Estimation of suitable habitat and fishing ground for
*Leiognathus splendens* (Cuvier, 1829) in Blanakan coast based
on environmental and metal Zn parameters

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Abstract. Blanakan coast is known as prominent fishing ground in West Java coastal ecosystems. This is related to the presence of suitable habitat for fish species living in coast. One of fish species known living in Blanakan coast and has commercial value is *Leiognathus splendens*. Respectively, this research aims to predict the suitable habitat for *L. splendens* by using environmental parameters including salinity, pH, dissolved oxygen (DO), temperature, turbidity and Zn. The habitat suitability estimation method used was the ranking and overlay of environmental parameters. Those parameters were combined and overlayed by using geographical information system assistance to identify the most suitable habitats. Based on the result, the most suitable habitats were located near river mouth. This habitat is influenced by high level DO (5.7 mg/L) and pH (7.51). Correspondingly, the suitable habitats near the river mouth considering that *L. splendens* has an adaptation to low salinity (9 ppt) and high turbidity (218.03 NTU) near river. In contrast, the less suitable habitats were identified offshore. In here, the habitats affected by high temperature (31 °C), Zn content (0.55 mg/L), low DO (1.1 mg/L) and pH (7.15). This research hence might contribute some potentially valuable insights into exploring the relationship between the *L. splendens* suitable habitats and the environmental parameters.

Keywords: Coastal environment, Leighnatus splendes, habitat, fishing ground

1. Introduction

*Leiognathus splendens* are demersal species belong to family Leiognathidae which are bottom-living fishes in shallow coastal waters, with several species entering brackish waters, especially the river estuaries and a few can go into fresh water [1, 2]. They occur at depths as shallow as 0.5 m and down to around 160 m. Deeper dwelling species have been reported to move away from the bottom to midwater at night [1, 2].

This species feed on copepods and phytoplankton, with large fish feeding predominantly on benthic invertebrates. Members of the genus *Gazza*, with their canine teeth, feed on small fishes and shrimps, while *Secutor* spp., with their upwardly projecting mouths, feed only on organisms living in the water.
column. Benthos was consumed by *Leiognathus* species, except *Leiognathus bindus* which, like the *Secutor* species that consumes zooplankton [2].

In Asian countries, Leiognathids constituted an important part of the commercial trawl catches of several in the past, but in several areas catches have declined - declining from 20 to 30 % of the total demersal catch to as little as 4 or 5 % in the last 20 years. Genus *Leiognathus* are often readily accepted in Indonesia fish markets. About 50,000 tons were captured in 1975 with 14,000 tons of which captured from the Malacca strait area. In Indonesia, the Western Java sea, Karimata strait and Indonesia's south China sea are resources for this species. High *Leiognathus* stock densities were in very shallow waters with peak at 25 m depth and make this species are easily overfished by trawling, while the bagan (lift-nets) tend to underfish them [2]. Correspondingly, high *Leiognathus* densities are also observed high at depth from 1 to 42 m [3, 4]. In East Java, the rainfall is correlated with the annual periodicity of *Leiognathus* fishery. The peak of *Leiognathus* fishing seasons are from December through March, while fishing seasons are lowest from July to September. *Leiognathus splendens* makes up the most of the Leiognathid stock (90 % and more).

The aquatic environmental parameters required by *L. splendens* are consisting of salinity, temperature, turbidity, pH and dissolved oxygen (DO). *L.splendens* prefers brackish water with salinity ranges of 9–21 ppt, warm temperature (26 to 29 °C), turbid water (< 6.29 NTU), alkaline water and DO > 4.0 mg/L [3, 5-7]. As aquatic organism, *L. splendens* avoid high Zn contents in water. Zn in water has negative correlation with fish species because Zn is toxic for aquatic organism [8].

In Blanakan coast, western of Java sea, the *L. splendens* is one of important commercial commodities for local fishermen (figure 1) [9]. However, information about the fishing ground and even suitable habitats of *L. splendens* are still limited. Hence to fulfill this gap, this study aims to estimate the suitable habitats and breeding grounds that can be used as primary information to support fishery practices of this species. The estimations were made based on the seawater physico-chemical parameters that suitable for *L. splendens*. Zn in water was selected to be measured in this study because Zn was the common heavy metal in water and the Zn content was higher than other metals (Cu, Pb) based on the previous study [10]. Moreover, Zn was also known as toxic metal to *L. splendens* and can cause mortality. Thus to estimate the suitable habitat for *L. splendens*, the Zn is needed to be measured.

