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Income Analysis of Seasonal Targeted Shark Fishers in Muncar, Banyuwangi, Indonesia

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Abstract. Shark fisheries hold significant economic importance for coastal populations, especially in areas where alternative livelihoods are scarce. In Muncar, East Java, shark fishing has historically contributed to both income generation and food security among local fishers. Nonetheless, rising concerns about overfishing and the subsequent decline of apex predator species underscore urgent sustainability challenges. This study investigates the socio-economic role of shark fisheries within the Muncar fishing community and evaluates the ecological impact of intensive shark harvesting. Data were collected through systematic monitoring of daily shark landings at local markets beginning in December 2019, complemented by in-depth interviews with fishers conducted from October 2023 to October 2024. The research analyzes community dependence on shark fishing and evaluates their economic adaptability amid potential ecological pressures. By integrating socio-economic dynamics with environmental considerations, the study highlights the trade-offs between livelihood sustenance and marine biodiversity preservation. The results are intended to guide the development of sustainable fishery management policies that align conservation efforts with the economic well-being of small-scale fishing communities. Key objectives include examining historical shifts in shark catch trends, identifying the ten most frequently landed shark species, and analyzing income patterns among fishers engaged in shark fisheries.

1 Introduction

Shark fisheries are a key economic asset for numerous coastal communities worldwide, especially in regions with few alternative livelihood options and in developing nations [1]. In Muncar, Banyuwangi, Indonesia, shark fishing has been an essential economic activity for

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many years, supporting the livelihoods of local fishers and their families [2]. However, the growing ecological impacts of these fisheries have become increasingly apparent, raising concerns about their sustainability. Striking a balance between economic dependency and ecological preservation is becoming more challenging, particularly in areas where overfishing and decreasing marine biodiversity threaten both ecosystem health and the long-term viability of livelihoods [3].

As apex predators, sharks are crucial for maintaining the stability of marine ecosystems [4]. The depletion of shark populations can lead to trophic cascades, causing unpredictable changes in the marine food web [5]. The global decline in shark numbers, driven by overfishing and bycatch, has been well-documented, with many species now classified as vulnerable or endangered by the International Union for Conservation of Nature [6]. In Indonesia, home to some of the most biodiverse marine environments, pressure on shark populations has risen sharply in recent decades due to growing local consumption and international demand for shark fins and other products [7].

In Muncar, shark fishing has long been vital for local income and food security. However, recent trends indicate unsustainable practices, such as reduced catch sizes and an increasing number of juvenile sharks being captured, signalling overexploitation of local populations [8]. This decline is troubling as the loss of apex predators can disrupt the entire marine ecosystem, harming other fish species and biodiversity [9]. The socio-economic effects are also significant, with fishers experiencing reduced catches, heightened competition, and the need to adapt to changing environmental conditions and regulations [10].

Muncar, a district in Banyuwangi, Indonesia, has become a major center for shark landings and trade. According to the 2023 data from the local port authority, Muncar saw 13,550 kilograms of shark landings, valued at approximately IDR 259.5 million. These figures emphasize Muncar's central role in the regional shark trade, highlighting its importance to the local economy and fishing industry. This study aims to assess the socio-economic effects of shark fisheries on the local fishing community in Muncar, while also investigating the broader ecological impacts. By analyzing data from local fishers, landings, and market statistics, this research will explore the extent of community dependence on shark fisheries and how this affects economic resilience. Additionally, the study will examine local views on conservation efforts, fishing regulations, and the potential for alternative livelihoods. By merging socio-economic and ecological perspectives, the study seeks to provide a thorough understanding of the trade-offs between economic reliance on shark fisheries and the need to protect marine biodiversity in Muncar.

The findings from this research will offer valuable insights for fisheries management and policy-making in Indonesia, where sustainable fisheries practices are essential for ensuring long-term economic and ecological resilience. Developing strategies that reconcile the economic advantages of shark fisheries with the need to safeguard vulnerable species and ecosystems will be critical for the sustainability of small-scale fishing communities in Muncar and other coastal areas. Therefore, the study's objectives include analyzing the historical trends of Muncar's shark fisheries, identifying the ten most frequently landed shark species, and assessing income patterns among shark fishers.

