Conservation status and diversity of shark species landed at Tanjung Luar Fishing Port, West Nusa Tenggara Province, Indonesia

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Abstract. Shark fisheries are the main target fish landed in Tanjung Luar, Lombok, with production value traded for export abroad. This study aimed to determine the conservation status based on the IUCN category, CITES appendices list, and species diversity based on the type of longline fishing gear observed from the composition of the number of individuals and total weight. The research was conducted at the Tanjung Luar Fishing Port, East Lombok Regency, West Nusa Tenggara Province. Data were obtained from enumerator records from February to December 2022 and February to June 2023. The results showed that there were 52 species of sharks, with a total of 23,929 individuals and a total weight of 798.787 kg. There were five dominant shark species landed, namely *Carcharhinus falciformis* (Müller & Henle, 1839) (340.184 kg (43.77%), *Galeocerdo cuvier* (Péron & Lesueur, 1822) (117.653 kg, 15.14%), *Prionace glauca* (Linnaeus, 1758) (76.841 kg, 9.89%), *Sphyrna lewini* (Griffith & Smith, 1834) (62.593 kg, 8.05%), and *Carcharhinus brevipinna* (Müller & Henle, 1839) (39.982 kg, 5.14%). The bottom and drift longline catches comprise shark species classified as Near Threatened by the IUCN, encompassing 32 species. Regarding trade convention, only five species dominate the catches, all listed under CITES Appendix II. The analysis results of diversity (H') and uniformity (E') showed that the value of the bottom longline was higher than that of the drift longline by 4.388 and 1.122, respectively.
Key Words: Appendix Cites, diversity, IUCN, sharks, Tanjung Luar.

Introduction. Shark fishery in Indonesia has been ongoing since the 1940s and is known as a multi-species fishery commodity (Christensen 2014). Indonesia is one of the World's most essential shark habitats, with 114 shark species in Indonesian waters (Fahmi 2010). In recent decades, shark populations have declined because of target fishing and bycatch (Carr et al 2013). The decline in shark populations is likely due to the increasing production of sharks due to domestic and export utilization and trade. Shark catch production in Indonesia is also dominated by bycatch, which makes it challenging to control fishing quotas. The production of shark catches will improve the sustainability of shark species and marine ecosystems if shark exploitation activities are addressed adequately. The global trade in shark products is estimated to be 1,145,087 tons/year, and most of these products are exported as fins, oil, and skin (Suryagalih 2012; Dent & Clarke 2015).

Increased shark exports accompanied by high demand and volume can increase fishing, potentially leading to the threat of extinction of shark species. The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) 2020 designated 14 shark species in the CITES Appendix II list. Using the CITES Appendix II-listed species from natural habitats, strict regulations are still allowed by applying three main principles: legality, sustainability, and traceability. Shark conservation activities involve saving endangered marine animal species and addressing global environmental issues (Aditya & Al-Fatih, 2017; Friedman et al 2018; Fowler et al 2021).

Indonesia is one of the World's largest producers of shark fishery products, with an annual volume of approximately 100 thousand tons annually, and contributes to sizeable foreign exchange. Shark conservation management is closely related to the data collection capacity and accuracy of catch data (Sadili et al 2015; Prasetyo et al 2021). Along with the decline in stocks, fishing began to lead to the eastern part of Indonesian waters (Prabuning et al 2015; Asut et al 2019). Tanjung Luar Harbor, located in West Nusa Tenggara, is one of the shark landing sites in the eastern region of Indonesia. The fishing gear commonly used by fishers in Tanjung Luar includes two types of longlines: drift longlines and bottom longlines. Drift or surface longlines are typically operated on the surface of the water column, extending from the high seas to the mid-ocean, targeting oceanic shark groups primarily. In contrast, bottom longlines primarily function at the bottom of nearshore waters or continental shelves, generally between depths of 50 and 100 meters, focusing on demersal shark groups (White et al 2012; Dharmadi et al 2013; Fahmi et al 2013).
According to Rahayu et al (2020), fishers at the Tanjung Luar Fishing Port caught several types of sharks, including *Eusphyra blochii* (Cuvier, 1816), *Carcharhinus albimarginatus* (Rüppell, 1837), *Carcharhinus amblyrhynchos* (Bleeker, 1856), *Carcharhinus limbatus* (Valenciennes, 1839), *Carcharhinus obscurus* (Lesueur, 1818), and *Galeocerdo cuvier* (Péron & Lesueur, 1822), and *Prionace glauca* (Linnaeus, 1758). Six shark species, including CITES Appendices II, landed at the Tanjung Luar TPI (*Alopias pelagicus* Nakamura, 1935*, Alopias superciliosus* Lowe, 1841*, Carcharhinus falciformis* (Müller & Henle, 1839)*, Carcharhinus longimanus* (Poey, 1861)*, Sphyrna lewini* (Griffith & Smith, 1834)*, Sphyrna mokarran* (Rüppell, 1837)) (Wahyudin et al 2019a). In Indonesia, the government seeks to address the problem of trade and exploitation of Indonesian wildlife, whose populations are threatened by implementing the rules and policies of CITES as an international environmental regime through Law No. 5 of 1990 concerning the Conservation of Natural Resources and Ecosystems, and Government Regulation No. 8 of 1999 concerning the Utilization of Wild Plant and Animal Species.

The utilization of shark fisheries caught at the Tanjung Luar Fishing Port still requires complete information related to size composition, conservation status, and the status of trade conventions, so this information is necessary for sustainable shark fisheries management. Fisheries management and shark conservation in Indonesia have been carried out optimally. One of the obstacles is that information related to the potential and status of sharks still needs to be improved (Dulvy et al 2017; Pacoureau et al 2023). The potential of shark fisheries in an area must be a benchmark for determining the allowable shark fishing quota to help sustain shark production. The management of shark resources with various policies can be applied effectively in an area if the trade size composition, utilization status, and conservation status are known.

Shark fishing quotas in an area regulated by the Indonesian government are related to the number of quotas and shark species based on IUCN threats and trade conventions that have made rules. Therefore, this study aims to determine the level of danger of shark species based on the IUCN category and the status of the shark trade Convention based on CITES and shark species diversity based on the total weight of the number of individuals landed at Tanjung Luar Fishing Port, so that it can provide important information for policymakers in formulating policies for sustainable shark fisheries management and trade in Indonesia.

