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Suitability assessment for fish santuary development through social-ecologycal approach: A case study in Segara Anakan Estuarine, Cilacap

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Abstract

Segara Anakan Estuarine known as one of the potential estuarine and become important habitat in providing space for fauna aquatic life, especially fish . The purpose of this study was to determine the appropriate location for the development of fish sanctuary in Segara Anakan Estuarine. Location of the study covers the whole region Segara Anakan estuarine with 13 stations in estuarine waters body and 8 Coastal Village. Data collected by using survey method (stratified sampling method). Assessment sutability for fish sanctuary development using ecological integrity and connectivity of social ecology approach, includes 22 parameters, while the analysis of the data using spatial analysis approach. The results of research obtained are very appropriate class of 1204.29 ha (scattered in Klaces, Kutawaru, Kembang Kuning river and Tritih), corresponding conditional class 1579.71 ha (scattered Ujung Alang, Panikel, partly Kutawaru waters and tritih) , and the class is not appropriate for 888.49 ha (scattered in Donan, Talun, and Ujung Gagak).

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Keywords: *social-ecology, estuarine, fish sanctuary, Segara Anakan.*

1. Introduction

Estuarine included in public waters, to be located above the lowest sea tide line to mainland (Nontji et al. 1986), has a free relationship with the open sea as well as receive input of fresh water from the mainland (Pickard, 2007). The formation of brackish water with a salinity habitat fluctuating form unique ecosystems. Water productivity estuarine areas are generally higher (1500 g/m2/year) compared to the productivity of ocean ecosystems (125 g/m2/year) and freshwater (400 g/m2/yr) (Saptarini et al.1995 in Supriharyono 2000), high productivity is an important habitat for the life of a variety of aquatic biota, both as nursery grounds, spawning ground and feeding ground for fish, shrimp and gastropods (Beck et al. 2001; Elliot and Hemingway 2002). Potential of High an estuary usually implies pushing rapidly to resource exploitation rather than sustainable use.

Segara Anakan estuarine is the one of potential estuaries in Indonesia. This area has the potential largest mangrove forests in Java and resource potential aquatic biota is characterized by the abundance of various distinctive and potentially covers 60 species of fish, 19 kinds of natural prawns dominated by Jerbung (P. Marguiensis), Peci (P. indicus) and Jari (Metapenaeus elegans), two types of economically important crab (Schylla and Portunus spp) and some types of shellfish (Dudley 2000) with economic value reached Rp. 62 billion / year. This location also become dependent upon around 1,450 RTP fisherman. In the process, the region this relegation due to land degradation,

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especially in the watershed Citanduy and Cimeneng impacting on shallowing waters, coupled with population growth prompting excessive utilization of resources and environmentally unfriendly, such as land conversion and logging, fishing gears dedukstrif. These conditions impact on the depletion of forests mangroves, and decreased production of aquatic biota, including decreased production of crab (keystone species), 1987-1988 average catch of fish traps at 4.5 kg/trip (Wasilun 1991), to 1.6 kg/trip in 1999-2000 (Dudley 2000). Shrimp and fish has decreased from 5,250 tons (1979) currently lives 2,000-3,000 tons/year (2005) with Apong catch rate of 15.1 kg/trip in 1987-1988 to 6.5 kg/trip (Dudley 2000) even 1.5-3 kg/trip (Suradi, 2005). The decline in production is also characterized by a decrease in the size of the shrimp, mostly juvenile with a range of 4-5 g/head (Dudley 2000) and even the range of 2 g/head (Nurfiarini et al. 2012).

Fisheries resource management issues, not only on the issue of population decline / stock due to utilization, but also the destruction of habitats and the absence of protected areas. Therefore, to maintain the basic components to maintain a system of fisheries is their ecological sustainability, namely the existence of protected areas (Adrianto et al., 2005). Nevertheless, the existence of a social system as an integrated system in Segara Anakan fisheries can not be ignored, so look at both aspects as an integral socio-ecological system into basic capital in an effort to fisheries management system. One of them is by using the approach of ecological integrity and connectivity. Regulation No. 60 of 2007 on the Conservation of fish resources, to ensure their estuarine conservation development in the form of asylum fish sanctuary. The purpose of this study is to determine the suitability of water for the development of estuarine fish sanctuary. In this paper socio-ecological integrity approach used to assess the most appropriate location for the development of fish sanctuary in Segara Anakan Estuarine.

