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IDENTIFICATION OF ACTORS AND MARKETING MARGINS OF PROTECTED FRESHWATER STINGRAYS IN MUSI RIVER, SOUTH SUMATERA

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ABSTRACT

The Musi River in Palembang, South Sumatra-Indonesia, serves as the habitat for three protected freshwater stingray species: the marbled whipray (Fluvitrygon oxyrhynchus), the white-edge whipray (Fluvitrygon signifier), and the giant freshwater whipray (Urogymnus polylepis). All three species are categorized as endangered on the IUCN Red List and are listed under Appendix II of CITES. However, communities along the Musi River continue to trade freshwater stingrays freely in local markets. This research aims to identify the economic potential of the freshwater stingray trade, which is suspected to drive illegal capture, by analyzing its supply chain and estimating its marketing margins. Descriptive analysis and marketing margin analysis were employed to address the research objectives. The findings indicate that the freshwater stingray trade in the Musi River involves a short supply chain and covers a wide range of capture areas. Positive marketing margins ranging from IDR 17,000 to IDR 60,000 per kilogram for the white-edge whipray and the giant freshwater whipray, and up to IDR 200,000 per individual for the marbled whipray, provide empirical evidence that freshwater stingrays contribute to the income of the market actors, thereby potentially encouraging the trade of protected species and potentially driving illegal trade.

Keywords: *Conservation, illegal trade, ornamental fish, protected species, wildlife trafficking*

INTRODUCTION

The Musi River in Palembang, South Sumatra (Indonesia), a tropical river, provides a suitable habitat for reproducing various freshwater stingray species (Kinakesti and Wahyudewantoro, 2017). The Musi River is home to at least 14 freshwater stingray species, with three species (see Figure 1) falling under protected wildlife, namely the marbled whipray (*Fluvitrygon oxyrhynchus*), the white-edge whipray (*Fluvitrygon signifier*), and the giant freshwater whipray (*Urogymnus polylepis*) (Iqbal *et al.* 2018). However, communities along the Musi River continue to trade freshwater stingrays freely in the local market.

Freshwater stingrays in the Musi River serve as one of the income sources for small-scale fishermen (Wijayanti *et al.* 2018). Every part of the freshwater stingray's body can be consumed (Isyhadu *et al.* 2021). Freshwater stingrays are also widely used as ornamental fish or raw material for leather crafts (Fahmi *et al.* 2008). These stingray species contribute significantly to the overall fishery sector in Indonesia (Wijayanti *et al.* 2018).

Despite being a source of income for small-scale fishermen, freshwater stingrays face sustainability threats from environmental, social, and economic perspectives (Carlson *et al.* 2019). Environmental hazards include pollution of the Musi River by industrial waste, which can lead to contamination and even -

(a) (b) (c)

Figure 1 Protected Freshwater Stingrays in Musi River (a) Marbled whip ray; (b) White-edge whip ray; (c) Giant freshwater whip ray. Source: Google Image (2022).

death (Prasetio *et al.* 2016). Environmental degradation resulting from human activities can pose a threat to the decline of freshwater stingray populations (Septiani *et al.* 2024).

Additionally, public awareness about protecting these species from extinction remains low due to the limited information received by small-scale fishermen regarding the conservation of freshwater stingrays (Ilham and Marasabessy 2021). The high economic value of freshwater stingrays also leads to overfishing, with catch levels exceeding the maximum capacity, thereby putting pressure on freshwater stingray populations (Haryono *et al.* 2020).

Freshwater stingray trade can also result from accidental capture or bycatch (Septiani *et al.* 2024). Dharmadi *et al.* (2016) estimated that approximately 72% of freshwater stingray captures in Indonesia occur as bycatch. This is confirmed by information from small-scale fishermen around the Musi River, stating that freshwater stingrays are inadvertently caught in the lower parts of nets or traps set to catch other fish.

On the other hand, freshwater stingrays exhibit slow growth, sexual maturity, and relatively long reproductive processes, which means that the population growth of freshwater stingrays is slow (Fahmi *et al.* 2008). Field observations show that most captured freshwater stingrays are small, typically weighing around 1-2 kg each, and nearly all of them are females, which can hinder the regeneration of freshwater stingrays. Freshwater stingrays are becoming increasingly scarce, leading to a decline in their catch yearly (Dulvy *et al.* 2017). The decreasing freshwater stingray population is suspected to indicate practices that endanger their sustainability (Iqbal *et al.* 2018).

