Fishers of Anambas Islands amid the resources landscape of North Natuna Sea waters

[1]Yoppie Christian, [1]Ari Gunawan, [2]Desmiwati, [1,3]Siti Erwina

[1] Center for Coastal and Marine Resources Studies (CCMRS), Bogor Agricultural University, Bogor, Indonesia; [2] Research Center for Society and Culture, Institute of Social Science and Humanities, National Research and Innovation Agency (BRIN) Jakarta, Indonesia; [3] Department of Communication Science and Community Development, Bogor Agricultural University, Bogor, Indonesia. Corresponding author: Y. Christian, lakulintang@gmail.com

Abstract. Fishers of the Anambas Islands Regency, Riau Islands Province, operate in the North Natuna Sea, which becomes the arena of jurisdictional disputes between states. Regarding fishery resources, the waters of the Anambas Islands, located in WPPNRI or Indonesian National Fishery Management Area 711, are already fully exploited and overexploited. This study investigated the relationship between the transformation of fishers to the contestation and resource depletion they face. The Fish Abundance Index was calculated to support data on resource depletion. The study results show that fishery resources in the waters of the Anambas Islands have exceeded the Maximum Sustainability Yield. Meanwhile, fishers have responsively changed their fishing effort by hunting for fish further and improving their boat, but the fishing gear used is relatively the same. The paper suggested four significant issues that must be developed in the policy: (1) the consolidation and institutional development of post-traditional fishers according to an organized commercial scale; (2) the strengthening water control for national fishers protection; (3) application of restrictions on the fishing gear and on the number of selective catches to recover resources, and (4) the addition of protected zones to accelerate resource recovery.
Key Words: depletion, fisheries, fish stock, maximum sustainable yield.

Introduction. The North Natuna Sea has received international attention in the last five years regarding the heating up of relations between Indonesia and China related to maritime boundary disputes. This dispute ranges between the justification of the exclusive economic zone (EEZ) according to the United Nations Convention on the Law of the Sea (UNCLOS) by Indonesia, on one side, and China's claim for a "traditional fishing ground" marked by "nine-dash lines" (Fernandes et al 2021), on the other side. Before the Joko Widodo presidential era, disputes related to Natuna had involved six countries: China, Taiwan, the Philippines, Vietnam, Malaysia, and Brunei Darussalam (Fravel 2011). Vietnam and China disputes in the previous era were resolved through diplomacy. Even in 2017, an understanding was signed between the administration of Joko Widodo and Xi Jinping regarding "China's One-Belt One-Road (OBOR) Initiative 2013" to recognize and respect the existence of UNCLOS (Setiawan & Kamil 2021; Suryadinata & Izzuddin 2017). However, to China's initiative to allowing their fishing vessels and coast guard to enter the Indonesian EEZ, on the grounds of "traditional fishing ground", the Indonesian government finally responded by holding a war exercise on May 18th and 19th 2017, which was led directly by the President (Suryadinata & Izzuddin 2017). For decades, the North Natuna region, especially in the Natuna Islands and Anambas Islands, has become an arena of international political contestation, in the struggle for both fishing resources (Rohingati 2014) and gas reserves. It is alleged that Natuna waters are rich in hydrocarbons (EIA 2013; Qin et al 2019). In addition to national borders policies, the policy regarding Illegal, Unreported, and Unregulated (IUU) Fishing and the "sink the vessel policy", since 2014, in the Susi administration, has strengthened Indonesia's maritime policy posture over the Natuna Sea or the South China Sea (Anggraini et al 2018). However, it did not receive full support, politically and economically, from the

internal country's administration (Scarpello 2020). There is a big paradox in the conflict regarding the Natuna Sea, related to the China's contestation in the capture fisheries sector. Until 2022, Indonesia was the second capture fisheries producer after China. According to FAO (2020), in 2018, China's total capture fisheries production was 12.68 million tonnes (15% of the global total), while Indonesia produced 6.71 million tonnes yearly (8% of the worldwide total). Of the total Chinese production above, it was reported that as much as 1.34 million tons were produced from a "distant-water catch" whose exact location is unknown (Syam et al 2020).

In the last forty years, capture fisheries in Indonesia have shown a decline in production (Heazle & Butcher 2007). The same condition also occurs in the North Natuna Sea, which is included in the National Fisheries Management Area (WPPNRI)711. Fisheries Management area is the area for capture and aquaculture which includes Indonesian waters, Indonesian exclusive economic zone, rivers, lakes, reservoirs, marshes and other bodies of water potential to be utilized. Indonesia divides the area into eleven, nationally.

Based on the Minister of Marine and Fisheries Decree No. 50/2017, the resources in WPPNRI 711 are already at an over-exploited level, especially for small pelagics, penaeid shrimp, lobsters, crabs, and squid. Meanwhile, large pelagic fish, demersal fish, reef fish, and blue swimmer crabs are in fully exploited status. The potential catches also decreased from 1,143,341 tons in 2016 to only 767,155 tons per year in 2017. Under these conditions, efforts to improve the capture fisheries sector are still constrained by the production mode of capture, that has not yet reached an industrial scale. The fisheries infrastructure is not complete. Market cycles are still local and unattractive for investment (Zulham et al 2017). It is another paradox situation from the fisheries perspective because the North Natuna Sea has a great posture in political diplomacy, but a weak economic power. The paradoxical situation raises the question addressed by the current research: what are the characteristics of the current fishers of the Anambas Islands amid the complexities of geopolitical contestations between countries and the threat of depletion of their fisheries resources.

