ILMU KELAUTAN: Indonesian Journal of Marine Sciences *December 2020 Vol 25(4):173-178* *ISSN 0853-7291*

Spatial and Temporal Distribution of Blue Swimming Crab Larvae (*Portunus pelagicus*) in The Conservation Area of Betahwalang, Central Java

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Abstract

Betahwalang has been one of the main contributors to the Blue Swimming Crab (BSC, Portunus pelagicus) fisheries production in Central Java Province. Recruitment of the BSC depends to a large extend on the abundance of crab larvae. However, information on larval distribution of the crab affecting the recruitment to the fishery, fishery management and decision making to support crab conservation in Betahwalang area has been lacking. The purpose of this study is to describe the spatial and temporal distribution of BSC larvae in the crab conservation area, to identify the larval stage most commonly occurs in the conservation area, and to develop process of decision making to managing conservation areas. This study was conducted in twelve months, starting from January until December 2018. The spatial distribution of the crab larvae was analyzed and mapped by means of SPSS and ArcGIS. The results of this study indicate that the crab larvae occur in the conservation area throughout the year. The highest larval abundance of the crab occurs in May, September, and November. The most commonly found crab larval stages were megalopa. As megalopa and crablet stages are relatively much more active and closer to the adult form, their occurrence in the conservation area and throughout the year of 2018 suggests the existence of continuous support to the Blue Swimming Crab recruitment for the following year. The spatial and temporal distribution of the larvae were influenced by oceanographic parameters including temperature, nitrate and phosphate, which were associated with monsoonal changes in the Java Sea.

Keywords : *Betahwalang, Larvae, Portunus pelagicus, distribution, conservation area*

Introduction

Portunus pelagicus has a complex life cycle. According to Kumar *et al.* (2003) and Potter *et al.* (2000), seasonal pattern of spawning is closely correlated with seasonal changes in sea surface temperature. The larval stages mainly occur in deep waters (Xiao *et al*., 2004). They undertake diel and tidal vertical migrations in the water column and are transported inshore, where they develop into juvenile crabs and forage predominantly on sand and mud flats (Prihatiningsih *et al*., 2009). Information about crab larvae, was important, cause its guide to conserve crab fisheries in a number of areas.

The Betahwalang waters area, had quite a potential BSC resources. But until now there had been no regulation on catching, caused decreasing crabs productivity. This could be due to the high intensity of small crab exploitation in Betahwalang waters, from the shallow coastal waters to the middle sea waters (Edi *et al.,* 2018).

Betahwalang began conducting breakthroughs in supporting the largest BSC producing area in Demak District in 2018,. Efforts were being made to form a BSC area conservation zone in the middle of the fishing area. The formation of the zone was done to help the process of breeding of the crab. But, information on the distribution of larvae in these areas has not been well explained, so that management of conservation zones has not been able to be carried out properly. The purpose of this study is to determine the distribution of larvae in the crab conservation area, to help in the management process and decision makers in managing conservation areas in Betahwalang Waters, Demak District.

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ijms.undip.ac.id
DOI: 10.14710/ik.ijms.25.4.173-178
Received : 27-10-2020
Accepted : 08-11-2020

Material and Methods

The field research was carried out in *Betahwalang Conservation Area* (LS 6° 48' 12.22" BT 110°33'23.64"), (LS 6°47'40.9" BT 110°32' 22.93"), (LS 6° 47' 1.97" BT 110° 32' 47.6"), (LS 6° 47'27.25" BT 110°33'42.5"), where is a new zoning in supporting (blue swimming crab) fisheries in Demak District. The measured location were 57 points, within *Betahwalang Conservation Area* and was taken at night for one year (Figure 1.).

The larvae of *Portunus pelagicus*, including plankton were collected by using plankton net 15 mm ring diameter with 450 mesh. The plankton net always sampled at least the under 30-50 cm of the waters. It began by lowering the plankton net a few meters and tied to the mast with a duration of 5 minutes at each sampling. Plankton net that has been lowered into water, will be pulled by using a ship around the study site. Each sample of plankton net was 1000 ml sea waters, which will be put into a sample bottle and given 5% formalin to be identified in the laboratory.

Along with the collection of larvae samples, some environmental parameters were also measured including temperature (^{0}C), salinity (ppt), dissolved oxygen (DO), pH, nitrate (mg.L^{-1}) and phosphate (mg.L^{-1}) in situ, in mid-water column at least 2 m from the surface, using WQC 22 (Water Quality Checker), Phosphate Test Kit HI3833, and Nitrate Portable ION321-NO3. Total densities of larvae measured by using SPSS and modeled with ArGIS to show the spread pattern of larvae *P. pelagicus*. The model was made by using calculated the number of larvae during one year of research.

