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Conservation status of sharks and rays caught in Indonesian Fisheries Management Area 712

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Abstract. *Lelono TD, Bintoro G, Setyanto A, Setyahadi D, Sutjipto DO, Adhihapsari W, Aliviyanti D, Isdianto A. 2024. Conservation status of sharks and rays caught in Indonesian Fisheries Management Area 712. Biodiversitas 25: 2603-2614.* Elasmobranchs, including sharks and rays, are some of the most vulnerable marine fish and are particularly at risk from fishing pressure. Sharks and rays landing data that listed in the Convention on International Trade in Endangered Species (CITES) appendices and/or assessed as in The International Union for Conservation of Nature (IUCN) Red List threatened categories were collected from [illegible]y to [illegible]tober 2023 at two sites in Indonesian Fisheries Management Area (FMA) 712, East Java, Indonesia, namely *Pelabuhan Perikanan Nusantara* (PPN) Brondong at Lamongan District and *Pelabuhan Perikanan Pantai* (PPP) Muncar at Banyuwangi. Stingray species designated as Critically Endangered (CR), Endangered (EN), or Vulnerable (VU) were recorded at both landing sites. Moreover, IUCN Red List threatened ray species were recorded at Brondong than at Muncar. Based on Brondong's international trade records, ray species landed at Brondong are at higher risk of extinction than those landed at Muncar. Six shark species are currently listed in CITES Appendix II: *A pelagicus, A. superciliosus, S. lewini, S. zygaena, C. falciformis,* and *I. oxyrinchus*. At Muncar, two of these species were traded. Sharks landing at Muncar included species in IUCN Red List categories, while those landing at Brondong were in four categories. Two CITES categories regulate the capture of sharks landed at Muncar and Brondong. At both sites, numerous species with conservation statuses of CR, EN, VU, and NT are still caught. In conclusion, exploitation and insufficient control threaten the shark and ray populations in Muncar and Brondong. To save these species, conservation efforts should prioritize trade monitoring, habitat protection, and stricter laws.

Keywords: CITES compliance, conservation status, elasmobranch fisheries, IUCN Red List

INTRODUCTION

Elasmobranchs are particularly susceptible to fishing pressure due to intrinsic traits which include sluggish growth, late maturity, large body size, and poor fertility (Hasan and Ridwan 2020). These traits constitute the primary anthropogenic threats to elasmobranch populations today (Dulvy et al. 2016; Hasan et al. 2021; Di Lorenzo et al. 2022). Additionally, the conditions are worsened by habitat loss, climate change, increased trade value, and lack of information, resulting in inadequate conservation action (Haque et al. 2021). Elasmobranchs, including sharks, rays, and chimeras (chondrichthyans), are among the most endangered marine megafauna listed in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Consales and Marsili 2021; Pimiento et al. 2023). Further, there are groups of shark-like rays from the order Rhinopristiformes, which is mainly comprised of five families: wedgefishes (Rhinidae), sawfish (Pristidae, guitarfish (Rhinobatidae), giant guitarfishes (Glaucostegidae), and banjo rays (Trygonorrhinidae). Surprisingly, the extinction risk of these five families was 90% for wedgefishes, 38% for banjo rays, 66% threatened for guitarfishes, 100% for giant guitarfishes, and 100% for sawfishes (Pytka et al. 2024). Due to an 18-fold increase in fishing pressure, sharks and rays have fallen by 71% worldwide since 1970. Further, sharks and rays have raised the worldwide extinction risk to three-quarters of these functionally important species (Pacoureau et al. 2021). Between 1980 and 2015, threatened species increased from 29% to 41% in the Northeast Atlantic and from 47% to 65% in the Mediterranean. In Europe, the number of threatened sharks and rays equals the number of threatened birds (Walls and Dulvy 2021).

Nevertheless, the evaluation of elasmobranch populations is constrained by the absence of precise data regarding captures and landings (Giovos et al. 2020). As a result, a significant proportion of elasmobranch populations are not being screened, resulting in a lack of appropriate management action (Williams et al. 2023). A previous study provided evidence of a recovery in tuna and beaked whales following the implementation of fisheries management measures in the 2000s (Juan-Jordá et al. 2022). However, due to a lack of management, sharks are at risk of extinction (Johri et al. 2021; Williams et al. 2023).

The leading cause of the elasmobranch threat is complex. However, unsustainable fishing might threaten many elasmobranchs. International trade is one example of unsustainable fishing practices that directly threaten species (Dell'Apa et al. 2014; Cardeñosa 2019; Hinrichs et al.