Material and Method. The data collection of the study used three methods. The first method was the literature review from the relevant publications and official statistics. The second method was observation and interviews with fishers at several sampling points in the Anambas Islands region. Meanwhile, the third method calculated the fish stock abundance using Schaefer and Fox's Production Surplus Model (Boer & Aziz 1995) at three fish landing sites: Tarempa Fishing Port, Palmatak Fishing Port, and Nyamuk Fishing Port. The three locations are the main fish landing in the Anambas Islands. The formula used to calculate the MSY is as follows:

$$\text{MSY} = \frac{1}{b}\, e^{(a-1)}$$

Where:
a - the intercept;
b - a slope;
e - exponential.

This formulation comes from:

$$Ln\frac{C_t}{f_t} = a - bf_t$$

$$\frac{C_t}{f_t} = e^{(a-bf_t)}$$

$$f_{MSY} = \frac{\partial C_t}{\partial f_t} = 0$$

$$\frac{\partial C_t}{\partial f_t} = e^{(a-bf_t)} - f_t\, e^{(a-bf_t)}\, b = 0$$

$$f_{MSY} = \frac{1}{b}$$

Where:
Ln - Logarithm natural;
C_t - catch of t time;
f_t - catch effort of t time;
f_{MSY} - allowable catch for sustainable yield.

The material and data used were the number of catches (primary data); fish length and weight (primary data); fishers' production for the last 5-10 years (secondary data); catch effort (secondary data); estimated fishing ground (primary data); and interviews with fishers (primary data). These three methods were used simultaneously to obtain information on the official status of fisheries in Anambas, investigate the abundance of fish caught by fishers, and explore the character of fishers based on the production equipment used, both fishing gear and fishing equipment. The data collection results were analyzed qualitatively and described to see the relationship between production patterns and the availability of resources.

Description of the study sites. Globally, fisheries make a significant contribution to developing countries, where one-third of the world's catch is exchanged through international trade. However, fisheries also continue under pressure and threats from economic and population growth (Garcia & Newton 1994). As one of the largest producers, Indonesia has experienced a long road to exploiting marine fisheries resources, including over-exploitation, which causes significant resource depletion (Bailey et al 1987). However, capture fisheries remain the most productive sub-sector, compared to aquaculture. The study location was in Anambas Island Regency, the Province of Riau Islands (Figure 1) and administratively within FMA 711 (Figure 2). The terrestrial area of the Anambas Islands Regency is 590.14 km² and it has 238 islands (BPS 2022a). Five islands in the Anambas Islands Regency are the outermost islands: Tokong Berlayar Island, Tokong Nanas Island, Mangkai Island, Damar Island, and Malangbiru Island. Various studies on the Anambas Islands focus more on the issues of conservation areas, especially coral reefs (Harahap et al 2014; Mustika et al 2013; Permana et al 2021; Putra et al 2021), the humphead wrasse (*Cheilinus undulatus*) aquaculture (Syam et al 2020) and the underwater tourism attraction (KKP 2013), although the capture fisheries are the oldest sector in the Anambas Islands.

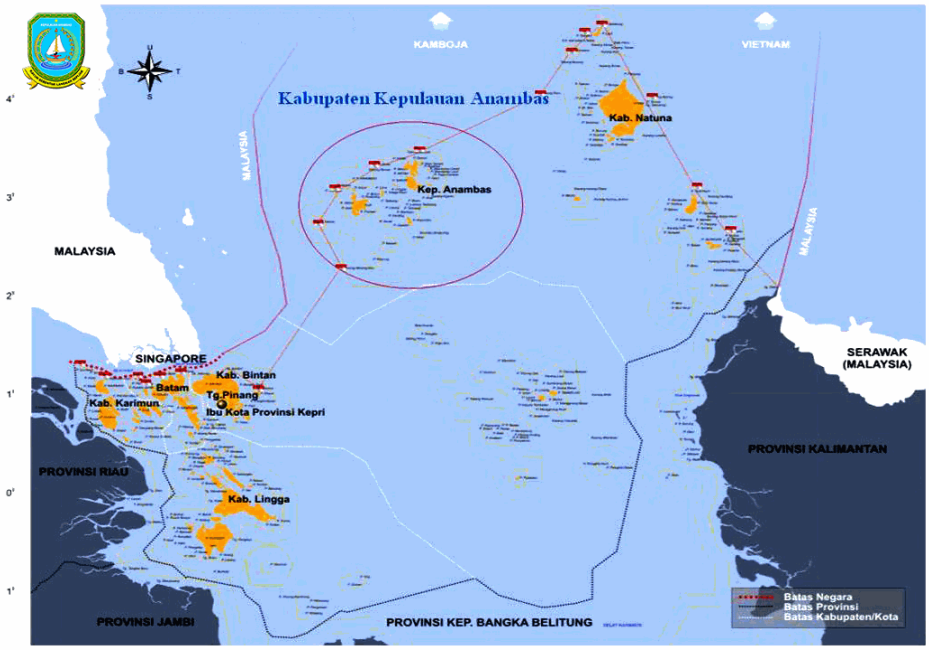


Figure 1. Map of Anambas Islands Regency (Source: PIDII 2022).

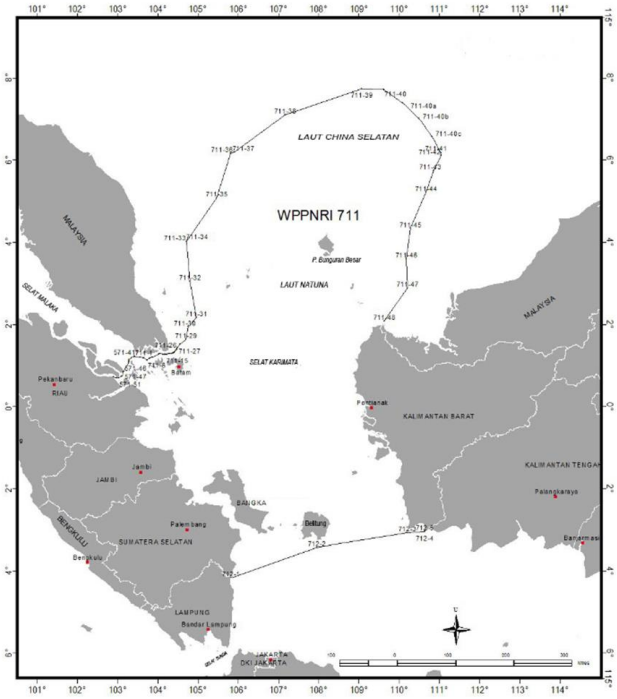


Figure 2. Location of Anambas Island in Fisheries Management Area (WPPNRI) 711 (North Natuna/South China Sea).

