Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and the Gulf of Thailand

FISHERIES REFUGIA PROFILE OF BANGKA BELITUNG PROVINCE

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CHAPTER I. PREFACE

The Bangka Belitung Archipelago Province geographically covers a total area of 81,725.14 km2 and is surrounded by sea with an area of approximately 65,301.00 km2 (Marine and Fisheries Service, Bangka Belitung Province, 2018). Fisheries resources in this province are part of the Republic of Indonesia's Fisheries Management Area (FMA) 711 together with the Provinces: Riau, Riau Islands, Jambi, South Sumatra, West Kalimantan, and Central Kalimantan. As an archipelagic province, Bangka Belitung has diverse potential fishery resource, from large pelagic, small pelagic, demersal, squid, crab, crab, penaeid shrimp, and lobster.

The potency of capture fisheries resource in the Bangka Belitung Province supported by sea area potency in Bangka Belitung reaches 65,501 km2 or 80% of the total land area with a coastal line of 1,295.83 km. In 2018 Bangka Belitung capture fisheries production reached 228,524.71 tons. Fishery production data shows that the most common type of fish caught in 2018 was snapper for 10,108.17 tons, followed by skipjack for 8,589.56 tons, squid for 5,320.05 tons, and mackerel for 3,593.58 tons (Marine and Fisheries Service, Bangka Belitung Province, 2019).

Squid is a fishery commodity belonging a high contribution to capture fisheries production in Bangka Belitung Province. The squid commodity is the sixth leading commodity in the fisheries of Bangka Belitung Province. The value of squid was not only from the volume and production value, but also from the aspect of the availability of post-processing industry and the export value. Frozen squid from the waters of Bangka Belitung is known to have the best quality in the export trade.

As an important commodity in fishery production, the exploitation rate of squid resources is high, thus, the sustainability of squid stocks are very important to be concerned. The results of a decade of research show indications of degradation to squid egg-laying habitat as well as spawning habitat due to various terrestrial and fishing activities, including the absence of policy regulations governing the exploitation system of egg-laying squid. This condition has prompted the local government to make efforts to maintain stock stability by designating some water areas which are squid nesting habitats to be protected, including the waters of Tuing Village, West Bangka Regency.

Efforts to manage fish resources with the Fisheries Refugia approach can be a management option for the sustainability of squid resources in Bangka Belitung. Fisheries refugia are defined as spatially and geographically defined marine or coastal areas where specific management measures are implemented to support important species (fish resources) during important stages of their life cycle, for sustainable use (UNEP, 2005). Fisheries refugia is an integrated habitat management and fish stock, which consider the critical life cycle of the fish or other economical aquatic species. Fisheries refugia relates to the sustainability of fish stocks, is applied to certain areas, and focuses on the relationship between the fish/shrimp critical life cycle and their habitats. For this reason, it is necessary to study the biological aspects of the squid, characteristics of critical habitats, and the socio-economic conditions of the community, so that further efforts to manage squid resources with Fisheries refugia approach can be carried out which are focused on the life cycle processes of squid in critical habitats.

CHAPTER II. OVERVIEW OF SQUID FISHERIES IN BANGKA BELITUNG PROVINCE

2.1. General Conditions of the Bangka Belitung Marine Area

Marine waters of the Province of Bangka Belitung are part of FMA-711 and connected with the adjacent waters such as FMA 712 (Java Sea) on the southern side, Bangka strait on the western side, Karimata strait on the eastern side, and the Natuna sea in the northern side. There are two terminologies of sea area in Bangka Belitung waters, so-called open waters and semi-closed waters. The open waters around Bangka Island are located on the north, east and south coasts of Bangka Island. Meanwhile, semi-closed waters are found in the Bangka Strait in the west and Kelabat Bay in North Bangka. Furthermore, there are narrow waters in the form of a strait, namely the Gaspar Strait which separates Bangka Island from Belitung Island. Meanwhile, the waters on Belitung Island are generally open water. The characteristics of its waters are part of the Sunda Shelf with a sea depth of no more than 100 m. The slope of the coastal waters around Bangka Island and Belitung Island is relatively gentle with a depth of less than 10 m (Figure 1).

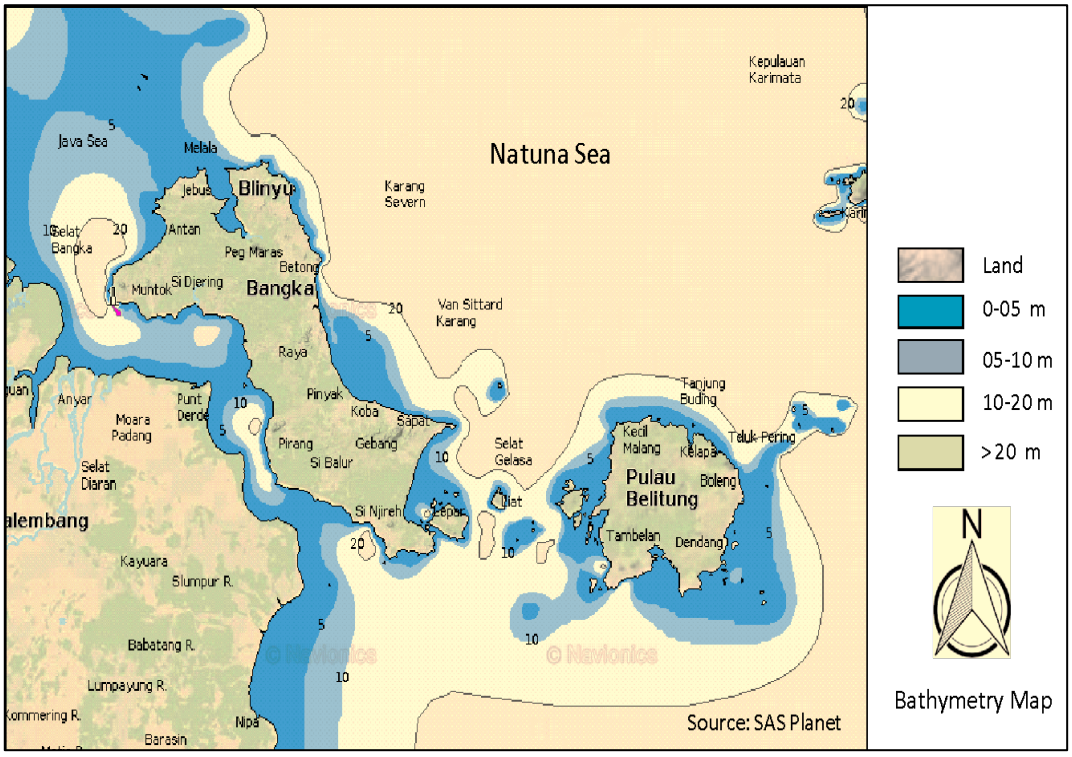


Figure 1.Map of the Bathymetry of the Province of Kep. Bangka Belitung

The total area of Bangka Belitung Province reaches 81,725.14 km2, approximately. About 79.9% (65,301 km^2) is the sea area, while the land area is 16,424.14 km^2 (20.1%), approximately. The area of sea waters up to a limit of 12 nautical miles is 43,034.027 km^2 (4,303,402.77 Ha), with a coastline length of 2,375.92 km (BIG, 2017). Based on the Zoning Plan document for Coastal Areas and Small Islands (RZWP3K) of Bangka Belitung In 2019, the percentage of space allocation for capture fisheries is reaching 2,676,503.6 Ha or 60% (Table 1).

