Geographical Characteristics of Coastal Fisheries of East-Java Sea

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ABSTRACT

Mapping on sea surface temperature (SST) and Chlorophyll-a (Chl-a), together with catch-effort surveys (CES), were conducted at 5 fisheries management areas of East Java, between May – October 2013. The study aims to characterize coastal fisheries per management area in line with the plan to develop network design of marine protected areas (MPA) in the region. SST and Chl-a showed monthly variations among geographical areas, particularly during dry season (July – September). Demersal species dominated in the catch composition of North-Java Sea and Madura Strait. On the contrary, catches in the South-Java Sea mostly consisted of Tuna pelagic species. Madura Islands was typical for reef associated species and Bali Strait for Lemuru, Oil Sardinella. Catches of coastal fisheries composed of 114 finfish species from 56 different families. Two rare species were found in Pacitan (Pantai Dangkal): Leiognathus daura (Family: Leiognathidae) and Thryssa setirostris (Family: Engraulidae). This probably due to low fishing pressure in the area as indicated from the number of fishermen. It is clear that marine capture fisheries in East Java should be managed locally. Maintaining free-entry principle to fisheries will lead to resource depletion and fishery collapse in North Java and Madura Strait.

Keywords: capture fisheries, geography, Jawa Sea, Indonesia

INTRODUCTION

In the last decade, Indonesia's production of marine capture fisheries surpassed four major countries: Peru, Japan, United States and Chile (FAO, 2012). With a total fish landing equals to 5.2 million tons (in 2011), Indonesia is now rank the second in world production of marine capture fisheries, as the great decrease of anchovy's catches from Peru. Government supposedly manages marine capture fisheries those are spatially divided into 11 fisheries management areas (BRKP-DKP, 2007). However, all areas remain open access (Bailey, 1987; Squires *et al*., 2003) and most, if not all, of Indonesia's marine capture fisheries are fully or overexploited (Mous *et al*., 2006; Heazle & Butcher, 2007).

Java Sea (Fishery Management Area 712) is by far, considered to be the most densely and over-exploited area (Bailey, 1997; Bailey, Dwiponggo, & Maharudin, 1987; Buchary, 1999; Prisantono, 2011). Analysis of capture fishery statistics (DJPT, 2011) showed that East-Java Sea is the most crowded fishery with highest numbers of fishermen, fishing vessels and gears, active fishing days, and catches. Purse seine fisheries, targeting small-pelagic species, mainly operate out-distance from the coastal areas. On the contrary, most of demersal fisheries operate near shore, exploiting the most vulnerable stocks. The main gears include mini-trawl, modified danish seine and beach seine.

Exploitation of the fishery resources in Indonesia has a long history. The intensity of exploitation has not spread uniformly over the whole area, causing several areas to be overexploited, and leaving the rest being underexploited (Martosubroto 1987). Stock of fishery may detach one to the other due to geographical isolation (Barber *et al*., 2000; Wiadnya *et al*., 2011). Pet *et al* (1998a; 1998b) proposed to divide fisheries management plan of East Java into five management areas. This study aimed to characterize the coastal fisheries of East-Java Sea, with specific objectives: (i) characterize fishery catches based on geographical differences, (2) describe physical characteristics per management area, and (3) to identify fish species in the catches.

MATERIALS AND METHODS

Pet *et al*. (1997a; 1997b) proposed to divide marine fisheries of East Java into five geographical fishing grounds: (1) Java Sea, (2) Madura Strait; (3) Madura Island; (4) Bali Strait, and (5) South-Java Sea (Figure 1). Fishery statistics of East Java (annually recorded per district area) was collected from Provincial Fisheries Office. Analyses were done (per management area)

on: number of fishermen, fishing boats and gears, and catch per species category. The results were used to describe geographical nature of fisheries. Physical characteristics for each management area were best described using sea surface temperature (SST) and Chlorophyll-a (Chl-a). Data of these two variables were freely accessed through NASA satellite images (www.oceancolor.gfsc.nasa.gov), aquamodis/level3. Daily variation of both SST and Chl-a were accumulated on monthly basis (data January – December 2011). The results were then spatially projected into base map of East Java. The results were used to describe environmental condition of each management area.

