Spatial and Temporal Variation of Biomass Blood Cockle (Anadara sp.) in Estuaries Dadapan, Sedati Sub-District, Sidoarjo, East Java

M R Ramadhan1*, K T Pursetyo2, Prayogo3 and N N Dewi3.
1Aquaculture, Faculty of Fisheries and Marine Airlangga University, Surabaya 60115
2Department of Marine, Faculty of Fisheries and Maritime Affairs, Airlangga University, Surabaya 60115
3Department of Aquaculture, Faculty of Fisheries and Marine, Airlangga University, Surabaya 60115
*roihan131313@gmail.com

Abstract. Biomass is one of the primary data in decreasing the quality and quantity of blood cockle because it can determine the constantly caught feathered shells that will run out of stock. Thus the temporal and spatial variation of the total value of the shell biomass will be connected whether it is related or not. Efforts to reduce the number of biomass is by catching fur shells in an area that many fishing activities conducted by fishermen. The catching activity is divided into three stations namely the river mouth distance of 1.5 km, 1.75 km and 2km. Spatially the total biomass of fur shells (Anadara sp.) Is at the mouth of the Dadapan river. Temporally the range of biomass at the mouth of the Dadapan river is greater in January at 1.75 km station of 11.53 gr/m², whereas biomass at 2 km station is 9.79 gr/m² and biomass at 1.5 km station 5.49 gr/m². The current velocity in January is 8-10 cm/sec, the wind velocity in January is 2-3 knots, and the wave height in January spreads from 1.76-0.81 meters. Current, wind and wave.

Keyword. Biomass, Spatial and Temporal Variation, Estuaries Dadapan, Anadara sp.

1. Introduction
Natural resources in Indonesia and their ecosystems took the center stage and play a critical role in national life and development. As such, they must be managed and utilized sustainably for Indonesian public welfare and humanity in general now and for the future. Examples of marine living natural resources that must be managed and utilized properly are Ark Shell (Anadara sp.) because most them consumed are gathered in the sea (Darmawan, 2014).

Ark Shell (Anadara sp.) and Blood Clam (Anadara granosa) are in the family of arcidae and genus anadara. In general, these two shells have almost the same morphology. Their shells have the same hemisphere attached to one another at the shell around the edges (Sudrajat, 2008). The difference between the two is in their morphology. Ark Shell’s (Anadara antiquata) shell is covered by hair and it is thinner than that of blood clams (Anadara granosa). Blood clam has thicker, coarser, more round and jagged shells at the top and featherless (Suwignyo, 2005).

According to data statistics from Department of Fisheries and Marine Affairs (2007), the production of Ark Shell (Anadara sp.) in Indonesia increased by 7 tons (2002) in 2002-2006, 2,869
tons (2003), 12,991 tons (2004), 16,348 tons (2005), and 18,896 tons (2006). In Sidoarjo Regency, the Ark Shell production decreased by 534 tons in 2013-2014, 1,695.6 tons in 2013, and 1,061.6 tons in 2014 (source: Department of Fisheries and Marine East Java, 2014). The disturbance of habitat and a decline in the environmental quality has caused a decline in their population and a shrinking trend in their maximum size, in which the length of Ark Shell is 30-40cm, it can even reach 45 cm long, 20-30 cm wide, 11-24 cm thick, and weighs 18-25 gr.

The research on Ark Shell biomass was conducted with the aim to determine the spatial and temporal variation of Ark Shell biomass in Dadapan estuary, Sedati District, Sidoarjo Regency which was influenced by several factors, including environmental quality, fishing activity, ecosystem existence, and oceanographic conditions. There were three sampling period in the field which took place from January to March 2017.

2. Research material and method
2.1. Research location and station
The research was conducted from January until March 2017 at the Dadapan estuary, Sedati District, Sidoarjo Regency, East Java, and Education Laboratory of Faculty of Fisheries and Marine, Airlangga University, Surabaya.

2.2. Equipment and materials
The equipment used in this study are; boat for sampling mobility, scallops to catch shells, cool boxes for storing the samples, a sliding 0.01 mm length to measure shell’s length, digital scales with an accuracy of 0.0001 grams, digital cameras, label paper, plastic clips, permanent markers, stopwatches, GPS (Global Positioning System) and devices to measure water quality such as thermometers, refractometers, DO kits, pH meters, and Secchi disks.

The material used in this study is Ark Shell from two different places of Dadapan estuary. Later on, the material was stored in a cool box filled with ice cubes as a preservative.