2. Material and Methodes

2.1. Research sites

The research was carried in Segara Anakan Estuarine during 2013-2014. The locations were set at 13 locations covering in West Plawangan and Kebun Sayur (representing the off shore), lagoons (representing the middle estuarine), some river estuaries like Estuary Citanduy, Estuary Muara Dua, Sapuregel, and Cigintung to represent the upstream estuary (Figure 1).

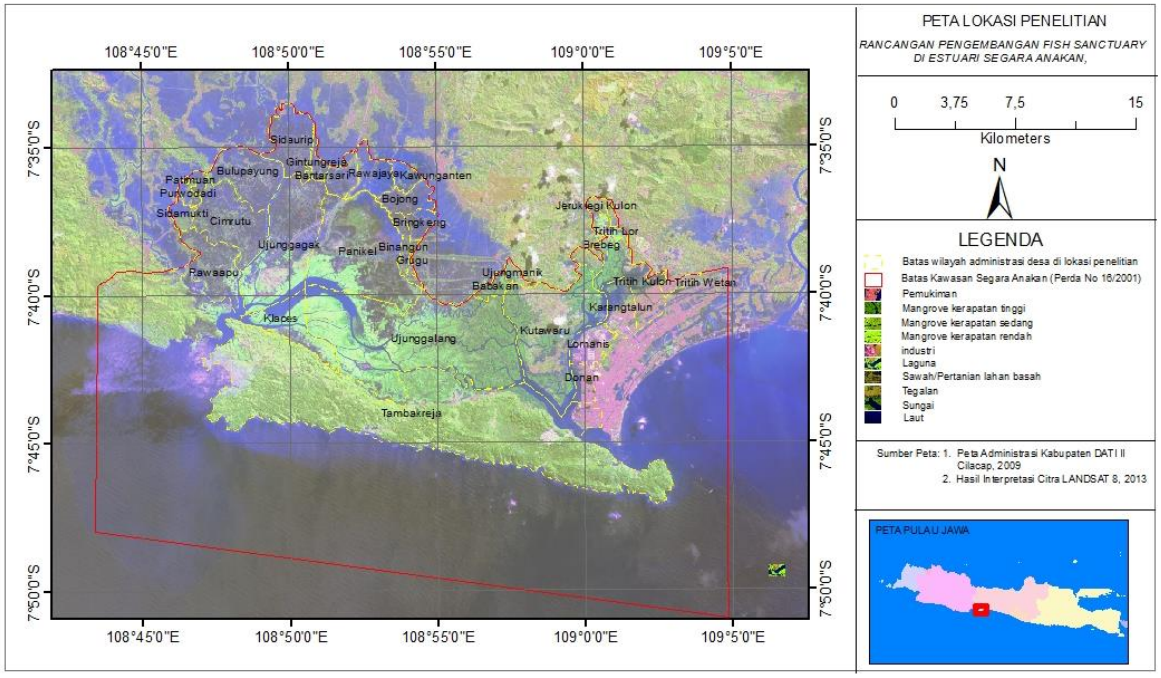

Figure 1. Map of research sites

2.2. Data Collection and Analysis

Conditions Morphological features and diversity of physical habitats (morphometry) interpreted from topographic map 1: 50,000 scale derived from Geospatial Information Agency (BIG) and Landsat TM satellite imagery 8 path 65/row 121 acquisition of May 31, 2013. To distinguish between the sediments and the water used band 5. The diversity of physical habitats approached with analysis of the type of substrate, and vegetation. Sediment samples taken by Ekman Grab then dried in an oven (temperature of 105oC), and in a class analysis grain and substrate type. Size and distribution of vegetation cover was allegedly using NDVI method. Water quality parameters include non-physical, nutritional, bullies, and the metal element. Sampling for the measurement of water quality parameters using a survey

method (stratified sampling method). Where the time period of one year based on the season. Analysis of water quality following the APHA (1976); using methods raised by Sokal & Rohlf (1995), Lutdwig & Reynolds (1998) and Wedepohl et al. (1990). Identification of plankton according Bold and Wynne (1985), while the abundance of plankton is calculated by the method LDMC (APHA, 1976).