Capture fishery is one of the leading sectors in the Anambas Islands, apart from the oil and gas sector (Hutabarat 2020). The total yield of capture fisheries in 2020 was 21,110 tons, with a value of USD 31,466,260 year^{-1} (BPS 2022b). This result was disproportionate to the area of the waters, covering 46,056.43 km^2 or about 98.7% of the total area (DP3 2015). Moreover, the Anambas Islands still have a poverty burden of 3,800 people or 7.09% of 47,408 inhabitants. The regency also has the second-lowest Human Development Index, 68.8, in the Riau Islands Province, compared to an average of 75.59 (BPS 2021). In terms of contribution to GRDP 2021, the agricultural sector (including fisheries), in 2020, only contributed with 6.10% (BPS 2020). Meanwhile, the macroeconomic growth figures in 2021 showed a decrease (-7.83%) (BPS 2022b). These figures show that despite having a large area of potential, the socio-economic condition of fisheries is still experiencing development issues and is not proportional to the average trend of the population's well-being and quality of life.

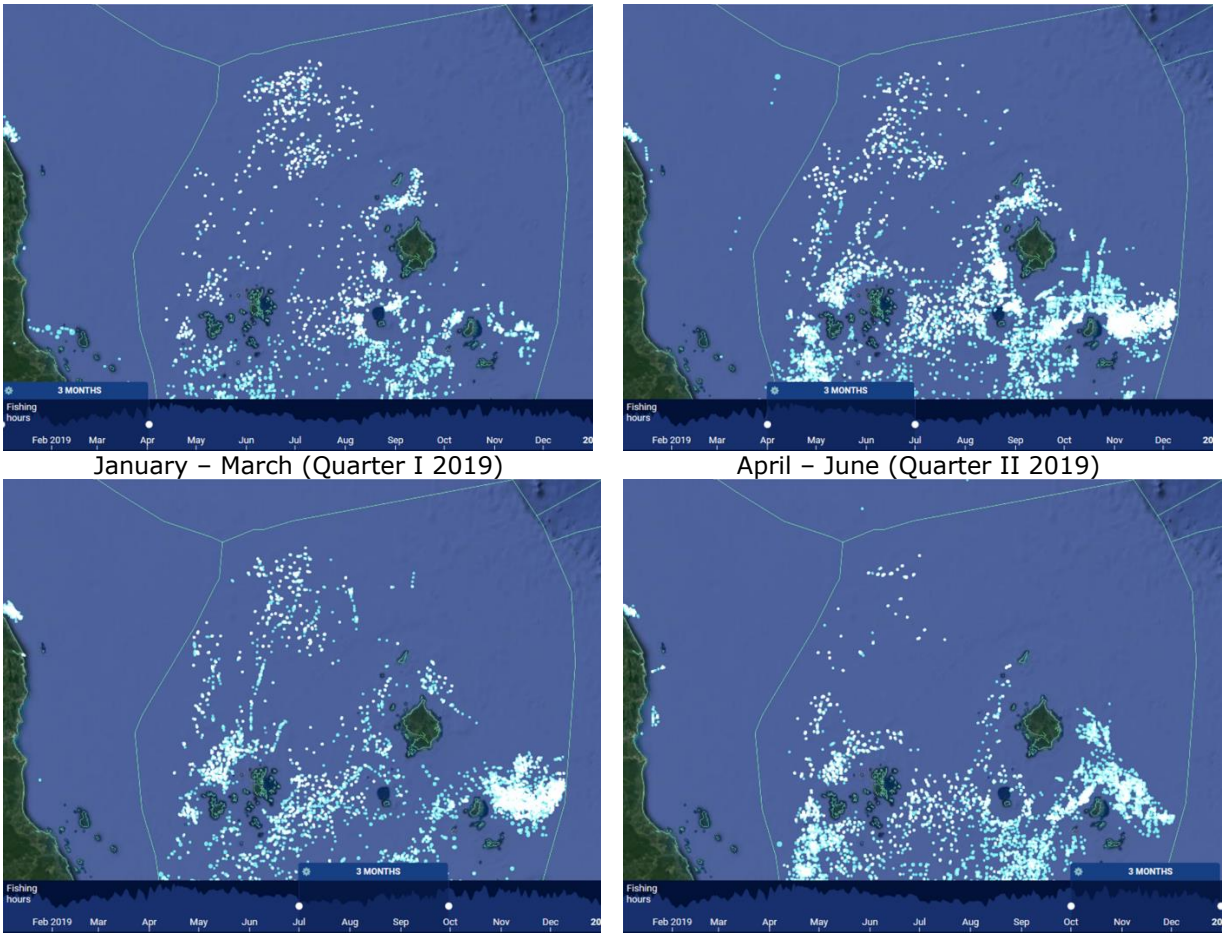
Table 1

Capture fisheries potentials in fisheries management area (WPPNRI) 711

Fish resources	*Potentials (tons)*	*Allowable catch (tons)*	*Level of exploitation (E)*	*Note* [b]
Small pelagics	330,284	264,227	1.41	Over exploited
Large pelagics [a]	185,855	148,684	0.93	Fully exploited
Demersal	131,070	104,856	0.61	Fully exploited
Reef fishes	20,625	16,500	1.53	Over exploited
Penaeid shrimps	62,342	49,873	0.53	Fully exploited
Lobsters	1,421	1,137	0.54	Fully exploited
Crabs	2,318	1,854	1.09	Over exploited
Blue swimmer crabs	9,711	7,769	1.18	Over exploited
Squids	23,499	18,799	1.84	Over exploited
Total	767,126			