Table 1.Percentage of space allocation in Kep Province. Bangka Belitung

No	Zones	Ha
1.	Aquaculture	162.881,70
2.	Harbour	58.963,70
3.	Capture fisheries	2.676.503,60
4.	Industry	553,5
5.	Wiring/pipes	138.575,50
6.	Conservation	822.453,90
7.	Mining	524.710,70
8.	Tourism	62.581,10

Source: RZWP3K Provincial of Bangka Belitung, 2019

2.2. Species Diversity of Squid in Bangka Waters

Based on landing statistics in FMA-711, at least 4 (four) species of squid were identified, namely *Loligo chinensis*, *L. singhalensis*, *L. edulis* and *L. duvaucelli* (Suwarso et al., 2019. Accepted). Furthermore, the Cephalopod resource group caught occupies a proportion of 75% from the Loliginidae group (squid) and 24% from the Sepiidae group (cuttlefish) with the dominant species being Uroteuthis edulis (53%), *Uroteuthis chinensis*, (21.5%) and *Sepia brevimana* (18%) (BPPL, 2016).

The results of the study during 2020-2021 showed that more than 50% of the fisher's catch composition were dominated by *Uroteuthis chinensis*, and *Sephia lessoniana* in a small proportion. As Syari (2016) in his research in Bangka waters stated that the two dominant species of squid caught were *Uroteuthis chinensis* and Sephia sp.

2.3. Squid Fishery in Bangka

In general, Bangka fishermen land their squid catch at nine fish landing sites. The largest landing site is Sungailiat Archipelagic Fishing Port (Bangka Regency), which is managed by the Central Government (KKP) and accounts for 64% of the total catch in Bangka Belitung Province, mainly utilized by fishermen based in Bangka Island and across provinces. The other landing sites such as Muara Sungai Baturusa Fishing Port and Pangkal Pinang Fishing Port, Muntok Fishing Port (in West Bangka Regency); Batu Belubang Fishing Port, Kurau and Sungai Selan Fishing Port (Central Bangka Regency); and Sadai and Toboali Fishing Port (South Bangka Regency) are managed by the Local Government (Province/Regency/City).

The squid resource potential for FMA 711 was estimated at 32,369 tons/year which the total allowable catch (TAC) is 80% of the sustainable potential or around 22,658 tons/year and the utilization rate is 05 (Decree of the Minister of Marine Affairs and Fisheries No. 19/KEPMEN-KP/2022). This means that the utilization rate of squid resources in these waters is already in the fully exploited category. This needs to be a concern for limiting fishing effort and encouraging fishermen to switch to other alternative livelihoods such as fish farming or fish processing industry.

Squid fisheries in Bangka waters are characterized by fishing activities using various size of boats. Small/traditional fleets such as canoe and motorboats are operated in waters around the coast usually less than 4 miles, while larger fleets are operated for

fishing location more than 4 miles. Small-sized boat are often used to catch squid using squid jigging for one day fishing. The 3-5 GT boat is the most widely operated in Bangka for squid fishing. These boats are operated in coastal and offshore zone for 3-7 days/trip fishing with fishing gears are squid jigging, seine net and trap. In addition, the 5-10 GT boats are operated for squid fishing using longline and gill net. This boats operates in offshore waters to waters above 12 miles with trip lengths ranging from 4-5 days/trip and crew numbers between 3-5 people. Large boats (15-20 GT) operate mini purse seine for small pelagic fishing, while squid is bycatch, at less than 1% of the total catch.

The most used fishing gears to catch squid in Bangka are squid jigging and lift nets. There are three types of lift nets operated: stationary lift net, floating lift net and boat lift net. Stationary lift net and floating lift net are operated in coastal area with a depth of between 60-70 m, while the boat lift net is operated using a 5-10 GT boat. Stationary lift net is operated during March to December. Squid are also caught by gill net, seine net and purse seine gears but only around 0.8 -2.3% of the catch composition and are usually categorized as bycatch of these gears.

2.4 Area and Fishing Season

Squid fishing grounds are spread almost throughout Bangka Belitung waters, including waters along the coast of Bangka and Belitung, waters around small islands scattered across Bangka Belitung province, and deeper waters in WPP 711. In general, the waters of WPP 711 are known as a location that has potential squid resources throughout the year. Bangka-Belitung fishermen catch squid not only around the island of Bangka Belitung but also to the west coast of West Kalimantan (Karimata island cluster, Tambelan, Lemukutan, Serasan, Subi), northward to Natuna (Natuna Islands, Tarempa), and westward to Lingga-Singkep Islands (Figure 2).

In principle, the fishing area for squid fishing in Bangka Belitung depends on the size of the boat. Vessels less than 5 GT fishing area is near the coast (inshore), while the fishing area for 5-10 GT vessels farther (offshore) can even reach the waters of West Kalimantan in the north.

Fishing activity occurs almost throughout the month except for December – February (west moonson). The peak of the fishing season occurs in April (transitional season-1) and September – November (transitional season-2), which is higher than transitional season 1.