Parameter fish resources include fish, shrimp, and crabs at various stages of growth of larvae, juvenile and adult. Stadia larvae and juveniles were collected with the help of tools Bonggo net and beam trawl. While data on the composition and structure of fish communities gained from the experiment arrests made during the four-month series, using fishing gear: mesh pockets with mesh sizes 1/5 - 3 inches, Apong nets with mesh sizes 1/5 - 5 inches, tek tek nets, widey and surungan. The diversity of fish species identified further data is analyzed by the approach of biological integrity index (Ganasham and Hughes 1998).

Data related to socio-cultural aspects include an assessment of the existence of local knowledge, participation of society as a social capital and institutional potential. While the economic aspects of society include linkages with fishery resources, the study of regional importance and the potential threat from economic activity. Data were collected through observation and interviews with respondents include fishermen, leaders, and officials representing the village. The number of samples were taken using sampling techniques socioeconomic refers Fauzi (2001) and analysis of data referring to early 2001; and Hartoto et al. 2008.

Furthermore, the suitability of prospective fish sanctuary is approached with analysis functions fisheries asylum follow Soselisa (2008), and Hartoto et al. (2008) are modified based on the status of the ecological integrity and ecological connectivity by 22 criteria (Table 1). Spatial approach used in selecting the fish sanctuary area is categorized into three classes of suitability, which is very appropriate (VA), according to conditional (CC), and is not suitable (NS).

Table 1. Matrix for Socio-ecological criteria to assessment fish sanctuary candidate

No	Parameter	Weight	Score Value					
			very appropriate (VA)	Score	According to conditional (AC)	score	Not suitable (NS)	score
A	**ECOLOGY:**	**60**						
1	Sedimentation	4	Nohing	3	minimal	2	available	1
2	Physical diversity of habitat (there are maender, trough, river branching)	4	All components	3	2 components	2	Nothing components	1
3	Physiography and morphology	4	stable	3	stable	2	fault	
4	Water depth	5	>5,02 m	3	5,02 – 3,26	2	<3,26	1
5	Turbidity	4	16,5-19,5	3	5-16,5; 19,5-25	2	<5; >25	1
6	Salinity	4	0,5–17	3	17 - 30	2	< 0,5; >30	1
7	Water surface temperature	4	<30	3	30-35	2	>35	1
8	pH	4	6,5 – 8,5	3	6, 9	2	<6, >9	1
9	Do	4	>5	3	2-4	2	<2	1
10	Water quality	4	good	3	midle	2	low	1
11	Feed resources (plankton)	4	high	3	midle	2	low	1
12	Vegetation integrity (Type of cover, density, and species diversity)	6	high	3	midle	2	low	1
13	Spawning/nursery habitats	4	Available	3	limited	2	nothing	1
14	Integrity of fish biology (index of fish biology integrity)	6	high	3	midle	2	low	1
B	**SOCIO-CULTURAL:**	**25**						
15	Social Capital	5	good	3	enough	2	less	1
16	Local value & wisdom system	5	Yes, active		There is, passive		Nothing	
17	Potential Threats (from extractive economic activity)	5	Very safe	3	Quite safe	2	not safe	1
18	Potential conflict of interest	5	low	3	midle	2	high	1
19	Institutional Potential	5	Performing-maturing	3	norming	2	Forming-brainstorming	1
C	**ECONOMIC**	**15**						
20	Important value of the region for the populist economy	5	The main source of livelihood	3	the main livelihood / raw materials of the people's industry	2	Source of PAD / industrial raw materials / export	1
21	Potential of tourism development	5	available	3	limited	2	nothing	1
22	Distance of location from other utilization (industry / settlement)	5	➢ 500 m	3	300-500 m	2	<300 m	1

Source: PP no. 60 Tahun 2007; Soselisa 2006; Hartoto et al. 2007 in modification

5. Result and Discussions

5.1. Ecological assessment of the Site

Physical diversity of habitat and Sedimentation

The physical diversity of the habitat at each location observed indicated sandy mud substrate conditions at stations 2,3, and 4, with sand percentages between 22.04-46.7%, the rest generally muddy, suspected as a result of sedimentation (table 2) . Sedimentation volume indicates that almost of the rivers that leads to the estuarine has a sedimentation effect with an average sediment settling between 0.009-0.021 cm3sec-1. The highest sedimentation occurs around the Citanduy Estuary, Cigintung Estuary, and Donan Estuary. Vegetation cover covers all waters.