Catch-Effort samplings (CES) were collected from seven fish landing sites: Gelondonggede and Brondong (Java Sea), Mayangan (Madura Strait), Sumenep (Madura Islands), Pulau Santan (Bali Strait), Prigi and Pantai Dangkal (South-Java Sea) (Figure 1). The best specimen from sampled catches were selected for species identification. Photograph for each species was collected from fresh sample. The samples for specimen were preserved using formalin 10% for 2x 24 hours, rinsed with running water for 2x 24 hours, and stored in saturated alcohol. Each species was then identified at family level mainly based on Carpenter & Niem (1998; 1999a; 1999b; 2001a; 2001b). The search up to species level used guideline per family. The results were cross-referenced with Froese & Pauly (2011). List of confirmed species was created for each sampling site. Similarity Index (dendogram) based on the presence of species in each management area was calculated using Numerical Taxonomy System (NTSys).

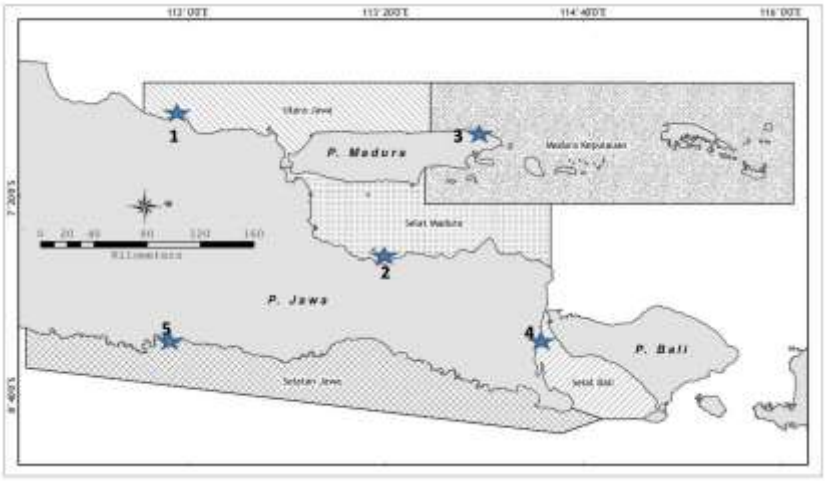

Figure 1. Proposed division of fisheries management into five different areas based on resource and geographical characteristics. Numbers and Stars indicate sampling sites (1 = Gelondonggede and Brondong; 2 = Mayangan; 3 = Sumenep; 4 = Pulau Santan; 5 = Prigi & Pantai Dangkal)

RESULTS AND DISCUSSIONS

Monthly variations of SST and Chl-a between geographical areas are shown in Figure 2. Both environmental parameters showed slightly different, particularly during June to October. SST in South Java Sea and Bali Strait were much lower than in the insular areas (Madura Strait, Madura Islands, and North-Java Sea). This lead to up welling event during the season (inverse with SST), continued with high concentration of Chlorophyll-a (Susanto & Marra, 2005) and fishery catches (Sartimbul *et al*., 2010) right after chlorophyll-a boom. These two environmental variables may affect fish resources, particularly at both areas, South and North-Java Sea.

South and North Coasts of Java developed with significantly different historical back ground. North-Java Sea is the extension of large Sunda Shelf, and has just inundated during the last sea level rise, 21 to 4.2 ka BP (Sathiamurthy & Voris, 2006; Hanebuth, Statteger, & Bojanowski, 2009). Prior to this de-glacial period, the Islands of Java, Kalimantan and Sumatera were connected with Paninsular Malaya and Cambodia. Currently, with maximum depth only reach ca 50 m, bottom topography of North-Java Sea is clearly different with South-Java Sea (Voris, 2000). Environmentally, Madura Strait is closely related to Java Sea in terms of historical development, water depth, bottom habitat structure and flushing with fresh water during rainy season. Madura Island may slightly different as its bottom substrate was dominated by coral reefs and it lays within marine Wallace Line (Barber *et al*., 2000)

