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Biological Hotspot of Ichthyoplankton in the Estuarine Environment Timbulsoko Village, Demak

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Abstract:- Biological Hotspot research of fish larvae in estuarine waters of Timbulsoko Village, Demak was conducted in April-June 2019 in Timbulsoko Village. Timbulsloko has fertile waters because many fishermen make this location as a fishing ground area. Timbulsloko has the potential to become a nursery ground area and feeding ground for fish due to natural mangrove habitat but the abrasion disaster resulted in the degradation of the nursery ground habitat for early stage fish. The results showed that fish larvae caught in the waters of Timbulsloko Village consisted of 13 families. The composition of the types of fish larvae caught are Mugilidae, Siganidae, Gobiidae, Leiognathidae, Scatophagidae, Chanidae, Latidae, Engraulidae, Gerreidae, Carangidae, Bagridae, Sillaginidae, Ambassidae. The most common types of fish larvae are Ambassidae fish larvae, which are 46.98%, while the least caught are Carangidae fish larvae, Sillaginidae which is 1.01%. The largest abundance of fish larvae is 428,271 ind / m3 found at D2P2, while the abundance of fish larvae is at least at E1P1270 point with an abundance value of 51,498 ind / m3. The similarity of ecological habitat values at D2P2 and A2G1 points based on PCA analysis and the similarity of contours from spatial depth interpolation indicate the biological hotspot in the mangrove waters of Timbulsloko Village.

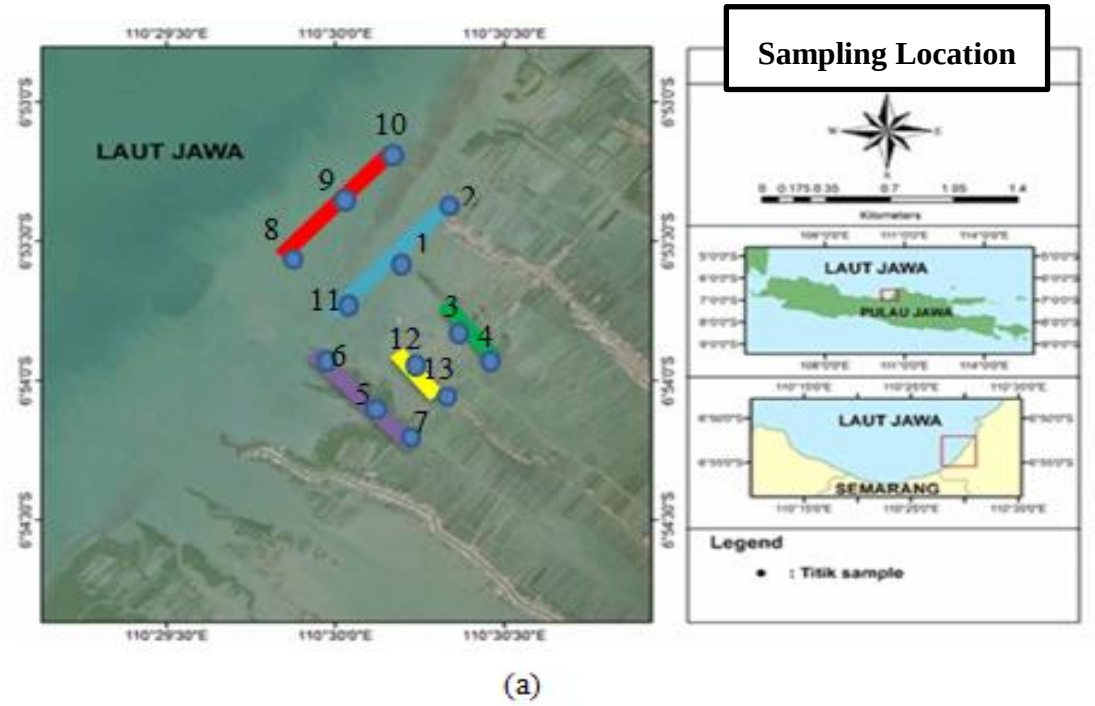
Keywords:- *Diversity; Ecology; Fishes; Geoscience.*