2.3. Work procedure
Samples of Ark Shell (Anadara sp.) were gathered using clam basket. Clam basket is operated by lowering the basket to the bottom of the water, then pulled it up to the surface. The distance between each post was determined by one minute-distance travel, the basket was lifted onto the boat to gather the catch. Samples of Ark Shells were then stored in a cool box with ice cubes. Later, they were measured on their length, width, height using calipers and their weight using digital scales in the wet laboratory of Faculty of Fisheries and Marine, Airlangga University. Additionally, secondary data collection includes fisheries statistics.

2.4. Data analysis
The biomass estimation was carried out based on the results from the catch gathered from clam basket. This data obtained during the study. The analysis was carried out using a swept area method. This method is based on the area swept, the length of the sweep, and the length of the rope. The length of the sweep flow was obtained from the total amount of withdrawing the clam basket distributed by a moving ship at a certain speed. Systematically, the long formula for sweeping was based on Sparre and Vanema (1999) formula:

\[ D = v \times t \]

Note:
D = Sweep/distance length swept (m)
v = Withdrawing Speed (Km/hour)
t = Time of Withdrawal (hour)
After calculating the sweeping length, we get an equation for a unit area of sweeping from clam basket obtained based on Sparre and Vanema (1999):

\[ a = D \times h \]

Note:
- \( a \) = sweep area unit (m\(^2\))
- \( h \) = Length of clam basket (m)

After calculating the equation for the unit area of sweeping area, the calculation of biomass for one pull according to Sparre and Vanema (1999) is as follows:

\[ B = \frac{C_w}{a} \times f \]

Note:
- \( B \) = Biomass (gr/m\(^2\))
- \( C_w \) = Total Catch (gram)
- \( f \) = Breakout Factor (0.4)

3. Result and discussion

3.1. Data of ark shell biomass (Anadara sp.)
Data of Ark Shell Biomass (Anadara sp.) taken from the station in January in Dadapan Estuary, Sub-District Sedati, District Sidoarjo, East Java is presented in Figure 1. There were three Ark Shell sampling stations (Anadara sp.), i.e. 2 km station, 1.75 km station and 1.5 km station.

In Dadapan estuary, the highest biomass in January was at 1.75 km i.e. 11.53 gr/m\(^2\), while the biomass at 2 km was 9.79 gr/m\(^2\) and biomass at 1.5 km was 5.49 gr/m\(^2\).

![Figure 1. Data on Ark Shell Biomass (Anadara sp.) according to the station in January.](image)

Data of Ark Shell biomass (Anadara sp.) based the station in February in Dadapan estuary, Sedati District, Sidoarjo Regency, East Java can be seen in Figure 2. There are three sampling stations for ark shells (Anadara sp.) i.e. station 2 km, station 1.75 km, and station 1.5 km. In Dadapan Estuary, the highest total biomass in February was from station 2 km at 11.34 gr/m\(^2\), while biomass at station 1.75 km was 7.5 gr/m\(^2\) and biomass at station 1.5 km was 3.38 gr/m\(^2\).
Figure 2. Data on Ark Shell biomass (Anadara sp.) based on data from the station in February.

Data on Ark Shell biomass (Anadara sp.) was taken from the station in March in Dadapan Estuary, Sedati Sub-District, Sidoarjo Regency, East Java as illustrated in Figure 3. There are three sampling stations for Ark Shell (Anadara sp.) i.e. station 2 km, station 1.75 km, and station 1.5 km. In Dadapan Estuary, the highest total biomass in March was at station 1.75 km i.e. 9.94 gr/m², while biomass at station 2 km was 7.51 gr/m² and biomass at station 1.5 km was 9.33 gr/m².

Data of Ark Shell biomass (Anadara sp.) is associated with fishing activities, pollution in seawater, sediments, and Ark Shell, and environmental factors e.g. temperature, pH, dissolved oxygen, salinity, brightness, and TSS Ark Shell (Anadara sp.) at Dadapan Estuary, Sedati Sub-District, Sidoarjo Regency, East Java.

Figure 3. Data on Ark Shell biomass (Anadara sp.) taken from the station in March.