Physiography and morphology

The results of physiographic and morphological typology analysis show that Segara Anakan Estuarine has topographic plains to hills, has a structure alluvial young to mixed rocks, and has 8 main watershed, namely Citanduy, Cibeureum, and Cimeneng Rivers (western zone), Penikel, Cikonde, and Ujung Alang Rivers (central zone), and the east zone covers Cigintung and Donan Rivers (Table 3).

Table 2. Physical diversity of habitat

No	***Physical diversity of habitat***	Site											
		East Zone			Central Zone					West Zona			
		Do	Tal	Tri	UA-1	UA-2	KW	UA-3	UA-4	Pan	Kla	UG-1	UG-2
		1	2	3	4	5	6	7	8	9	10	11	13
1.	type beach / river channel	Flow of the river / straight	Flow of the river / straight	Mangrove forested river flow / maender	Mangrove forested river flow / maender	Mangrove forested river flow / maender	Mangrove forested river flow / maender	Mangrove forested river flow / maender	Mangrove forested river flow / straight	Estuary of a wooded mangrove / straight	Mangrov e forested river flow / straight	Estuary	Mouth of Estuary
2.	Aquatic Base Profile	high Sediment accumulatio n	Low Sediment accumulatio n	high Sediment accumulatio n	midle Sediment accumulatio n	Midle Sediment accumulatio n	Minimum sediment accumulatio n	Morpholog y is rather rough / there is a mixture of rocks	midle Sediment accumulatio n	midle Sediment accumulatio n	Morpholog y is rather rough / there is a mixture of rocks	high Sediment accumulatio n	high Sediment accumulatio n
3.	dominan ce Substrate grain size	5 µm; 20 µm; 0,25mm	5 µm; 1 mm	5 µm; 1 mm	5 µm; 20 µm; 0,25mm	5 µm; 20 µm; 0,25mm	5 µm; 1 mm	5 µm; 20 µm;	5 µm; 20 µm;	5 µm; 50 µm;	5 µm; 50 µm;	5 µm; 50 µm;	5 µm; 50 µm;
4.	Texture of water substrate	sandy clay loam	sandy clay	sandy clay	sandy clay loam	sandy clay loam	silty clay	silty clay	silty clay	Clay loam	Clay loam	silty clay	silty clay
6	Water depth (m)	5,6	5,8	4,2	5,2	6,2	6,8	2,2	1,5	2	2,1	2,5	4,1
7	Riparian vegetatio n	-	True mangrove, thick	True mangrove, thick	Mangrove mix	Mangrove mix	True mangrove, thick	Mangrove mix	Mangrove mix	Mangrove asosiasi	Mangrove asosiasi & pioner	Mangrove asosiasi & pioner	Mangrove asosiasi & pioner

Information:
Do : Donan Tal : Karang Talun Tri : Tritih Pan : Panikel UG : Ujung Gagak
UA : Ujung Alang KW : Kuto Waru UA : Ujung Alang Kla : Klaces

Tabel 3. Distribution of geomorphological and watershed conditions in Segara Anakan Estuarine

No	Parameter	Villages of Estuary							
		East Zone			Central Zone		East Zone		
		Do	Ta	Tri	KW	UA	Pan	Kla	UG
1.	Topography	Plains	Plains	Plains	Plains	Plains	Plains	Plains -hills	Plains
3	Geomorphology	Alluvial	Alluvial	Alluvial	Alluvial	Alluvial, mixture	Alluvial, Young	Alluvial, Young	Alluvial, Young
2.	Watershed	limited	limited	limited	luas	luas	luas	limited	luas