I. INTRODUCTION

Bioecology in fisheries studies about the relationship between fish and the aquatic environment as a natural habitat for fish. The concept of hotspots in fisheries is part of bioekology itself, but this term is better known as the biological hotspot in the field of earth science (geoscience). Biological hotspots are an area of concentration of biological life due to environmental factors, natural structures and productivity of an ecosystem [1]. Hotspots are a radical aspect to identify conservation areas and spatial resource management strategies. The intertidal zone as a meeting area between two ecosystems is a productive area which results in high biodiversity of the biota, besides that the risk of habitat degradation is also very high because the interaction of two ecosystems that continues to occur results in erosion, sedimentation, exploitation, etc. [2]–[4]. In-depth studies for this area are considered very important to prevent damage that occurs considering the high potential of environmental degradation caused by humans and nature. The Intertidal Zone of the village of Timbulsloko began to experience the effects of abrasion which developed rapidly since 2000 due to changes in the flow of ocean currents due to development and as a wave and rob barrier that occurred in the coastal city of Semarang [5], [6]. The purpose of this study was to inventory data on early stage fish in the Timbulsloko waters.

II. MATERIALS AND METHODS

This research was carried out in the intertidal zone of Timbulsloko Village, Demak. Primary data is obtained by conducting direct observation in the field during April - June 2019.



(a)

Fig 1:- Research station on R (Red), LB (Light Blue), P (Purple) lines: River, Y (Yellow), G (Green): (a) Research location.

Data collection for early stage fish is carried out during high tide and daylight hours. The tool used to catch fish larvae is fish trap net larvae with a mesh size of 0.45 mm temporarily placed in the mangrove channel area.

• *Abundance of Fish Larvae*

The abundance of fish larvae which is defined as the number of fish larvae united in water volume is calculated using the formula:

$$N = n/V_{tsr} \quad , \qquad (1)$$

Where:

N = abundance of fish larvae (ind / m3)

n = number of larvae enumerated

Vtsr = volume of filtered air (Vtsr = l x t x v)

l = the width of the larvae mouth opening

t = duration of meeting (minutes of withdrawal) (minutes)

v = speed of playback time (crane speed) (meters / minute)

- *Diversity Index*

An index of a collection of types of fish larvae used to determine the number of individuals between genera in a community. This value is calculated using the Shannon-Wiener index, the Shannon-Wiener Membership Index Formulation is based on the following equation:

$$H' = \sum_{i=1}^{n} pi \ln p i \quad , \qquad (1)$$

Information:

H '= Shannon-Wiener Diversity Index

N = total number of individuals in the community (ni)

ni = number of individual species or species i

pi = proportion of the second individual species (ni / N)

i = 1,2,3, ..., s

s = number of genus / species

- *Domination Index*

The dominance index to find out the dominant types of fish larvae is obtained using the following formula (Odum, 1994):

$$D = \sum_{i=1}^{s} (pi)^2 = \sum_{i=1}^{n} \left(\frac{ni}{N}\right)^2 , \quad (1)$$

Where:
D = dominance index
this = number of individual genus i
N = total number of individuals
pi = proportion of individual species i
I = 1,2,3, ..., s
s = number of genus

- Simillarity Index

Simillarity is an illustration of the distribution of individuals from each species in the commotation of fish larvae. The uniformity index value (E) is calculated based on the following equation:

$$E = \frac{H'}{H\ maks} \text{ atau } = \frac{H'}{\ln\ s} , \quad (1)$$

Where:
E = uniformity index
H '= variation index
s = number of genus / species

The Simillarity Index (E) is used to find out the large number of each genus / species at the community level. Uniformity index value between 0-1. E Value Loading 1 agrees to the distribution of individuals between types evenly (uniform) while Spelling Value 0 is considered to be an unequal distribution of individuals or there are types that are contradictory.

- *Spatial Analysis*

Spatial analysis was used to interpret the map of biological hotspots of fish larvae in Timbulsloko in this study the software used was QGIS software. The biological larvae hotspot are known from the relationship between fish larvae and oceanographic parameters, then from the value of the community structure (collection, dominance, uniformity and abundance can be used in accordance with the provisions of the initial stage fish distribution in an area in the temperature range, and salinity).

