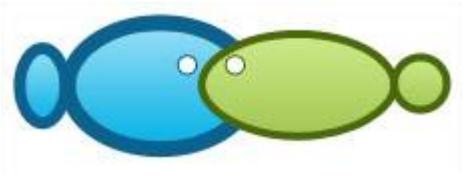

Physical oceanographic analysis on blue swimming crab (*Portunus pelagicus*) habitat in coastal waters of Pangkep Regency

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Abstract. The blue swimming crab (*Portunus pelagicus*) is a crustacean animal which is one of the commodities in the world of fisheries that has a high economic value both in Indonesia and abroad. Environmental factors and the quality of the waters where the blue swimming crab lives can influence its growth rate. This research was carried out in June-July 2023 and aims to assess the quality of physical oceanography in the natural habitat of blue swimming crab in the coastal waters of Pangkep Regency. This research uses a descriptive survey method with random sampling. The research results show that the water brightness ranges from 1.00 to 19.49 m, the temperature ranges from 28.9 to 33.5°C, the current speed ranges from 0.06 to 0.24 m s^{-1}, and the depth ranges from 1.10 to 24.19 m, so the water parameters are suitable for blue swimming crab habitat.
Key Words: crab, current, depth, physical parameters, temperature.

Introduction. Pangkajene Regency is characterized by its water area being wider than its land area, with a ratio of 17:7. In this region, there are 117 islands, and of these, 80 islands are inhabited by residents. These islands are divided into 3 sub-districts, namely Liukang Tupabbiring, Liukang Kalmas and Liukang Tangaya. Marine wealth in Pangkep Regency is very abundant, and one of its resources is the blue swimming crab (*Portunus pelagicus*). It is included in the Crustacea Class and it lives on the seabed, but sometimes swims close to the surface of the sea water to search for food. Because of this behavior, it is also known as the blue swimming crab (Mawaluddin et al 2016). Blue swimming crab is also a fishery commodity that has high economic value in Indonesia, where around 60% of the catch is exported abroad (Sidauruk 2015). Crab can be found living in various types of habitat, including fish ponds in coastal waters that receive an adequate supply of sea water. Crabs can be found in varying water depths, around 0 to 60 meters. The basic substrate of crab habitat is very diverse, ranging from coarse sand, fine sand, a mixture of sand and mud, to waters covered with seagrass.

Factors that influence the growth of an organism include the growing medium, water quality, and feed quality. Physical oceanographic factors including temperature are important factors in the development of the juvenile phase of crab. According to Ikhwanuddin et al (2012), the optimum temperature for growth and development of blue swimming crab larvae on a lab scale is 30°C. Research results in the Indian Ocean show that the optimum temperature for crab development ranges between 28 and 30°C (Ravi & Manisseri 2012). Currents are horizontal movements of water masses that can be caused by wind blowing on the sea surface. Water currents have a significant influence on the physical and chemical conditions of waters (Hadi & Radjawane 2011). Current patterns and characteristics which include the dominant current type, speed and direction as well as patterns of ocean current movement cause the condition of a water to become dynamic. The movement of currents carries materials contained in water bodies (Hadi & Radjawane 2011). According to Ikhwanuddin et al (2012) bathymetry or water depth