Source: Minister of Marine and Fisheries Decree No. 50/Kepmen-KP/2017; [a] Large pelagic exclude tuna and skipjack; [b] E<0.5: moderate, the exploitation effort may be intensified; 0.5≤E≤1: fully exploited, the exploitation effort keep maintained with tight monitoring; E≥1 overexploited, the exploitation effort must be reduced.

Table 1 shows that the fishery resources in this area are already at the utilization threshold because the recovery rate is not proportional to the utilization. The Illegal, Unregulated and Unreported (IUU) Fishing is allegedly one of the causes of resource depletion, decline in the number of fishers in WPPNRI 711, and weakness of domestic fishing technology (Ismail et al 2018). Therefore, a business-as-usual model will not be sustainable in this area. Data from Global Fishing Watch based on the Vessel Monitoring System (VMS) on vessels with a tonnage of 30 GT (gross tons) and above indicates that North Natuna waters are a bustling and congested area throughout the year.



January – March (Quarter I 2019) April – June (Quarter II 2019)

July – September (Quarter III 2019) October – December (Quarter IV 2019)

Figure 3. Distribution map of fishing grounds for vessels >30 GT, during 2019 (Source: https://globalfishingwatch.org/map).

Figure 3 shows that fishing density is relatively high throughout the year, except in the Fourth Quarter, which decreases in the north but is concentrated in the south. A reason is that October-December is a period of stronger north and west winds. However, fishing is still possible to conduct. The northern area is the main fishing area because it is considered that its warm waters are rich in fish resources. The existence of offshore platforms is also an attraction for fish. The small fishing fleets, using inboard engines ("pompong"), of Anambas also hunt in this area, although they still use handlines, competing with fleets with larger tonnage sizes and using purse seines.

Regarding the fishing season, in the Natuna and Anambas areas, fishers identify four seasons for catching: the northern season from December to March (extreme winds cause fishers to reduce the number of trips); the eastern season from March to June (relatively calm winds causing a peak catch and fish prices decrease). The other two seasons are the southern season from July to September (somewhat stronger but fluctuating winds, allowing a regular fishing) and the western season from October to December (extreme winds with big waves, when fishing is still ongoing, especially for pelagics).

Results and Discussion

The scale of fishing effort. According to the CEC (2000), the development of fisheries policies provides significant potential for reducing poverty. In the Anambas Islands, more numerous are the fishers which have experienced the dynamics of modernization characterized by the use of motors, than those continuing to use non-motorized boat ("jongkong"). However, they are still classified as small-scale fishers. The fishing vessels used by fishers in the Anambas Islands have an average size of 5 GT and operate around the Anambas waters to the North Natuna Sea (Table 2). The size of fishing vessels has increased. Many vessels have been equipped with navigational equipment such as radio communication, GPS, and fish finder, so fishing with handlines has a more extended range. In the past, one-day fishing trips used to be carried out, but now many fishers operate in areas above 12 miles distance, with an operating time of about 4-5 days per fishing trip. In addition to technical developments, the production and marketing of fishery products also experienced an expansion, indicating the adoption of techniques and investments by fishers to be able to compete for the existing resources.

Table 2

Number of fishing fleets by district in Anambas Island Regency year 2020

District	*Non-motorized*	*Motorized*
South Siantan	39	373
Siantan	37	213
Central Siantan	36	182
East Siantan	40	302
Palmatak	199	859
North Siantan	NA	NA
Kute Siantan	NA	NA

NA: data not available and still included with the main district before the division of the district. Source: DP3 2020.

The number of fishers in the Anambas Islands, according to the Fishers Association (HNSI) of the Anambas Islands Regency, is estimated at 4,744 people in 2021 (Syahputra 2021), while the government records count 2,385 people in 2019 (DP3 2020), with a majority of small-scale fishers. By definition, small-scale fishers carry out fishing activities for daily needs, using non-motorized or motorized boats with a maximum tonnage of 5 GT (Law No. 7/2016). However, in the Anambas Regency DP3 data (2020) regarding the number of vessels, the total number of fishing fleets is 2,501.

Table 3

Fishers composition by vessels tonnages

District	*Number of capture fleets (Pompong) by capacity (GT)*											
	Non-motorized	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*>10*	*TOTAL*
Siantan	37	86	99	17	5	8	0	0	0	0	2	217
Palmatak	214	504	152	156	31	8	8	2	1	0	1	863
East Siantan	40	90	84	57	42	32	0	0	0	0	0	305
South Siantan	39	301	50	12	2	10	0	0	0	0	1	376
Central Siantan	36	163	16	1	0	1	2	0	0	0	0	183
Subtotal	450	1492	526	303	95	62	13	3	1	0	6	2,501

Source: DP3 2020.

Table 3 shows that fishing vessels measuring 1-3 GT dominate almost 92% of the Anambas Islands Regency fishing fleets. The ability of fishing vessels 1-3 GT is to

perform fishing activities around the coast, at about 3-5 nautical miles from the beach. The number of fishing vessels that can catch at a distance over 12 miles, with a size >5 GT, is only about 85 units. Fishers with non-motorized vessels hunt for fish around the coast, with an average catch of under 50 kg, while the motorized fishers produce a catch capacity of up to 5 tons (Kholison 2006). A very common practice in the Anambas Islands is that although fishers go to sea using 6-8 GT small pompong boats and only use handlines, the fishing area can be up to 80 miles, at the border with Malaysia waters, in the area around offshore oil and gas platforms. This type of capture is usually carried out in groups of at least three pompongs for safety reasons.