Regulations regarding the conservation and trade of freshwater stingrays on a global scale are established by the International Union for Conservation of Nature (IUCN) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). The IUCN has categorized the three freshwater stingray species in the Musi River, namely the marbled whipray, the white-edge whipray, and the giant freshwater whipray, as endangered (EN). These three species are also listed under CITES Appendix II. The Indonesian government has also issued regulations for completely protecting freshwater stingrays through the Minister of Marine Affairs and Fisheries Decree (Kepmen-KP) of the Republic of Indonesia Number 1 of 2021 concerning Protected Fish Species.

The Kepmen-KP states that freshwater stingrays are one of the protected fish species at all stages of their life cycle, body parts, and derivatives. All forms of freshwater stingray utilization, such as (1) research and development, (2) breeding, (3) trade, (4) aquaria, (5) exchange, or (6) maintenance for enjoyment, require written permission from the Minister of Marine Affairs and Fisheries in the form of a Fish Utilization Permit Letter (Surat Izin Pemanfaatan Jenis Ikan or SIPJI). Specifically for trade, SIPJI is mandatory for domestic trade participants and legal entities engaged in foreign trade. Therefore, any activities related to freshwater stingray trade, including collection, processing, packaging, inter-province transportation, export, import, and re-export without SIPJI, are considered illegal or in violation of the law. Offenders may face penalties of up to IDR 100 million in fines and a maximum prison sentence of 5 years.

However, these regulations have not been effective in governing the capture by small-scale fishermen because, to date, the communities around the Musi River continue to engage in trade freely in the local market. Similar circumstances were also found by Ilham and Marasabessy (2021) in Sorong City, West Papua Province, where small-scale fishermen were still trading three critically endangered conservation status and CITES Appendix II-listed stingray species.

The sustainability of freshwater stingrays in the Musi River is closely linked to the supply chain and marketing margins obtained by the marketing actors involved. The supply chain of freshwater stingrays needs to be identified to determine capture locations and the trade of freshwater stingrays for conservation area designation. Information about marketing margins is essential to demonstrate freshwater stingrays' contribution or role in the community's well-being. This information can be used to formulate sustainable freshwater stingray management strategies by the government.

Therefore, this research aims to identify the economic potential of the freshwater stingray trade that encourages illegal capture. This general aim can be achieved by addressing two specific objectives: (1) analyzing the freshwater stingray supply chain in the Musi River, Palembang, South Sumatra, and (2) estimating the marketing margins of freshwater stingrays in the Musi River, Palembang, South Sumatra.

METHODS

This study was conducted between February and May 2023 in the Musi River region, with a primary focus on Palembang City, South Sumatra (Indonesia). The study area was selected based on pre-survey interviews with freshwater stingray distributors, which identified this region as a critical location for capturing protected freshwater stingrays. The research also incorporated online data collection via platforms like Zoom Meeting.

To achieve the research objectives, field observations and structured surveys using questionnaires were employed. The data collection targeted specific aspects: identifying the actors involved in the supply chain, marketing locations, and capture sites to address the first research objective, as well as gathering data on the number of captures, selling prices, and buying prices of freshwater stingrays to address the second research objective.

The analysis of the supply chain was carried out using a qualitative descriptive approach. This method involved mapping the supply chain structure, identifying the roles of key actors, and analyzing the flow of goods, information, and financial transactions along the chain. The marketing margin was analyzed by calculating the price differences at each level of the supply chain to determine the distribution of added value among actors.

We utilized the snowball sampling method to select participants, including fishermen, traders, and other stakeholders involved in the freshwater stingray trade. This method began by identifying initial respondents who met predefined criteria, and these respondents recommended additional individuals who fit the criteria, continuing the process until all necessary data were obtained. The selection criteria for participants included individuals with experience in transactions involving freshwater stingrays, small-scale fishermen operating vessels under five gross tons, and fishermen who consider freshwater stingrays as their primary or secondary catch.

Data on respondents who had captured and sold freshwater stingrays were obtained with assistance from fisheries extension officers in the Seberang Ulu II, Plaju, Kertapati, and Gandus sub-districts. In total, 44 small-scale fishermen were interviewed, but 6 had not sold any freshwater stingrays in the past month, leaving 38 respondents for analysis. The data collection process also gathered information on marketing locations and the specific roles of fishermen, traders, and distributors. Marketing locations for consumable freshwater stingrays were identified as Kalangan Musi II Market, Simpang Sungki Market, Kertapati Market, Cinde Market, and 16 Ilir Market, which were supplied by three village-level collectors. Meanwhile, non-consumable freshwater stingrays were sold to a single distributor located at Tangga Buntung Market.

Descriptive Analysis

We employed descriptive analysis to describe the situation, actors involved, or issues within the freshwater stingray supply chain in the Musi River, Palembang, South Sumatra. We use this method to categorize the types of freshwater stingray supply chains suspected to have distinctive characteristics. Every supply chain may have different motives, objectives, operational systems, cost structures, and actors (echelons) than other types, making this information valuable.