greatly influences the physical and chemical conditions of waters, because depth can influence the intensity of light that reaches the bottom of the waters. The deeper the water, the less intense the light received will be. This can affect photosynthesis, algae growth, and the distribution of organisms that need light to live. Water depth can also affect water temperature. Deeper waters tend to have cooler temperatures than shallower waters. This can affect the speed of chemical reactions, the metabolism of organisms, and the movement patterns of aquatic animals. Furthermore, the depth of the water can affect dissolved oxygen levels. In deep waters, dissolved oxygen levels tend to be lower. However, in shallow waters exposed to direct sunlight, oxygen production through photosynthesis by algae and aquatic plants can increase dissolved oxygen levels (Sahabuddin 2023). Crab can be found in a very diverse range of habitats, namely found from the intertidal zone to offshore waters with a depth of 50 m (Edgar 1990; Kumar et al 2000). This is related to the habitat preferences for each crab life cycle, starting from larval, juvenile to adult crab habitats. According to Rahman & Fuad (2019), the crab has a wide habitat, starting from mangrove areas, near the sea surface, and the seabed with a depth of < 1-50 meters. Information regarding the physical oceanographic conditions that characterizes crab habitat, especially on the coast of Pangkep district, is still limited, making it difficult to develop the potential of crab as a sustainable fishery commodity. Therefore, it is necessary to carry out a physical oceanographic analysis of the crab habitat on the coast of Pangkep Regency to obtain a more complete picture of the factors that influence crab production and estimate the distribution of crabs based on environmental or habitat suitability. Based on the description in the problem statement, this research aims to examine the physical oceanographic factors in the blue swimming crab habitat in the coastal waters of Pangkep Regency.

Material and Method. This research was carried out in June-July 2023 in the coastal area of Pangkep Regency (Figure 1).