Material and Method

Description of the study sites. The research was conducted at the Tanjung Luar Fishing Port, East Lombok Regency, West Nusa Tenggara Province (Figure 1). Data were obtained from direct recordings by enumerators stationed at the Tanjung Luar Fishing Port for 14 months, from February to November 2022 and February to June 2023.

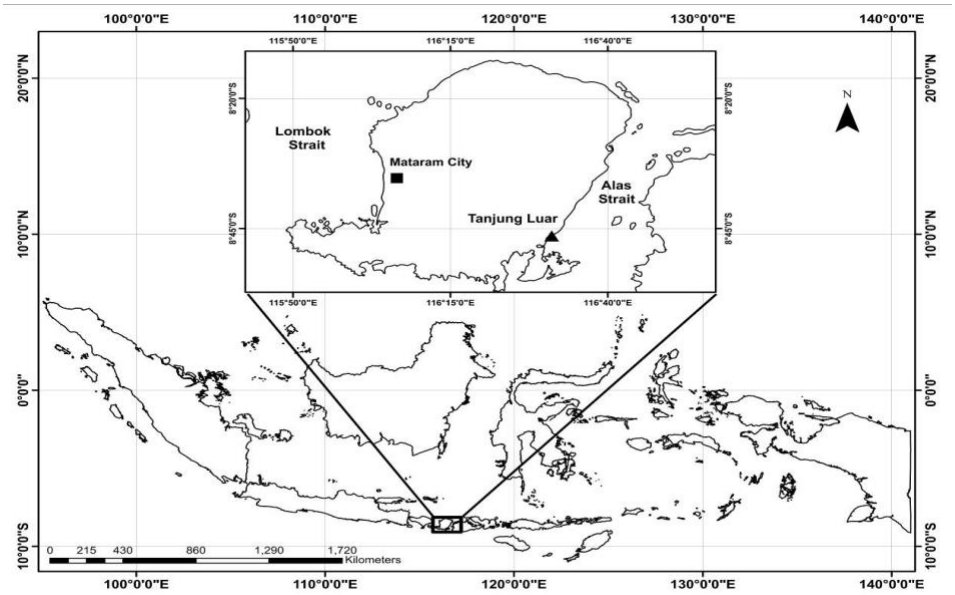

Figure 1. The location of Research at Tanjung Luar, West Nusa Tenggara, Indonesia.

Data-collection. Direct data-collection methods were used in this study. The collected data included gear name, species name, weight, number of individuals, and total length (TL). Shark species were identified using the guidelines of Daley et al (2022) and White et al (2006). Data collection was carried out by taking measurements of the landed shark catch daily in the form of total length data, which is the length measured from the tip of the snout to the posterior part of the tail using a roller meter. Individual weights were calculated for the entire shark condition using scales. The total data obtained is 20,809 with details; namely, the bottom longline has 6,120 individuals, while the drift longline catches 14,689 individuals.

Statistical analysis. The obtained data were then analyzed for catch composition for each fishing gear based on its global threat level using the IUCN status list and grouping based on the CITES appendices list. The data were analyzed using Excel and are presented as tables and graphs. Shark data collected and grouped based on the two types of fishing gear targeting shark catches, drift gear and bottom gear, were analyzed for diversity indices to determine the diversity of shark catches caught in each gear operated following the Shannon guidelines:

$$H' = -\sum_{i=1}^{S} (p_i \log p_i)$$

Where S = number of taxa
H’ = Shannon diversity index

$$p_i = \frac{n_i}{N}$$

Where ni = number of individuals of the i-the species
N = total number of individuals
The diversity index value (H') ranged from 0 to ∞ according to the following criteria:
H’ < 3.2: low population diversity
3.2 < H’ < 9.9: Moderate population diversity
H’ > 9.9: high population diversity

The Shannon diversity index analysis in this study was to analyze the diversity of catch from the fishing gear used. The more diverse the catch, the lower the selectivity of the fishing gear.

Results. Shark fishing at Tanjung Luar Fishing Port is conducted by fishers using two methods: drift and bottom longlining. The drift longline is operated on the surface of the water. It consists of a nylon mainline measuring 4-6 mm in diameter and ranging in length from 3,000 to 4,000 m. This method includes branch lines that are 4-6 meters long, with hooks numbered 30-250. The distance between each fishing hook is set at 5-6 m. The bottom longline is deployed on the seabed. It features a mainline made of nylon, measuring 4-6 mm in diameter, with a length between 8,000 and 12,000 m. This setup includes branch lines of 4-8 meters in length, and hooks numbered 250-500. The distance between the hooks is maintained at 20-30 m.

The composition of shark catches landed at Tanjung Luar Fishing Port is grouped into catches based on species, number of individuals (fish), and total weight (Kg) and in detail, the IUCN categories, namely Near Threatened (NT), Endangered (EN), Critically Endangered (CR), Vulnerable (VU) Least Concern (LC) and Data Deficient (DD) and CITES Appendix II and Non-Appendix categories. The characteristics of the shark species that landed at the Tanjung Luar Fishing Port are shown in Table 1.

Table 1

Characteristics of the shark species by quantity and weight and IUCN and CITES status landed at Tanjung Luar Fishing Port