Identifying types within the freshwater stingray supply chain in the Musi River followed the model formulated by Snyder and Shen (2019). These supply chains were described by the relationships between marketing actors (echelons) at each supply chain phase (node) (Sanders, 2012). However, in line with the dynamic nature of supply chains, the nodes within each type of freshwater stingray supply chain might be more complex or more straightforward based on field conditions. The

number of echelons involved can also vary between freshwater stingray supply chains.

Marketing Margin

The analysis of marketing margins aimed to estimate the price difference received by sellers compared to the price paid by consumers at each node. This method estimated the value received by each echelon in the freshwater stingray supply chain in the Musi River, which was expected to vary. Each marketing margin an echelon receives would differ at each node and location in the supply chain, making this information essential. The value of marketing margins received by echelons was obtained by using Equation 1, where Ps represents the selling price at each echelon, and Pb represents the buying price at each echelon (Tomek and Kaiser, 2014):

$$M = Ps - Pb \quad (1)$$

A share margin determines the price difference between what sellers receive and what buyers pay in the form of a percentage. Information about this share margin is employed to understand the type of supply chain that can provide the most significant margin for an echelon. The share margin can be calculated by estimating the percentage of the selling price at one echelon (Ps) relative to the buying price at the next echelon (Pb). Therefore, Equation (2) expresses the share margin (Tomek and Kaiser 2014):

$$S = (Ps / Pb) * 100\% \quad (2)$$

RESULTS

Marketing Supply Chain of Protected Freshwater Stingray in the Musi River, Palembang City, South Sumatera

Generally, the marketing actors (echelons) of freshwater stingrays that can be identified consist of fishermen, village-level collectors, and distributors (see Table 1), making the marketing supply chain of freshwater stingrays relatively short. According to the survey results, there were 43 respondents among the marketing actors, with a breakdown of 38 fishermen (88.4%), four village-level collectors (9.3%), and one distributor (2.3%). Most respondents were male (97%) and fell within the age range of 41–50 years (34.9%).

In the supply chain of freshwater stingray consumption marketing, fishermen sell freshwater stingrays and other catches to village-level collectors (see Figure 2) daily in the morning, so fishermen rarely engage in storage processes. The village-level collectors purchase all the catches from the fishermen on that day (including freshwater stingrays and other fish species), resulting in spontaneous purchasing without prior orders. According to fishermen, this is related to the perishable nature of the fish, requiring special tools like cool boxes to extend the shelf life of the fish. However, due to financial constraints, only a portion of the fishermen (52.6%) and village-level collectors (25%) own such equipment. In addition, fishermen and village-level collectors conduct cash transactions, transferring the goods (freshwater stingrays) to the collectors once they receive a cash payment.

In contrast to white-edge whiprays and giant freshwater whiprays, which are utilized for consumption, marbled whiprays (Fluvitrygon oxyrhynchus) are sold live for non-consumption purposes as ornamental fish. The marketing supply chain for non-consumption freshwater stingrays also has a short supply chain with few marketing actors involved, including fishermen, distributors, and consumers (see Figure 3). This reinforces the findings of Gonzales-Plasus *et al.* (2022), which showed that the marketing supply chain for non-consumption fish consists of fishermen, sellers or distributors, and consumers. According to distributors, consumers of freshwater stingrays for ornamental fish purposes come from urban areas (Jabodetabek). This aligns with previous research results, which stated that the marketing supply chain for non-consumption fish (ornamental fish) has locations of marketing actors with broader and more diverse reach (Ambali *et al.* 2020).

Marketing Margin of Protected Freshwater Stingray in The Musi River, Palembang City, South Sumatera (Indonesia)

The selling price of freshwater stingrays (Ps) varies depending on their species. White-edge whiprays are priced at around IDR 10,000 – IDR 20,000 at the fishermen level and about IDR 30,000 per kilogram at the village collector level. Additionally, the giant freshwater whiprays are sold at IDR 15,000 per kilogram at the fishermen's level and IDR 40,000 per kilogram at the village collector level. Furthermore, giant freshwater whiprays processed into salted fish are priced at IDR 30,000 per kilogram at the fishermen's level and IDR 90,000 per kilogram at the village collector level. Meanwhile, the marbled whipray species has a relatively high selling price compared to other species, IDR 40,000–IDR 50,000 per individual at the fishermen level and IDR 250,000–IDR 300,000 per individual at the distributor level.

This study did not consider marketing costs or the profits obtained by each marketing actor due to field conditions, so the marketing margin is estimated based on the price difference between the selling price (Ps) and the buying price (Pb). The selling price of freshwater stingrays at the village collector or distributor level can serve as the buying price at the consumer level (Pb) because these marketing actors sell freshwater stingrays directly to consumers. The price values provided in this assessment represent the mean values from the price ranges reported by the involved actors.