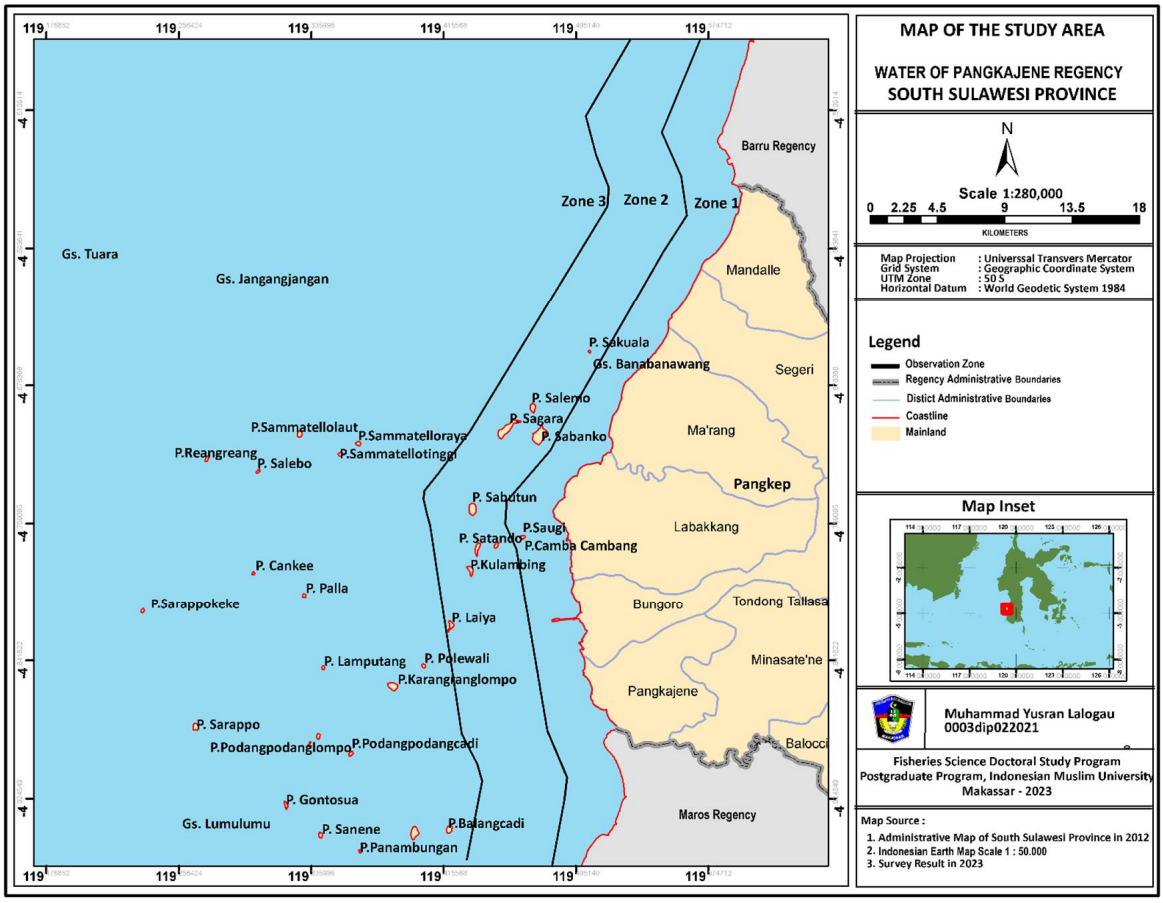

Figure 1. Map of observation locations.

To observe the quality of physical oceanography, water physical parameters were measured which included brightness, temperature, currents and depth. Measurements were taken every day for one week in June, in the beginning of the study, the data analysis continued until the end of July. Determining the observation location was carried out using the participatory fishing ground mapping method, which is based on information from fishermen who are experienced and have carried out fishing activities for sufficient time. Measurements of oceanographic parameters, namely brightness, temperature and currents, are carried out in each zone according to the coordinate points (Table 1).

Table 1

Location of oceanographic parameter measurements

Zone	*Station*	*Observation point*	
		Latitude	*Longitude*
1	1	04°37′14.26′′S	119°32′54.23′′E
	2	04°37′15.30′′S	119°32′37.38′′E
	3	04°37′55.05′′S	119°32′30.05′′E
	4	04°38′07.74′′S	119°32′48.32′′E
	5	04°38′25.76′′S	119°32′39.07′′E
	6	04°38′23.88′′S	119°32′52.48′′E
	7	04°44′45.29′′S	119°28′23.07′′E
	8	04°47′00.77′′S	119°28′50.44′′E
2	1	04°39′43.31′′S	119°29′39.64′′E
	2	04°40′18.11′′S	119°29′57.90′′E
	3	04°40′16.18′′S	119°29′10.17′′E
	4	04°41′08.91′′S	119°29′31.28′′E
	5	04°42′07.21′′S	119°27′51.83′′E
	6	04°43′18.30′′S	119°28′32.35′′E
	7	04°43′56.05′′S	119°27′24.31′′E
	8	04°44′11.94′′S	119°25′34.69′′E
	9	04°44′55.13′′S	119°26′49.27′′E
	10	04°45′49.99′′S	119°27′25.79′′E
	11	04°46′01.38′′S	119°28′26.91′′E
	12	04°46′47.00′′S	119°28′03.08′′E
	13	04°47′30.54′′S	119°28′24.43′′E
3	1	04°43′07.64′′S	119°24′26.34′′E
	2	04°46′18.26′′S	119°23′05.47′′E
	3	04°46′33.64′′S	119°21′21.68′′E
	4	04°48′06.10′′S	119°20′33.59′′E

The measurement procedures for each observed physical parameter are further described. Brightness measurements were carried out using a Secchi disc. Water temperature measurements were carried out using a thermometer. Current measurements were carried out using a current meter. Water depth data was collected using Garmin 585s GPS Maps equipment. Depth data was taken according to predetermined fishing routes. GPS Maps was installed on the ship with a depth transducer of 0.5 m above sea level. Depth data collection was carried out in waters based on predetermined observation zones. The depth data collection path was made in a zigzag manner with the aim of obtaining more accurate water depth profile data.

Data analysis. The data results were then analyzed descriptively and then carried out comparisons using previous research data.

Results and Discussion. The data from physical oceanographic measurements in the coastal waters of Pangkep district can be seen in Table 2.