Concerning the fisheries' potential for poverty reduction, the social-economic status of fishers from the Anambas Islands reflects the nature of their business. Referring to the classification of fishers by (Satria 2001), there are four types of fishers based on their business characteristics: traditional fishers, post-traditional fishers, commercial fishers, and industrial fishers (Table 4).

Table 4

Fisher's categorization by the business characteristics

Type	*Economic and market orientation*	*Level of technology*	*Relation of production*
Traditional	Subsistence, household	Low	The non-hierarchical structure consists of an owner and homogenous laborers/crews.
Post-traditional	Subsistence, surplus, household, domestic market	Low	The non-hierarchical structure consists of an owner and homogenous laborers/crews.
Commercial	Surplus, domestic market, export	Middle	The hierarchical structure consists of an owner, manager, and heterogenous laborers/crews.
Industrial	Surplus, export	High	The hierarchical structure consists of an owner, manager, and heterogenous laborers/crews.

Source: Satria 2001.

Of the four categorizations of fishing businesses, most fishers in the Anambas Islands are commercial businesses. Some indications show that:

a. The orientation of the fishing effort is the market. The main fish landing location for the Anambas local market is Antang Tarempa Fishing Port in Siantan District. In addition to this port, the other distribution chain is through fish collectors on each island, for the commodities to be brought to Tanjung Pinang, the capital of the Riau Islands Province, for further distribution towards national and export markets. Especially for the live grouper products, sales are made directly to companies from Tarempa, for further exporting to Hong Kong, which is docked in the district capital and accommodates grouper cultivated by the community (Humas KKP 2020).
b. In terms of technology, although the main fishing gear used is the handline, the capture vessels are equipped with adequate supporting equipment such as radio communication, GPS, and fish finder. Longer ranges are an option to get fish with high economic value, including getting around oil and gas platforms and near the national borders, in the north.
c. Although each vessel is operated by the owner individually, some organizations already regulate the trip, risk calculations, and joint fishing efforts, when several vessels are used in one trip. Owners, management, and crew are very heterogeneous and no longer family-based.
d. There is no establishment oriented toward capital accumulation. The existing organizations are issued from a collective effort to work together for an evenly

distributed benefit. This is an opportunity to create a regional solidarity for facing competition with fishers outside the region. This happened in the case of the placement of 30 Danish seine-netter (cantrang) vessels from Central Java in North Natuna waters, in order to compensate for the activities of Chinese fishers in early 2020 (Wiyoga & Utami 2020).

The developments indicate that the fishers of the Anambas Islands are adapting to optimize the utilization of aquatic resources. Anambas waters are still considered to provide livelihood guarantees for fishers. On the other hand, fishers in the Anambas Islands and Fisheries Management Area (WPPNRI) 711 must also face the threat of resource depletion.

Fishing gears and targeted fishes. Although the status of fishery resources in the Fishery Management Area (WPPNRI) 711 is already at the fully exploited and overexploited levels, fishing activities can still be carried out in line with the resource recovery and monitoring efforts. North Natuna waters are an area that has long been a fishing ground for fishers from various countries. In 2014, the Fishery Management Area (WPPNRI) 711 contributed with 10.93% of the total national production (Pregiwati et al 2017). Capture fisheries produce high economic value fish, such as Spanish mackerel, Mackerel tuna, Chubbed mackerel, Sardinella, and Scads (Kepmen KP No.78/2016, 2016). Adrim et al (2004) noted that there were 403 fish species identified in Anambas and Natuna waters. This amounts 12% of the total 3365 fish species recorded by Randall & Lim (2000) in the entire South China Sea region. The fisheries administrative office records 21,110 tons of fish commodities produced in the Anambas Islands, in 2020, less than in 2019 (23,232 tons) as shown in Table 5 (DP3 2020.).

Table 5

Fish species captured in Anambas Islands in 2019-2020

Type of fish	*Production (tons)*	
	2019	*2020*
Bigeye scads	565	494
Yellowtail	435	361
Blue marlin	598	525
Sardinella	955	868
Grey mackerel tuna	1759	1656
Frigate tuna	1827	1732
Rabbitfish	571	493
Spanish mackerel	1163	1070
Blacktip shark	545	468
Marine catfish	1201	1097
Trevally	1337	1240
Painted sweetlips	541	463
Emperor	842	756
Chubbed mackerel	603	525
Gerres	588	515
Blue mackerel	819	733
Pinjalo snapper	770	676
Threadfin bream	1815	1700
Giant groupers	979	889
Leopard coral groupers	766	685
Red Snapper	1147	1040
Squids	863	777
Cuttlefish	570	498
Other reef fish	1820	1850
Total	23,079	21,110

The fishing gear in the Anambas Islands Regency is generally environmentally friendly, such as handlines, pots, lift nets and cast nets. Anambas fishers, by convention, reject

the use of seine net, trawl, and purse seine in the coastal waters of all islands. The fishing gear used by Anambas fishers are handlines, trolling lines, and long lines. Handline fishing gear is used to catch reef fish such as grouper, marine catfish, shark, rabbitfish, snapper, and other reef fishes: the trolling lines and longline fishing gear target pelagic fish like mackerel tuna and Spanish mackerel. Of the various types of lines, handlines are the best fishing gear for use in Anambas waters, dominated by coral reefs (Pregiwati et al 2017). Pots are used to get live fish like groupers. Meanwhile, the lift net targets small pelagics such as sardinella, mackerel scads, anchovy, ponyfish, or squid (Figure 4).