Based on the analysis results (see Table 2), the highest marketing margin for freshwater stingrays in Sungai Musi is associated with the marketing channel for the marbled whipray species (fishermen > distributor > consumers), as this channel generates the highest margin value compared to other media (IDR 205,000). This finding is supported by previous research, which states that the marketing margin for non-consumable or ornamental fish is higher due to the product's higher selling price than consumable fish (Muyot *et al.* 2019). The high marketing margin for the marbled whipray is attributed to the high price received by the distributor (share margin 72.00%), indicating an unequal distribution of earnings among marketing actors. This is consistent with the findings of Suryadana *et al.* (2021) and Soumya & Ramachandran (2011), which suggest that the highest share of revenues from the marketing chain of non-consumable fish, such as ornamental fish, is usually obtained by retailers, in this case, the distributor.

Table 1 Marketing Actors (Echelons) of Protected Freshwater Stingrays in the Musi River (South Sumatera, Indonesia)

Marketing Actors (Echelon)	**Characteristics**	**Description**
Fishermen	Spending > 80% of productive time on fishing	Actors who capture freshwater stingrays and other types of fish for profit possess a knowledge base and experience in identifying various fish species.
Village-level Collector (*Lorong*)	Spending > 80% of productive time on fish trading (buying and selling)	Actors who purchase a variety of fish types in large quantities from fishermen and sell them to consumers, either in their local areas or at the nearest district markets, to make a profit.
Distributor	Spending > 80% of productive time on fish distribution	Actors who directly distribute freshwater stingrays as ornamental fish to consumers.

Source: Modified from Gonzales-Plasus *et al.* (2022)

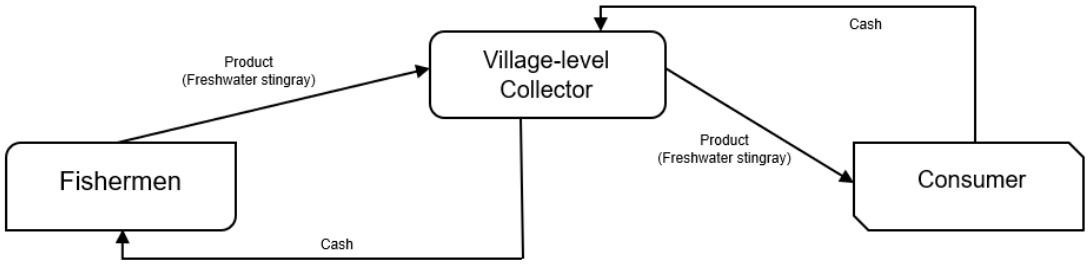


Figure 2 Protected Freshwater Stingray Consumption Supply Chain in the Musi River (South Sumatera, Indonesia). Source: Primary data, processed (2023)

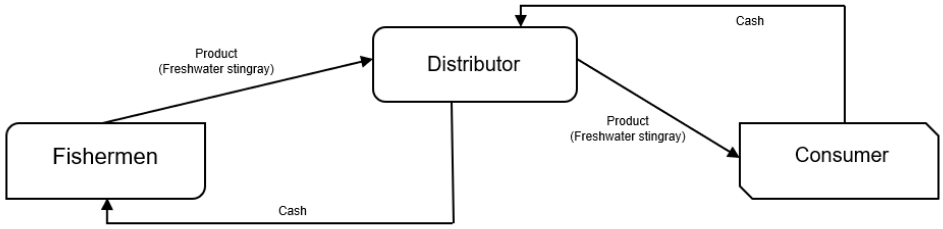


Figure 3 Supply Chain for Non-Consumption Protected Freshwater Stingrays in the Musi River (South Sumatera, Indonesia)
Source: Primary data, processed (2023)

Table 2 Results of Marketing Margin and Share Margin Calculation for Protected Freshwater Stingrays in the Musi River, Palembang City, South Sumatera (Indonesia)

No.	Marketing Actors (Echelon)	Buying Price (Pb) (IDR)	Selling Price (Ps) (IDR)	Margin (M) (IDR)	Share Margin (S) (%)
		(1)	(2)	(3) = (Ps2-Ps1)	(4) = (Ps1/Ps2) * 100%
Marbled Whipray (*Fluvytrigon oxyrhynchus*)					
1	Fishermen		45,000	205,000	18.00
2	Distributor	45,000	250,000		
White-edge Whipray (*Fluvytrigon signifier*)					
1	Fishermen		12,595	17,405	41.98
2	Village-level collector	12,595	30,000		
Giant Freshwater Whipray (*Urogymnus polylepis*)					
Channel I (Frozen-cut form)					
1	Fishermen		15,000	35,000	37.50
2	Village-level collector	15,000	40,000		
Channel II (Salted-cut form)					
1	Fishermen		30,000	60,000	33.33
2	Village-level collector	30,000	90,000		

Source: Primary data, processed (2023)

* The unit of marketing margin value is IDR /individual for the marbled whipray species and IDR /kg for the white-edge whipray and giant freshwater whipray species.