2021; Niedermüller et al. 2021). The number of chondrichthyan fish species classified as Vulnerable (VU), Endangered (EN), and Critically Endangered (CR) has doubled between the 2014 and 2021 global assessments (Cardeñosa et al. 2022; Scacco et al. 2024). In contrast, the market value of Chondrichthyan products, including processed and raw meat for local consumption, is relatively low. However, as export commodities, these products would gain value and enable selective retention of high-value species, leading to overfishing (De Mitcheson et al. 2018; Cardeñosa et al. 2022). Overfishing might reduce and exhaust numerous elasmobranch populations that may require several decades to restore (Dulvy et al. 2014; Daris et al. 2022; Porcher and Darvell 2022). Therefore, there is a need for the sustainable management and conservation of these stocks on a global scale (Dulvy et al. 2008; Dulvy et al. 2016; Jabado et al. 2017; Yan et al. 2021). However, there is quite a mismatch in international trade flow between Indonesia and partner countries, which sharks and rays are still frequently caught by local fishers using fishing vessels or gillnets due to their economic values (Sjafrie et al. 2020; Prasetyo et al. 2021). Also, there is a few unreported or illegal trading activities between 2012-2018 (Prasetyo et al. 2021).

Due to their high value, globally traded species shoul be categorized as threatened in the IUCN Red List if this i true. IUCN has been at the leading edge of ...nise...ation efforts for more than five decades and se...ve...s a ...tform for objective assessment of the ex...tion ri... of sp...s (Dulvy et al. 2014; Bräutigam ...t al. 2...6). Mea...while, the Convention on Internatio... Trade in E...dangered Species (CITES) regulations on t...de a...y to lan...d fish classified as vulnerable o... ...nge... species. Nevertheless, it is difficult to m... the r...quire...nts ...r species enumerated in CITES appe... ...g., ...egality, sustainability, and traceability) an... those of other regulatory in Indonesia frameworks due t... he diverse processing methods applied in elasmobranchs (Abdullah et al. 2020). This study aims to better understand elasmobranch (shark and ray) fisheries at regional and local levels by collecting catch data on species of conservation concern and trade.

MATERIALS AND METHODS

Study area

The study collected data on sharks and rays caught in Indonesian Fisheries Management Area (FMA) 712 and landed at two fishing ports: *Pelabuhan Perikanan Nusantara* (PPN) Brondong (hereinafter called Brondong) in Lamongan District and *Pelabuhan Perikanan Pantai* (PPP) Muncar (hereinafter called Muncar) in Banyuwangi District, East Java, Indonesia (Figure 1). Data was collected from both ports between July and October 2023.

Procedures

Techniques for species id...fication

Identification of s...k (...elachi...rpha) and ray (Batoidea) sp... was ...done by observing their morphological cha...cteristi... ...comparing them with identi... book... Where field identification was unce...in, photograp... were taken according to CITES guide...es fo... aquatic species and compared with the identi...tion ...ooks used in this study (White et al. 1977; ...e et al. 2011; Indian Ocean Comission and FAO 2014; Valencia and Giraldo 2019).

Techniques for coding and photographing research objects

To facilitate field identification and reduce uncertainty in the identification process, all fish samples collected were coded and photographed, including sharks (Selachimorpha) and rays (Batoidea). The codes assigned correspond to the fish species to be documented. The first species encountered was coded 1, and subsequent encounters with the same species were coded 1.1 to 1.n. The code was updated for each subsequent species encountered by adding 1 (2, 3, and so on).