- *PCA (Principal Component Analysis)*

Principal Component Analysis (PCA) can be simply interpreted as a projection method to determine the maximum variability of a group of data (matrix) [7]. PCA is used to find linear combinations of environmental and biological parameters in maximum or minimal variation data with ordination techniques which project matrix dispersions from multidimensional data in a flat space. By reducing space, new axes are obtained which represent optimally from the majority of the variability of multidimensional matrix data so that relationships between characteristics and relationships between objects can be found. PCA divides the parameter correlation matrix into several components, then arranges the diversity of the relevant components from the largest on the axis of the main component to obtain spatial distribution of biological, physical and chemical parameters in a particular area. The linear correlation between the two parameters analyzed from the synthetic index is the variety of the two normalized parameters. This analysis is used to determine the distribution of aquatic bio-physicochemical parameters [7], [8]. Main Component Analysis uses the Euclidean distance index on the data. Euclidean distance relationship is based on the formula:

$$D^2\ (i, i') = \Sigma\ (Xij - Xi'j)^2 , \quad (1)$$

Where :
i, i '= two stations (on the line)
j = environmental parameters

The smaller the Euclidean distance between the 2 stations, the more bio-physicochemical characteristics between the two stations are similar, and vice versa. PCA calculations are carried out with the help of the R Studio statistical program package (https://www.datacamp.com/community/tutorials/pca-analysis-r).

III. RESULTS

A. *Fish Larvae Collected*

➢ *Fish larvae proportion*

Fish Larvae Caught The overall composition of fish larvae caught based on repeat sampling is presented in Figure 2.

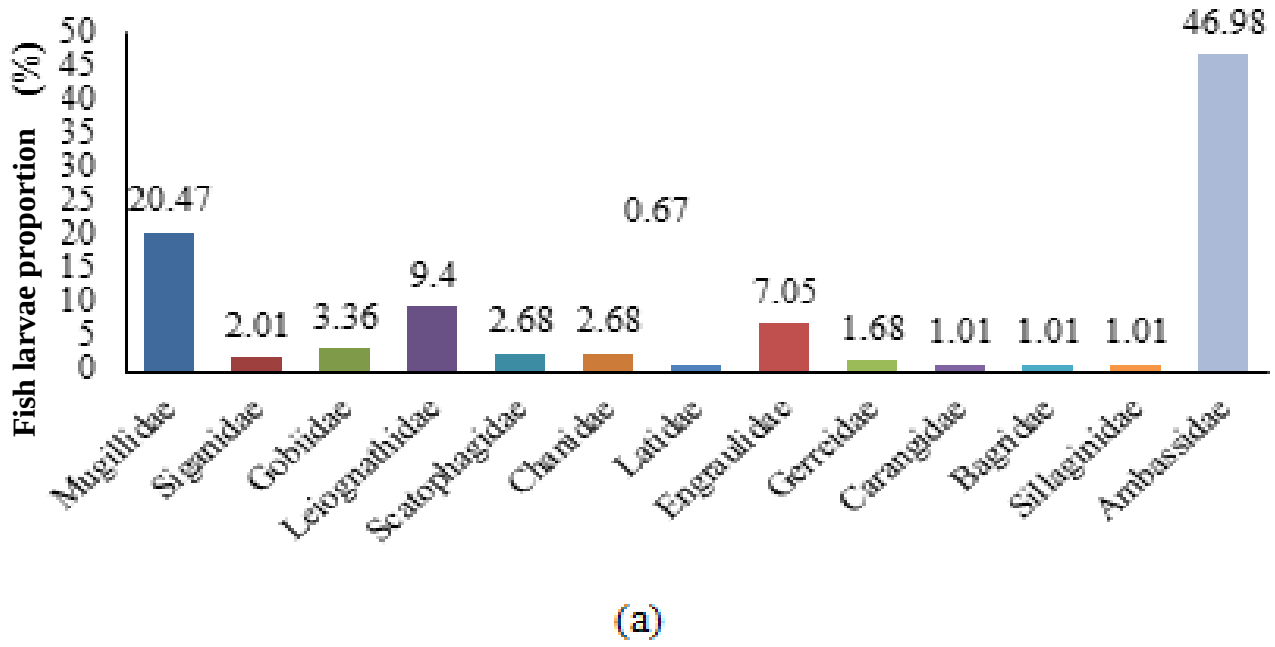


Fig 2:- The composition of the types of fish larvae that are caught are Mugilidae, Siganidae, Gobiidae, Leiognathidae, Scatophagidae, Chanidae, Latidae, Engraulidae, Gerreidae, Carangidae, Bagridae, Sillaginidae, Ambassidae: (a) Fish larvae (%).