Results and Discussion

Oceanographic parameters

The average value of temperatures throughout the study period was of 29,27^{0}C, with values that ranged between 27,99 and 30,13^{0}C. The highest temperature captured in May within range 30.07-30.13^{0}C, while the lowest temperature figure occurred in February within range 27,76-27,99^{0}C. This was temperature trend for one year in the Betahwalang conservation area. Salinity fluctuated with an average of 29.06. The highest salinity was captured in August 30,37, while the lowest salinity occurred in January 27,86. This salinity trend was in the night at Betahwalang conservation area.

Dissolved oxygen patterns averages were 6,22, and was trend for one year. The highest in April 7,64, while the lowest in January 5,43. The others pH fluctuated between 6,9-8,1 and relatively no different for one year. Nitrate and phosphate trend in the study periods were 0,74 and 0,10 mg.L^{-1}, with the highest nitrate in December ranged 0,92 mg.L^{-1} and phosphate in January 0,18 mg.L^{-1}. The lowest nitrate and phosphate in August with 0,47 and 0,03 mg.L^{-1}. The average oceanographic parameter in the study area for one year can be seen in (Table 1.)

The result of water temperatures (Table 1.) affected by low seasonal wind and decreasing temperatures in sea water surface (Wirasatriya *et al.,* 2018). The transitional seasons such as July and February affected low temperature. Others, The lowest salinity was caused by higher rainfall in the dry season months such as in November to February. This rainy season decreases salinity because of the river brings a lot of rainwater from the mainland to decrease the salinity in sea waters (Latifah *et al.*, 2015). According to Aeni (2011), this effect of decreasing in salinity can be seen physically or found a new colony plants such as (*E. crassipes*) in the estuary of Betahwalang waters.

Dissolve oxygen and pH values were in normal threshold of a waters and support an organism. According to Minister of LH Decree No. 115/2003 concerning Guidelines for Determining the Status of Water Quality, and Minister of Environment Decree No. 51/2004 concerning Sea Water Quality Standards for Marine Biota.

Nitrates and phosphates often increase in the rainy season and when coming of seasonal winds. The rainy season will bring a lot of nitrate and phosphate sourced from the mainland in the form of domestic or industrial wastes through the river (Latifah *et al*., 2015). This high value was observed during the rainy months such as December, February and January. Meanwhile, the results of the waves will stir nitrate and phosphate in the sediment followed by an increase in the waters (de Lestang *et al*. 2003). This was shown in April and May while in August it was seen to be low because of the low winds in the month.

Larva stages

The larvae of *P. pelagicus* found throughout the study was identified as 3 stages larvae, scilicet zoea, megalopa, and crablet. During the study, megalopa stages were the most common crab larvae, due to sizes ranging from 0.5 mm to 1.30 mm. The larval stage during the study can be seen in Table 2.

Larvae found (Table 2) during the study included 3 stages, namely zoea, megalopa, and crablet. The most commonly found larvae are megalopa larvae. These larvae are found in almost all months. This, because in the form of megalopa larvae phase, the larvae are still in a floating condition in the water column, even though they look like small crabs. While the zoea and crablet larvae stages are found in several locations, but in certain seasons, zoea and crablet are not found. According to Kunsook *et al.* (2014) megalopa larvae are plankton feeders, which settled in certain habitats that provided protection. While the crablet phase which would prefer small fish species in the sediment and move frequently (Rasheed *et al*., 2010). This proves that *P. pelagicus* larvae in Betahwalang are often found in megalopa type at the time of data collection, but the zoea and crablet cycles are part of the cycle with the minimum number in the study area. As megalopa stage is relatively more active and close to the adult form, the occurrence of megalopa throughout the conservation area suggests the continuous support to crab recruitment.

Spatial and temporal distribution of larvae

Spatial and temporal distribution of larvae in the crab conservation area was carried out during one year of research. the highest larval distribution occurred in May, September, and November, while the lowest occurred in December, January and February. Larva distribution was modeled using ArcGis 12 based on data on the quantity of larvae in the Betahwalang conservation area. The larval distribution can be seen in Figure 2. As megalopa and crablet stages are relatively much more active and closer to the adult form, their occurrence in the conservation area and throughout the year of 2018 suggests the existence of continuous support to the Blue Swimming Crab recruitment for the following year.