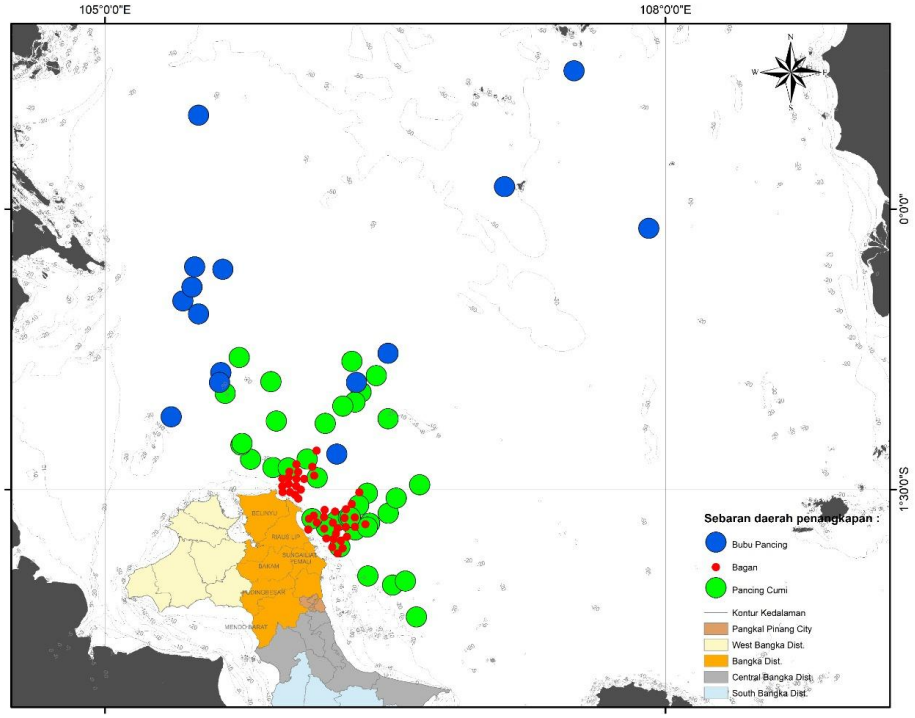


Figure 2. Squid fishing grounds in Bangka Waters

Squid jigging Trap Lift net

CHAPTER III. HABITAT AND BIOLOGICAL ASPECT OF *Uroteuthis chinensis*

3.1. Squid Habitat

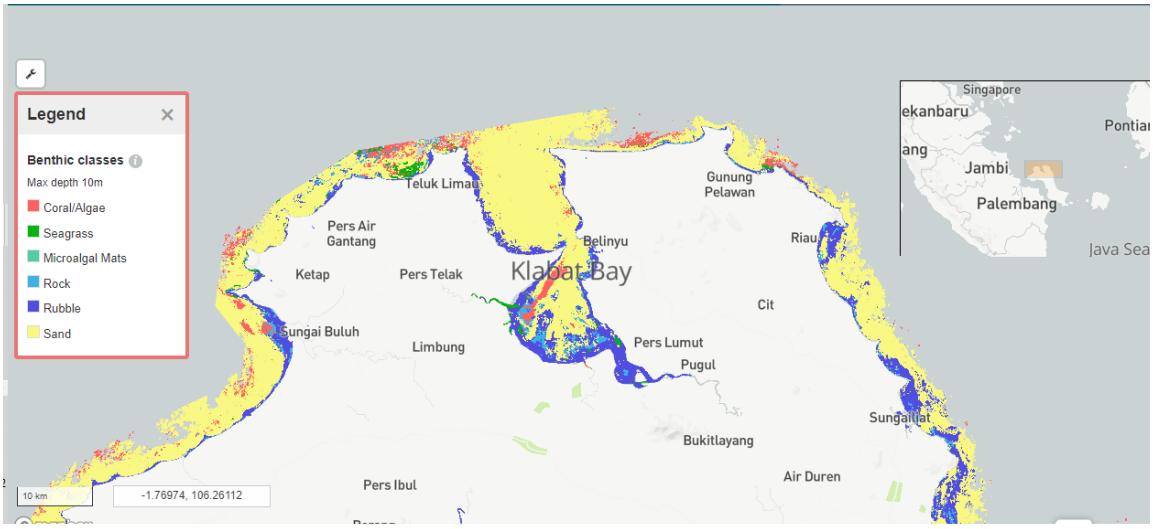
Squid are generally found living in shallow demersal waters, close to shore, in seagrass and coral ecosystems up to 700 m deep (Jereb & Roper, 2010). The optimum water temperature for squid life is in the range of 29-30°C (Aras & Hasmawati, 2016), however in Bangka waters squid can be found in water temperature conditions between 21-32.1°C (Prasetyo et al., 2014). Other oceanographic parameters that affect squid life are salinity, current speed and light illumination (Hasmawati & Sugiharti, 2014). The optimum salinity for squid is 31-32 ppt, current speed 0.02-0.05 m/sec, visibility/illumination 3-7 m (Aras & Hasmawati, 2016). Squid also like waters with a sandy bottom mixed with a little mud especially for egg laying.

Squid habitats in Bangka waters were found in shallow waters with an average depth of 30 m with the type of bottom substrate dominated by sand. The results of the measurement of environmental parameters in squid habitats showed that the temperature range ranged from 30.12-31.65 ^{0}C; salinity 31-31.5 ppt; pH ranged from 8.31-8.99 in the surface layer; and water clarity ranged from 2.4-10.1 m with turbidity ranging from 0.2-7.95 NTU and TDS evenly distributed with a range of values between 25.8-28.7 mg/l. In general, the water clarity of Bangka Waters is less than 50% of the depth, indicating a high level of turbidity that will affect the penetration of sunlight in the water column. Turbid environmental conditions will interfere with the sustainability of squid in these waters, because squid like clear waters, especially for their spawning habitat.

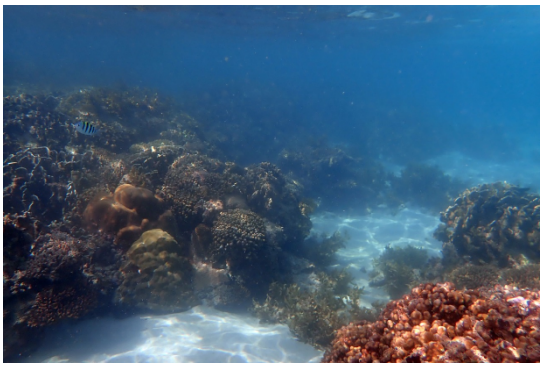
3.2 Coral Reef and Seagrass

Coastal ecosystems included in the management of squid refugia areas are seagrass and coral ecosystems. The identification results of seagrass ecosystem potential in Bangka Belitung waters amounted to 11,646.9 Ha and coral ecosystems amounted to 17,744.85 Ha, where most seagrass and coral ecosystems are found in Belitung Regency Waters and several small islands in Central Bangka Waters (DKP Prov. Kep. Bangka Belitung, 2018).

Seagrass ecosystems in Bangka Coastal Waters are 364 hectares, in the north of Mapur and Tengkalat Waters which are generally associated with coral reef ecosystems. The area of coral reef ecosystems in Bangka Waters are around 231.7 Ha, concentrated in the north of Mapur and Tengkalat Waters and several reef flat spots in Riau Silip. The good condition of the coastal ecosystem in the northern part of Bangka and West Bangka Regencies makes this water area an important function as a nursery area that will be managed with a fisheries refugia approach.



(a)



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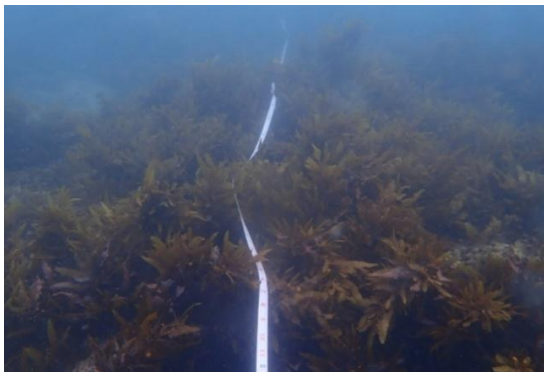


(c)

Figure 3 (a) Benthic classes of coral ecosystem in northern Bangka; (b) coral reef ecosystem in Mapur-Riau Silip ; and (c) lamun ecosystem in Mapur -Riau Silip, Bangka (Allencoral Atlas, 2021).