No	Name of species	Type of longline fishing gear				Status	
		Drift longline		Bottom longline			
		Quantity individual	Weight (kg)	Quantity individual	Weight (kg)	IUCN	CITES
1	*Carcharhinus longimanus* (Poey, 1861)	22	919	0	0	CR	App II
2	*Centrophorus atromarginatus* Garman, 1913	12	28	14	20	CR	NA
3	*Sphyrna lewini* (Griffith & Smith, 1834)	932	26.804	618	35.789	CR	App II
4	*Sphyrna mokarran* (Rüppell, 1837)	7	437	16	965	CR	App II
5	*Alopias pelagicus* Nakamura, 1935	178	6.612	52	1.367	EN	App II
6	*Carcharhinus amblyrhynchos* (Bleeker, 1856)	226	4.321	321	6.442	EN	App II
7	*Carcharhinus obscurus* (Lesueur, 1818)	88	7.099	296	23.924	EN	App II
8	*Carcharhinus plumbeus* (Nardo, 1827)	2	72	31	793	EN	App II
9	*Centrophorus lusitanicus* Barbosa du Bocage & de Brito Capello, 1864	0	0	10	27	EN	NA
10	*Halaelurus buergeri* (Müller & Henle, 1838)	0	0	4	2	EN	NA
11	*Hemitriakis indroyonoi* White, Compagno & Dharmadi, 2009	15	50	169	517	EN	NA
12	*Isurus oxyrinchus* Rafinesque, 1810	193	8.965	35	1.832	EN	II
13	*Isurus paucus* Guitart, 1966	88	4.629	1	140	EN	II
14	*Mustelus manazo* Bleeker, 1854	8	33	131	554	EN	NA
15	*Stegostoma tigrinum* (Forster, 1781)	1	12	13	170	EN	NA
16	*Alopias superciliosus* Lowe, 1841	88	5.285	9	478	VU	App II
17	*Carcharhinus albimarginatus* (Rüppell, 1837)	153	2.911	126	2.750	VU	App II
18	*Carcharhinus amboinensis* (Müller & Henle, 1839)	0	0	1	24	VU	NA
19	*Carcharhinus brevipinna* (Müller & Henle, 1839)	331	9.811	1,165	3.0171	VU	App II
20	*Carcharhinus falciformis* (Müller & Henle, 1839)	8,942	33.2403	305	7.781	VU	App II
21	*Carcharhinus leucas* (Valenciennes, 1839)	5	372	29	1.919	VU	App II
22	*Carcharhinus limbatus* (Valenciennes, 1839)	208	7.041	432	16.143	VU	App II
23	*Carcharhinus melanopterus* (Quoy & Gaimard, 1824)	11	116	108	1.338	VU	App II
24	*Carcharhinus sealei* (Pietschmann, 1913)	0	0	1	4	VU	App II
25	*Centrophorus moluccensis* Bleeker, 1860	1	4	18	40	VU	NA
26	*Hemigaleus microstoma* Bleeker, 1852	1	1	25	88	VU	NA
27	*Hemipristis elongate* (Klunzinger, 1871)	7	215	40	1.148	VU	NA

No	Name of species	Type of longline fishing gear				Status	
		Drift longline		Bottom longline			
		Quantity individual	Weight (kg)	Quantity individual	Weight (kg)	IUCN	CITES
28	*Nebrius ferrugineus* (Lesson, 1831)	5	156	27	1.108	VU	NA
29	*Odontaspis ferox* (Risso, 1810)	1	105	4	416	VU	NA
30	*Rhizoprionodon acutus* (Rüppell, 1837)	0	0	9	120	VU	App II
31	*Sphyrna zygaena* (Linnaeus, 1758)	0	0	3	57	VU	App II
32	*Squalus montalbani* Whitley, 1931	2	5	55	139	VU	NA
33	*Triaenodon obesus* (Rüppell, 1837)	18	207	274	2.554	VU	NA
34	*Atelomycterus marmoratus* (Anonymous [Bennett], 1830)	0	0	9	7	NT	NA
35	*Carcharhinus altimus* (Springer, 1950)	84	4.051	112	5.323	NT	App II
36	*Carcharhinus sorrah* (Valenciennes, 1839)	170	1.904	302	3.136	NT	App II
37	*Chiloscyllium punctatum* Müller & Henle, 1838	5	27	32	177	NT	NA
38	*Deania calceus* (Lowe, 1839)	0	0	1	3	NT	NA
39	*Galeocerdo cuvier* (Péron & Lesueur, 1822)	1,501	90.587	433	27.066	NT	App II
40	*Heptranchias perlo* (Bonnaterre, 1788)	0	0	20	64	NT	NA
41	*Hexanchus griseus* (Bonnaterre, 1788)	7	616	66	5.465	NT	NA
42	*Hexanchus nakamurai* Teng, 1962	14	151	130	967	NT	NA
43	*Loxodon macrorhinus* Müller & Henle, 1839	27	69	104	204	NT	NA
44	*Orectolobus leptolineatus* Last, Pogonoski & White, 2010	20	123	289	1.822	NT	NA
45	*Prionace glauca* (Linnaeus, 1758)	1,277	76.453	6	388	NT	App II
46	*Squalus edmundsi* White, Last & Stevens, 2007	13	19	104	138	NT	NA
47	*Squalus nasutus* Last, Marshall & White, 2007	0	0	30	27	NT	NA
48	*Cirrhigaleus barbifer* Tanaka, 1912	0	0	2	9	LC	NA
49	*Mustelus stevensi* White & Last, 2008	20	95	130	541	LC	NA
50	*Pseudocarcharias kamoharai* (Matsubara, 1936)	1	5	0	0	LC	NA
51	*Pseudotriakis microdon* de Brito Capello, 1868	5	280	0	0	LC	NA
52	*Cephaloscyllium signourum* Last, Séret & White, 2008	0	0	1	2	DD	NA
	Total	14,689	592.989	6,120	184.152		

Near Threatened (NT), Endangered (EN), Critically Endangered (CR), Vulnerable (VU), Least Concern (LC), and Data Deficient (DD), while for basic longline, respectively are Near Threatened (NT), Endangered (EN), Critically Endangered (CR) Vulnerable (VU), Least Concern (LC) and Data Deficient (DD).

The length distribution of sharks caught varies between species. *Carcharhinus falciformis* was captured in a size range of 60 to 280 cm, *Galeocerdo cuvier* ranged from 100 to 430 cm, *Carcharhinus brevipinna* (Müller & Henle, 1839) was found in the range of 70 to 320 cm, *Sphyrna lewini* was caught in the length range of 60 to 330 cm, and *Prionace glauca* was captured in size range of 160 to 360 cm. The length distribution of dominant sharks landed at Tanjung Luar Fishing Port is illustrated in Figure 2.