(a) (b)

Figure 4. (a) The "pompong" vessel of Anambas; (b) Common handlines gear.

Fish abundance. The study obtained data on the zonal density level by period. It mapped the spatial distribution of fish, the boundaries of fish distribution, the seasonal distribution of resources and population structure, and the current fish stocks using the fish abundance index. Based on the analysis results conducted on primary data collected during the survey at Tarempa, Palmatak, and Nyamuk fishing ports, the length and weight data were collected for the sample fish are presented in Table 6.

Table 6

Distribution of length-frequency and age groups

Fish	*Age groups*	*Parameter*	
		Length (mm)	*Weight (g)*
Mackerel tuna	1	291.73	238.88
	2	495.38	405.46
Trevally	1	354.12	639.55
	2	402.71	1,084.93
Threadfin bream	1	196.04	79.07
	2	228.85	121.75
Chubbed mackerel	1	172.35	71.87
	2	202.13	100.29
Sardinella	1	181.81	122.65
	2	203.79	184.37
Blue mackerel	1	145.22	30.05
	2	173.45	47.62

The analysis of the length-frequency distribution above shows that each type of fish has two age groups. The similarities or differences in the age groups of fish depend on the catch composition and the fish samples that were taken. Data were analyzed based on the relationship between length and weight. The length and weight of fish are crucial to determining growth, either of a population or a stock.

Table 7

Analysis of fish growth

Fish	*Parameter*		
	a	*b*	*Growth pattern*
Mackerel tuna	0.00005	2.3	Negative allometric
Trevally	0000009	3.27	Positive allometric
Threadfin bream	0.000025	2.89	Negative allometric
Chubbed mackerel	0.000006	3.10	Positive allometric
Sardinella	0.000001	3.59	Positive allometric
Blue mackerel	0.00003	2.91	Negative allometric

Based on the growth analysis, the relationship between length and weight of the sample fish resulted in a negative allometric and positive allometric. Examples of fish with a negative allometric growth pattern are mackerel tuna, threadfin bream, and sardinella fish. Meanwhile, the samples with a positive allometric growth pattern are trevally, chubbed mackerel, and blue mackerel fish. A negative allometric indicates that fish length growth dominates over its weight growth. Positive allometric means that weight growth is more prevalent than length growth. The difference in growth patterns is thought to be due to internal factors of species (genetic differences) and to external factors like the aquatic environmental conditions (temperature, salinity, food availability, and fishing time) (Effendie 2022). The analysis of mortality and exploitation rates, using the approach of Gulland (1971), found that the level of exploitation of the sample fish: trevally, threadfin bream, chubbed mackerel, and blue mackerel fishes indicated a very high fishing pressure on fish stocks in the waters of the Anambas Islands. The value of the exploitation rate of fish is relatively high, even above the value of 50% (Pauly 1982). Fish in the waters of the Anambas Islands are more likely to die from being captured than naturally. In calculating the sustainable level of utilization of fish resources, the Production Surplus model is used. The model regulates the fishing effort allowed to catch fish resources without exceeding the maximum sustainable yield (MSY). In addition, an analysis was also conducted to calculate the Abundance Index, which assesses the stocks of pelagic fish. Abundance is assumed to be correlated with the catch per unit of effort (CPUE = C/f, where C is the catch, and f is the effort given for each fishing operation).

Table 8

Analysis of maximum sustainable yield and fish abundance

Age group	*Average weight (g)*	*Total average weight (g)*	*Total weight (g)*	*Total weight (ton)*	*MSY (ton year^{-1})*	*Abundance (Individuals)*
1	238.88	644.34	3,126.49	0.00312649	50,611.56	16,187,981
2	405.46					
1	639.55	1,724.48				
2	1,084.93					
1	79.07	200.82				
2	121.75					
1	71.87	172.16				
2	100.29					
1	122.65	307.02				
2	184.37					
1	30.05	77.67				
2	47.62					

The MSY analysis table shows that the MSY value is 50,611.56 tons year^{-1}. The MSY value obtained is related to the exploitation rate results which beyond 50% (trevally 0.53, threadfin bream 0.52, chubbed mackerel 0,60, and sardinella 0,67). The high rate of exploitation is one of the causes of fluctuations in the MSY value. The fishery statistical

data of the Anambas Islands Regency 2021 indicate that the number of catches and the gears used from year to year tended to increase. From the analysis results, the total abundance of fish in the Anambas Islands waters is estimated to be 16,187,981 individuals. The abundance of fish in the waters of the Anambas Islands is estimated small. It is related to the high rate of exploitation in these waters, which affects the abundance of fish.

In the context of resources, fish depletion is confirmed through studies on the fish abundance and on the fishers' behavior patterns and social-economic status. Anambas fishers are transforming into commercial fishers. Fishers strive to continuously increase their catch by increasing their technological performance and by increasing their fishing operations zone, in line with Widodo & Suadi (2006), who stated that although fisheries continuously increase their fishing effort, meaning a longer fishing time, more vast fishing grounds, smaller mesh sizes, the result is still a decrease in the productivity of the catch per unit of effort.