Water Quality

The results of the environmental waters quality assessment for the suitability of fish sanctuary development covering 21 parameters in 5 categories are presented in Appendix 1. The range of salinity values does not describe the upwardly downstream estuary pattern, with a value of 3.75-13.55 ppt, meaning the distribution of the estuary water's

sanitability remains within the recommended range to support the aquatik fauna in estuary. Estuary fish generally have high tolerance to salinity variation (euryhalin), and between 3.99 - 32.79 NTU. Temperature, pH, and DO values almost entirely support biota life, in some stations exhibiting higher temperature values (> 30 ° C), and potentially increasing streess in nektons fauna (Kirby-Smith et al., 2003).

Average nutritional parameters (N-NO3, P-PO4, T-N) have a very concentrated range of concentrations supporting estuarine biota life, but T-P values exhibit lower concentrations than required values. natural waters typically have nitrate concentrations ranging from 0.05-0.2 mg / L (Wetzel 2001). T-N and T-P respectively> 1.5 mg / L and> 0.05 mg / L indicating fertile waters. However, lower conditions make it possible for waters with good vegetation associated with ecological functions as natural filters in the process of reduction of sediments, nutrients and pollutants. The interference parameter is represented by N-NO2 and N-NH4. Average nitrite concentrations were still below the range set by PP No.20 of 2000, ie <0.006 mg / L, but the N-NH4 concentration tended to be higher than the maximum limit for aquatic biota life (> 0.002 mg / L), but pH and temperature are high enough, will help the process of oxidation of ammonia and nitrate into nitrite.

The metal parameters of Calcium (Ca), Sodium (Na), Potassium (K), Iron (Fe), and Manganese (Mn) are metallic elements that are at some level necessary in the process of organism metabolism. Calcium ions are required in the formation of mollusc shells and invertebrate organisms that are abundant in estuary waters. Na aids plant growth, K as cell activation enzyme, Fe as oxidative metabolism and photosynthesis in citrokrom plant, while Mn as co-factor of several enzymes. Magnesium (mg) is required in the energy transfer / enzyme transfer process, and is not a significant limiting factor. The results of aquatic metals analysis indicate that the metal concentrations that contribute to the survival of aquatic biota are largely within the support range. Unless K shows a low value (<200 mg / L) and Ca is above the threshold. This condition is thought to have an effect on the production of abundant oceans. While the concentrations of Mn, Pb, Cd in each station are relatively low and safe (PP No.20 tahun 2000, jorgensen 1980), except in copper (Cu) generally in the range > 0.1, a condition quite harmful to lives for aquatic fauna (Jorgensen 1980).

Natural feed resource parameters (plankton) are the feed resources of organisms that determine the production of organisms at the next trophic level. The results showed that the phytoplankton composition included four groups of Bacilariopiceae (28 genera), and Chloropyceae (10 genera), Cyanopiceae and Dinopyiceae five and four genera with 179,759 - 1,831,564 cells / L abundance respectively. This type of plankton is dominated by Chaetoceros, Asterionella, Coscinodiscus sp, Holospharea sp, Oscilatoria sp, Bacteriastrum, and diatoms. The range of diversity index values of 0.196 - 1.831 is included in the moderate category (Shannon-Wenner in Odum, 1998), except at the End of Crow station. The zooplankton group consists of 5 groups of Crustaceans (14 genera), Cilliata and molluscs of each of three genera, Rotatoria and Holoturadea each one genera.

Mangrove Integrity

Result of interpretation of Landsat image to the estimation of extent and distribution of mangrove forest density in Segara Anakan is 8,234,46 ha divided into 3 classes, namely mangrove dense, medium, and rare. Mangrove vegetation found 27 species consist of 17 species of trees, two types of shrubs, two types of lianas / climbers, three types of palma, and three types of herbs. The central zone has the highest number of species of 18 species dominated by Rhizopora Apiculata and Ceriop tagal, as well as the eastern zone where R. Apuculata species has the highest Important Index Value (IIV) at each growth stage, while the western zone is dominated by type Avicenia marina, Soneratia alba, and S. caseolaris with IIV range 47.78 - 135.18 (trees) and 46.80-148.02 (seedlings), and 51.47-95.30 (seedlings).