Table 2

Data from physical oceanographic measurements

Zone	*Station*	*Brightness (m)*	*Brightness (%)*	*Temperature (^oC)*	*Current ($m\ s^{-1}$)*	*Depth (m)*
1	1	2.96	70.48	30	0.12	4.20
	2	2.74	54.84	29.5	0.16	5.00
	3	2.98	71.07	29	0.11	4.20
	4	1.39	100.00	30	0.14	1.40
	5	2.60	100.00	31	0.15	2.60
	6	1.00	100.00	30	0.16	1.10
	7	2.34	66.82	30	0.13	3.50
	8	2.97	65.99	33.5	0.14	4.20
	Average	2.37	78.65	30.37	0.13	3.27
2	1	3.55	38.44	29	0.18	9.22
	2	2.58	46.59	29.4	0.12	5.54
	3	3.81	40.62	29.2	0.24	9.37
	4	2.67	32.29	30	0.12	8.27
	5	1.92	97.87	30.5	0.18	1.97
	6	3.08	93.69	29.5	0.15	3.29
	7	4.00	94.64	29.8	0.15	4.23
	8	6.64	72.30	30	0.15	9.18
	9	6.75	96.40	31	0.19	7.00
	10	4.25	63.71	30	0.17	6.67
	11	6.38	66.68	29.6	0.12	9.57
	12	5.00	51.93	29.6	0.06	9.61
	13	3.68	53.87	29.8	0.13	8.50
	Average	4.17	65.31	29.8	0.15	7.10
3	1	11.49	67.45	29.8	0.12	17.03
	2	16.38	67.70	29	0.17	24.19
	3	19.49	96.89	28.9	0.15	20.12
	4	17.71	73.50	29	0.14	24.09
	Average	16.26	76.38	29.17	0.14	21.35

Brightness. Based on measurements in the field shown in Table 2, the results obtained were that zone 3 had the highest average brightness level of 16.27 m with an average brightness percentage of 69.22%. Zone 3 is the outermost area that is far from the coast so it has clearer water conditions or is less influenced by local factors. Meanwhile, Zone 1, which is around the coast, has the lowest average brightness level, namely 2.36 m and a brightness percentage of 76.57%. Low brightness in zone 1 is influenced by sedimentation and human activities, which can cause a decrease in water brightness. One of the human activities that can affect the level of water clarity is seaweed cultivation. This activity produces waste that contains substances that can pollute the water, pollutant substances such as heavy metals, chemicals or excess nutrients can cause excessive algae growth. Excessive algae will cause water to become cloudy and reduce transparency, thereby reducing the brightness of the water (Minister of State for the Environment 2004). However, a high percentage of brightness was obtained in zone 1 because it is a shallow area.

Meanwhile, Zone 2, which is the middle zone, has an average brightness level of 4.3 m and an average brightness percentage of 74.91%. This zone is still experiencing the influence of human activities, especially seaweed cultivation activities which are still classified as high in this zone. Based on observations, in general the brightness level in the waters of Pangkep Regency is still relatively good, with a brightness level of 1-19.49 m. Most of the observation results are still above sea water quality standards for marine biota in Minister of Environment Decree No. 51 of 2004, except at several points in zone

1, to be precise in zone 1 point 4, point 5 and point 6 with brightness levels of only 1.3 m, 2.6 m and 1 m respectively.

Temperature. Based on Table 2, it appears that temperatures generally range between 28.9 and 33.5^{o}C. The temperature distribution tends to be even throughout the waters. The highest temperature, reaching 33.5^{o}C, was observed in zone 1 which is close to the coast, while the lowest was recorded in zone 3 which is the outermost zone with a temperature of 28.9^{o}C. Overall, the temperature range obtained from these measurements is still within normal conditions and supports the spawning rate and growth of crabs (Ikhwanuddin et al 2012).

Temperature is an important factor in the development of the juvenile stage of crab. According to Ikhwanuddin et al (2012), the optimum temperature for growth and development of blue swimming crab larvae on a lab scale is 30^{o}C. Research results in the Indian Ocean sub-continent showed that the optimum temperature for blue swimming crab development ranged between 28 and 30^{o}C (Ravi & Manisseri 2012). Potter & de Lestang (2000) also stated that the greatest abundance of blue swimming crab in their research was in southwestern Australia, namely in the Leschenault estuary, found at relatively high water temperatures (> 25^{o}C), while the lowest abundance was found in areas with temperatures lower than 10°C. Sunarto (2012) stated that the facts about the widespread distribution of crabs in both tropical and subtropical areas have proven that crabs are eurythermal organisms that can adapt to a very large temperature range.