3.2. Data on water quality

The results of water quality measurement in Dadapan Estuary showed that some parameters of water quality were still within the normal range to support the Ark Shell (Anadara sp.), other data showed slightly below the recommended quality standard. The measurement result of water quality in Dadapan Estuary is illustrated in Table 1.
Table 1. Data of water quality in Dadapan Estuary.

| Parameter                 | Unit       | January | February | March |
|---------------------------|------------|---------|----------|-------|
| Temperature               | ºC         | 28      | 29       | 29    |
| Salinities                | ppt        | 29      | 29       | 29    |
| pH                        |            | 8       | 8.2      | 8.1   |
| Clarity                   | cm         | 40      | 45       | 40    |
| Dissolved Oxygen          | mg/l       | 5       | 5        | 5     |
| Suspended Solid substance (TSS) | mg/l | 7.5     | 19       | 9     |

(Sumber: Data Pribadi, 2017)

Table 2. Sea water quality standard based on Ministerial decrees.

| Parameter                 | Unit       | Sea Water Quality Standard |
|---------------------------|------------|---------------------------|
| Temperature               | ºC         | 20º                      |
| Salinities                | ppt        | 28-33º                   |
| pH                        |            | 7-8.5º                   |
| Clarity                   | cm         | >40º                     |
| Dissolved Oxygen          | mg/l       | 5º                       |
| Total Suspended Solids (TSS) | mg/l | 7º           |

Source
- a: Ministerial Decree No.51 of 2004
- b: Ministerial Decree No.20 of 1990
- c: Ministerial Decree No.8 of 2009

3.3. Oceanographic condition
According to Barus (2001), current speed is one of the critical factors in both fast and slow waters. This is related to the spread of organisms, dissolved gases and minerals in the water. The speed of water flow varies vertically. Water flows in fast waters are generally truculent, i.e. water flow that moves in all directions so the water will be distributed to all parts of the water.

According to Husabarat and Stewart (2008), current is defined as a very wide water movement that occurs in all oceans in the world. Current plays a very important role in determining the direction for ships. According to Barus (2001), in a limber ecosystem, current is influenced by the strength of the wind, as such, the stronger the wind therefore the stronger and deeper the current in influencing the water surface. In calm waters, the current velocity is generally around 3m/s. However, it is very difficult to set a limitation regarding a current speed, because the flow in an aquatic ecosystem fluctuates from time to time depending on the debit fluctuations, the water flow, and the existing substrate conditions.

The speed of river current is influenced by the slope and the river content fertility. The depth and fullness of the river, so that the flow velocity along the river flow can vary which will then affect the type of river substrate (Suliati, 2006). Below is the table of current and wave data in Dadapan Estuary.

Table 3. Data on current speed, wind speed and wave height.

| Month  | Station | Current Speed (cm/sec) | Wind Speed (knot) | Wave Height (meter) |
|--------|---------|------------------------|-------------------|---------------------|
| January| 2km     | 8.38                   | 3.5               | 0.76                |
|        | 1.75km  | 10.64                  | 3.1               | 0.79                |
|        | 1.5km   | 10.84                  | 2.8               | 0.81                |
| February| 2km     | 13.75                  | 8.6               | 1.51                |
|        | 1.75km  | 15.82                  | 8.4               | 1.53                |
3.4. Catch data
According to statistical data from the Department of Fisheries and Marine Affairs (2007), Ark Shell production 2002-2006 was 2,862 tons (2002), 2,869 tons (2003), tons (2004), 2,864 tons (2005) and 2,896 tons (2006). In 2013-2016 shellfish production showed a decline of 534 tons, namely 1,695.6 tons in 2013 and 1,061.6 tons in 2014. In 2015-2016 ark shell production showed a decrease of 268 tons, namely 1,014.9 tons in 2015 and 747.9 tons in 2016 (Department of Fisheries and Marine East Java, 2017). This was also in line with the increase in the number of shellfish fishing equipment in Sidoarjo Regency from 2013 i.e. 125 units of seashell fishing gear, in 2014 - 174 units, in 2015 - 261 units, and in 2016 - 307 units (East Java Fisheries and Marine Service, 2017).

3.5. Discussion
Ark Shell biomass (Anadara sp.) in Dadapan Estuary. Spatially, the total shellfish biomass (Anadara sp.) is at the estuary of the Dadapan river. Temporally the biomass range at the Dadapan river estuary is greater in January, i.e. station 1.75 km at 11.53 gr/m², while biomass at 2 km at 9.79 gr/m² and biomass at 1.5 km at the station 5.49 gr/m². Water quality which includes temperature, salinity, dissolved oxygen, brightness, TSS and pH is within normal limits. The speed of the current, wind speed and wave height in January are not too high so the distribution of shells does not move too far due to current, wind and wave factors. In the limber ecosystem, the current is influenced by the strength of the wind, the stronger the wind will cause the current to be stronger and deeper to affect the water layer. In calm waters, the current velocity generally around 3 m/s. However, it is very difficult to set a limitation regarding the current speed because the flow in an aquatic ecosystem fluctuates from time to time depending on debit fluctuations, the flow water, and the existing substrate conditions. The speed of river current is depended by the slope and fertility of river contents. The depth and fullness of the river, as such the current speed along the river flow can vary which will then affect the type of river substrate.