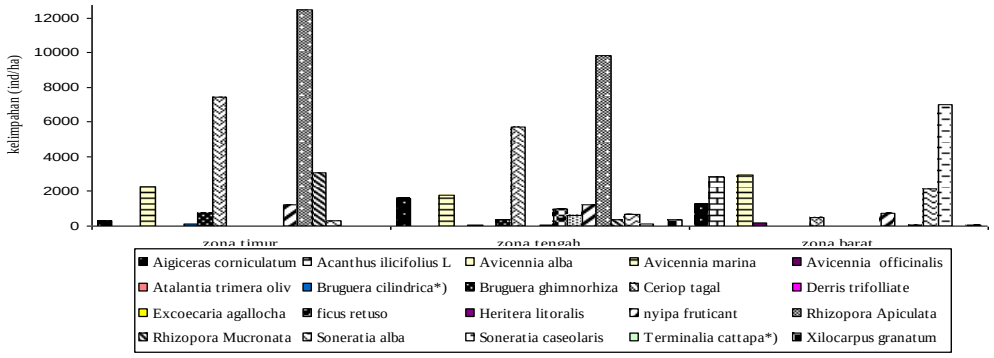

Figure 2. Histogram of abundance of mangrove species in each zone

Spawning & Nursery Ground

Two key parameters related to spawning and nurseryng habitat are the integrity of meroplankton and juvenil. Observations of meroplankton for along 1 year showed that abundance ranged from 4.723 - 96.229 ind./1.000 m3 with an average of 26,905 ind./1.000 m3 (Figure 3). The highest abundance is in Kota Waru station 96.229 ind./1000 m3. The composition of meroplankton is dominated by zoea and Copepoda.

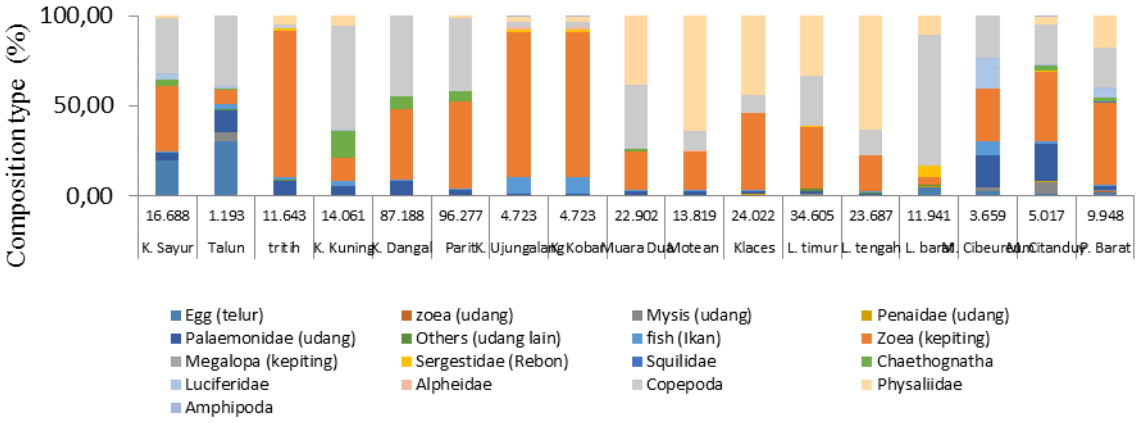

Figure 3. Composition species and abundance of larvae (ind/1.000m3)

Results of observation of juvenile fish, shrimp and crabs obtained 62 species, consisting of 36 species of fish, 22 species of shrimp and 4 types of crabs. Juvenile abundance ranged from 0.02-41.81 ind./1.000 m2 with an average of 3.79 ind./1.000 m2. The highest abundance was the family of Sergestidae with Rebon (Acetes sp) (average 41.81 ind./1.000 m2), followed by family of Penaeidae (Udang Dogol), Palaemonidae, and Bagridae (4.49 ind./1.000 m2) (Figure 4). Meanwhile, according to the observation station, the average abundance of juveniles ranged from 7-203 ind./1.000 m2 with an average of 99 ind./1.000 m2. The highest juvenile abundance is at the Karang Kobar station.