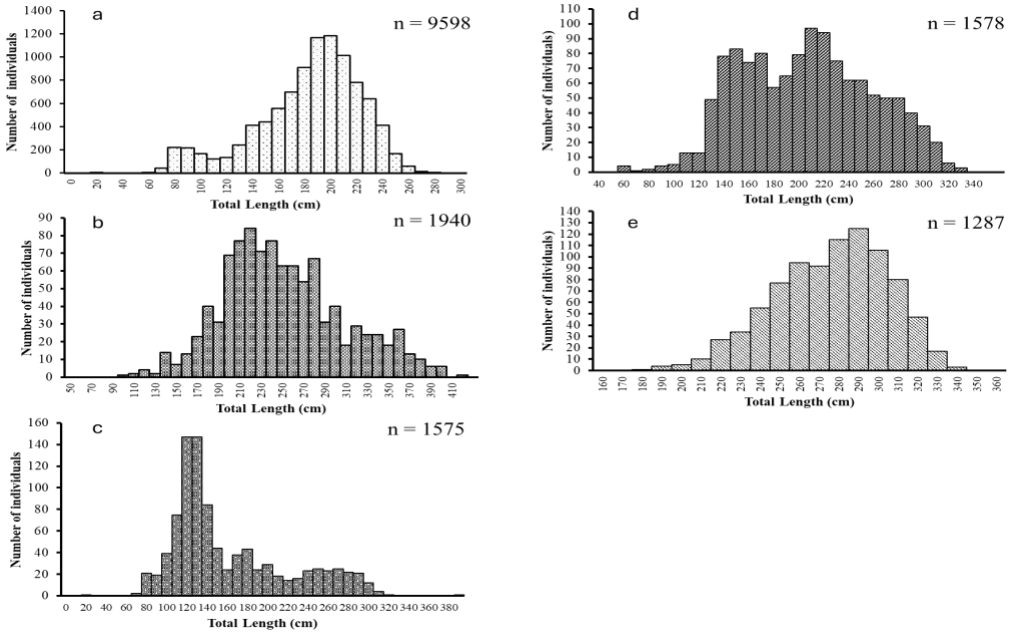

Figure 2. Length distribution of dominant sharks landed at Tanjung Luar Fishing Port a. *Carcharhinus falciformis*, b. *Galeocerdo cuvier*, c. *Carcharhinus brevipinna*, d. *Sphyrna lewini*, e. *Prionace glauca.*

IUCN and CITES Appendix II category based on type of longline. The results showed that there were 52 shark species with 23,929 individuals and a total weight of 798.787 kg, with the dominance of five main types of sharks with the highest to lowest total catch weight in a row: *Carcharhinus falciformis* (340.184 kg), *Galeocerdo cuvier* (117.653 kg), *Prionace glauca* (76.841 kg), *Sphyrna lewini* (62.593 kg), and *Carcharhinus brevipinna* (39.982 kg). The composition of the catch based on the type of fishing gear is grouped based on the number of species, namely, drift longline caught 41 species, and bottom longline caught 50 species. Overall, the catch shows that sharks caught using longlines were dominated by as many as 32 species in the Near Threatened category. In detail, the IUCN category based on longline fishing gear landed at the Tanjung Luar Fishing Port consists of drift gear-catching sharks with categories from high to low in a row: Near Threatened (NT), Endangered (EN), Critically Endangered (CR), Vulnerable (VU) Least Concern (LC), and Data Deficient (DD), while for the basic longline, Near Threatened (NT), endangered (EN), Critically Endangered (CR) vulnerable (VU), Least Concern (LC), and Data Deficient (DD), as shown in Figure 3.

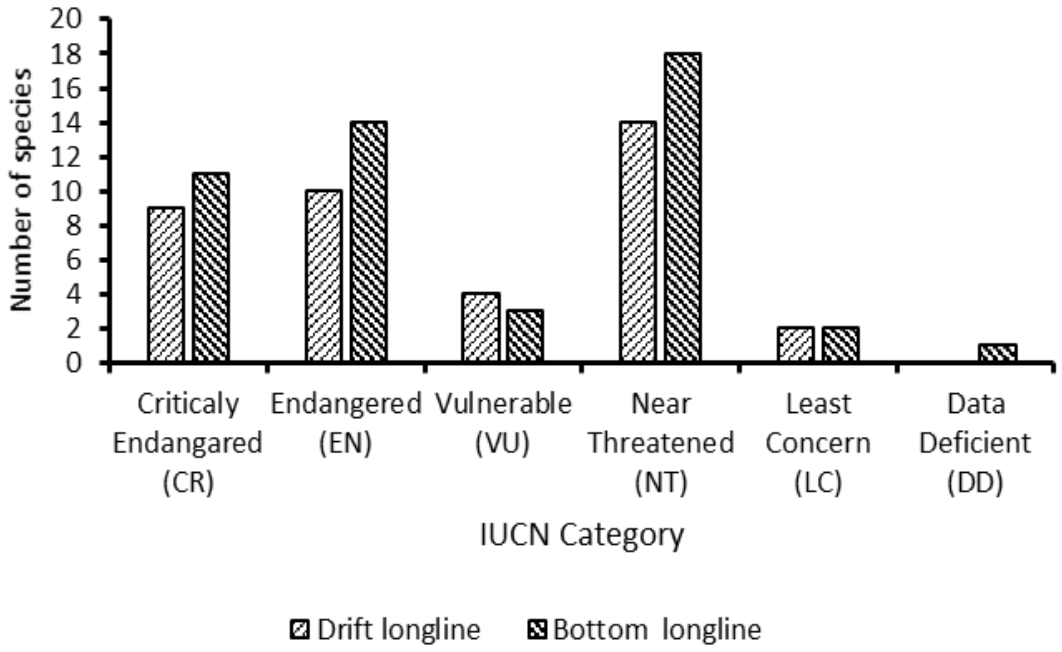

Figure 3. Comparison of the number of shark species caught using drift and bottom longlines based on IUCN categories.

The catch of sharks differentiated based on the type of longline gear shows that 22 types of sharks are included in CITES Appendices II, caught using drift longline and 19 non-Appendices. In comparison caught using the bottom longline, 22 types of sharks caught in Appendices II CITES and 27 have Non-Appendices status. However, of all the species caught, only five types of sharks dominated the catch, all included in the CITES Appendix II category. The grouping of shark catches landed at the Tanjung Luar Fishing Port for drift gear and bottom longlines using CITES categories is shown in Figure 4.