3.3 Spawning Habitat

Identification of squid spawning habitat is based on the location of matured squid were found in a significant proportion of the overall catch. The observation in four sites, Tuing, Bedukang, Rebo dan Batu Belubang in November 2020 and 2021 showed that the matured squid (gonad maturity level 3 and 4) were ranged from 20-50% of total catch. The sites were identified as spawning habitat are characterized by water depths ranging from 6-15 m, water temperatures ranging from 30.16-30.78°C, salinities 31-31.4 ppt, and sand-dominated substrates. Furthermore, the delineation of the distribution of spawning areas for the North Bangka Waters and surrounding areas was obtained (Figure 4).

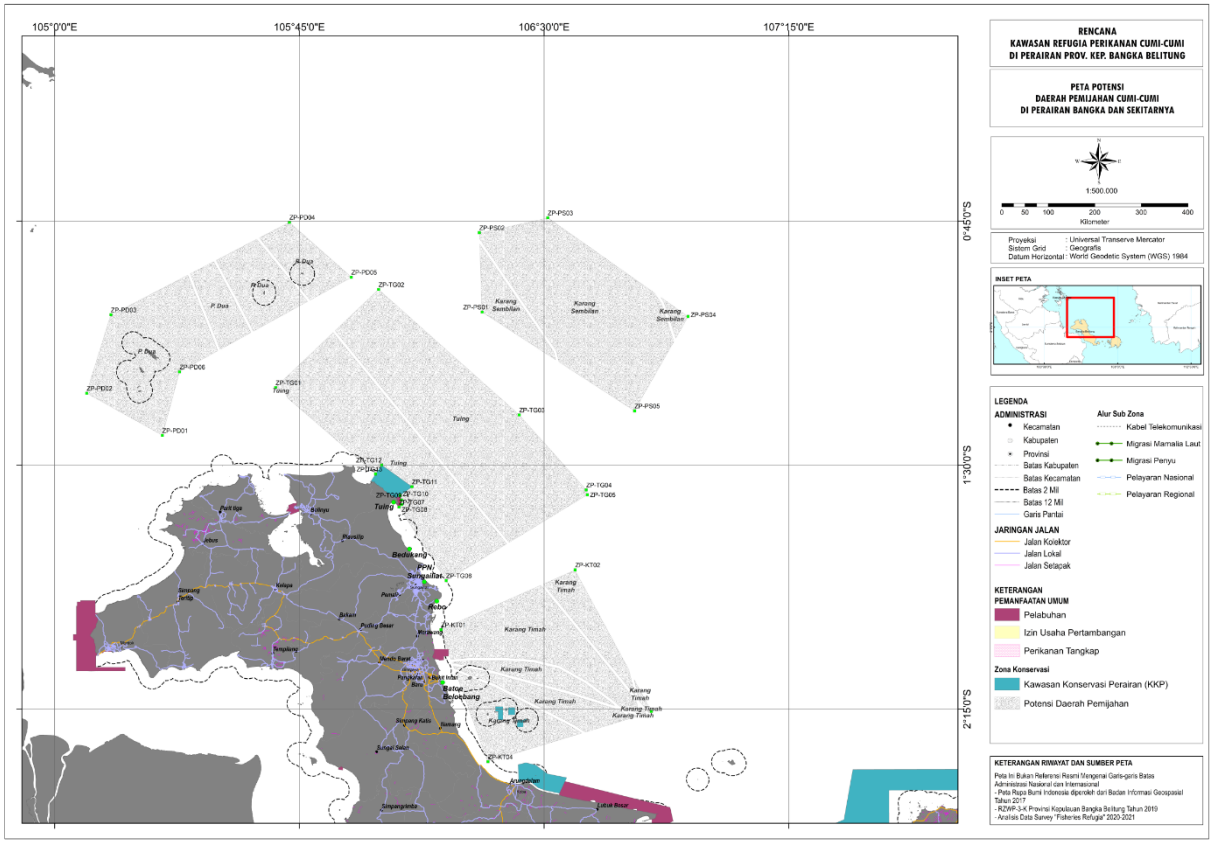


Figure 4. Map of spawning habitat of squid in Bangka waters.

3.4 Egg Laying and Nursery Habitat

The identification of egg-laying and nursery habitats is based on at least three important indicators, namely: (1) water quality suitability, (2) water depth contours, and (3) water bottom substrate typology. Environmental parameters that play an important role in egg-laying habitat are substrate and turbidity. Egg-laying habitat is characterized by the abundance of eggs attached to various types of substrates, while nursery habitat characteristics are characterized by the presence of abundant squid larvae and juveniles.

Based on observations in 2021, water temperature values in the egg-laying habitat ranged from 29.98 to 30.55 °C, while the water temperature range for the nursery habitat ranged from 30.24 to 31.07 °C. The salinity of the egg-laying habitat ranged from 30.1-31.3 ppt, while the salinity of the rearing habitat ranged from 30.3 - 31.4 ppt. According to Samudra et al. (2016), the ideal salinity to support optimal egg development is 30-31 ppt and the optimal water temperature is in the range of 28-30.5 °C.

Squid usually lay their eggs in shallow waters. Based on observations, the egg-laying habitat was at a depth of 4-21 m. However, in some deeper waters it is still possible for squid to attach their eggs if the waters have substrate characteristics that allow the eggs to attach safely during the egg development period until hatching. Shallow coral flat zone contained sandy substrate, macroalgae (Sargassum), and dead coral is a suitable habitat egg attachment.

Based on observations, the larval and juvenile squid were found in coastal area, which stationary lift net are operated (depth 13.3-24.5 m) and in patch reef located in island cluster (Figure 5).