DISCUSSION

Marketing Supply Chain of Protected Freshwater Stingray in the Musi River, Palembang City, South Sumatera (Indonesia)

Protected Freshwater Stingray Consumption Marketing Supply Chain

Freshwater stingrays (and other fish species) can be sold for consumption between fishermen and village-level collectors in their respective villages or district markets. Village-level collectors will not purchase fish from fishermen they do not know, so they only buy catches from fishermen residing in the same town. According to the village-level collectors, this is a form of cooperation and solidarity within the community. Furthermore, most village-level collectors (75%) are female, often mothers, wives, or relatives of the fishermen, and engaging in trade at the market or in their villages is a way to contribute to the household income of the fishermen.

After purchasing freshwater stingrays from fishermen, village-level collectors sell the fish to consumers at district markets on the same day. Based on field identification and confirmation from fishermen, the species of freshwater stingrays often sold as whole for consumption are the white-edge whip rays (*Fluvitrygon signifier*) and the starry nose stingrays (*Pastinachus stellurostris*) (see table

Table 3 Marketing Actors and Protected Freshwater Stingray Species Sold in the Musi River (Indonesia)

Species	Protection Status (Kepmen-KP/1/2021)	Marketing Actors (Echelon)		
		Fishermen	*Lorong*	Distributor
Marbled whip ray (*Fluvitrygon oxyrhynchus*)	Fully protected	4	0	1
White-edge whip ray (*Fluvitrygon signifier*)	Fully protected	35	1	0
Giant freshwater whip ray (*Urogymnus polylepis*)	Fully protected	3	2	0
Starry nose stingray (*Pastinachus stellurostris*)	Unprotected	38	1	0

Source: Primary data, processed (2023)

(a) (b)

Figure 4 Species of Protected Freshwater Stingrays Consumed in the Musi River (Indonesia): (a) White-edge whip ray; (b) Starry nose stingray. Source: Author's documentation (2023)

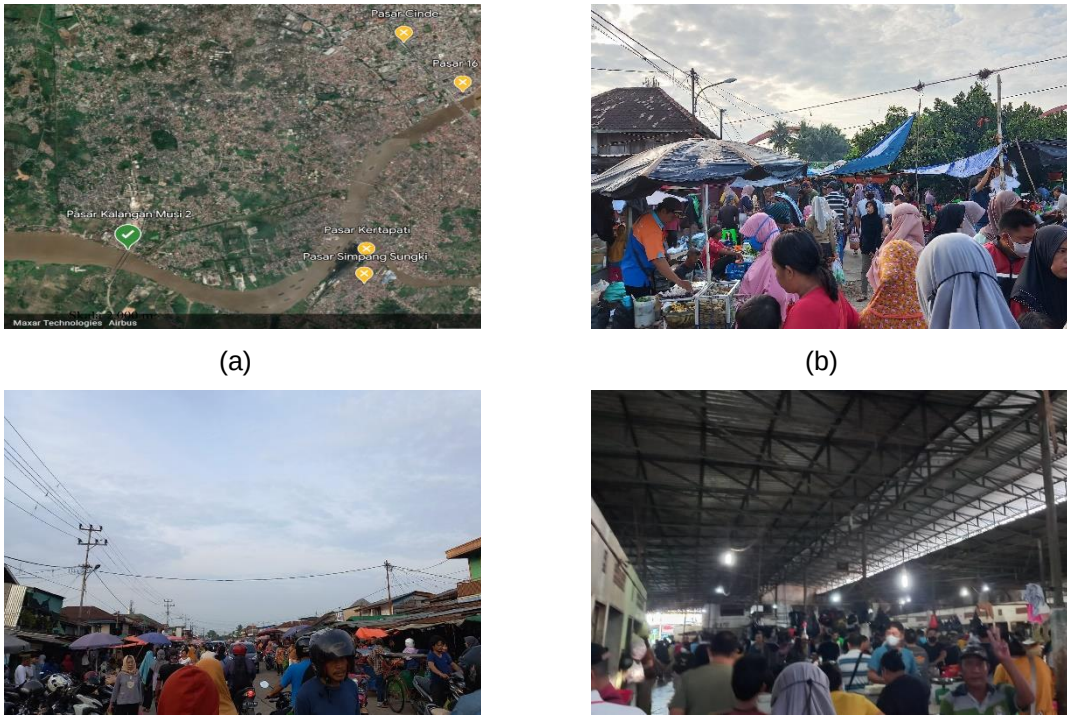
3 and Figure 4). Consequently, the supply chain of freshwater stingray consumption from fishermen (upstream) to consumers (downstream) takes place on the same day without ordering and storage processes. Based on field surveys, this occurs because freshwater stingrays are not the primary catch (caught accidentally as bycatch), and selling them is a way for marketing actors to avoid losses caused by storing the products (fish) for too long.