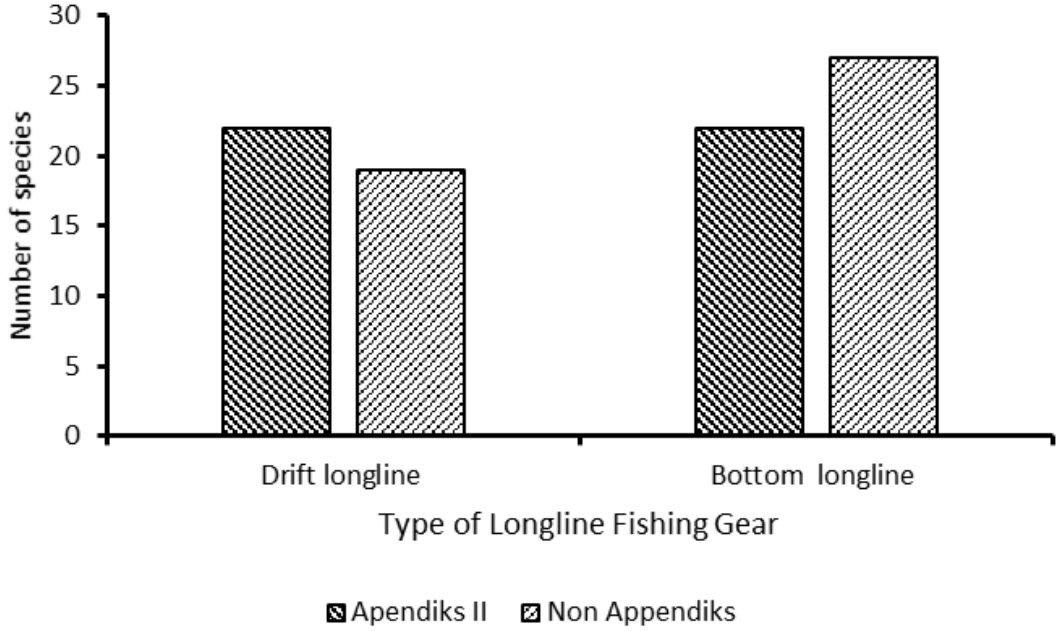

Figure 4. Comparison of shark catches by type of shark species caught using drift longline and bottom longline by CITES Category.

The catches of Longline 5 shark species were grouped in the CITES Appendix II category, based on the IUCN vulnerability category, including *Carcharhinus falciformis* in the vulnerable category (9,247 individuals), *Galeocerdo cuvier* in the Near Threatened category (1,943 individuals), *Sphyrna lewini* in the Critically Endangered category (1,550 individuals), *Carcharhinus brevipinna* in the vulnerable category (1,496 individuals), and *Prionace glauca* in the near-threatened category (1,283 individuals). A comparison chart of the number of individuals (fish) for the top five captured species is shown in Figure 4.

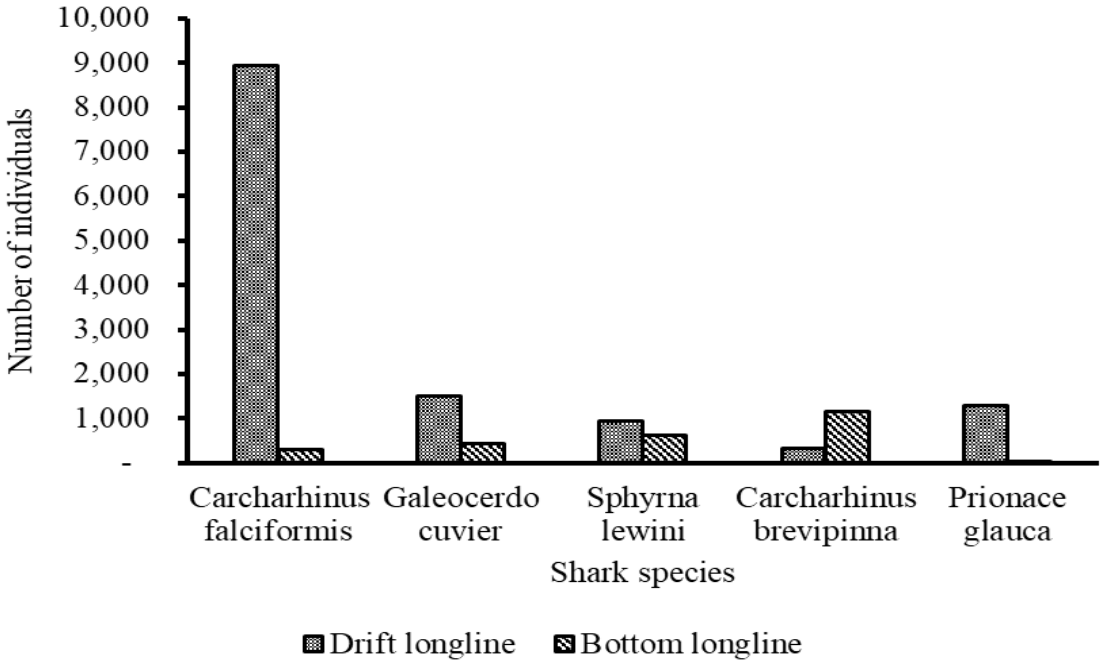

Figure 5. Diagram of the five dominant shark species caught using drift longline and bottom longlines by number of individuals

Diversity (H') and uniformity (E') based on the type of longline. The results of the analysis of diversity (H') and uniformity (E') of drift longline and bottom longline catches are presented in Table 2 and Figure 5. The data showed that the highest value of diversity of drift longline catches was for the *Carcharhinus falciformis* shark species with an H' value of 0.435. The total diversity value (H') of the drift longline shark catch is 2.254, which means it has a value in the medium category, while the diversity value (H') of the bottom longline is 4.388, which indicates a high diversity value. The uniformity value (E') of the total catch of the longline shark species was 0.611, while the uniformity value (E') of the longline was 1.122.