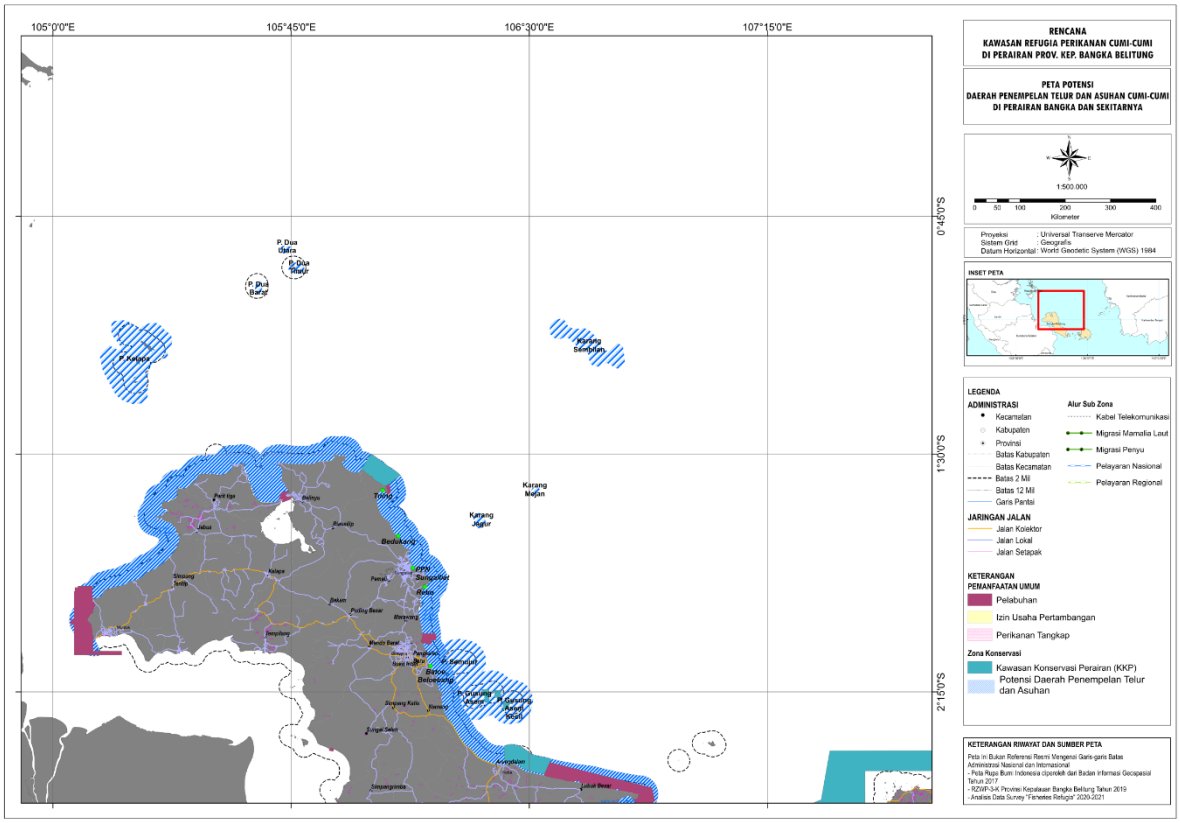


Figure 5. Map of potential habitat for squid egg-laying and nursery area in Bangka

Squid-laying and nursery habitat

3.5. Spawning season

Spawning season is associated with the fishing season index of *U. chinensis* (Rosalina et al., 2010). This is because matured *U. chinensis* dominates the catch of fishermen in the fishing season, in April, May, June, October and November (Figure 6). This indicates that the *U. chinensis* spawning season occurs twice a year in the April-June and October-November periods The spawning season in April-June is related to the east monsoon while that in October-November is related to the west monsoon (Rosalina et al., 2010).

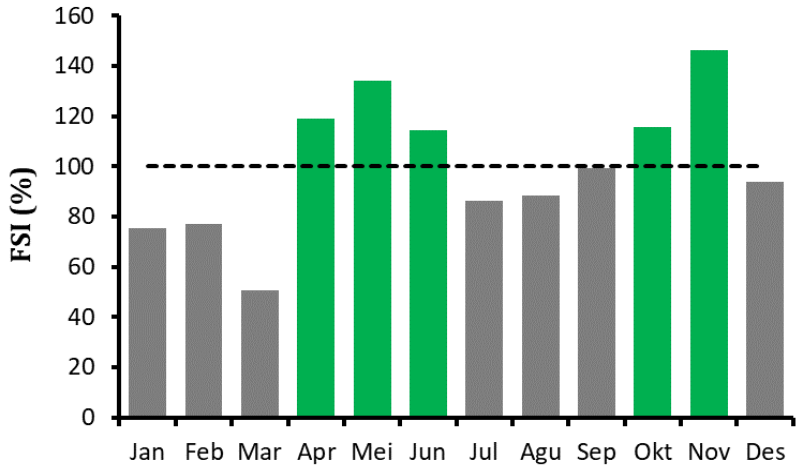


Figure 6.Fishing season index U.(P.) chinensis in Bangka waters (Rosalina et al., 2010)

The criteria for U. (P.) chinensis immature gonads are *U.chinensis* with gonadal maturity levels I-II while the criteria for mature is gonadal maturity levels III-V. Based on observations in November 2020, *U. chinensis* from northern Bangka waters (samples from Sungaliat) and southern Bangka waters (samples from the Sukadamai area) were estimated started their spawning period in November with a percentage of matured individuals of more than 20% (Figure 7). Observation on November 2021 also showed similar condition, the composition of matured *U. chinensis* in November at the four observed sites in Bangka reached more than 20% (Figure 8). This indicated that *U. chinensis* started their spawning season in November.

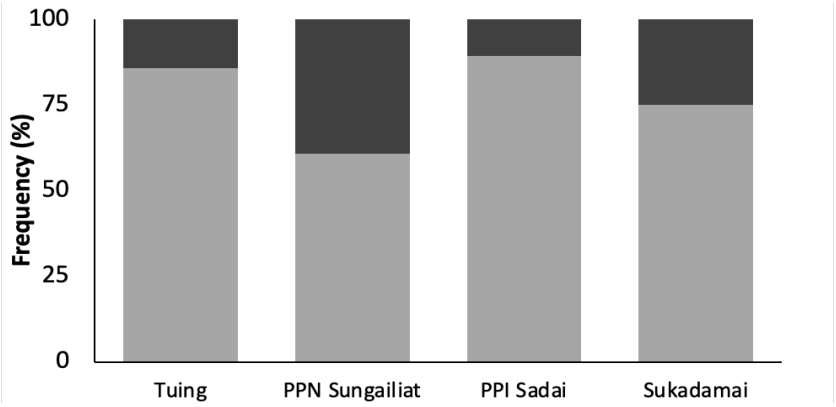


Figure 7.Spatial distribution of U.(P.) chinensis spawning areas on November 2020 in North and south of Bangka Waters (light gray for immature individuals, dark gray for mature individuals)

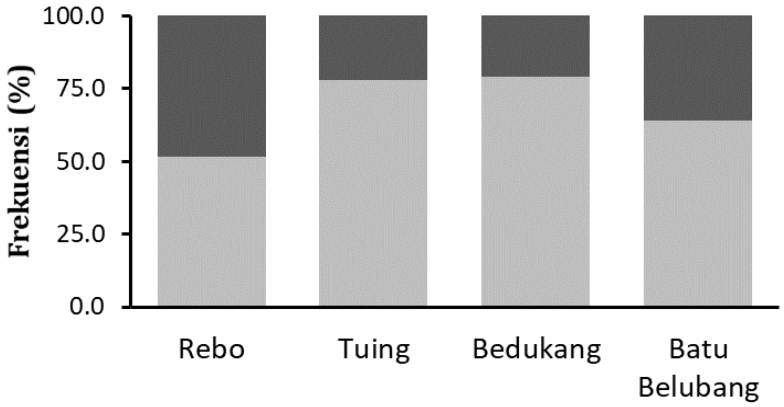


Figure 8.Spatial distribution of U.(P.) chinensis spawning areas on November 2021 in North of Bangka Waters (light gray for immature individuals, dark gray for mature

.