Fisheries characteristics among management areas are summarized in Table 1. South-Java Sea is typically important for Tuna fisheries, comprises 60% of all Tuna catch from the region. This species categories consist of mainly: Tuna (*Thunnus spp*), Billfishes (*Makaira sp*), Frigate Tuna

(*Auxis sp*), Skipjack (*Katsuwonus sp*), and Eastern Little Tuna (*Euthynnus sp*). Some portions of Frigate and Little Tuna were also caught from Madura Islands (19% of total Tuna catch). These two species include in the schooling-pelagic and neritic species that associated with coral reefs (Froese & Pauly, 2011), as typical habitat for Madura Islands. In addition, Madura Islands are suitable for live-reef fish fishery, such as groupers (Serranidae), Snappers (Lutjanidae) and Trevallies (Carangidae). Up to 50% of reef and reef-associated catches in East Java were from this fishing management area.

Bali Strait is typical for almost mono-species, Oil Sardine, *Sardinella lemuru*, fishery as up to 67% of total Lemuru landings in East Java came from catch of Bali Strait (Table 1). This schooling small-pelagic fishery is unique (Wudianto *et al*., 2013). SST variations that lead to Chl-a blooms in the southern area, combined with bottom topography and cone-shaped narrow strait has made this sea area very suitable for Lemuru.

North-Java Sea and Madura Strait are shallow, with maximum depth of not more than ca 50 m, and with bottom habitat of muddy-sand that not suitable for remote-sensing based data (Hasyim, Hartuti, & Sulma, 2009). Up to 82% of total demersal species landings were from North-Java Sea, and the rest 14% from Madura Strait (Table 1). The most dominant species were members of Family: Leiognathidae, Nemipteridae, Haemulidae, Sciaenidae, and Ariidae. All the member are typical for shallow and muddy bottom habitat (Froese & Pauly, 2011). In short, South-Java Sea is typical for pelagic oceanic fisheries. On the contrary, North-Java Sea and Madura Strait are suitable areas for demersal fisheries with muddy and sandy bottom habitats. Madura Islands is the area for live-reef fish fisheries and Bali Strait can be considered as mono-species fishery of Lemuru, Oil Sardinella.

Table 1. Characteristics of marine fisheries among fisheries management areas in East Java (Source: DPK-Jatim, 2011)

No	Fishery characteristics	North Java	Madura S.	Madura I.	Bali S.	South-Java S.
1	Catch composition (%)					
	Tuna oceanic species	9	5	19	7	60
	Lemuru Oil Sardinella	1	6	3	67	23
	Reef associated species	27	13	52	5	3
	Demersal species	82	14	3	0	1
2	Number of fish landing sites	13	13	7	2	11
3	Number of fishermen (%)	39	26	7	4	26
4	Number of fishing vessels (%)	39	26	6	4	26
5	Number of fishing gears (%)	33	9	32	3	23
6	Total catch (%)	37	16	18	8	21
7	Catch/fishermen/year (ton)	6	4	16	14	6

Catch species identified from seven landing sites resulted in total 114 species from 56 different Families – some specimen need further confirmation, especially on DNA sequencing. Catch species of Madura Islands (site: Sumenep) were closely related to that of North-Java Sea (sites: Gelondonggede and Brondong). Catch species of Madura Strait is placed in one group with North-Java and Madura Islands. However, the level of similarity was lower than that between North-Java and Madura Islands (Figure 3A). P_Dangkal (Pacitan) represents species of South-Java Sea. Site Prigi is geographically very close to P_Dangkal, Pacitan. However, its species similarity was closely related to that of Bali Strait (site: P_Santan).