Current. Based on the observation results shown in Table 2, it can be seen that the speed of sea surface currents at the time of observation had values ranging from 0.06 to 0.24 m s^{-1} with the dominant current direction being north to northeast. The highest current speed was measured in zone 2 station 3 with the value of 0.24 m s^{-1}, while the lowest speed was in zone 2 station 12 with a value of 0.06 m s^{-1}.

The current speed observed at the research locations is classified as slow to moderate, which is in accordance with the opinion of Mason (1981) in Risnawati et al (2018), which groups waters as follows: with very fast currents (> 1 m s^{-1}), fast (0.5-1 m s^{-1}), medium (0.25-0.5 m s^{-1}), slow (0.1-0.2 m s^{-1}) and very slow (< 0.1 m s^{-1}). Ocean currents in the study area are thought to be weak due to two factors. The first factor is the East season, where ocean currents are generally weaker than in the West season. The second factor is calm water conditions and tidal conditions that are close to peak tidal conditions. Peak tidal conditions have a relatively small and stable height difference between high and low tide, causing the air flow to slow down.

Depth. Based on data from observations in the field, the bathymetry in the observation zone ranged from 1.10 to 24.19 meters. The shallowest areas are located in zone 1 and parts of zone 2, namely around the coast to Salemo Island, Sabangko Island and Saghara Island. Meanwhile, the deepest area was observed in zone 3, precisely around Pala Island, with a depth of 24.19 meters. The average bathymetry of waters in zone 1 is 3.27 meters, then zone 2 has an average depth of 7.10 meters, and zone 3 has an average depth of 21.35 meters. Based on data analysis, it is known that the bottom profile of the waters in Pangkep Regency tends to be sloping.

Water bathymetry greatly influences the physical and chemical conditions of waters, because depth can influence the intensity of light that reaches the bottom of the waters (Sahabuddin 2023). The deeper the water, the less intense the light received will be. This can affect photosynthesis, algae growth, and the distribution of organisms that need light to live. Water depth can also affect water temperature (Ikhwanuddin et al 2012). Deeper waters tend to have cooler temperatures than shallower waters. This can affect the speed of chemical reactions, the metabolism of organisms, and the movement patterns of aquatic animals. Furthermore, the depth of the water can affect dissolved oxygen levels (Minister of State for the Environment 2004). In deep waters, dissolved oxygen levels tend to be higher due to the process of oxygen diffusion from the atmosphere to surface waters. However, in shallow waters exposed to direct sunlight,

oxygen production through photosynthesis by algae and aquatic plants can increase dissolved oxygen levels.

Blue swimming crab can be found in a very diverse range of habitats, namely found from the intertidal zone to offshore waters with a depth of 50 m (Edgar 1990; Kumar et al 2000). This is related to the habitat preferences for each crab life cycle, starting from larval, juvenile to adult crab habitats. According to Rahman & Fuad (2019), the blue swimming crab has a wide habitat, starting from mangrove areas, near the sea surface, and the seabed with a depth of < 1-50 meters. The results of depth measurements show that the waters of Pangkep district are a suitable area for crab habitat.

Conclusions. The results of the research show that the physical oceanographic conditions (brightness, temperature, current and depth) of the waters are still in the appropriate category for blue swimming crab development. Therefore, efforts need to be made to maintain the condition of the coastal waters of this area so that it continues being a good habitat for the survival of the blue swimming crab, which is a source of livelihood for fishermen who live in the coastal areas of this location.

Conflicts of interest. The authors declare that there is no conflict of interest.

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