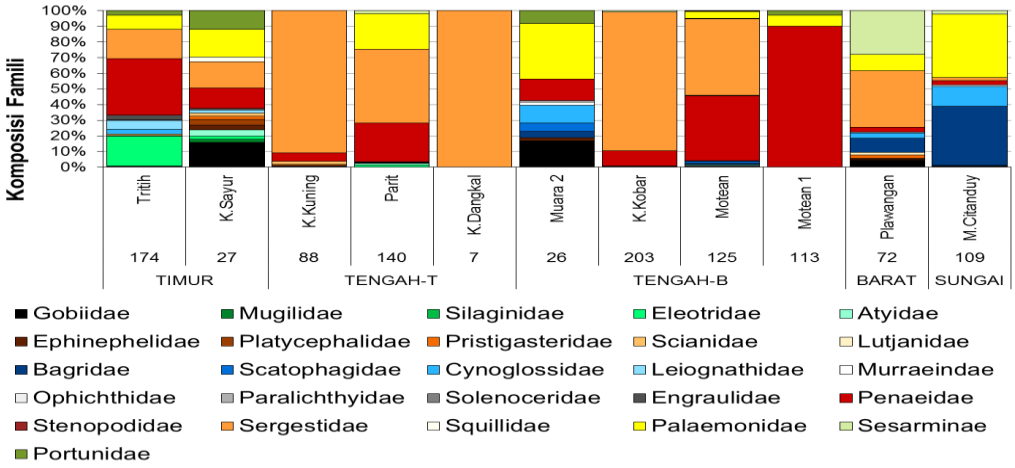

Figure 4. Family Composition and Abundance of Juvenile

Fish Resources

Results of observations during the study collected as many as 23,521 fish, consisting of 87 species of fish from 45 families. Most fish species come from the Gobidae (9 species), then Engraulidae, Carangidae, Lutjanidae, Leiognathidae, Belontidae and Mugillidae in the range of 3-7 species. Furthermore, the results of the analysis of the biological integrity of fish resources refer to Ganasham and Hughes (1998), modified on the health and fish abundance, then obtained the values of IBI from each prospective fish sanctuary (Figure 5). The figur to show that St.Tritih, Kuto Waru and Ujung Gagak has an IBI value higher than other locations, or in other words the integrity of fish resources is better.

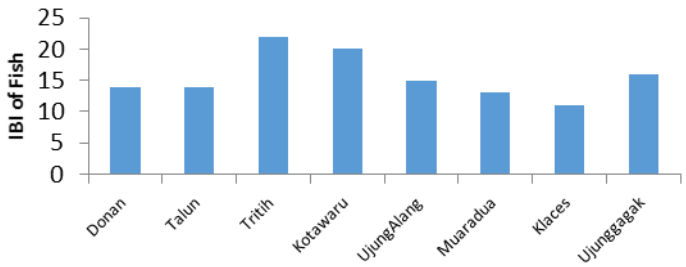

Figure 5. Integrity Biological Index (IBI) of Fish in Segara Anakan Estuarine

System of Values and Wisdom, social capital, and institution

Assessment of the value of local wisdom shows that almost all regions have no specific samawi value / wisdom developed, and even tend to have bad morals of water resources. The only value system that began to develop was in fishery activities in Panikel village in the form of holiday to sea, and quota restriction on shellfish fishery in Kutawaru Village. The result of social capital analysis of fisherman society around estuary are on level until good enough with score 2,55 - 4 at level 1-5. Social networking capital criteria and connections between friends and family / between communities are the criteria with the highest score. While the criteria of participation provide sufficient value, can be the initial capital in implementing the estuary management in a participatory manner. The institutional potential criteria indicate that almost all villages are at the Brainstorming level.

Potential Threats of Economic Functions, and the significance of the region

In the criteria of resource economic function as habitat and source of raw material have a threat value between 4 -8 of 9 sub criteria, or are on unsafe-safe score. While the criteria of economic function as a fish resource almost entirely in safe conditions. This is because almost all the results immediately seal tillers on the interests of local trade / inter-regional only. While the assessment of the important value of waters as a source of capture fisheries and aquaculture fisheries have a range of values 5-13 ie from not important to quite important.