3.6 Length at first capture (L_{c50}) and length at first maturity (L_{m50})

The average Length at at first caught (Lc50) of *U.chinensis* in Bangka from observation in October-November was 10.6 cm for males and 11.9 cm for females (Figure 9), meanwhile the average length of *U.(P.) chinensis* when 50% of the population reached gonadal maturity (Lm50) was 19.7 cm for males and 15.7 cm for females (Figure 10).

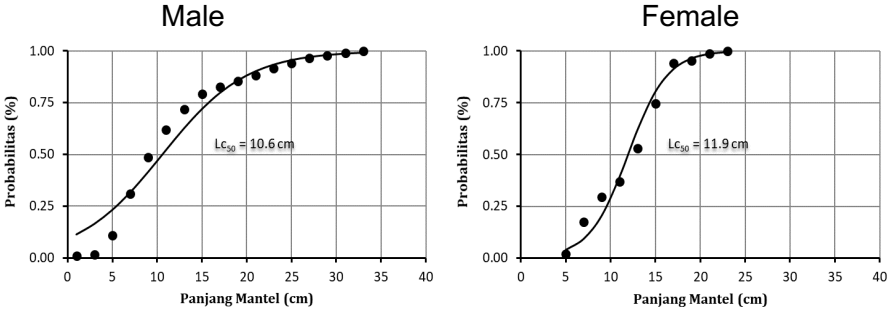


Figure 9.Length at first capture for male and female squid Uroteuthis chinensis) in October – November 2020 from Bangka waters. (x axis for mantle length, y axis for probability)

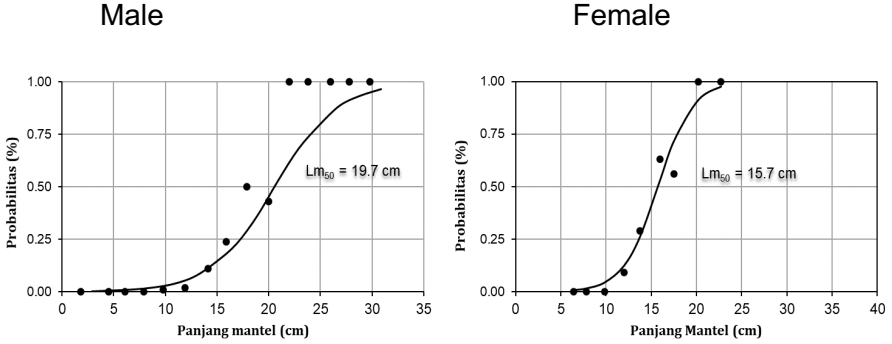


Figure 10. Length at first maturity for male and female squid Uroteuthis chinensis) in October – November 2020 from Bangka waters. (x axis for mantle length, y axis for probability)

Based on the logistic curve, it was found that *U. chinensis* in Bangka waters in November 2021 had an average size at first caught (Lc50) of 12.4 cm for males and 13.9 cm for females (Figure 11). The average length of *U.chinensis* when 50% of the population reached gonadal maturity (Lm50) was 18.8 cm for males and 15.1 cm for females (Figure 12).

An average Lc of *U.chinensis* from this observation in Bangka was larger than *U.chinensis* from Lamongan Waters, East Java (Lc = 9.4 cm) and either from Banyuasin, South Sumatera (Lc=10.3 cm) (Mulyono et al., 2017; Fauziyah et al., 2020). An average length at first maturity (Lm) of *U. chinensis* from Bangka in this study was larger than Lm of the same species from Lamongan waters, East Java (Lm50=12.47 cm) (Mulyono et al., 2017). Meanwhile, the Lm_{50} of *U.chinensis* from Banyuasin South Sumatera was slightly higher (Lm50 = 14.7 cm) than Lm_{50} from this study (Fauziyah et al., 2020). Chotiyaputta (1990) found that *U. chinensis* reached maturity at 10.5 cm for males and 10.0 cm for females in the West Waters of the Gulf of Thailand.

U. chinensis both male and female were indicated being caught before spawning, represented by value Lc50 < Lm50.This certainly threatens the sustainability of squid stocks in the future, therefore it is urgent to control the capture of matured squid.

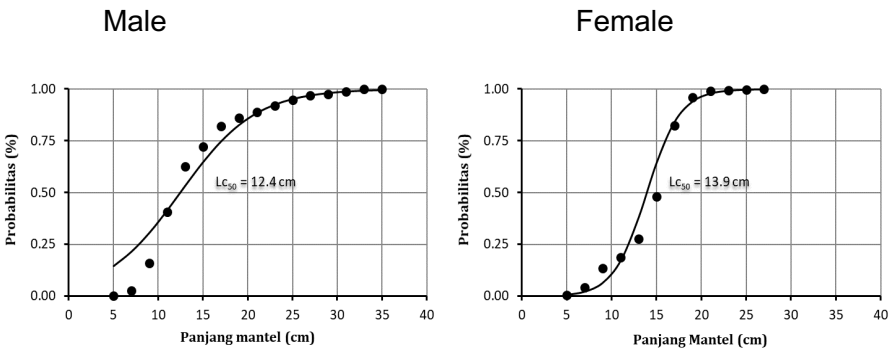


Figure 11.*Length at first capture for male and female squid Uroteuthis chinensis) in November 2021 from Bangka waters. (x axis for mantle length, y axis for probability)*

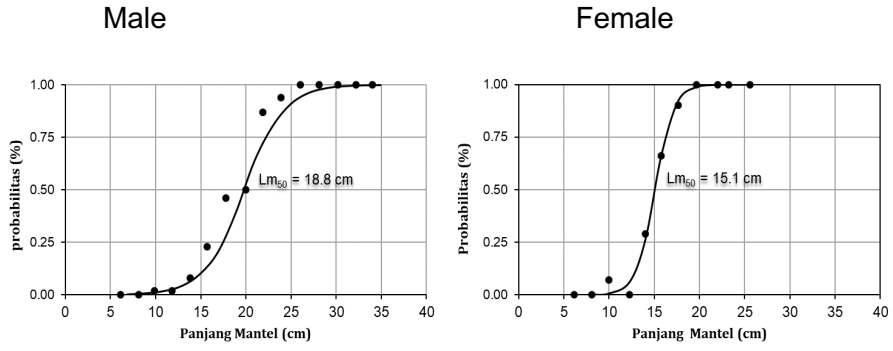
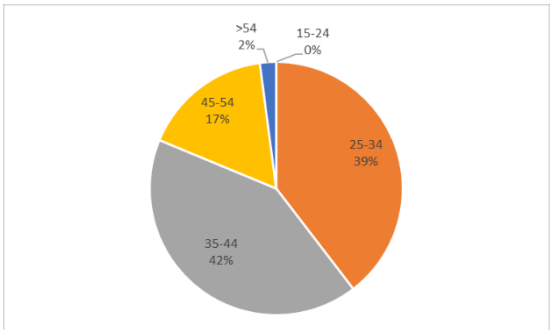


Figure 12.Length at first maturity for male and female squid Uroteuthis chinensis) in November 2021 from Bangka waters. (x axis for mantle length, y axis for probability)