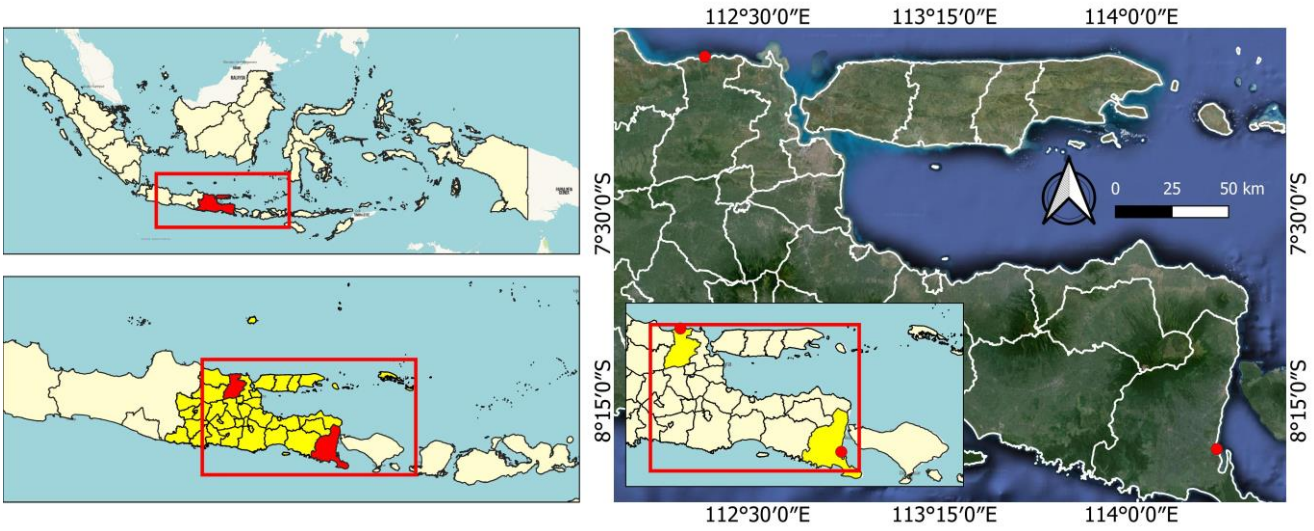


Figure 1. Map of the data collection sites in Indonesian Fisheries Management Area (FMA) 712, East Java, Indonesia

The shark and ray photography during this research adhered to the Standard Operating Procedures (SOP) for Sharks, Rays, and Skates Data Collection in Southeast Asian Waters (SEAFDEC 2017) (Figure 2). Multiple photographs were obtained at the same sampling times to ensure accurate documentation.

Conformity to national and international regulations

Data obtained from this identification process were in the form of stingray and shark species names. These data were used to explore the regulations governing the capture of these species, nationally and internationally. This analysis aimed to determine the regulations governing the capture and trade of stingray and shark species caught at the two fishing ports, Muncar and Brondong. National regulations are based on Indonesia Marine and Fishery Ministry regulations, and international regulations are based on CITES**.**

Conservation status assessment

Conservation status can be determined based on assessment status by the experts through the IUCN Red List of Threatened Species (Figure 3). Based on Williams et al. (2020) and the IUCN Red List (2023), the conservation status is divided into nine categories (Table 1).

RESULTS AND DISCUSSION

Shark

For sharks, 28 species were identified from 678 samples at Muncar, Banyuwangi and 22 species from 1120 samples at Brondong, Lamongan (Figure 4).

Figure 2. F branch p tograph documentation technique (Source: AFDEC 2017)

Figure 3. Conserva stat CN 2023)

Table 1. The nine categories of conservation status

Category	Explanation	Example
Extinct (E)	Species where it has been proven (beyond reasonable doubt) that the last individual of a species has died.	
Extinct in the Wild (EW)	Species whose existence is known only in captivity or outside their natural habitat.	
Critically Endangered (CR)	Species at risk of extinction in the near future.	*Glaucostegus typus*, *Pristis pectinata*, *Pristis pristis*, *Rhina ancylostoma*, *Rhinobatos jimbaranensis*
Endangered (EN)	Species that are at imminent risk of extinction in the wild.	*Rhinobatos penggali*
Vulnerable (VU)	Species that face the risk of extinction in the wild in the future. For example, cassowaries and green peacocks.	*Urolophus javanicus*
Near Threatened (NT)	Species that may be in a threatened or near threatened state or near threatened with extinction.	
Least Concern (LC)	Species that have been evaluated but do not fall into any other category.	
Data Deficient (DD)	Species that have unclear extinction data.	
Not Evaluated (NE)	Species that have not been evaluated based on the IUCN criteria.	

Figure 4. Shark catch at: A. Muncar, Banyuwangi District and B. Brondong, Lamongan District, East Java, Indonesia

The findings of the shark analysis, which is based on national and international regulations and includes data from Muncar and Brondong, can be found in Tables 1 and 2. In Brondong, 22 species of sharks were identified, while in Muncar, 38 species were identified. Muncar is subject to 5 national shark catch regulations, and Brondong is subject to 3. According to national regulations, Muncar is home to six species of shark, i.e. *A. pelagicus*, *A. superciliosus*, *S. lewini*, *S. zygaena*, *C. falciformis*, and *I. oxyrinchus*. Muncar catches more sharks than Brondong, specifically two species, i.e. *S. lewini* and *C. falciformis*.