Table 2

Catch a diversity of drift and bottom longline sharks landed at Tanjung Luar

No	*Name of species*	*Dift longline diversity(H')*	*Bottom longline diversity (H')*
1	*Carcharhinus longimanus* (Poey, 1861)	0.014	0.002
2	*Centrophorus atromarginatus* Garman, 1913	0.008	0.010
3	*Sphyrna lewini* (Griffith & Smith, 1834)	0.253	0.267
4	*Sphyrna mokarran* (Rüppell, 1837)	0.005	0.042
5	*Alopias pelagicus* Nakamura, 1935	0.077	0.205
6	*Carcharhinus amblyrhynchos* (Bleeker, 1856)	0.059	0.111
7	*Carcharhinus obscurus* (Lesueur, 1818)	0.044	0.117
8	*Carcharhinus plumbeus* (Nardo, 1827)	0.002	0.069
9	*Centrophorus lusitanicus* Barbosa du Bocage & de Brito Capello, 1864	0.000	0.007
10	*Halaelurus buergeri* (Müller & Henle, 1838)	0.000	0.002
11	*Hemitriakis indroyonoi* White, Compagno & Dharmadi, 2009	0.010	0.101
12	*Isurus oxyrinchus* Rafinesque, 1810	0.082	0.209
13	*Isurus paucus* Guitart, 1966	0.044	0.000
14	*Mustelus manazo* Bleeker, 1854	0.006	0.000
15	*Stegostoma tigrinum* (Forster, 1781)	0.001	0.027
16	*Alopias superciliosus* Lowe, 1841	0.044	0.019
17	*Carcharhinus albimarginatus* (Rüppell, 1837)	0.059	0.111
18	*Carcharhinus amboinensis* (Müller & Henle, 1839)	0.000	0.015
19	*Carcharhinus brevipinna* (Müller & Henle, 1839)	0.123	0.220
20	*Carcharhinus falciformis* (Müller & Henle, 1839)	0.435	0.452
21	*Carcharhinus leucas* (Valenciennes, 1839)	0.004	0.098
22	*Carcharhinus limbatus* (Valenciennes, 1839)	0.087	0.211
23	*Carcharhinus melanopterus* (Quoy & Gaimard, 1824)	0.008	0.098
24	*Carcharhinus sealei* (Pietschmann, 1913)	0.000	0.011
25	*Centrophorus moluccensis* Bleeker, 1860	0.001	0.007
26	*Hemigaleus microstoma* Bleeker, 1852	0.002	0.034
27	*Hemipristis elongate* (Klunzinger, 1871)	0.005	0.060
28	*Nebrius ferrugineus* (Lesson, 1831)	0.004	0.047
29	*Odontaspis ferox* (Risso, 1810)	0.001	0.039
30	*Rhizoprionodon acutus* (Rüppell, 1837)	0.000	0.022
31	*Sphyrna zygaena* (Linnaeus, 1758)	0.000	0.027
32	*Squalus montalbani* Whitley, 1931	0.002	0.032
33	*Triaenodon obesus* (Rüppell, 1837)	0.012	0.141
34	*Atelomycterus marmoratus* (Anonymous [Bennett], 1830)	0.000	0.014
35	*Carcharhinus altimus* (Springer, 1950)	0.043	0.110
36	*Carcharhinus sorrah* (Valenciennes, 1839)	0.075	0.198
37	*Chiloscyllium punctatum* Müller & Henle, 1838	0.004	0.036
38	*Deania calceus* (Lowe, 1839)	0.000	0.002
39	*Galeocerdo cuvier* (Péron & Lesueur, 1822)	0.337	0.330
40	*Heptranchias perlo* (Bonnaterre, 1788)	0.000	0.000
41	*Hexanchus griseus* (Bonnaterre, 1788)	0.005	0.060
42	*Hexanchus nakamurai* Teng, 1962	0.001	0.034
43	*Loxodon macrorhinus* Müller & Henle, 1839	0.017	0.038

No	Name of species	Dift longline diversity(H')	Bottom longline diversity (H')
44	*Orectolobus leptolineatus* Last, Pogonoski & White, 2010	0.013	0.016
45	*Prionace glauca* (Linnaeus, 1758)	0.307	0.267
46	*Squalus edmundsi* White, Last & Stevens, 2007	0.009	0.014
47	*Squalus nasutus* Last, Marshall & White, 2007	0.000	0.024
48	*Cirrhigaleus barbifer* Tanaka, 1912	0.000	0.004
49	*Mustelus stevensi* White & Last, 2008	0.006	0.116
50	*Pseudocarcharias kamoharai* (Matsubara, 1936)	0.001	0.002
51	*Pseudotriakis microdon* de Brito Capello, 1868	0.004	0.002
52	*Cephaloscyllium signourum* Last, Séret & White, 2008	0.000	0.005
	Diversity (H')	2.254	4.388
	Uniformity(E')	0.611	1.122

Discussion. The type of shark fishing business used by Tanjung Luar Fishing Port fishers can be grouped into drift and bottom longline fisheries. The contribution of the shark longline fishery to the number of shark species landed shows that drift longline is more dominant than basic longline because of the level of operation, which is still traditional and highly dependent on geographical conditions and fisher's habits. Shark fishing with surface longlines by Tanjung Luar fishers is considered artisanal fishing because they catch bait fish first during their trip to the fishing location (Sentosa 2016a).

The composition of the total catch of the number of individuals, there are five species of sharks caught quite dominant in both types of fishing gear, namely *Carcharhinus falciformis*, *Galeocerdo cuvier*, *Sphyrna lewini*, *Carcharhinus brevipinna*, and *Prionace glauca*. Sulaiman & Triharyuni (2021) suggested that the *Carcharhinus* shark is the genus of sharks most caught by Tanjung Luar fishers. The catch of sharks using drift longline was dominated by *Carcharhinus falciformis* and the least by *Carcharhinus brevipinna*. This result is supported by the research results of Simeon et al in 2018. The results of shark catch using bottom longlines were dominated by *Carcharhinus brevipinna*, and the least was *Prionace glauca*. According to Dewi et al (2018), the types of sharks caught in Namosain and Kupang-East Nusa Tenggara are *Carcharhinus brevipinna*, *Carcharhinus limbatus*, and *Carcharhinus sorrah* (Valenciennes, 1839). In contrast, the minor shark type was the *Prionace glauca* (Chodrijah et al 2019). Meanwhile, Aceh shows that the shark species that dominate the catch landed at PPI Sungai Kakap is *Carcharhinus brevipinna* (Hidayat et al 2018).

Based on five types of shark catches, including *Carcharhinus falciformis*, *Galeocerdo cuvier*, *Sphyrna lewini*, *Carcharhinus brevipinna*, and *Prionace glauca*, the kinds of *Carcharhinus falciformis* and *Sphyrna lewini* are the most in-demand by collectors, making them the dominant catch of the fishers. The fins are first taken, and then all parts of the shark body are traded and utilized to meet local and international market demands. In East Lombok, shark species are categorized as facing threats or risk of extinction. They are included in the list of species that may be threatened by extinction if the trade continues without regulations (Triyono et al 2020). The sharks mostly caught in Sorong are *Carcharhinus falciformis*, and the lowest is *Hemipristis elongate* (Klunzinger, 1871), which has fins, skin, bones, and oil products (Nurastri & Marasabessy 2021).

Sharks caught using longlines had different diversity and uniformity values in the two types of fishing gear used. By comparing the values of diversity and uniformity based on the type of longline fishing gear, the drift longline was found to have a medium diversity and uniformity category. The higher the diversity value of the catch, the greater the impact on the selectivity of fishing gear. The selectivity of fishing gear is relatively selective for tuna longlines and shark longlines but not selective for gill nets because the Shark longline fishery is carried out by Cilacap Fishers, such as artisanal fisheries (Sulaiman et al 2018). According to Kamil et al (2023), the diversity index analysis of sharks landed at PPI Rigaih Aceh Jaya showed that the shark diversity index was in the medium category, namely

H'=2.00 The uniformity index showed a moderate shark species uniformity index, with E=0.78. The diversity of shark and ray species at the Pemalang Fish Auction Site is moderate, with H'=1.124 (Sukmaningrum et al 2022).