Geographically, stock fishery of East Java can be divided into two big groups (Figure 3): North and South-Java Sea. Stock species of Madura Strait (site: Mayangan) lays in between North and South-Java Sea. On the contrary, Bali Strait and Prigi form one group that close to P_Dangkal. Two rare species was found in Pacitan (site: P_Dangkal): *Leiognathus daura* (Family: Leiognathidae) and *Thryssa setirostris* (Family: Engraulidae) (Figure 3B). These two species have never been recorded from catches in East Java. This probably due to low fishing pressure in the area as indicated from the number of fishermen (Table 1)

In a nutshell, marine capture fisheries of East Java can be divided into five management areas: North-Java Sea, Madura Strait, Madura Islands, Bali Strait, and South-Java Sea. This was indicated by the differences in environmental variables (SST, Chl-a, water depth, topography and bottom habitats), catch species categories, and catch species composition between management areas. Number of fish landing sites indicate level of exploitation, where North-Java Sea showed the most densely populated area with fishermen.

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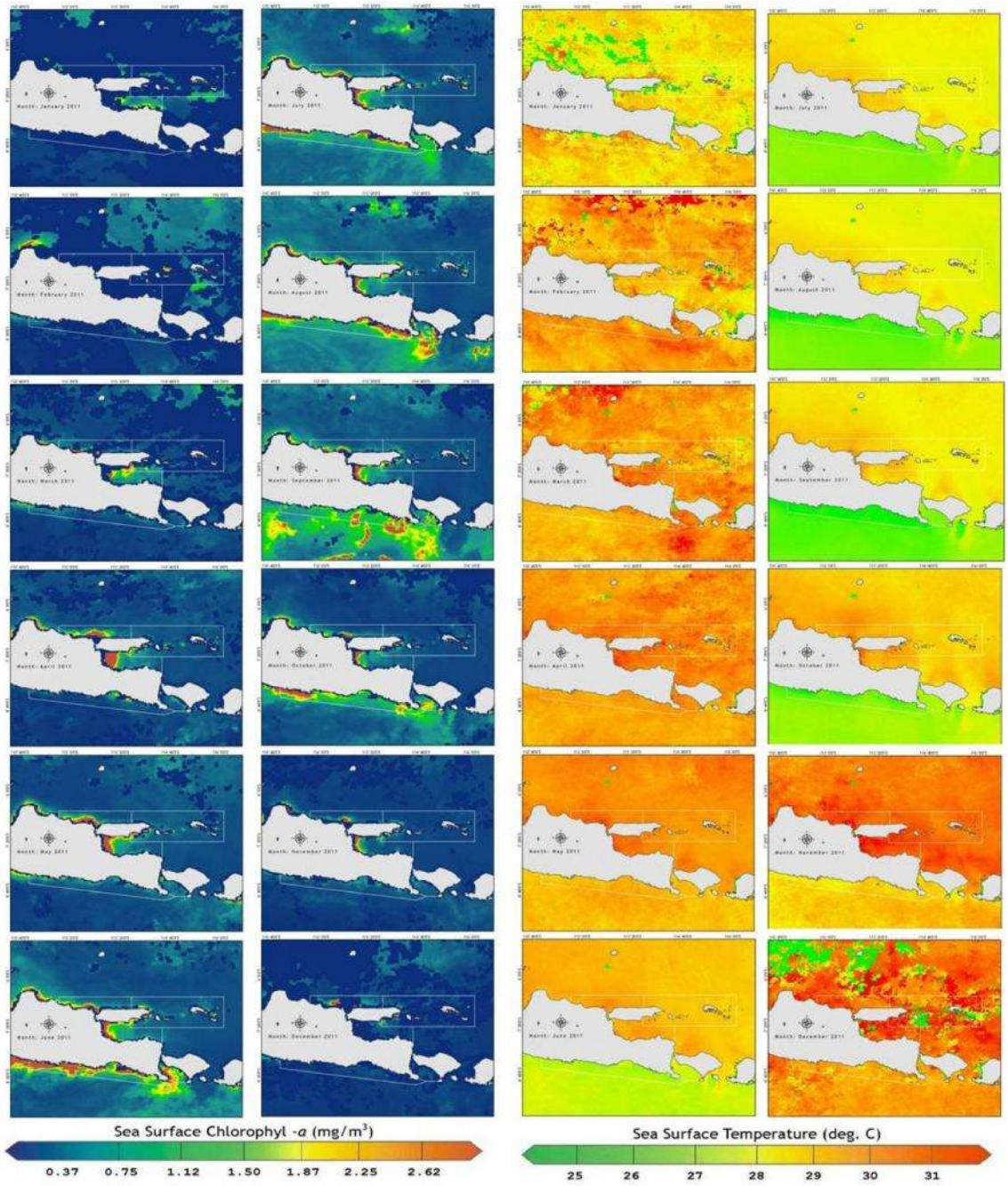