Fish larvae caught in the Mangrove Conservation Area as much as ind / m3 consisting of 13 families. The composition of the types of fish larvae caught are Mugilidae, Siganidae, Gobiidae, Leiognathidae, Scatophagidae, Chanidae, Latidae, Engraulidae, Gerreidae, Carangidae, Bagridae, Sillaginidae, Ambassidae. The most caught types of fish larvae in each repetition are Ambassidae fish larvae. While the least caught species of fish larvae in each repetition are Carangidae, Bagridae, Sillaginidae fish larvae. The percentage of fish larvae that appear frequently is Mugilidae, Leiognathidae, Ambassidae. The Ambassidae family was caught at each point with an emergence percentage of 46.98%. The least common fish larvae are the Carangidae, Bagridae, Sillaginidae families with an emergence percentage of only 1.01%.

B. *Aquatic Chemistry Physics Paremeter*

Physics-Chemistry Parameters measured are temperature, pH, salinity, brightness, depth, current velocity. The results of the measurement of Aquatic Chemical Physics Parameters are presented in Table 1.

Site	Code Name	Water Quality					
		Temp (^{0}C)	Salinity (ppt)	Visibility	Depth (cm)	Ph	DO (mg/l)
1	A1LB1	32,5	30	6,8	45	8,23	6.2
2	J1LB3	32,2	24	34	76	8,13	6.3
3	A2G1	28,1	26	17,2	17,2	7,6	6.6
4	C1P1	29,3	28	67,8	199,6	7,14	6.7
5	D2P2	28,6	25	33	190	7,33	6.8
6	E1P1	29,2	28	52,3	117	7,46	6.5
7	E1P1270	27,7	30	31,5	242	7,92	6.4
8	C1R1	28	30	42	197	8,05	6.4
9	D1R1	28,2	26	90	218	8,3	6.8
10	F1R1	28	28	88	233,5	8,28	6.6
11	B1R1	27,7	30	38	199	8,15	6.7
12	H1Y1	29,7	31	0	65	8,76	6.5
13	I1Y1	29,1	30	36,4	73	8,6	6.5

Table 1:- Aquatic Chemistry-Physics Parameters.

The average water temperature ranges from 27.7 - 32.5 ° C, the average value of water salinity obtained is 24-30 30, the average value of water brightness ranges from 0 - 90, the average value of water depth ranged from 17.2 - 250 cm, the average value of water pH ranged from 7.33-8.76, the mean value of DO waters ranged from 6.2 to 6,8.

C. Community Structure of Fish Larvae

The calculated community structure includes diversity (H '), uniformity (E), and dominance (D). The results of the calculation of the diversity index, uniformity, and dominance values in the waters of Timbulsloko Village are presented in Table 2.

Site	Code Name	Abundance	Diversity	Domination	Evenness
1	A1LB1	155.844	0.630	0.370	1.260
2	J1LB3	103.896	0.750	0.250	0.750
3	A2G1	324.675	0.633	0.367	1.003
4	C1P1	194.805	0.289	0.711	0.458
5	D2P2	428.571	0.590	0.410	0.935
6	E1P1	181.818	0.856	0.144	0.856
7	E1P1270	51.948	0.319	0.681	0.639
8	C1R1	116.883	0.392	0.608	0.784
9	D1R1	142.857	0.679	0.321	1.076
10	F1R1	168.831	1.138	0.138	1.138
11	B1R1	116.883	0.805	0.195	0.805
12	H1Y1	90.909	0.527	0.473	0.836
13	I1Y1	155.844	0.909	0.091	0.909

Table 2:- Community Structure of Fish Larvae in the Waters of the Timbulsloko Village.

The diversity index value at each sampling point is smaller than 1, so the diversity level is low. The uniformity index value at point A1LB1 is classified as a high level of uniformity. The highest Domination index value is located at point C1P1.

IV. DISCUSSION

The interaction between physical and biological parameters resulted in the distribution of abundance and diversity of fish larvae in the estuary area of tropical waters. Among the environmental variables (salinity, temperature, brightness, and DO) with regularity or irregularity in each of these variables that are fluctuating (always changing in each time), greatly determine how ecological sustainability in the estuary region [9], [10]. The fluctuating changes in environmental variables at night and during the day have differences as in the correlation analysis of Figure 3.