2. Methodology
The samples were collected from 7 stations that located in water of Blanakan coast (figure 2). The sample collection activities were conducted in April 2019. The samples that collected and measured directly from the seawater were sea surface temperature (SST), dissolved oxygen (DO), pH, salinity, turbidity and Zn. Meanwhile, the *L. splendens* was captured from seawater. The sample and data collections in each station were done 3 times (3 replications). The SST, DO, pH and salinity parameters were chosen to be measured because those parameters were having significant influences on physiology of marine fish. The particular Zn was measured because it has the highest contents compared to other metals like Cu and Pb [4, 11-13].

***Figure 1.*** The *Leiognathus splendens* sold in traditional market.
2.1. Study site
The Blanakan coast is located in northern part of Subang district, West Java province. The 7 stations geocode coordinates were located from western part at latitude: -6.22691, longitude: 107.66431 (station 4) to eastern part at latitude: -6.23, longitude: 107.67953 (station 7) (figure 2). The coordinate of study sites were recorded using hand held GPS Garmin Etrex.

2.2. Seawater physico-chemical parameters measurements
The parameters including SST, DO, pH, salinity and turbidity were measured directly in the seawater. DO and SST measured by using DO meter (Lutron DO 5510), pH with pH meter (Lutron PH 208), salinity with refractometer (Atago) and turbidity with turbidity meter (Ezdo TUB-430) respectively. In each station, the direct seawater physico-chemical parameter measurements were done in 3 replications.

2.3. Zn sampling and analysis
In the field, the seawater was sampled by using polyethylene bottle and kept in cooler box to be transported to the laboratory. In laboratory, the seawater sample was analyzed by using Atomic Absorption Spectrometry (AAS) to obtain the Zn values [10, 14].

2.4. Seawater physico-chemical and Zn parameters mapping
All the coordinates of physico-chemical and Zn parameters were recorded by using GPS Garmin Etrex. Geographical information system (GIS) software (ArcView 3.3). was used to map the physico-chemical and Zn parameters of Blanakan coast. The map of physico-chemical and Zn parameters then overlayed with the suitable physico-chemical parameters for L. splendens.

2.5. Suitable habitat estimation methods
The suitability method used was the ranking and overlay of environmental parameters [15-17]. All the physico-chemical and Zn parameter values were ranked from the lowest and the highest. The lowest rank of parameters was considered as least suitable and the highest rank of parameters was considered as more suitable. Then all the rank values were tabulated into the Geographical Information System (GIS) table along with their geocordinates. Furthermore, the tabulated GIS tables contained physico-chemical and Zn parameter ranks were used and interpolated to create GIS layers and vector shapes. All the layers were overlayed and rank values in each environmental parameter layer and vector shape were summed to create composite layers. The final step was to classify rank values in composite layers and the vector shapes with the highest rank values were classified as the most suitable habitat (figure 3). While, the vector shapes with the lowest rank values were classified as least suitable habitat. This process was conducted by using GIS software (ArcView 3.3).

![Figure 2. The locations of 7 stations in Blanakan coast.](image-url)
Figure 3. GIS based suitable habitat estimation process based on the ranking and overlay of physico-chemical and Zn rank values.

The layers of salinity, temperature, turbidity, pH, DO and Zn ranks were overlayed and summed up to develop the composite layer. Moreover, the rank values in composite layer then were classified from the lowest rank to the highest rank. The lowest rank indicates the least suitable and the highest rank indicated the most suitable.

3. Results and discussion
The results provided a clear distribution patterns (figure 4) of physico-chemical parameters and Zn contents in inshore and offshore of Blanakan coast. The measured salinity parameter indicates that Blanakan coast included both brackish water (9 ppt) and saline water (21 ppt) ecosystems. *L. splendens* is known having wide tolerant to low and near freshwater salinity and common in river mouth (table 1). Hence, the marine ecosystems of Blanakan coast both inshore and offshore are suitable for *L. splendens*. The pH was ranging from 7.15 to 7.51. The pH near river mouth was higher than pH in eastern and western parts of Blanakan coast. It indicates that only river mouth parts that has higher pH is considered suitable as habitats. The pH ranges suitable for supporting life of demersal fish in coastal zone are 6.5–8.5 [5]. The ideal pH for *L. splendens* is 7.5–8.5 [4, 13].