Similar to the white-edge whipray species (fully protected) and the starry nose stingray, giant freshwater whiprays (*Urogymnus polylepis*) are often caught unintentionally (bycatch) and sold to avoid losses due to their large size (over 30 kg per individual). Giant rays are usually cut into pieces and placed in a cool box to prevent losses from unsold products within a day. Additionally, fishermen frequently process giant rays into salted fish form (see Figure 5) before selling them to village-level collectors. According to the fishermen, the ice storage process can extend the product's shelf life for up to two to three days, while the salting process can extend the product's shelf life for up to two months.

The marketing locations for freshwater stingrays for consumption, according to fishermen, include Pasar Kalangan Musi II, Pasar Simpang Sungki, Pasar Kertapati, Pasar Cinde, and Pasar 16 Ilir (see Figure 6). According to the fishermen, these markets often serve as trade locations for fish consumption every morning between fishermen and village-level collectors. However, based on field observations, only one call, Pasar Kalangan Musi II, had village-level collectors (4 individuals) selling freshwater stingrays. No village-level collectors were found in other locations and had never been present selling freshwater stingrays. According to one fisheries extension officer's statement, the village-level collectors at these market locations might already know about the full protection regulations for freshwater stingrays. Furthermore, according to fishermen, it is also possible that village-level collectors at these market locations are avoiding sanctions for violating the complete protection regulations for freshwater stingrays because there have been cases of collectors being caught for selling freshwater stingrays.

(a) (b)

Figure 5 Giant Freshwater Whipray for Consumption in the Musi River (Indonesia) (a) Whole captured form; (b) Processed salted fillet form. Source: Author's documentation (2023)



(a) (b)

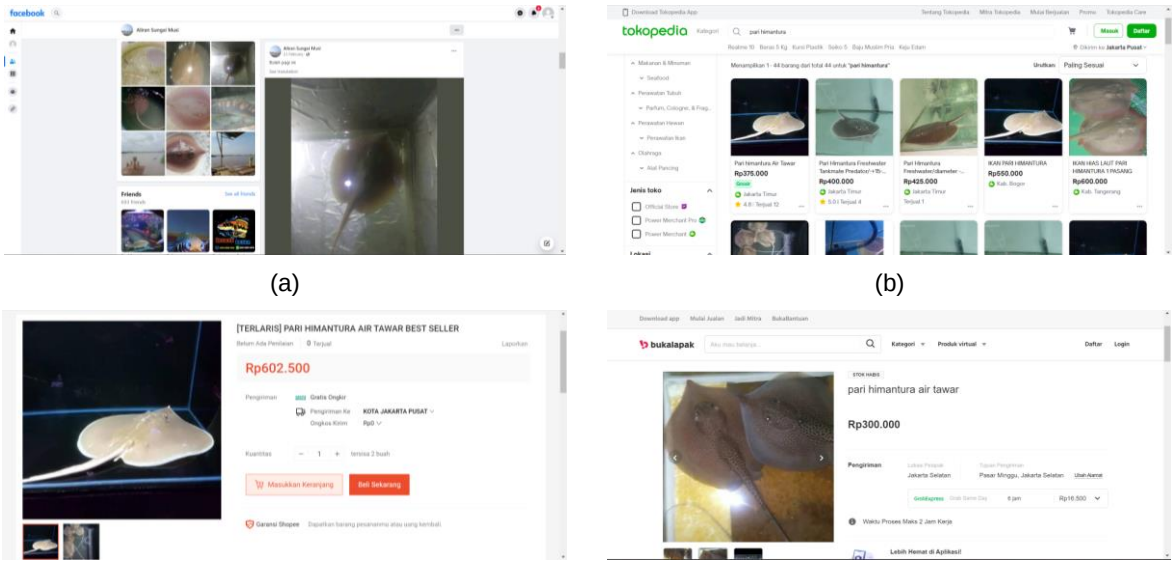
(c) (d)