Conclusions. Amid the territorial jurisdiction disputes and resource depletion threats, Anambas fishers prioritize the issue of resource exploitation by increasing fishing gear and equipment capacity, and operations zone, in order to catch up with the rising demand. However, this increase in fishing efforts is not in line with the condition of the resources. The exploitation rate in the Anambas Islands Regency waters is relatively high and sometimes it indicates over-exploitation. Only mackerel tuna and blue mackerel fish still have an exploitation rate below the optimum exploitation rate of 45% and 49%. The surplus-production model analysis results showed that the maximum sustainable yield in the waters of the Anambas Islands Regency was 50,611.56 tons year^{-1}, with an estimated abundance of fish reaching 16,187,981 individuals, relatively tiny. The situation is related to the rising fishing effort and exploitation rate in the Anambas Islands Regency waters. In achieving sustainable development indicators (SDG 2030), especially SDG 1: No Poverty and SDG 14: Life Below Water, the Anambas Islands still face a dilemma, especially due to their geopolitical conditions. The policymakers may conduct an integrated effort in the Natuna and Anambas Islands, focusing on four aspects: (1) the consolidation and institutional development of post-traditional fishers into an organized commercial scale; (2) the strengthening of water control that for protects national fishers protection; (3) the application of restrictions on the fishing gear and on the number of selective catches to recover resources; and (4) the addition of protected zones to accelerate resource recovery.

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References

Adrim M., Chen I., Chen Z., Lim K. K. P., Tan H. H., Yusof Y., Jaafar Z., 2004 Marine fishes recorded from the Anambas and Natuna. The Raffles Bulletin of Zoology Supplement 11:117–130.

Anggraini D. S., Kusumawardhana I., Ramadhan I., 2018 The implication of Indonesia's iuu fishing policy in Natuna territorial waters towards South China Sea geopolitics. Jurnal Hubungan Internasional 7(2):1-15.

Bailey C., Dwiponggo A., Marahudin F., 1987 Indonesian capture fisheries. International Center for Living Aquatic Resources Management, Directorate General of Fisheries, Ministry of Agriculture, Marine Fisheries Research, 196 p.

Boer M., Aziz K. A., 1995 [Basic principles of fisheries resource management through bio-economy approach]. Jurnal Ilmu-ilmu Perairan dan Perikanan Indonesia 3(2):109-119. [In Indonesian].
Effendie M. I., 2022 [Biology of fisheries]. Yogyakarta, Yayasan Pustaka Nusatama, 162 p. [In Indonesian].
Fernandes I., Daulay Z., Ferdi F., Delfiyanti D., 2021 Status of Indonesia's sovereign rights in the North Natuna Sea conflict area consequences of China's nine-dash line claim. Linguistics and Culture Review 5(S3):1775–1783.
Fravel M. T., 2011 China's strategy in the South China Sea. Contemporary Southeast Asia 33(3):292–319.
Garcia S. M., Newton C., 1994 Current situation, trends and prospect in world capture fisheries, Paper presented at the Conference on Fisheries Management. Global trends. FAO, Seattle, Washington, USA, 33 p.
Harahap S. A., Amron, Supriyadi, 2014 Condition of coral reefs in Anambas Islands. Jurnal Akuatika 5(2):96–103.
Heazle M., Butcher J. G., 2007 Fisheries depletion and the state in Indonesia: towards a regional regulatory regime. Marine Policy 31(3):276–286.
Hutabarat R. Y., 2020 [Determination of leading sectors in Anambas Islands Regency]. Jurnal Samudra Ekonomi Dan Bisnis 11(1):95–110. [In Indonesian].
Ismail K., Kusasi F., Fitriana R., 2018 Fishers' welfare in Natuna waters post iuu fishing policy, Indonesia Marine Fellowship Program-MFP, https://www.conservation-strategy.org/en/publication/fishers-welfare-natuna-waters-post-iuu-fishing-policy-implementation#.XVOEHehLiM8.
Kholison Y., 2006 [Local fisher's resistance toward Thailand's foreign fishers breach (case study on Anambas Islands fishers in Siantan District, Natuna Regency]. Magister Thesis. Faculty of Social and Political Science, University of Indonesia, Depok, 175 p. [In Indonesian].
Mustika P. L. K., Gunawan T., Erdmann M. V., 2013 A marine rapid assessment (MRAP) of the Anambas Islands marine tourism park. Ministry of Marine and Fisheries, Indonesian Institute of Science (LIPI), the Government of Anambas Regency, The Nature Conservancy, Conservation International Indonesia, Denpasar, 143 p.
Pauly D., 1982 Studying single-species dynamics in a tropical multispecies context. In: Theory and management of tropical fisheries. Pauly D., Murphy G. I. (eds), ICLARM, Cronulla, Australia, 360 p.
Permana R. D., Sunarto S., Harahap S. A., Riyantini I., Ilham Y., 2021 Potassium cyanide (KCN) content in coral reefs and its effect on the abundance of indicator-fishes in the Anambas Islands. Journal of Science and Applicative Technology 5(1):214.
Pregiwati L. A., Wiryawan B., Wisudo S. H., Satria A., 2017 The superior commodity and fishing technology selection. Marine Fisheries 8(1):113–122.
Putra R. D., Siringiringo R. M., Suryanti A., Sari N. W. P., Sinaga M., Hidayati N. V., Hukom F. D., Abrar M., Makatipu P. C., Sianturi R., Ilham Y., 2021 Impact of marine protected areas on economical important coral reef fish communities: An evaluation of the biological monitoring of coral reef fish in Anambas Islands, Indonesia. Biodiversitas 22(10):4169–4181.
Qin X. W., Zhao B., Li F. Y., Zhang B. J., Wang H. J., Zhang R. W., He J. X., Chen X., 2019 Deep structural research of the South China Sea: progresses and directions. China Geology 2(4):530–540.
Randall J. E., Lim K. K. P., 2000 A checklist of the fishes of the South China Sea. The Raffles Bulletin of Zoology Supplement 8:569–667.
Rohingati S., 2014 [Foreign vessels sinking: The Indonesian maritime law enforcement]. Info Singkat Hukum 6(24):1-4. [In Indonesian].
Satria A., 2001 [The dynamics of fisheries modernization: Social formation and fishers mobility]. Humaniora Utama Press, Bandung, 30 p. [In Indonesian].
Scarpello F., 2020 Susi versus the rest: the political economy of the fisheries industry in Indonesia during Jokowi's first term. Asian Journal of Political Science 28(2):122–141.

