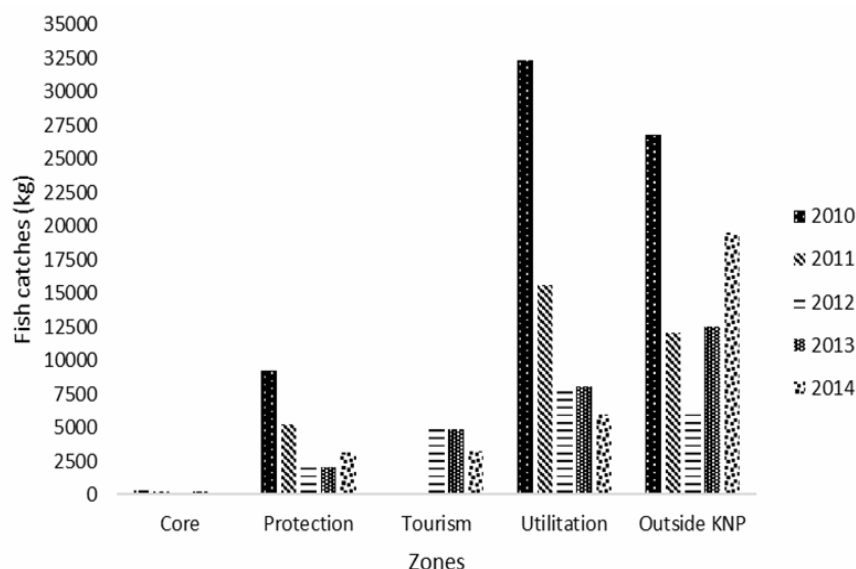


Figure 4. The fish catches in each KNP zone in the period 2010-2014 (Source: WCS 2013).

The number of fishing trips was observed and is presented in Table 9. The average level of the fishers compliance to the core and protection zone is 78.56%, lower than the compliance level in the period 2009-2011 which was 84.87% (KNPA 2013b). It can be concluded that 21.44% fishers did not comply with the zoning laws. When compared to the results presented in Table 2, that 12.77% of the fishers were not aware of the zoning system. It means that some of the fishers (8.67%) who did not comply actually were aware of the zoning system. Most of the fishers still believe that economic goals are the most important, causing them to ignore the zoning system.

Table 9  
The number of fishing trips to the core and protection zones and the fishers compliance level in the period of 2010-2014 (Source: WCS 2013)

Year	Trips to core zone	Trips to protection zone	Total number of trips	Compliance level (%)
2010	23	216	1116	78.58
2011	9	169	807	77.94
2012	0	105	611	82.82
2013	10	111	507	76.13
2014	6	96	450	77.33
Average				78.56

The compliance level trend was measured from 2010 to 2014 and the results are presented in Figure 5. There was a rise in compliance level between 2010 and 2012, and then it fell between 2012 and 2014. This demonstrates that the implementation of the zoning system is not yet effective in managing the fishers fish-catching activities.