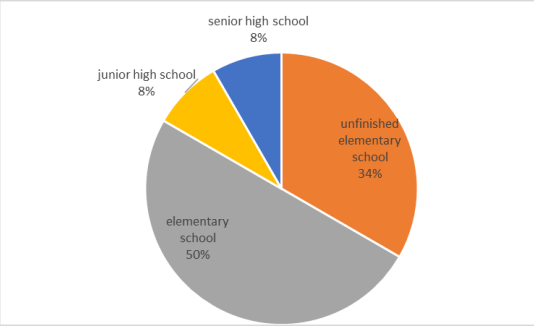
CHAPTER IV. SOCIO-ECONOMIC CONDITIONS, INSTITUTIONS AND STAKEHOLDER ROLES

Squid fisheries activities are spread across almost all regions of Bangka Belitung. The three main squid centers are in Belitung, South Bangka and Bangka Regency with the highest squid production compared to other Regencies. This has implications for the large percentage of fishers who have direct access to the resource. For example, in Tuing Waters, Mapur Village, Riau Silip Sub-district (Bangka Regency) as one of the centers of squid production, the number of fishermen reaches 559 people or 40.24 % of the population (Mapur Village Profile, 2021). Fishermen who utilize Tuing Waters as their fishing ground come from Riau Silip Sub-district, especially Cit, Pugul, and Deniang Villages with a total of 513 Fishery households (Riau Silip Sub-district in figures, 2021), as well as fishermen from outside such as Belinyu and Sungai Liat with a total of more than 1,000 RTP.

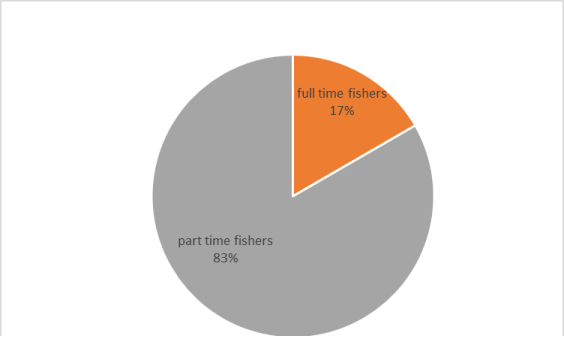
The profile of squid fishermen in Tuing are characterized by 25-51 years old and are dominated by 25-44 years old (81.25%) (Figure 13a). The education level of fishermen is dominated by low education (elementary school equivalent) which reaches 54.17%, while the remaining 45.83% have secondary and high school education (Figure 13b). The status of the fishing business is a part-time job (83.33%), which is carried out every day on a part-time basis between fishing and gardening (Figure 13c). The working period as a fisherman is between 5-30 years (62.50%) and only about 33.33% are new fishermen (less than 5 years of working period) (Figure 13d).



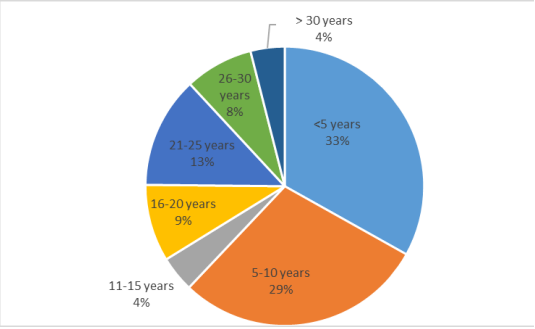
(a) Composition of fishers by age group



(b) Composition of fishers by education level



(c) Composition of fishers based on business status



(d) Composition of fishers based on experience level

Figure 13.Fishermen Profile in Tuing Waters

The fishermen's institution, which is the social capital in the management plan, is characterized by the high awareness of the fishing community to group. Almost all fishermen have joined in the fishermen group in each village since 2019. There are 8 fishermen group have been established in Riau Silip Sub-district, wich categorized as norming level. Norming is a form of group development, where aspects of supervision and sanctions have become part of the integrity of the institution in carrying out its roles and functions. However, some elements of mature-level institutions are still not implemented in the local institutional system, so institutional strengthening through coaching and mentoring should be conducted.

Stakeholders related to the utilization and management of squid resources in the study area include: (1) Ministry of Maritime Affairs and Fisheries (MMAF); (2) Provincial/Regency Government; (3) fishermen; (4) collectors; (5) exporters; (6) fishermen group/ community surveillance group; (7) Fishing Port and Fish Auction Place); (8) Fisheries Extension Officers; (9) Fish Quarantine Agency; (10) DG of Marine and Fisheries Resources Surveillance (11) Non-Governmental Organizations (NGOs); (12) Universities/Research Institutions; and (13) Village Governments. The stakeholders were then grouped into primary and secondary stakeholders based on their interests and authority related to squid resource utilization and management (Table 2).

Table 2.Identification of stakeholders, interests and roles in the management of squid resources

Stakeholders Groups	***Stakeholders***	**Interests/Roles**
Primary	Fishermen	utilization and management of fisheries resources to meet their needs
	Collectors	Interested in the utilization and management of fishery resources to fulfill their daily needs
	Exporters	utilization and management of fishery resources to fulfill the needs of their business/company
	Processor	Interested in processing fisherman's catch
Secondary	MMAF	Interested in managing stock status and protecting the sustainability of squid resources
	Local Government (Provincial/Regency)	Have an interest in the management, utilization, capacity development, and contribution and sustainability of Squid Resources
	Fishermen Groups/Community Surveillance Groups	Play a role in supervising the utilization and surveillance of resources
	Village Government	Play a role for improving the welfare of the fishing community
	NGO	Play a role in increasing community capacity through mentoring activities and strengthening community institutions

Fishing Ports	Play a role in increasing the capacity of the community through the implementation of facilities, infrastructure, and facilities
Surveillance for Marine and Fisheries Resource	Play a role in providing support for supervision and prosecution of disregarding resource utilization activities
Universities/ Reasearch Institutes	Play a role in providing research support that can be applied to the community and help stimulate effective management
Fisheries Extension	Play a role in increasing community capacity through mentoring activities and strengthening community institutions

CHAPTER V. SQUID FISHERY REFUGIA AREA

Based on the results of the area prioritization analysis, the recommended area for squid spawning refugia in Bangka is 229,721.48 ha, covering the area of Karang Jagur of 78,352.69 ha, North Tuing of 69,734.39 ha; Pulau Dua waters of 48,205.32 ha and Karang Sembilan of 33,429.08 Ha while for nursery habitat area is 9,581.27 ha (Figure 14, Table 3).