4. Conclusion and suggestion
Our conclusion is to find out the spatial and temporal variation of Ark Shell biomass (Anadara sp.) in Dadapan Estuary, Sedati Sub-District, Sidoarjo Regency, East Java. Spatially, the total Ark Shell biomass (Anadara sp.) was found in Dadapan Estuary. Temporally, the range of biomass in the Estuary is higher in January, i.e. station 1.75 km at 11.53 gr/m², while biomass in station 2 km was 9.79 gr/m² and biomass in station 1.5 km was 5.49 gr/m². The water quality which includes temperature, salinity, dissolved oxygen, clarity, TSS and pH was within the normal limit. The current speed, wind speed and wave height in January were not too high so that the distribution of Ark Shell was not far due to the current, wind and wave factor. In addition, further studies on Ark Shell biomass (Anadara sp.) should be done from April to December to find out the value of scallop biomass (Anadara sp.) in Dadapan Estuary. Our suggestion is all stakeholders should get involved in managing and monitoring due to the water condition with a lot of anthropogenic influences and environmental degradation so he Ark shell resources (Anadara sp.) remain sustainable.

5. References
[1] Afiati, N. 2007. Gonad Maturation Of Two Intertidal Blood Clams Anadara granosa (L.) and Anadara antiquata (L.)(Bivalvia:Arcidae) in Central Java. Journal of Coastal Development, 10 (2). 105-113.
[2] Afsyah, S. 2012. Upaya Penurunan Kadar Cadmium Pada Kerang Bulu (*Anadara antiquata*) Dengan Pemanfaatan Larutan Chitosan. FKM.USU

[3] Barnes RD. 1987. Invertebrate Zoology. Fifth edition. Sounders Collage. Philadelphia.

[4] Baron J. 1992. Reproductive cycles of the bivalvia molluscus Atactodea striata (Gmelin), Gafrarium tumidum Roding and *Anadara scapha* (L.) in New Caledonia. Aust. J. Mar. Freshwater Res. (43) : 393-402.

[5] Beesley, Pamela and Graham BJB Ross, A. Wells. 1998. Mollusca the Southern synthesis. Csiko Publishing. Australia.

[6] Blanchard F. Jean B. 2001. Temporal Variability of Total Biomass in Harvested Communities of Demersal Fishes. Fisheries Research 49 (2001): 283-293.

[7] Broom MJ.1982. Analysis of the Growth of *Anadara granosa* (Bivalvia : Arcidae) in Natural, Artificially-seeded and Experimental Populations. Mar. Ecol. Prog. Ser. Vol 4 : 69-79.

[8] Brower JE, Zar JH, and Von Ende CN. 1990. Field and laboratory methods for general ecology ed ke-3. Wm. C. Brown Publishers. Dubuque, lowa. 237 hlm.

[9] Campbell, Neil A. and J.B. Reece 2008. Biologi, Edisi Kedelapan Jilid 3. Terjemahan: Damaring Tyas Wulandari. Jakarta: Erlangga.

[10] Dance SP. 1977. *The Encyclopedia of Shells*. Blanford Press. London. 288p

[11] Darmawan S. 2014. Studi Aspek Biologi Reproduksi Kerang Darah (*Anadara ganosa*) di Perairan Teluk Kendari. Skripsi. Manajemen Sumberdaya Perairan. Fakultas Perikanan dan Ilmu Kelautan. Universitas Halu Oleo. Kendari. 45 hal.

[12] Dinas Kelautan dan Perikanan Jawa Timur, 2013. Laporan Tahunan Statistik Perikanan Tangkap di Jawa Timur Tahun 2013, Surabaya.

[13] Dinas Kelautan dan Perikanan Jawa Timur, 2014. Laporan Tahunan Statistik Perikanan Tangkap di Jawa Timur Tahun 2014, Surabaya.

[14] Effendi, H. 2003. Telaah Kualitas Air Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan. Penerbit Kaniskus. Yogyakarta.

[15] Hadi, Sutrisno. 2004. Metodologi Research Jilid 3. Yogyakarta : Andi.