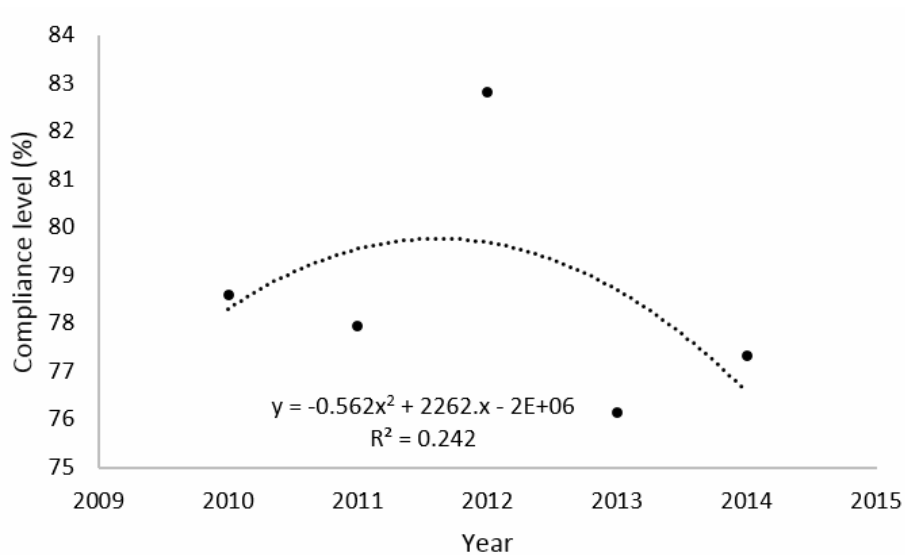


Figure 5. The fishers compliance level trend in the period 2010-2014 (Source: WCS 2013).

The CPUE analysis of the core and protection zones was conducted to observe the development of catch per trip (fishing efforts) and the results are presented in Figures 6 and 7.

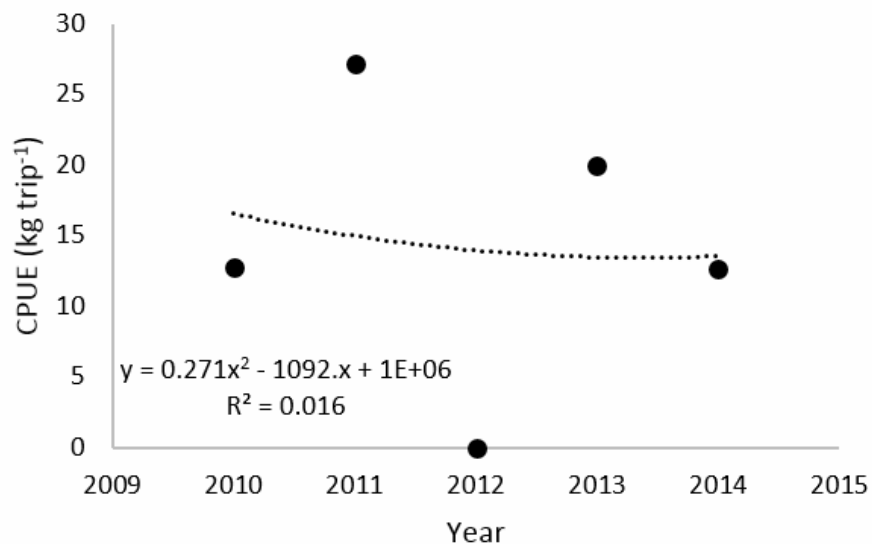


Figure 6. The CPUE of the core zone in the period 2010-2014 (Source: WCS 2013).

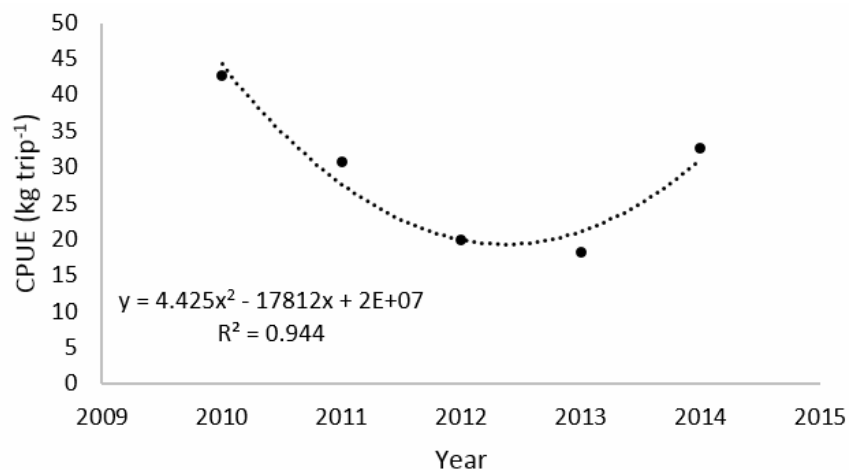


Figure 7. The CPUE of the protection zone in the period 2010-2014 (Source: WCS 2013).