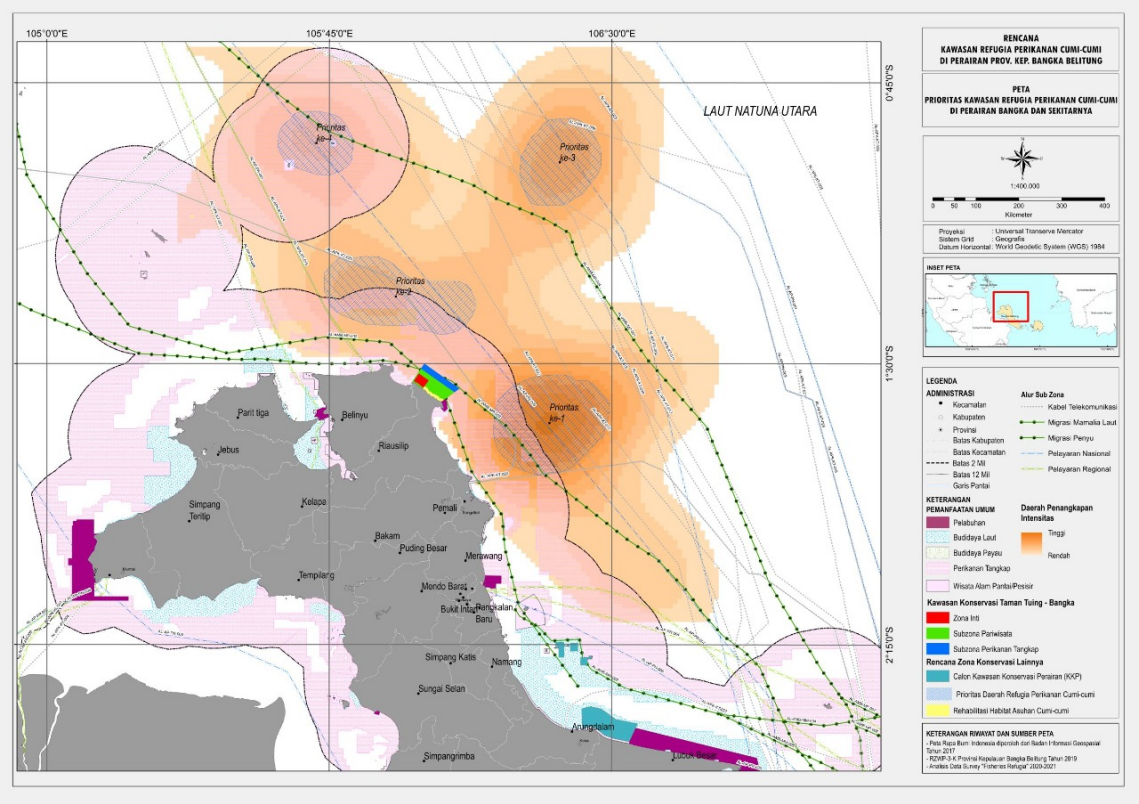


Figure 14. Recommended area for fisheries refugia of squid in Bangka

Table 3. Recommended area for fisheries refugia of squid in Bangka

A. Nursery and egg-laying zone

Name		Area (Ha)	Longitude (°)	Latitude (°)
Karang Jagur	1,790.10	ZPA02	-1.709889	106.342778
Karang Mejan	713.43	ZPA03	-1. 616888	106.518313
Riau Silip coast -Sungailiat	4,187.85	ZPA05	-1.754767	106.092274
Tuing-Riau Silip Coast	610.67	ZPA01	-1.582374	106.024846
Belinyu coast	2,279.22	ZPA04	-1.523562	105.890342

Name		Area (Ha)	Longitude (°)	Latitude (°)
Total Nursery Refugia	**9.581,27**			

B. Spawning zone

Site	Area (Ha)	Code	Longitude (°)	Latitude (°)
Karang Jagur	78,352.69	ZPP01	-1.658585	106.334644
North Tuing	69,734.39	ZPP02	-1.320854	105.926674
Karang Sembilan	48,205.32	ZPP 03	106.361624	-0.962704
Pulau Dua	33,429.08	ZPP 04	105.715515	-0.910898
Total Spawning refugia	**148,087.08**			

CHAPTER VI. RECOMMENDATIONS AND MANAGEMENT OPTIONS

Fisheries management using the fisheries refugia approach is basically integrated fisheries management and is part of the implementation of ecosystem-based fisheries management (EAFM/ Ecosystem Approach to Fisheries Management), so that for its implementation it is necessary to manage several domains in parallel. Some efforts that can be made to implement fisheries refugia in the management of squid resources in Bangka waters are shown in Table 4.

Tabel 4. Rekomendasi upaya pengelolaan berdasarkan isu dan permasalahan

Domain	***Isu***	***Existing condition***	***Recommended management measures***
Squid resources	(1) Fishing for female broody squid	(1) The peak fishing season coincides with the peak phase of squid gonad maturity. (2) Belum ada aturan penangkapan cumi-cumi bertelur.	Pengaturan penangkapan cumi-cumi bertelur di area rekomendasi refugia perikanan (Gambar 21) melalui mekanisme : a) Buka tutup penangkapan (*close season*) pada musim pemijahan. Rekomendasi Waktu penutupan adalah dua kali dalam setahun yaitu pada April–Mei dan Oktober–November. Lama durasi waktu penutupan ditentukan berdasarkan kesepakatan bersama antar pemangku kepentingan; dan/atau b) Pelarangan penangkapan cumi-cumi bertelur yakni cumi-cumi berukuran < 15,7 cm untuk cumi-cumi betina dan < 19,7 cm untuk cumi-cumi jantan. Regulation of fishing squid in the fisheries refugia area through the following mechanisms: a) Open and close fishing (closure season) during the spawning season. The recommended closing time is twice a year, namely in April-May and October-November. The duration of the closing time is determined based on mutual

			agreement between stakeholders; and/or b) Prohibition of catching broody squid, especially the squid. less than 15.7 cm TL for female squid and less than 19.7 cm TL for male squid.
	(2)Capture juvenile squid	(1)Abundance of juvenile squid are being captured by liftnet	relocate the operation of the lift net to the non-nursery ground area and change the mesh size of the lift net to a larger size.
Squid habitat	Critical habitats of squid are located in utilization areas such as marine conservation areas, ports, capture fisheries, and mining,.	Nursery and egg-laying habitat of squid are adjacent to mining areas, so the risk of sedimentation is high	increase conservation areas based on nursery and egg-laying habitat for squid
	Degradation of nursery and egg-laying habitat	Sedimentation in coastal areas and damage to coral ecosystems due to destructive fishing gear	(1) Rehabilitate damaged coastal habitats through physical (hard structure) and biological (mangrove planting) engineering to trap sediment. (2) Ban destructive fishing gear operating in Bangka Belitung.
Social Economy	(1) Fishing community acceptance of refugia-based management efforts	No alternative livelihoods during the implementation of the squid close season	Encourage the Local Government to create alternative livelihoods for fishermen during the fishing area closure period through the development of local potential-based livelihoods.
	(1) Conflicts of interest between fishermen and between fishermen and mines	(2) There are conflicts between local fishermen who have a vision of protecting the coastal environment and habitat protection with migrant fishermen who only exploit squid resources, and between fishermen and tin mining because it disturbs fishermen's fishing grounds.	Optimizing local wisdom for squid resource management.

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