[16] Mcnaughton, S.J and Larry L. Wolf. 1990. Ekologi Umum. Edisi Kedua. Terjemahan: Sunaryo Pringgoseputro dan B. Srigandono. Yogyakarta: Gadjah Mada University Press.

[17] Michael, P. 1984. Ecologycal System Metode For Field and Laboratory Investigations. New Delhi: Tata Mcgraw-Hill Publishing Company Limited.

[18] Mubarak H. 1987. Distribusi *Anadara* spp. (Palecypoda : Arcidae) dalam Hubungannya Dengan Karakteristik Lingkungan Perairan dan Asosiasinya Dengan Jenis-Jenis Moluska Benthi Lain di Teluk Blanakan Kabupaten Subang, Jawa Barat. [thesis]. Fakultas Pascasarjana Institut Pertanian Bogor.

[19] Mzighani, S. 2005. Fecundity of Population of Cockles, *Anadara antiquata* L. 1758 (Bivalvia:Arcidae) From a Sandy/Muddy Beach Near Dar Es Salaam, Tanzania, Western Indian Ocean. Journal of Marine Science, 4 (1). 77-84.

[20] Nina N.D. 2016. Variasi Spasial dan Temporal Struktur Komunitas dan Biomassa Ikan di Perairan Pesisir Kabupaten Tangerang, Provinsi Banten. Fakultas Perikanan dan Ilmu Kelautan Institut Pertanian Bogor.

[21] Nurdin, J., N. Marusin, Izmiarti, A. Asmara, R. Deswanti dan J. Marzuki. 2006. Kepadatan Populasi dan Pertumbuhan Kerang Bulu *Anadara antiquata* L. (Bivalvia: Arcidae) di Teluk Sungai Pisang, Kota Padang, Sumatra Barat. Makara Sains. 10 (2). 96-101.

[22] Nybakken. 1988. *Biologi Laut Suatu Pendekatan Ekologi*. Gramedia. Jakarta.

[23] Odun E.P. 1994. Dasar-Dasar Ekologi. Edisi Ketiga. Terjemahan: Tjahjono Samingan. Yogyakarta: Gadjah Mada University Press.

[24] Pechenik JA. 2000. *Biology of The Invertebrate*, Fourth Edition. Van Hofmann Press Inc. The United State of America.

[25] Peraturan Pemerintah Republik Indonesia. 2001. Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air. Nomor: 82 Tahun 2001.
[26] Peraturan Pemerintah Republik Indonesia. 2008. Pengelolaan Sumberdaya Air. Nomor: 42 Tahun 2008.
[27] Peraturan Menteri Kesehatan Republik Indonesia.1990. Syarat-syarat dan Pengawasan Kualitas Air. Nomor: 416 tahun 1990.
[28] Sparre P. Vanema SC. 1999. Introduksi Pengkajian Stok Ikan Tropis Buku E-manual (Edisi Terjemahan). Kerjasama Organisasi Pangan. Perserikatan Bangsa-Bangsa dengan Pusat Penelitian dan Pengembangan Perikanan. Badan Penelitian dan Pengembangan Pertanian. Jakarta. 438 hal.
[29] Squires HJ., B. Estevez, O. Barona and O. Mora 1975. Mangrove Cockle, Anadara spp (Mollusca : Bivalvia) of the Pacific Coast of Columbia. Veliger 18 : 57-68.
[30] Sugiyono. 2005. Metode Penelitian pendidikan pendekatan kuantitatif dan kualitatif. Alfabeta. Bandung.
[31] Sukmadinata, N .S, (2011). Metode Penelitian Pendidikan. Cetakan ke-7. Bandung. Remaja Rosdakarya.
[32] Tetelepta CHA. 1990. Hubungan Antara Kandungan Logam Berat Zn, Pb, Cd dan Hg Dalam Habitat Serta Jaringan Tubuh Terhadap Kemungkinan Terjadinya Anomali Ova Kerang Darah (Anadara granosa) di Muara Mati dan Muara Mauk. [Thesis]. Program Pascasarjana Institut Pertanian Bogor.
[33] Wibowo, R. K. A. 2009. Analisis Kualitas Air Pada Sentral Outlet Tambak Udang Sistem Terpadu Tulang Bawang, Lampung. Skripsi. Fakultas Perikanan dan Ilmu Kelautan. Institut Pertanian Bogor. Bogor.
[34] Widyastuti, A. 2011. Perkembangan Gonad Kerang Bulu (Anadara antiquata) di Perairan Pulau Auki, kepulauan Padaido, Biak, Papua. Oceanologi dan Limnologi di Indonesia, 37 (1). 1-17.