It can be seen in Figure 6 and 7 that the CPUE trend in the core zone is falling between 2009 and 2012, and then rising between 2013 and 2014. This demonstrates that the fish biomass in the core zone has started to recover in 2013 after the decrease the previous year. The number of fishing trips has constantly decreased between 2010 and 2012 (Table 8), giving a chance for the fish biomass to recover between 2013 and 2014. The decrease in the reef fish biomass as a result of coral reef habitat damage because 70% of the people in Karimunjawa practice artisanal fishery. Moreover, mariculture activities have caused the decrease in fishery resources in the last 20 years. Some of the fishers still use potassium even though this destructive fishing practice has been banned by the Karimunjawa National Park Authority (Campbell et al 2013).

**Zoning and fishing gear infringement cases.** Fishing activities in the core and protection zones are strongly related to the surveillance by the KNPA. Table 10 presents the number of zoning and fishing gear violation cases handled by the KNPA. The infringements are divided into cases processed by law, processed by counseling, and the moving/removal of zone markers. Based on the results of an interview with the head of SPTN II Karimunjawa, the cases that were processed by law were the ones by repeat-offenders, local Karimunjawa fishers who had been apprehended three times. Fishers who come from outside of Karimunjawa that had committed zoning and fishing gear infringements within the park could immediately be processed by law. The leniency demonstrated for the local Karimunjawa fishers is meant to reduce institutional friction between KNPA as the national park authority and the locals. It is hoped that KNPA could collaborate with the local community harmoniously.

Table 10

The number of zoning and fishing gear infringements (Source: KNPA 2013b)

Year	Number of cases			Total
	Legal process	Counseling	Zone marker moving/removal	
2002	2	-	-	2
2003	0	-	-	0
2004	2	-	-	2
2005	0	-	-	0
2006	2	-	-	2
2007	0	1	-	1
2008	0	0	-	0
2009	2	2	-	4
2010	2	3	-	5
2011	1	4	-	5
2012	0	5	-	5
2013	3	2	8	13
2014	0	4	3	7
Average				3.54

It can be see in Table 10 that the trend in the number of zoning and fishing gear infringements is rising, suggesting that the fishers awareness is still low, similar to that of the fishing gear. KNPA (2013b) explains that infringements involving fishing gear are usually committed by fishers from outside Karimunjawa who usually use trawls to catch fish within KNP. Zoning infringements are usually committed by Karimunjawa fishers using traditional fishing gear. These offenses are serious infringements because the buoys serve to warn the fishers that certain areas are no-take zones. The absence of markers would make it difficult for fishers to know the boundaries of areas which are prohibited and allowed to catch fishes.

**Conclusions.** In general, the fishers perception of the zoning system is fairly good, except for the clarity of the zone markers. Most of the fishers (65.95%) believed that the

zone boundary markers were not clearly visible, making it difficult for them to differentiate the core and protection zones from the other zones. Surveillance is not running well, due to a large percentage of fishers, 52.13% and 65.96%, did not report other fishers who caught fish in the core and protection zones to the KNPA.

The level of the fishers' compliance in not fishing in the core and protection zones in average was 78.56%. The compliance level trend between 2010 and 2014 is polynomial. There was a rise in the compliance in the period 2010-2012, and then there was a fall from 2012 to 2014. The implementation of zoning system is not yet effective in managing the fishers fish-catching activities.

The infringements are classified into cases processed by law, those processed by counseling, and moving/removal of zone boundary markers. The number of the cases involving zoning and fishing gear increased linearly between 2002 and 2014, suggesting that the fishers awareness regarding both the core and protection zones and the use of fishing gear is still low. A more effective approach of fishery management is needed in the long term. In the short term, there needs to be more intensive efforts in public education about the core and protection zones to build the fishers awareness. Surveillance by both the government and the community needs to be improved in order to increase the effectiveness of the zoning system.

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