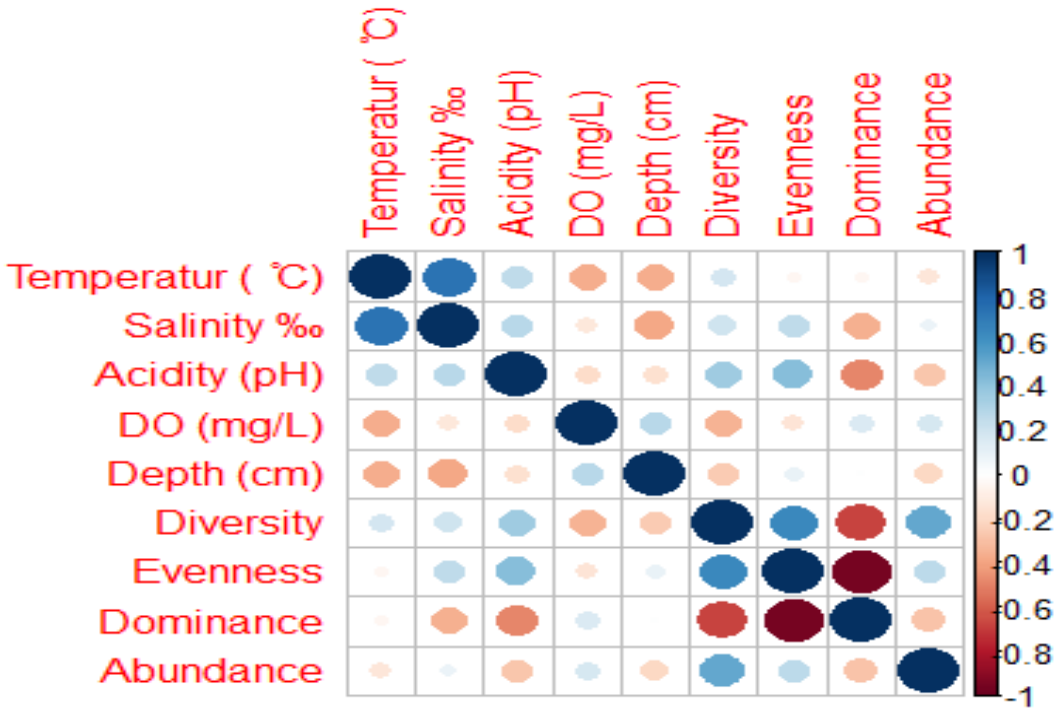


Fig 3:- The relationship of physical chemistry parameters in a scale of values 1 to - 1: (a) Correlation analysis using R Studio [11].

Salinity and temperature are positively correlated, that is, when salinity increases, the temperature also increases and vice versa. In other variables pH correlates positively with salinity and temperature, but has a weak relationship. Diversity index and uniformity are positively correlated with temperature and salinity with weak relationships between variables. This study is in accordance with research conducted by [12], where the index of uniformity and diversity has the same tendency of relations. On the other hand there was a negative relationship between diversity index and dominance index in this study which was similar to the study of the Naaf river estuary.