The IUCN categories of sharks landed at the Muncar and Brondong, and both landing sites are shown in Figure 5. The analysis results indicate that the sharks caught in Muncar and Brondong are both subject to regulation under the CITES category (Figure 6).

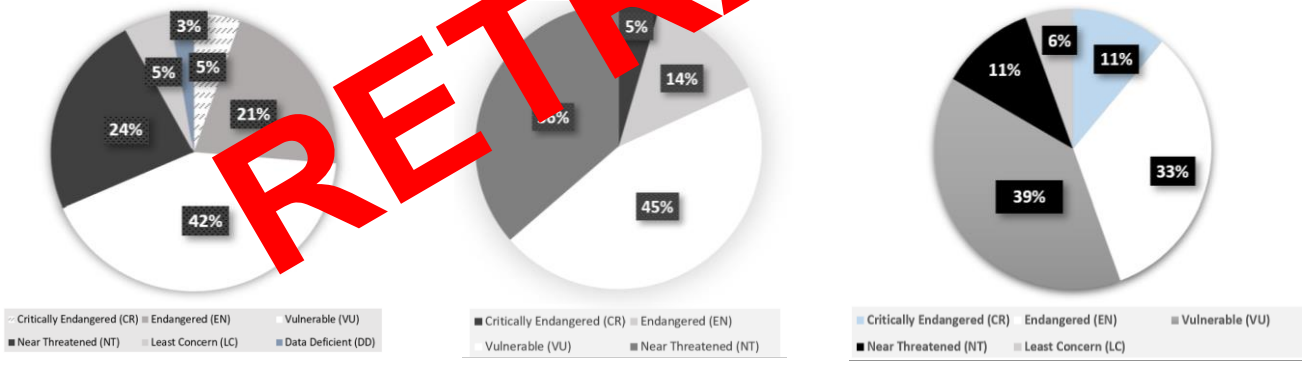
The following results were obtained based on the existing CITES trade status categories in Muncar, i.e.: 6 species (*S. lewini*, *S. zygaena*, *A. pelagicus*, *I. oxyrinchus*, *C. falciformis*, and *A. superciliosus*) with Appendix II trade status or not endangered but may become endangered if trade continues unregulated and 23 other species with Not Evaluated trade status. Endangered if trade continues without regulation and for 23 other species with a Not Evaluated trade status. Based on the existing CITES trade status categories in Brondong VAT, the following results were obtained: 2 species (*S. lewini* and *C. falciformis*) with Appendix II trade status or not endangered but may become endangered if trade continues unregulated and 20 other species with Not Evaluated trade status.

Rays

The identification results of rays show that 22 species were caught in Muncar out of 490 samples examined, whereas in Brondong, 28 ray species were found out of 1830 samples (Figure 7). Six IUCN categories apply to the catch of rays at the Muncar, and four IUCN categories apply at the Brondong (Figure 8). The analysis results indicate that the rays caught in Muncar, Brondong, and Brondong Muncar are subject to regulation under the CITES category (Figure 9).

Based on the identification results in Muncar harbor, 2 species were found in the Critically Endangered (CR) category: 8 species in the Endangered (EN) category, 8 species in the Vulnerable (VU) category, 4 species in the Near Threatened (NT) category and 2 species in the Least Concern (LC) category. In Brondong, 7 species were found in the IUCN Critically Endangered (CR) category, 10 in the Endangered (EN) category, 9 in the Vulnerable (VU) category and 2 in the Least Concern (LC) cat[illegible]y (Figure 10).

The identification results at th[illegible]ort i[illegible]Munca[illegible]are found Appendix II. There are [illegible]speci[illegible] an[illegible]1 [illegible]cies included in the Minister [illegible]Mari[illegible]ffairs an[illegible]Fisheries Regulation No. 61 of [illegible]01[illegible] In Br[illegible]don[illegible]are 7 species included in App[illegible]II, an[illegible] specie[illegible]are included in the Minister of M[illegible]ne Affairs an[illegible]isheries Regulation No. 61 of 2018 (Figu[illegible]11).