Grouping of shark species caught in Tanjung Luar Lombok using longline gear types and their relationship to the level of species threat based on IUCN categories showed that basic longline and drift gears caught more shark species in the Near Threatened (NT) category and the slightest catch in the Data Deficient (DD) category. According to Sentosa (2016a), *Carcharhinus falciformis* is one of the dominant sharks caught and landed in Tanjung Luar based on the IUCN Red List is Near Threatened.

However, the grouping of shark species caught at Tanjung Luar Lombok based on the CITES category shows that sharks caught using drift longline catch sharks in the CITES Appendix II category. In contrast, the bottom longline catch sharks are included in the CITES Non-Appendix II list. The shark species that are primarily caught with drift longlines and bottom longlines is *Carcharhinus falciformis*. According to Dewi et al (2018), many CITES Appendix II sharks were caught by drift longlines in the Timor Sea, East Nusa Tenggara. Sharks in the CITES Appendix II category can still be caught from nature through strict regulations by applying legality, sustainability, and traceability. Jatmiko et al (2019) stated that vulnerable conservation status occurs in *Carcharhinus longimanus*, *Alopias pelagicus*, and *Carcharhinus falciformis*.

Fishers already know the status of shark species but still, catch them because they are still doubtful and unsure of the impact that will occur on the marine ecosystem if sharks become extinct. At the Tanjung Luar Fish Landing Site, 43.33% of fishers still believe sharks will not become extinct if hunted continuously, and 63.33% doubt that shark extinction will affect the marine ecosystem (Sentosa 2016b). This illustrates the need for the surrounding community to be more sensitive to the interests of sharks in the underwater ecosystem, supported by their level of education, which is one of the obstacles faced by the government of Indonesia in implementing CITES rules related to shark trade. CITES provisions have been regulated so that information needs to be improved and continued every year to monitor the population of sharks landed and to support the risk analysis of shark utilization listed in Appendix II CITES in Indonesia (Sentosa 2016c; Dharmadi et al 2019). Efforts have been made to experience various obstacles, ranging from the ambiguity of CITES regulations globally to domestically and the government's limited capacity to implement CITES related to shark protection in Indonesia (Maynelfa 2023).

Socioeconomics is one of the critical factors that can occur because of the strong ties between shark fishers and collectors, which makes fishers highly dependent on the capital ties provided by collectors. Constructive policies must be implemented to improve the sustainability of elasmobranch fisheries in the East Lombok Regency (Wahyudin et al 2019b). The government must consider this condition, especially in accelerating the increase in knowledge and awareness of the community to maintain the wealth of biological resources in the marine and fishery sectors so that they can be utilized sustainably.

Conclusions. Sharks landed at the Tanjung Luar Fishing Port and consisted of 52 species. The five dominant species are *Carcharhinus falciformis*, *Galeocerdo cuvier*, *Sphyrna lewini*, *Carcharhinus brevipinna* and *Prionace glauca*. The composition of the catch based on the type of fishing gear is grouped based on the number of species, namely, drift longline caught 41 species, and bottom longline caught 50 species. Overall, the catch shows that sharks caught using longlines were dominated by as many as 32 species in the Near Threatened category. The results of shark catches differentiated by the type of longline gear show that 22 types of sharks are included in CITES Appendix II, caught using drift longline and 19 non-appendices. In comparison, sharks caught with basic longlines had 22 kinds of CITES Appendices II, and 27 had non-Appendices status.

The diversity (H') and uniformity (E') analysis results show that the value of the basic longline is higher than that of the drift longline. However, these two types of longline fishing gear are still categorized as selective. However, fishers still caught sharks in the threatened category. Because the community considers that the kind of shark being traded

is still not prohibited, community participation in supervision, regulation, and authority between related stakeholders needs to be done well and reviewed.

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References

Aditya Z. F., Al-Fatih S., 2017 Legal protection for sharks and stingrays to maintain the balance of Indonesian Marine Ecosystems. Legality 24(2):224-235.

Asut H., Hamdani H., Dewanti L. P., 2019 Analysis of stingray catches which landed in fish landing site of Labuan Bajo, West Manggarai Regency of East Nusa Tenggara. World News of Natural Sciences 24:89-99.

Carr L. A., Stier A. C., Fietz K., Montero I., Gallagher A. J., Bruno J. F., 2013 Illegal shark fishing in the Galapagos Marine Reserve. Marine Policy 39:317-321.

Christensen J., Tull M., 2014 Historical perspectives of fisheries exploitation in the Indopacific. Di dalam: Springer Netherlands, editor 12:237.

Chodrijah U., Sentosa A. A., Prihatiningsih P., 2019. [Population parameters of Tiger shark *Galeocerdo cuvier* Peron & Lesuer, 1822 in the southern waters of West Nusa Tenggara]. Jurnal Penelitian Perikanan Indonesia 24(4):253-261. [in Indonesian]

Dent F., Clarke S., 2015 State of the global market for shark products. FAO Fisheries and Aquaculture technical paper 590(I).

Daley R. K., Stevens J. D., Last P. R., Yearsley G.K. 2002. Field guide to Australian sharks and rays. CSIRO Publishing.

Dewi S. P. S., Lasniroha R., Pumpun Y. K., Abidin Z., Wardono S., 2018 Catch composition and fishing ground of shark CITES Appendix II Landed in Namosain-East Nusa Tenggara. Jurnal Penelitian Perikanan Indonesia 24(2):149-156.

Dharmadi R., Faizah L., Sadiyah, 2013 Shark longline fishery in Tanjungluar East Lombok. Indonesia Fisheries Research Journal 19(1):39–46.

Dharmadi, D., Samusamu, A., Oktaviani, D., Wiadnyana, N. N., 2019 [Effectiveness of the policy on banning export shark related to Appendix II Cites's product]. Jurnal Kebijakan Perikanan Indonesia 11(1):1-10. [in Indonesian]

Dulvy N. K., Simpfendorfer C. A., Davidson L. N., Fordham S. V., Bräutigam A., Sant G., Welch D. J., 2017 Challenges and priorities in shark and ray conservation. Current Biology 27(11):R565-R572.

Fowler S., Bräutigam A., Okes N., Sant G., 2021 Conservation, fisheries, trade and management status of CITES-listed sharks.