Figure 6 Marketing Locations for Protected Freshwater Stingrays in Palembang City (Indonesia) (a) Location map; (b) Pasar Kalangan Musi II; (c) Pasar Simpang Sungki; (d) Pasar 16 Ilir. Source: Author's documentation (2023)

The marketing supply chain for the consumption of freshwater stingrays, whether white-edge whipray or giant freshwater whipray species, is short. This is in contrast to the study by Setyaningrum *et al*. (2022) and Nasution & Alda (2023), which found that the marketing supply chain for fish consumption tends to be long and involves many marketing actors. Additionally, unlike the marketing supply chain for fish consumption in general, which has various types of marketing channels (Indriyani *et al*. 2022), the marketing supply chain for freshwater stingrays for consumption only has one kind of marketing channel (from fishermen to village-level collectors, then consumers). According to the fishermen's explanations, this can occur because freshwater stingrays are low-value market fish, which makes them less attractive for fishermen and village-level collectors to trade.

Protected Freshwater Stingray Non-Consumption Marketing Supply Chain

Field observations indicate that the marketing supply chain for non-consumption



(a) (b)

(c) (d)

Figure 7 Non-Consumable Protected Freshwater Stingrays in Various Online Media (a) Marbled whip ray on Facebook; (b) Marbled whip ray on Tokopedia; (c) Marbled whip ray on Shopee; (d) Marbled whip ray on Bukalapak. Source: Author's documentation (2023)

freshwater stingrays (ornamental fish) differs from that of consumable fish in terms of marketing function. According to statements from fishermen, marbled whiprays are captured based on orders (by request) from distributors in a live and unblemished form, and they are required to be small (under 1 kg per individual). Additionally, distributors offer a higher selling price to fishermen (around IDR 50,000 per individual) than freshwater stingrays' selling price for consumption (approximately IDR 15,000 per kg). To increase their income, fishermen catch marbled whiprays through fishing to fulfill the distributor's orders. This finding aligns with the study by Ariffien *et al*. (2024), which indicates that the supply chain can be an alternative to enhance fishermen's income.

Unlike freshwater stingrays for consumption, which are marketed directly through stalls in traditional markets, non-consumption freshwater stingrays are sold to consumers online through social media and online marketplaces. Several stores selling leopard ray freshwater stingrays in some online marketplaces can be found (see Figure 7).

In addition to differences in the marketing function, the supply chain of freshwater stingrays for consumption and non-consumption also varies regarding information flow. Fishermen do not receive information about the subsequent supply chain for selling live marbled whiprays, including the actors, locations, and marketing purposes, leading to information asymmetry between fishermen and distributors. Based on field findings, fishermen state that the live marbled whiprays they sell are intended for aquaculture, while distributors say the fish is sold as ornamental. Furthermore, the supply chain for marketing freshwater stingrays for consumption and non-consumption also differs in terms of knowledge related to complete protection. Most sellers of freshwater stingrays for consumption (80% of village-level collectors) are unaware of the complete protection of freshwater stingrays. In comparison, sellers of freshwater stingrays for non-consumption (100% distributors) are aware of the complete protection of freshwater stingrays.

The supply chain for freshwater stingrays also exhibits diversity in capture areas. Based on species, the white-edge whipray species (yellow indicators) can be found in the middle to downstream areas of the Musi River. In contrast, the giant freshwater whipray species (orange arrows) can only be found in the middle regions of the Musi River (see Figure 8). These findings are supported by Nurhayati *et al*. (2015), who stated that white-edge whiprays are more tolerant to high salinity, allowing them to thrive in both the middle river (freshwater ecosystem) and the downstream river (brackish water ecosystem). In contrast, giant freshwater whiprays are obligate freshwater species and thus can only survive in the middle river area. Compared to the giant freshwater whipray species, the marbled

whipray species (brown indicator) can only be found downstream of the Musi River (see Figure 8). This supports the findings of Iqbal *et al*. (2018), which stated that leopard stingrays are one of the species that can thrive in the downstream river area (brackish water/estuarine ecosystem) to coastal beach areas (saltwater/coastal ecosystem). According to experts, there is a possibility that marbled whiprays are marine species migrating or spawning in brackish water (downstream river), but further studies are needed to confirm this.

Marketing Margin of Protected Freshwater Stingray in The Musi River, Palembang City, South Sumatera (Indonesia)

According to the marketing margin analysis, the distributor in the non-consumable fish supply chain is the actor who accrues the highest profit from the trade of protected freshwater stingrays. The market's high price of marbled whiprays incentivizes marketing actors to trade these protected species. This aligns with the findings of Mulyati *et al*. (2022) which show that the ornamental fish trade is a potential business because it can create high margins, especially for distributors and exporters. The increased amounts of freshwater stingrays offered for non-consumable purposes may lead to overfishing or excessive capture due to the low population reproduction process caused by the biological characteristics of freshwater stingrays that make it difficult for them to reproduce (Fahmi *et al*. 2008). Therefore, the high prices of freshwater stingrays, especially for the marbled-whip ray species, can jeopardize the sustainability of their populations in the wild.