A **B** **C**

Figure 5. Shark catches landed in East Java, Indonesia at: A. Muncar, B. Brondong are regulated by the IUCN, C. The summarizes of conjoined two locations

A **B** **C**

Figure 6. Sharks have been caught in Muncar and Brondong, East Java, Indonesia and both fall under CITES suggestion

Table 2. List of shark catches landed at Muncar and Brondong, East Java, Indonesia, regulated by national and international regulations

Species name	National regulations							International references												
								IUCN									CITES			
	a	b	c	d	e	f	g	EX	EW	CR	EN	VU	NT	LC	DD	NE	I	II	III	NE
Muncar																				
Alopias pelagicus	●	●	●				●				●							●		
Alopias superciliosus	●		●				●					●						●		
Atelomycterus marmoratus													●							●
Carcharhinus amblyrhynchoides												●								●
Carcharhinys amblyrhyncos											●									●
Carcharhinus brevipinna												●								●
Carcharhinus falciformis			●				●					●						●		
Carcharhinus limbatus												●								●
Carcharhinus melanopterus												●								●
Carcharhinus obsucurus											●									●
Carcharhinus sorrah													●							●
Chiloscyllium punctatum													●							●
Chimera phantasma												●								●
Galeocerdo cuvier													●							●
Hemigaleus microstoma												●								●
Hemipristis elongata												●								●
Heptranchias perlo													●							
Isurus oxyrinchus			●								●									
Loxodon macrorhinus													●							●
Orectolobus leptolineatus													●							
Prionace glauca													●							●
Pseudocharias kamoharai																				●
Rhizoprionodon acutus												●								●
Sphyrna lewini			●	●			●			●								●		
Sphyrna zygaena			●	●			●											●		
Squalus altipinnis															●					●
Squalus megalops														●						●
Triaenodon obesus																				●
Brondong																				
Atelomycterus marmoratus													●							
Carcharhinus amblyrhyncoides												●								●
Carcharhinus brevipinna												●								●
Carcharhinus falciformis												●						●		
Carcharhinus leucas												●								●
Carcharhinus limbatus												●								●
Carcharhinus melanopterus												●								●
Carcharhinus sealei												●								●
Carcharhinus sorrah													●							●
Chiloscyllium hasseltii											●									●
Chiloscyllium plagiosum													●							●
Chiloscyllium punctatum													●							●
Galeocerdo cuvier													●							●
Hemigaleus microstoma												●								●
Hemipristis elongata												●								●
Loxodon macrorhinus													●							●
Mustelus manazo											●									●
Orectolobus leptolineatus													●							●
Rhizoprionodon oligolinx													●							●
Sphyrna lewini			●	●			●			●								●		
Stegostoma fasciatum											●									●
Triaenodon obesus												●								●

Note:

a = PERMEN KP No 12 tahun 2012
b = PERMEN KP No 30 tahun 2012 jo PERMEN KP No. 26 tahun 2013
c = PERMEN KP No 61 tahun 2018
d = PERMEN KP No 5 tahun 2018
e = KEPMEN KP No 18 Tahun 2013
f = KEPMEN KP No 30 Tahun 2023
g = Surat Edaran Direktur KKHL No 2078/PRL 5/X/2017

EX = Extinct
EW = Extinct in the Wild
CR = Critically Endangered
EN = Endangered
VU = Vulnerable
NT = Near Threatened
LC = Least Concern
DD = Data Deficient
NE = Not Evaluated