Friedman K., Gabriel S., Abe O., Adnan Nuruddin A., Ali A., Bidin Raja Hassan R., Ye Y., 2018 Examining the impact of CITES listing of sharks and rays in Southeast Asian fisheries. Fish and Fisheries 19(4):662–676.

Fahmi, 2010 Sharks and rays in Indonesia. Marine Research Indonesia 35:43-54.

Fahmi, Dharmadi., 2013 [Overview of shark fisheries status and conservation efforts in Indonesia, Directorate of Marine Conservation and Biodiversity. Jakarta]. [in Indonesian]

Hidayat E. H., Alkadrie S. I. T., Getreda G., Sabri M., 2018 [Species diversity of sharks and rays in West Kalimantan waters]. Proceedings of Fisheries Research Center 1(1):89-95. [in Indonesian]

Jatmiko I., Rochman F., Wujdi A., 2019 [Composition, CPUE, and conservation status of Tuna longline caught sharks in the South Indian ocean waters of Java]. Proceedings of the Fisheries Research Center 1(1):129-136. [in Indonesian]

Kamil F., Zurba N., Sihombing A. C., 2023 [Identification of the diversity of sharks and rays caught by fishers in wpp 572, rigaih fish Landing Port, Aceh jaya district]. Journal of Aceh Aquatic Sciences 7(2):59-67. [in Indonesian]

Maynelfa C., 2023 Indonesia's implementation of cites in the hammerhead and silky shark trade. Frequency of International Relation Journal 5(1):143-167.
Nurastri V. D., Marasabessy I., 2021 Conservation status of endangered fish traded out of Sorong City (Case study: shark based on identification at the resource management Loka Sorong coast and sea). Journal of Fisheries and Marine Research 3(1):303-318.
Pacoureau N., Carlson J. K., Kindsvater H. K., Rigby C. L., Winker H., Simpfendorfer C. A., Dulvy N. K., 2023 Conservation successes and challenges for wide-ranging sharks and rays. Proceedings of the National Academy of Sciences 120(5):e2216891120.
Prabuning D., Setiasih N., Ningtias P., Yahya Y., Harvey A., 2015 Shark and ray trade chain in NTB (West Nusa Tenggara) and NTT (East Nusa Tenggara) provinces. Proceedings of Shark and Ray Symposium. Pp 127-134.
Prasetyo A. P., McDevitt A. D., Murra, J. M., Barry J., Agung F., Muttaqin E., Mariani S., 2021 Shark and ray trade in and out of Indonesia: Addressing knowledge gaps on the path to sustainability. Marine Policy 133:104714.
Rahayu S. M., Syuhriatin, Desy I., 2020 Fish identification at Tanjung Luar Fishing Port, Lombok Island, West Nusa Tenggara Province, Harpodon Borneo Journal 13(1):30-38.
Sadili D., Dharmadi, Fahmi, Sarminto, Ramli I., Sudarsono., 2015 [National action plan (NAP) for shark and ray conservation and management, Ministry of Marine Affairs and Fisheries. Jakarta]. [in Indonesian]
Sentosa A. A. 2016a. [Profile of shark fishing by surface longline vessels in western waters of Sumba Island]. In Isnansetyo et al (eds), Proceedings of the XIII Annual National Seminar on the Results of Fisheries and Marine Research. Pp. 315–325. [in Indonesian]
Sentosa A. A., Hedianto D. A., 2016b [Type and size distribution of sharks landed at Tanjung Luar, East Lombok, West Nusa Tenggara]. Proceedings of the Annual National Scientific Meeting. (PIT) XIII ISOI, 902-914. [in Indonesian]
Sentosa A. A., Widarmanto N., Wiadnyana N. N., Satria F. 2016c [Differences in shark catches from drift and bottom based longlines at Tanjung Luar, Lombok]. Jurnal Penelitian Perikanan Indonesia 22(2):105-114. [in Indonesian]
Simeon B. M., Muttaqin E., Mardhiah U., Ichsan M., Dharmadi, Prasetyo A. P., Fahmi, Yulianto I., 2018 Increasing abundance of silky sharks in the Eastern Indian Ocean: good news or a reason to be cautious?. Fishes 3(3):29.
Sukmaningrum S., Suryaningsih S., Habibah A. N., 2022 Species diversity and conservation status of sharks and rays at the Pemalang fish auction place, Al-Kauniyah. Journal Biologi 15(1):130-139.
Sulaiman P. S., Patria M. P., Sue R. A., 2018 The shark bycatch of tuna longline fisheries in Southern Indian Ocean of Java, Indonesia. In E3S Web of Conferences 74: 02004.
Sulaiman P. S., Triharyuni S., 2021 Shark fisheries management as a sustainable development implementation in Indonesia's fishery sector. In IOP Conference Series: Earth and Environmental Science 718(1):012069.
Suryagalih S., 2012 Management study of shark fisheries in North Coastal Java Island, Marine Fisheries. Journal of Marine Fisheries Technology and Management 3(2):149-159.
Triyono T., Oktaviyani S., Sjafrie N. D. M., 2020 Shark resources from the perspective of social ecological systems (case study in Tanjung Luar, East Lombok, West Nusa Tenggara). Jurnal Enggano 5(3):451-465.
Wahyudin I., Kamal M. M., Fahrudin A., Boer M., 2019a [Sustainability analysis of elasmobranch fisheries in Tanjung Luar, East Lombok Regency]. Jurnal Ilmu dan Teknologi Kelautan Tropis 11(1):103-116. [in Indonesian]
Wahyudin I., Kamal M. M., Fahrudin A., Boer M., 2019b Length-weight relationship and reproductive size of silky shark *Carcharhinus falciformis* and scalloped hammerhead shark *Sphyrna lewini* collected in Tanjung Luar fish landing port, East Lombok, Indonesia. AACL Bioflux 12(1):355-362.
White W. T., Last P. R., Stevens J. D., Yearsley G. K., Fahmi D., 2006 Economically important sharks and rays of Indonesia. ACIAR monograph series; no. 124. Australian Centre for International Agricultural Research, Canberra. Pp. 329.

White W. T., Dichmont C., Purwanto S. Nurhakim, Dharmadi R. J., West R. B., Sadiyah L., Faizah R., Sulaiman P. S., Sumiono B., 2012 Tanjung Luar (East Lombok) Longline Shark Fishery. Report prepared for ACIAR Project FIS/2006/142, Developing new assessment and policy frameworks for Indonesia's marine fisheries, including the control and management of Illegal Unregulated and Unreported (IUU) Fishing. Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia. Pp. 53.

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