5.2. Suitability Assessment for fish sanctuary development site

Based on the results of the assessment of the parameter of suitability for the development of fish sanctuary obtained successively class according to 1,204.29 ha (spread in the waters of Klaces, Kuto Waru, Kembang Kuning and Tritih), class according to conditional 1,579,71 ha (Ujung Alang Village, Panikel, some waters Kuto Waru and tritih), and the class does not suitable to 888.49 ha (scattered in the waters of Donan Village, Talun, and Ujung Gagak). Furthermore, through the concept of zonation, the area that has a high suitability, can be defined as a candidate core zone, while the adjacent areas downstream, defined as buffer zones and other utilization.

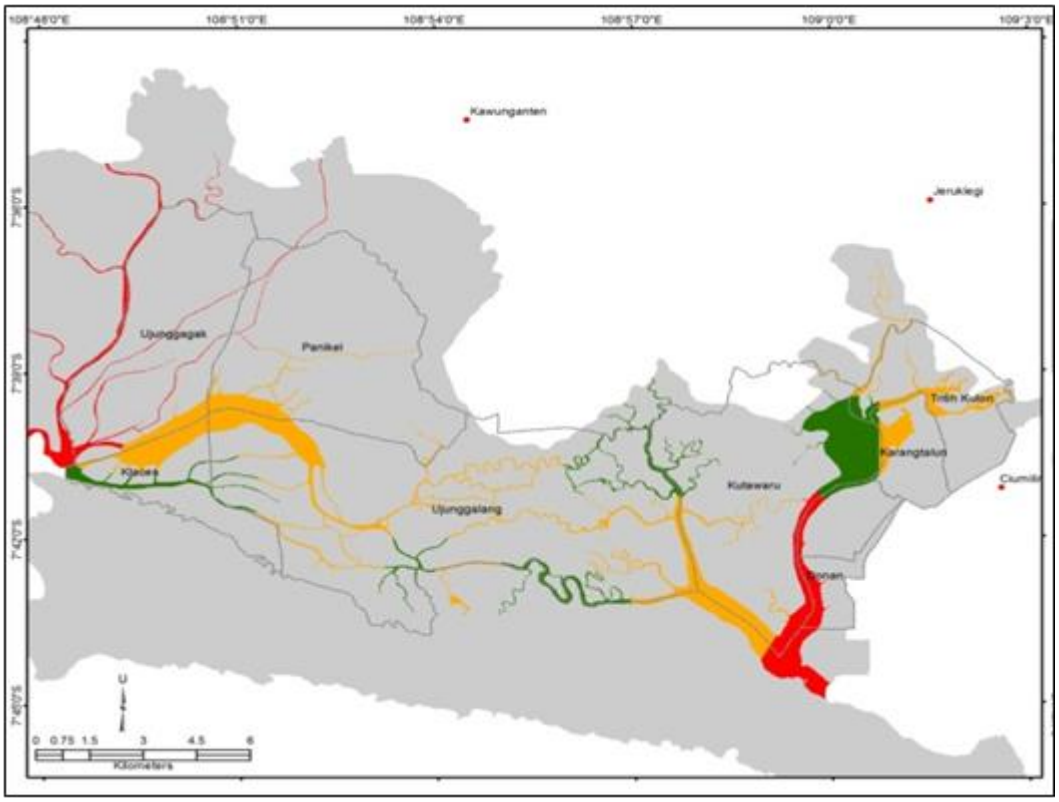

Figure 6. Composite Map Suitability of Fish Sanctuary at Segara Anakan Estuarine

6. Conclusions

Based on the assessment of the suitability of the location of prospective fish sanctuary in Segara Anakan Estuarine that of 13 locations observed, five of them are suitable to be developed as asylum with high suitability ie Kuto Waru, Tritih, Kembang Kuning, and Klaces), six locations with medium degree of conformity Talun, Sapuregel River, Dangal River , Ujung Alang River, Muara Dua and Lagoon-Ujung Gagak), and 2 locations are in appropriate locations (Donan, and Citanduy estuary). - Fishermen involved

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