I = APPENDIX I
II = APPENDIX II
III = APPENDIX III

Figure 7. Rays Catch at (A) Muncar and (B) Brondong, East Java, Indonesia

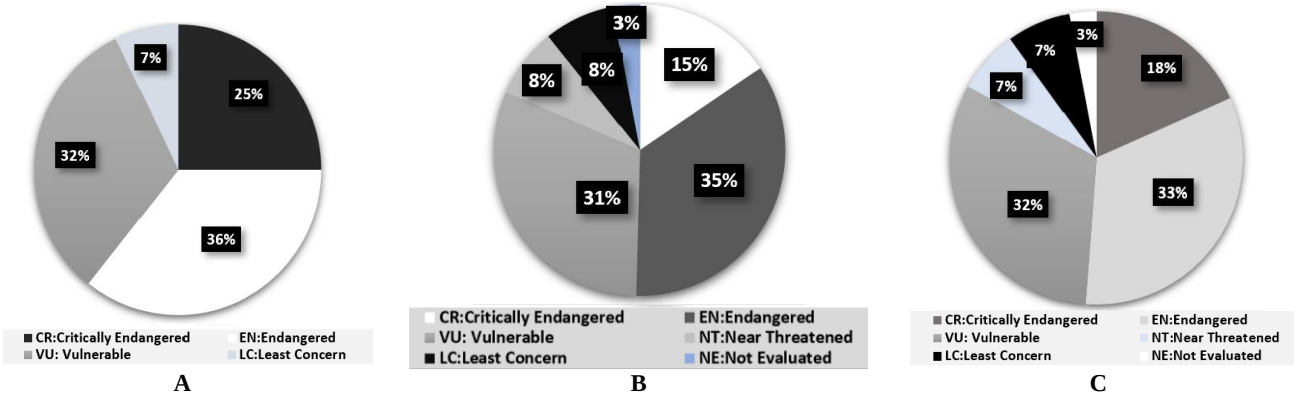


Figure 8. Rays landed at Muncar and Brondong, East Java, Indonesia and both landing areas are regulated by the IUCN

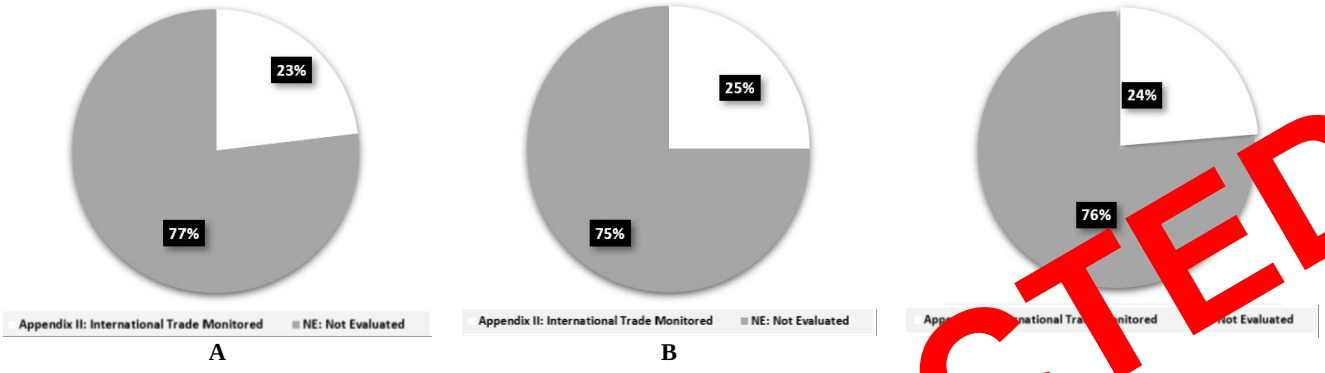


Figure 9. Rays have been caught in Muncar and Brondong, East Java, Indonesia and fall under CITES regulations