Most of the larvae distribution results showed the highest concentrations in May, September and November. High and low concentration of larvae in the waters can be influenced by the annual seasonal cycle in Indonesian waters. The influence of this season will be followed by various changes in oceanographic parameters (Johnstons *et al*., 2011). These parameters affect the difference in the level of larval concentration in each month. At the beginning of the transition to the rainy season in September, salinity will slowly fall due to the occasional fall of rain that month. The cycle of the crab parent will release its eggs in high salinity (30-32 ppt) then the larvae will go to the low salinity in the mouths of the Betahwalang river (Nybakken, 1986; Edi *et al.,* 2008).

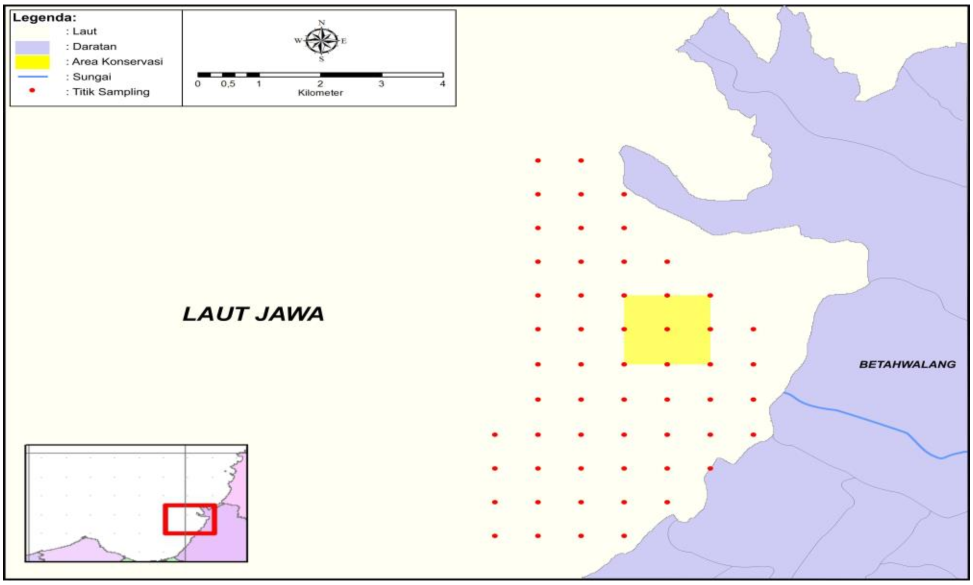

Figure 1. Study area and sampling stations (dots) in Betahwalang Conservation Areas in January-December 2018.

Table. 1. Oceanographic Parameters

Parameters	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp (^{0}C)	28.44	27.99	28.87	30.11	30.13	29.94	29.17	28.52	28.72	29.7	30.02	29.62
Salinity (ppt)	27.86	28.42	28.56	28.72	29.19	29.34	29.35	30.37	30.27	29.47	28.89	28.23
DO (mg.L^{-1})	5.43	6.81	5.92	7.64	5.65	6.23	6.78	6.01	6.31	6.29	5.73	5.89
pH	7.1	6.9	7.5	7.8	7.9	8.1	7.7	7.8	7.4	7.9	7.3	7.4
NO_3 (mg.L^{-1})	0.83	0.76	0.79	0.81	0.72	0.64	0.55	0.47	0.73	0.88	0.81	0.92
PO_4 (mg.L^{-1})	0.18	0.11	0.12	0.15	0.09	0.07	0.07	0.03	0.04	0.09	0.16	0.14