Furthermore, in the supply chain of protected freshwater stingrays for consumption, village-level collectors emerge as the marketing actors who attain the highest profit compared to the fishermen. Village-level collectors gain the highest profit when selling giant freshwater stingrays in salted-cut form compared to selling them in fresh-cut form. According to them, selling the fish in salted form extends its shelf life and increases its value. According to village-level collectors, local community preference is relatively low for purchasing either giant freshwater whiprays or white-edge whiprays in fresh-cut form due to the soft and slimy texture of the meat. They prefer to buy other local fish, such as belida or patin, for consumption.

The overall positive marketing margin for freshwater stingrays provides empirical evidence that these species contribute to marketing actors' income in their trade. This poses a challenge in implementing the conservation of freshwater stingrays because some of the payment of the community, in this case, the fishermen, village-level collectors, and distributors, will be lost. Therefore, efforts are needed to diversify the lost income from freshwater stingrays, which can encourage a reduction in the supply side of the freshwater stingray trade.

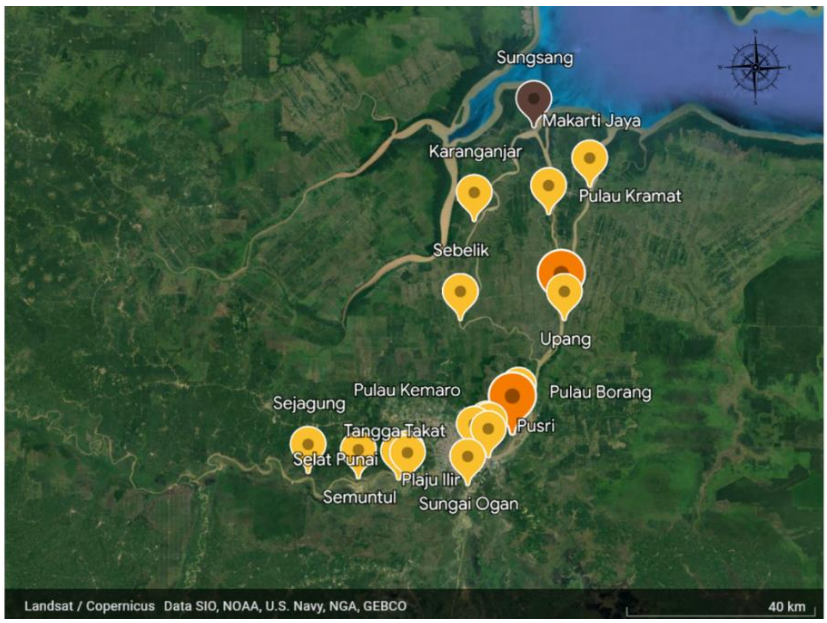


Figure 8 Map of Protected Freshwater Stingray Capture Locations in the Musi River (Indonesia). Source: modified from Google Earth (2023)

CONCLUSION

Based on the results and discussions, the trade of freshwater stingrays in the Musi River, both for consumption and non-consumption purposes, has a short supply chain and encompasses diverse capture areas. The freshwater stingray supply chain involves marketing actors such as fishermen, village-level collectors, distributors, and consumers. The downstream area of the Musi River serves as the capture zone for the marbled whipray, the central part of the Musi River for the capture of giant freshwater whipray, and the entire central to downstream section of the Musi River for the capture of white-edge whipray.

The trade of freshwater stingrays in the Musi River generates high marketing margins for marbled whipray, while margins for white-edge whipray and giant freshwater whipray are lower. The overall positive marketing margins for freshwater stingrays serve as empirical evidence that freshwater stingrays contribute to the marketing actors' income, potentially encouraging illegal trade.

SUGGESTION

The recommendation from this research is for the Indonesian Government, through the Fisheries Department of Palembang City, Fisheries Extension Officers of Palembang City, and BPSPL Padang within the Palembang Work Area, to conduct awareness campaigns regarding the complete protection of freshwater stingrays among fishermen and fish traders in the market (both for consumption and non-consumption purposes) operating in these areas to prevent the illegal capture and illegal trade of freshwater stingrays or those without the proper authorized permit, such as SIPJI. Additionally, the Indonesian Government, through PSDKP Batam in the Palembang Work Area, and local communities through Community Surveillance Groups (Pokmaswas), could collaborate to address the illegal trade of protected freshwater stingrays or those lacking the required authorized permit, such as SIPJI.

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