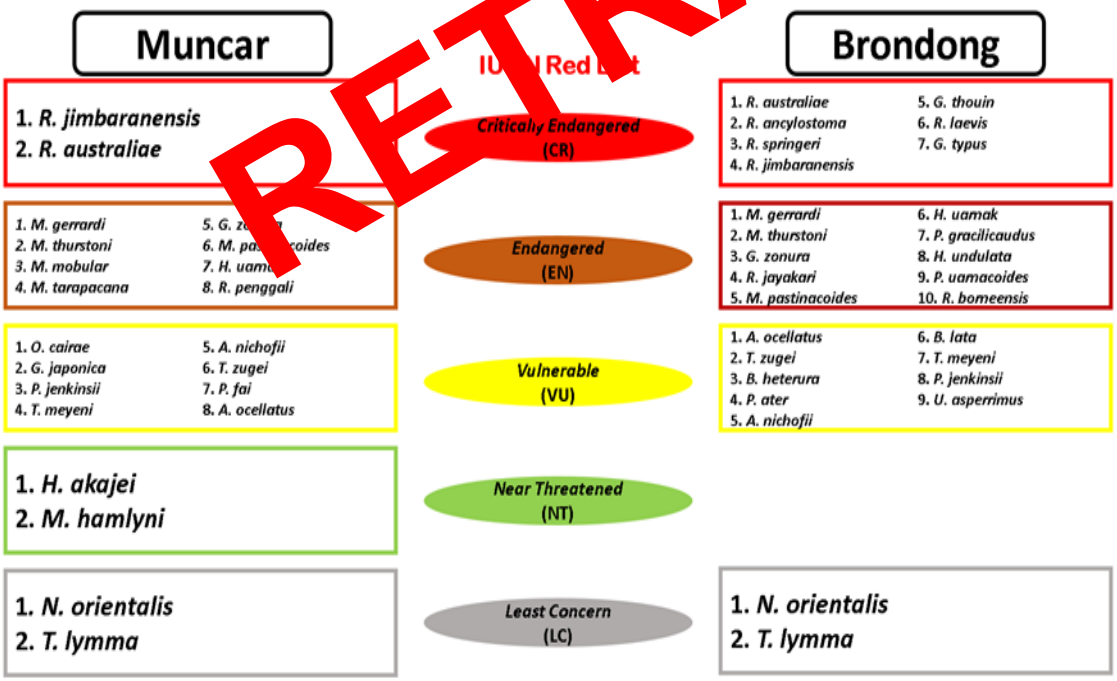


Figure 10. Species list based on the International Union for Conservation of Nature (IUCN) Red List

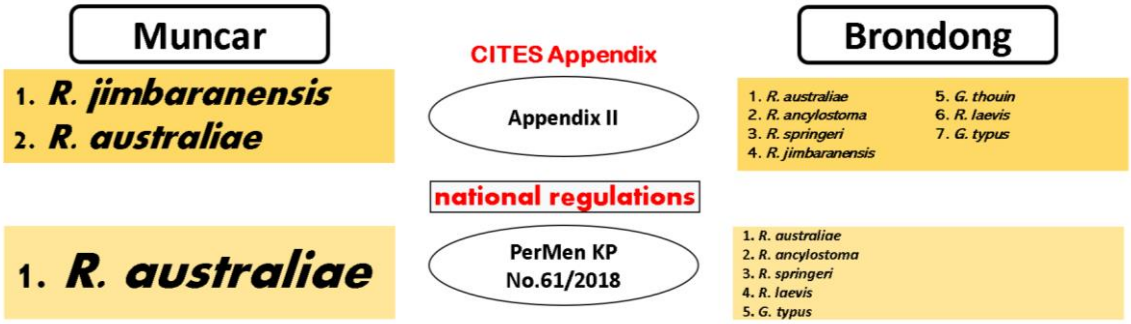


Figure 11. The lists of species based on CITES and national regulations

Discussion

The present study can provide novel insights into national and international policies governing the sustainable management of sharks and rays. Following national and international policies is necessary to manage rays and sharks sustainably in Indonesia. Certain rules are made to guarantee the preservation and wise utilization of certain marine species. Indonesia is a member of the CITES, which promotes the international trade in sharks and rays, among other endangered species. Under its appendices, CITES lists specific ray and shark species and offers limits on their international trade to protect them. CITES decision-making procedures can be informed by the useful information on the conservation status of species included on the Red List. The Minister of Marine Affairs and Fisheries issued Indonesian Government Regulation No. 61 of 2018 on the Utilization of Protected Fish Species and/or Fish Species Listed in the CITES Appendices (Ministry of Marine Affairs and Fisheries 2018a). Shark and ray extinction status and vulnerability are detailed in this list. It may be applied to prioritize trade restrictions, sustainability protection, and conservation initiatives. Also, the species concerned with CITES and IUCN are included in the list.

Identifying the endangered species allows for the implementation of careful management strategies. CITES serves as an additional instrument to support fisheries management (Vincent et al. 2014). CITES presently recommends an international trade that poses difficulties for law enforcement and the responsibilities of national fishing authorities. However, it is argued that CITES has limitations in effectively managing the trade of species from southern countries due to socioeconomic differences (Magnuson 2023). For example, endangered hammerheads have been listed in the CITES Appendix II since 2014. However, a researcher recommended a number of specific changes to improve the usability of the CITES Trade Database. These recommendations include the following: (i) combine permit numbers with export and import reports to allow clear identification of overall trade flows; (ii) clearly specify calculation methods for tabulating gross and net trade volumes in the database guidelines; (iii) clearly define terms (form) to avoid possible confusion; (iv) prohibit automatically assigning values to blank fields (Berec et al. 2018).