Figure 2. Monthly Sea Surface Temperature (SST) and chlorophyll-a variations between fisheries management areas in East Java (data download from satellite images: Aquamodis/level3 – www.oceancolor.gfsc.nasa.gov)

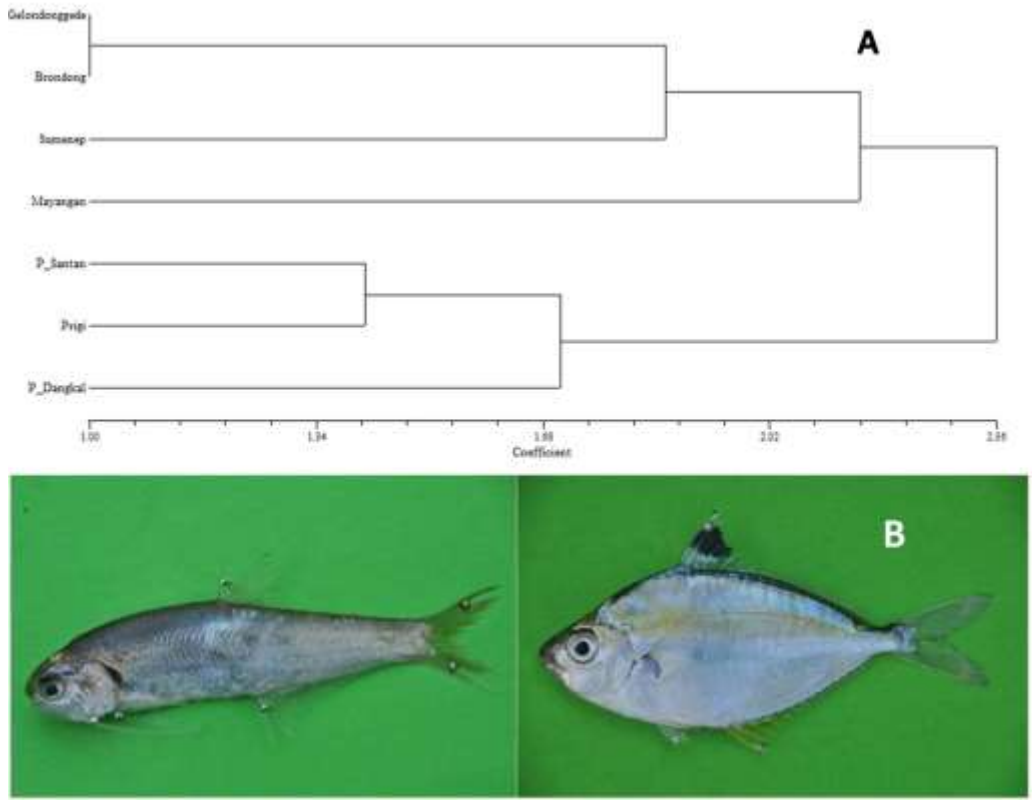

Figure 3. Dendogram showing similarity of geographical areas in terms of the presence of species in the ceatch of each management area (A); Photograph of two rare species, *Thryssa setirostris* (left) and *Leiognathus daura* (right), only found in catch of fishermen from Pantai Dangkal, Pacitan (B)