The DO was also observed high near river mouth (figure 4). A very low DO (1.10 mg/L) was recorded in eastern and western parts of Blanakan coast. This indicates that the suitable habitat for *L. splendens* is restricted near river mouth only with high DO of 5.7 mg/L. The DO values that suitable for *L. splendens* are > 4.0 mg/L [3] (table 1). The Blanakan coast is a warm ecosystem since it has high sea surface temperature. The *Leiognathus* prefers more marine ecosystem with temperature ranging from 26 to 29 °C. Correspondingly, inshore and some of offshore parts of Blanakan coast with temperature less than 30 °C are suitable for this species [6].

The Blanakan coast that located near river mouth has experienced high turbidity (figure 4). Nonetheless, the high turbidity does not have an effect on *L. splendens*. The number of *L. splendens* is higher in seawater with turbidity up to 6.29 NTU as observed in Wosi island, Papua in comparison to clear water with low turbidity (1.22 NTU) [7]. *L. splendens* has adaptation to live in the turbid water. This species has developed a bioluminescence organ to attract its prey. Furthermore, *L. splendens* prefers turbid water to avoid predator [18].
Figure 4. The patterns of seawater physico-chemical and Zn parameters in Blanakan coast, (a) salinity, (b) temperature, (c) turbidity, (d) pH, (e) dissolved oxygen and (f) Zn.

| Parameters          | Ranges and values                           |
|---------------------|---------------------------------------------|
| Salinity            | Brackish-seawater (0.5–30 ppt) [2]          |
| Temperature         | 26.0–29.0 °C [8]                            |
| Turbidity           | > 6.29 NTU [9, 10]                          |
| pH                  | 6.5–8.5 [6]                                 |
| Dissolved oxygen    | > 4.0 mg/L [7, 12]                          |
| Zn                  | < 0.09 mg/L [11]                            |

The seawater of Blanakan coast was containing Zn ranging from 0.25 to 0.55 mg/L. The Zn content was higher in offshore than in onshore. Hence, high Zn contents in offshore may limits the distribution of *L. splendens*. Correspondingly, fishes captured from this location are not recommended since it may
The estimated suitable habitats and fishing grounds for *L. splendens* in Blanakan coast.

have high Zn. The Zn contents have exceeded the Zn permissible limits for water, which is the limit is 0.09 mg/L for seawater [19].

The figure 5 provided detailed estimates of suitable habitats and potential fishing grounds that can be used by local fishermen to optimize their catches. This estimated habitat map was made by analyzing and overlaying physico-chemical parameters and Zn contents that may influence *L. splendens* in its natural habitat. Based on these maps, the most suitable habitats for *L. splendens* were centred near river mouth. This study also provided the area of suitable habitats to provide the comprehensive picture of how large is the potential fishing grounds that can be utilized. Total potential fishing grounds for *L. splendens* is 518,994 m². This area comprises the core of suitable habitats with size equal to 116079 m².

The modelling result of suitable habitats as presented in figure 5 has accommodated the physiological characteristics of *L. splendens*. The most fundamental factor in the suitable habitat model that can affect the fish physiology was the Zn. In fish physiology system, Zn will be absorbed through the gills, circulated in the blood vessels and accumulated in the kidney and liver. If the water contains high Zn with value above 0.09 mg/L (table 1) absorbed by the blood circulation physiology system of *L. splendens*, it will be followed with the Zn accumulation in *L. splendens* kidney and liver and then causing fish mortality [11, 12]. Respectively and considering the toxic effect of Zn on fish physiology system, the most suitable habitat in the model is the area that has the lowest Zn contents (<0.09 mg/L).

4. Conclusion
The most suitable habitats for *L. splendens* were located near river mouth. This habitat is influenced by high DO, pH, low salinity and high turbidity near Blanakan river. In contrast, the less suitable habitats were identified offshore. In here, the habitats were affected by high temperature, Zn content, low DO and pH. The estimated suitable habitats can be used to indicate the potential fishing grounds to support the local fishermen. Total potential fishing grounds are estimated closed to 518994 m². The most potential fishing grounds are located in the core of suitable habitats with area equal to 116079 m².

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