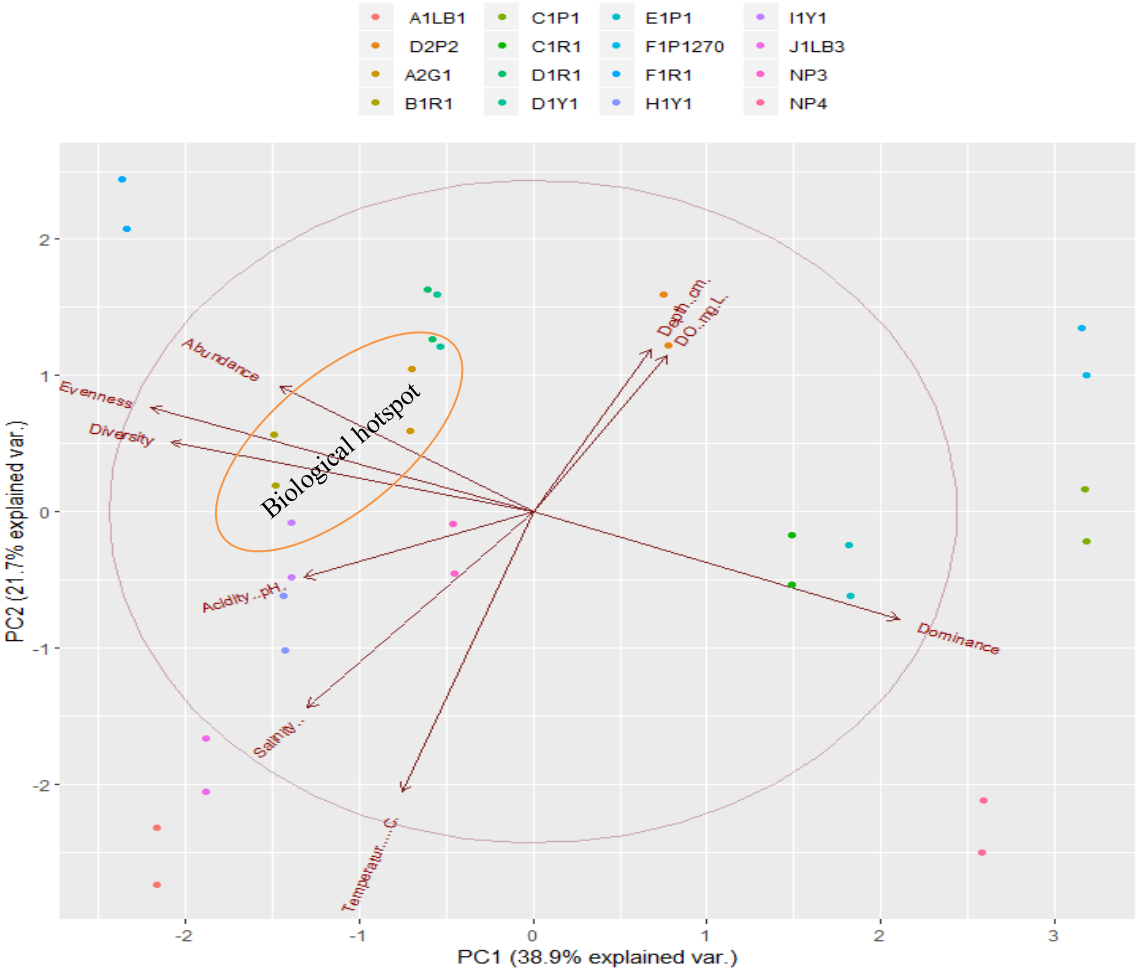


Fig 4:- Euclidean distance shows the similarity of values at point D2P2 and A2G1: (a) Output from Principal Component Analysis.

D2P2 and A2G1 stations have similarities which are close to the values of pH, Salinity, Uniformity Index and Diversity Index. This shows that there is an area with potential as an area of preference for fish larvae to survive. Besides that, it can be seen from the depth contour map and spatial vegetation that the D2P2 and A2G1 regions have the same regional contour pattern and vegetation type and are located in a straight line which indicates the influence of oceanogarafi parameters in determining the biological hotspot of fish larvae. The ecological similarity can also explain the traces of the mangrove habitat's fertility before the abrasion in Timbulsloko Village.

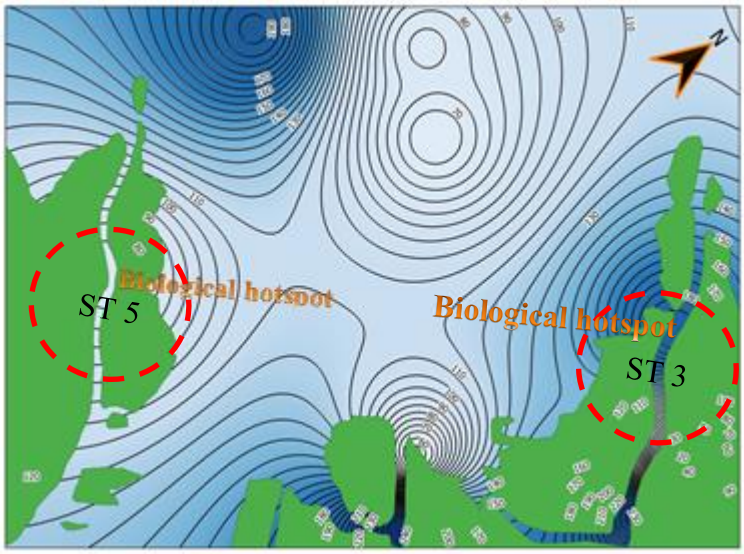


Fig 5:- Estimated location of the Biological Hotspot.

V. CONCLUSIONS

The similarity of ecological habitat values at D2P2 and A2G1 points based on PCA analysis and the similarity of spatial contours from spatial depth interpolation indicate the biological hotspot in the mangrove waters of Timbulsloko Village.

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