Setiawan R. R., Kamil M., 2021 National policy on China One Belt-One Road (OBOR) initiative towards Indonesia as global maritime nexus. Jurnal Sosial Politik 7(1):77–88.
Suryadinata L., Izzuddin M., 2017 The Natunas: Territorial integrity in the forefront of Indonesia-China relations. ISEAS Publishing 5:1-33.
Syahputra D., 2021 [The number of Anambas fishers increase]. https://rri.co.id/tanjungpinang/ekonomi/1269101/jumlah-nelayan-di-anambas-terus-meningkat. [In Indonesian].
Syam A. R., Mujiyanto, Indriatmoko, 2020 Sustainable aquaculture of a protected species: The case of juvenile Humphead wrasse (*Cheilinus undulatus*) around the Anambas Islands. IOP Conference Series: Earth and Environmental Science 521(1):147-160.
Wiyoga P., Utami K., 2020 [Fishers of Anambas and Natuna confront Danish-seiners with FADs]. https://www.kompas.id/baca/nusantara/2020/12/14/nelayan-anambas-dan-natuna-melawan-kapal-cantrang-dengan-rumpon. [In Indonesian].
Widodo J., Suadi, 2006 [Marine fisheries resources management]. Yogyakarta, Gajah Mada University Press, 252 p. [In Indonesian].
Zulham A., Subaryono, Anggawangsa R. F., 2017 [Recommendations for capture fisheries development in Natuna and surrounds]. PT. Rajagrafindo Persada, Jakarta, 62 p. [In Indonesian].
*** BPS, Badan Pusat Statistik, 2020 [The Anambas Island Regency's economic growth year 2020]. Berita Resmi Statistik BPS Kabupaten Kepulauan Anambas, 39/03/2105/Th. IV. [In Indonesian].
*** BPS, Badan Pusat Statistik, 2021 [Human development index of Anambas Islands Regency] 2020:21050.2119. [In Indonesian].
*** BPS, Badan Pusat Statistik, 2022a Anambas Islands Regency in figure 2022: 21050.2105. [In Indonesian].
*** BPS, Badan Pusat Statistik, 2022b [Production value from capture fisheries by type of commodity 2020]. https://anambaskab.bps.go.id/indicator/56/508/1/Nilai-Produksi-Perikanan-Tangkap-Menurut-Jenis-Komoditi.html. [In Indonesian].
*** CEC, Commission of the European Communities, 2000 Communication from the commission to the council and the European Parliament: Fisheries and poverty reduction. Brussels, 8.11.2000 COM(2000) 724 final.
*** DP3, Dinas Perikanan, Pertanian dan Pangan, 2015 [Office of Fisheries, Agriculture and Food of Anambas Islands Regency Strategic Plan, Year 2016-2021]. Dinas Perikanan, Pertanian dan Pangan Kabupaten Kepulauan Anambas, Tarempa. [In Indonesian].
*** DP3, Dinas Perikanan, Pertanian dan Pangan, 2020 [Number of fishers by district in Anambas Islands Regency 2019]. Dinas Perikanan, Pertanian dan Pangan Kabupaten Kepulauan Anambas, Tarempa. [In Indonesian].
*** EIA, U.S. Energy Information Administration, 2013 Contested areas of South China Sea likely have few conventional oil and gas resources. https://www.eia.gov/todayinenergy/detail.php?id=10651.
*** FAO, 2020 The state of world fisheries and aquaculture 2020: sustainability in action, Rome, 224 p.
*** Humas KKP, 2020 [Anambas cultivators exported 28 tons of live groupers to Hongkong]. https://news.kkp.go.id/index.php/pembudidaya-anambas-eskpor-28-ton-kerapu-hidup-ke-hongkong/. [In Indonesian].
*** KKP, Kementerian Kelautan dan Perikanan, 2013 [Dive enchantment of Anambas Islands], Kementerian Kelautan dan Perikanan, Jakarta, 56 p. [In Indonesian].
*** Law No 7 of the Year 2016 [Protection and empowerment of fishers, fish cultivators and salt farmers]. [In Indonesian].
*** Map and Data, Global Fishing Watch, https://globalfishingwatch.org/map.
*** Minister of Marine and Fisheries Decree No. 70 of the Year of 2016 [Fisheries management plan of the fisheries management area of the Republic of Indonesia]. [In Indonesian].

*** Minister of Marine and Fisheries Decree No. 50 of the Year 2017 [The estimation of potentials, allowable catch, and level of utilization of fish resource in the fisheries management area of the Republic of Indonesia]. [In Indonesian].

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Authors:
Yoppie Christian, Center for Coastal and Marine Resources Studies Bogor Agricultural University, Jalan Raya Padjadjaran No. 1, 16127, Bogor, Indonesia, e-mail: lakulintang@gmail.com
Ari Gunawan, Center for Coastal and Marine Resources Studies Bogor Agricultural University, Jalan Raya Padjadjaran No. 1, 16127, Bogor, Indonesia, e-mail: arigunawan@pksplipb.or.id
Desmiwati, Research Center for Society and Culture, Institute of Social Science and Humanities, National Research and Innovation Agency (BRIN), JL. Jend. Gatot Subroto No.10, 12710, Jakarta, Indonesia, e-mail: desmiwati.wong@gmail.com
Siti Erwina, Center for Coastal and Marine Resources Studies Bogor Agricultural University, Jalan Raya Padjadjaran No. 1, 16127, Bogor, Indonesia, e-mail: erwinasiti@gmail.com

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