The National Conservation stated that Muncar has six shark species, *A. pelagicus*, *A. superciliosus*, *S. lewini*, *S. zygaena*, *C. falciformis*, and *I. oxyrinchus*, while Brondong has two species, *S. lewini and C. falciformis*. The Indonesian Marine and Fisheries 18 KEPMEN/KP 201 regulation requires all captured sharks and rays to be released or reported dead, especially *C. falciformis* because it was protected (Ministry of Marine Affairs and Fisheries 2013). In addition, the expulsion of *C. longimanus* and hammerhead sharks (*Sphyrna* sp.) from the territory of the Republic Indonesia is prohibited by PERMEN KP No. 5 of 2018 (Ministry of Marine Affairs and Fisheries 2018b). Protected fish species and/or fish species listed in Appendix to the CITES of Wild Fauna and Flora are regulated by KP Regulation No. 61/2018 (Ministry of Marine Affairs and Fisheries 2018a). The difference in shark catches between Muncar and Brondong is attributed the lack of national regulations providing legal protection for shark fishing in Indonesia, and the lack of data on shark and ray catch, potential diversity, biology, and exploitation rates is a major impediment to shark and ray management in the country. Muncar has been known for its significant fishing activity, including shark fishing, due to its proximity to the sea and the livelihoods of many residents' dependent on fishing (Prasetyo et al. 2021).

The Ministry of Marine Affairs and Fisheries (KKP) monitors shark catches in Indonesia. The permitted species, catch limits, gear limitations, minimum size limits, seasonal closures, data reporting, licensing, and enforcement are some of the typical measures included in the regulations. These regulations may be implemented differently at Muncar and Brondong depending on local factors such as the species composition of sharks, fishing pressure, and socioeconomic considerations. Additionally, local community regulations or customary laws may further govern shark fishing activities in these areas. The catch of sharks landed at the Muncar is currently listed in 6 IUCN categories, while the catch of sharks landed at the Brondong is listed in 4 IUCN categories. On the other hand, there are different conservation values. For example, 12 shark species with VU status are found in Muncar and 10 in Brondong with VU conservation status.

In Muncar and Brondong, many species are listed as CR, EN, VU, and NT. Overexploitation of fish stocks, particularly concerning sharks and rays, poses a significant threat to their sustainability and future availability in trade markets (Bintoro et al. 2021; Lelono et al. 2021a,b; Lelono et al. 2023; Ramadhani et al. 2023). The lucrative market demand for shark products, including meat, fins, and liver oil, is a driving force behind their overexploitation, exacerbating the issue (Camhi et al. 2007; Cardeñosa 2019). Approximately one-third of chondrichthyan species face the imminent risk of extinction due to unsustainable fishing techniques, predominantly driven by market demands. Efficiently managing international trade restrictions is essential for conserving coastal chondrichthyans, as their exploitation frequently originates from export markets. Regulation and control of the trade and circulation of these species are imperative for their conservation. Government intervention is essential to address the trade dynamics concerning sharks and rays, ensuring sustainable practices. CITES acknowledges the socioeconomic dimensions of wildlife trade. Their conservation strategies often prioritize wildlife over development. A more balanced approach, integrating trade and conservation considerations, is necessary for long-term sustainability (Gomar and Stringer 2011).

Muncar is home to 29 shark species, while Brondong houses 22 species. Dominant shark catches in Muncar include species like *C. falciformis*, *C. brevipinna*, *A. pelagicus*, and *A. superciliosus*. In Brondong VAT, dominant catches include *S. lewini*, *C. punctatum*, *C. sealei*, and *C. falciformis*. Stingray species are also diverse, with 22 species identified in Muncar and 28 species in Brondong. Dominant stingray species in Muncar include *M. mobular* and *N. orientalis*, while in Brondong, species like *R. australiae* and *M. gerrardi* are dominant.

Sharks in Muncar face significant concerns with a mix of CR, EN, VU, and NT conservation status. Brondong also has conservation challenges, with species listed as CR, EN, VU, and NT conservation status. Stingrays at Brondong potentially face a higher risk of extinction than those at Muncar, with more species falling into threatened categories. The trade status of both sharks and stingrays in Brondong suggests a need for conservation measures, as some species are listed under CITES Appendix II, indicating they are threatened or near threatened. Both locations lack specific regulations for many shark species, contributing to their high utilization. Some shark species are regulated nationally, but overall, comprehensive regulation is lacking. Stingray species also face challenges in terms of regulation and trade, with potentially higher risks in Brondong VAT. Their high market value drives the enormous demand for sharks and stingrays. The absence of precise laws worsens the exploitation of these species. Thus, this suggests an urgent need for comprehensive management strategies.

In conclusion, both Muncar and Brondong host diverse populations of sharks and rays, and they face significant conservation challenges due to exploitation and inadequate regulation. Conservation efforts should focus on implementing stricter regulations, monitoring trade, and protecting habitats to ensure the sustainability of these species.

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