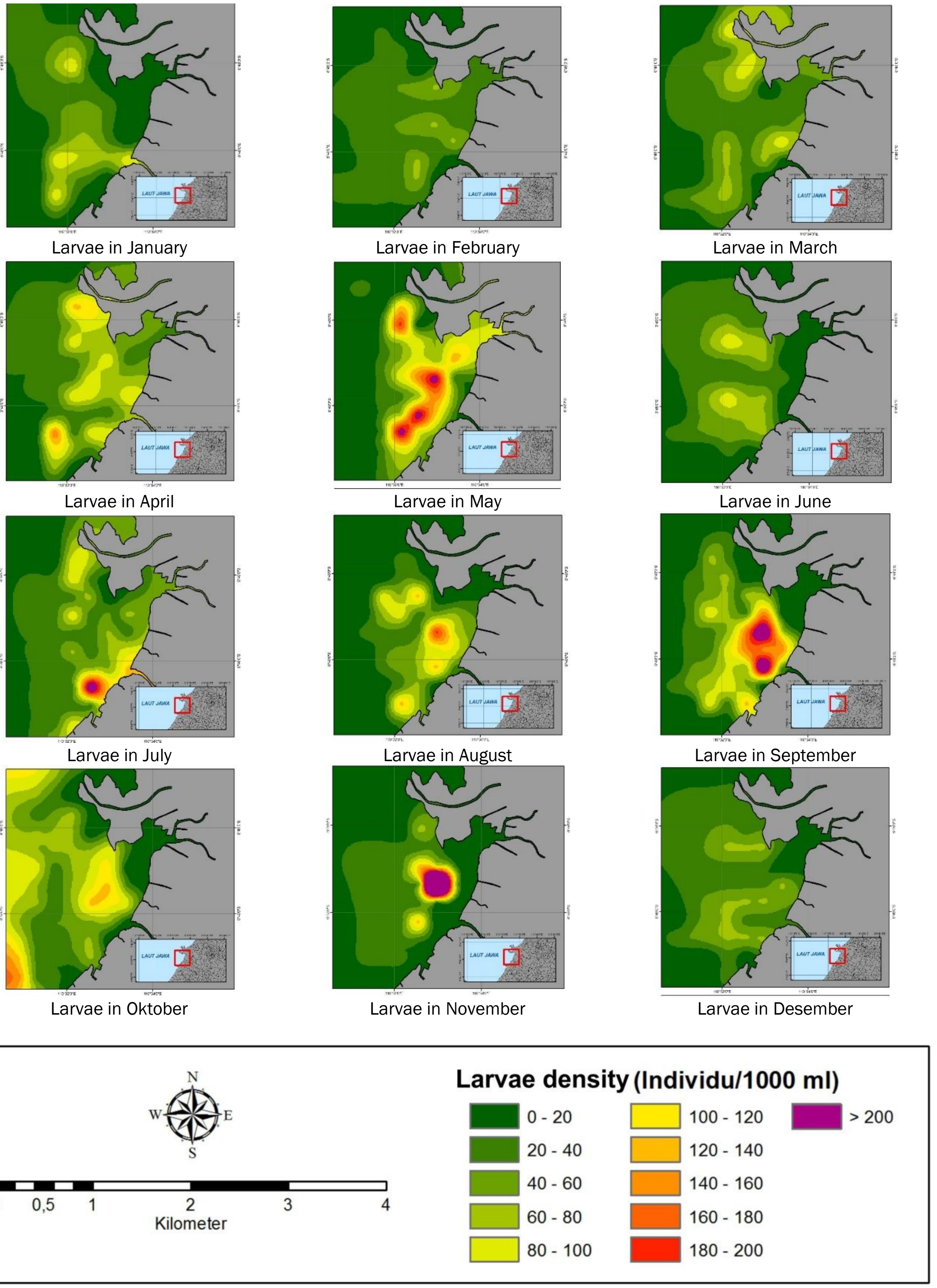

Figure 2. Spatial and temporal Distribution of larvae *Portunus pelagicus* larvae in Betahwalang water from January to December, 2018

Table 2. The stages of larva *Portunus pelagicus*

Larvae Stages	Month												Range
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(mm.cm^{-1})
Zoea	+	+	+	+	+	-	-	-	+	+	-	-	0,05 - 1,30 mm
Megalopa	+	+	+	+	+	+	+	+	+	+	+	+	1,40 - 1,20 mm
Crablet	-	+	-	-	+	+	+	-	-	-	-	-	1,25 - 2,56 cm

According to research on how blue crab larvae (*Callinectes sapidus*) in Virginia to estuary was mengandaled humic acid family or acid decomposition of organic substances that were usually high concentrations in the estuary region. Top waters or surfaces that contain humic acid were used by larvae to guide their direction and bottom waters or in providing undercurrent which is used as a mode of transportation to the site. The larvae will sink and float to get to the location of enlargement that is close to the estuary (Epifano, 2019). This can occur in Betahwalang waters which have many estuaries which can reduce salinity and carry humic acid far to the hatchery location during the rainy season. Other highest peak larval concentrations also occur in November and May which are still affected by the rainy season.

During the study, a series of meetings with village administration and local community of Betahwalang were also held to discuss about part of the above findings. Agreement was achieved to legally manage the Blue Swimming Crab conservation area of 6 km^2, based on this study, in particular the map of Blue Swimming Crab distribution. This agreement was further incorporated in the revised version of the Village Regulation (PERDES) No. 2/2019, which was signed on 21st of May, 2019, which delineates the geographic position of: 6^{0}48' 12.22"S -110^0 33' 23.64"E; 6^{0}47' 40.9"S - 110^0 32' 22.93"E; 6^{0}47'1.97"S - 110^{0}32'47.6"E.

Conclusions

The most commonly found crab larvae were megalopa, where the highest larval distribution occurs in May, September, and November. The spatial distribution is influenced by oceanographic parameters including temperature, nitrate and phosphate, where oceanographic parameters are affected by the annual season. During the study, oceanographic parameters were still below the threshold and support the crab for breeding.

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