2 Method

2.1 Study site

Muncar has established itself as a key center for fisheries in East Java, integrating both traditional and industrial fishing practices. This research was conducted at the Brak Fish Market (TPI Brak) and the Muncar Fishing Port in Muncar, East Java, Indonesia, over a period of one year, from October 2023 to October 2024. These sites were selected for their prominence as primary locations for shark landings and trading activities in the region, making them crucial to understanding local fisheries dynamics.

The Brak Fish Market, being one of the largest and most active in the area, serves as a focal point for fishers and traders involved in the shark trade, while the Muncar Fishing Port is an essential point for the unloading, processing, and distribution of shark catches. These venues play a critical role in the region's maritime economy, reflecting both the challenges and opportunities facing the local fishing community. By focusing on these locations, this study aims to gain a comprehensive understanding of the socio-economic and ecological implications of shark fishing in Muncar, contributing valuable insights into the broader context of sustainable fisheries management in the region.

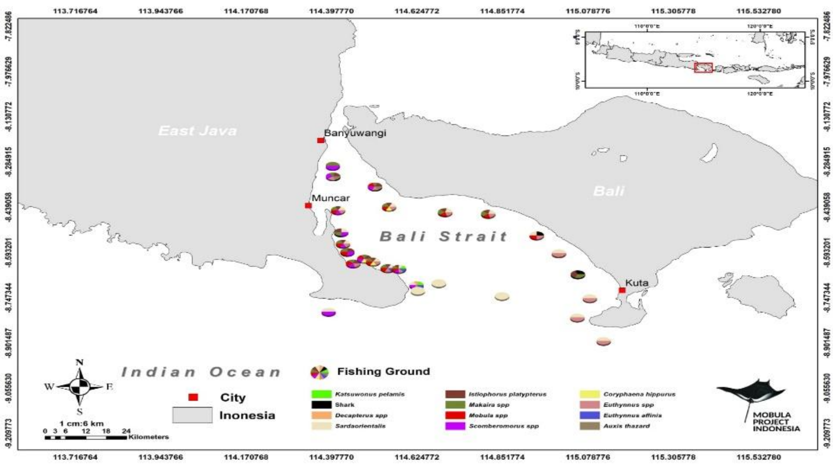

Fig. 1. Map of the fishing ground of Muncar's Fishers.

2.2 Sampling method

Data collection was carried out daily by trained local enumerators at the Muncar shark auction site, operating between 6:00 a.m. and 10:00 a.m., over the course of one year from October 2023 to October 2024. A census approach was employed to ensure comprehensive coverage of all shark landings within the study area. The recorded data included biological parameters such as morphometrics, meristic counts, sex identification, and the maturity stage of claspers.

In addition, catch-related metrics were gathered, including the number of sharks landed, as well as operational fishing characteristics such as fishing date, gear type, and vessel specifications. Enumerators utilized standardized equipment, including weighing scales, measuring boards, plastic mats, and tag identifiers, and documented the information systematically in field logbooks.

Furthermore, interviews were conducted with all 11 captains of shark fishing vessels active in the area, representing a complete sample due to the limited number of such vessels operating locally. These captains were selected because they represent the full population engaged in the seasonal, targeted shark fishery unique to Muncar. The interviews aimed to collect qualitative and quantitative information on the historical development of shark fishing, fishing grounds, gear used, trip duration, vessel types, species composition, trip costs, revenue sharing mechanisms, and market dynamics.

2.3 Data analysis

The data obtained were analysed using descriptive statistics to determine the history of Muncar shark fishers, a list of the top ten sharks landing data, total revenue, total costs and income of the fishers from catching sharks. The proportion the income analysis was calculated using the following equation.

$$\pi = TR - TC \qquad (1)$$

Description:
TR = Total Revenue (IDR)
TC = Total Cost (IDR)

The data was analysed using a combination of tools, including MS Excel, RStudio, and RawGraph.

3 Results and discussion

3.1 History of Shark catch in Muncar

Fisher in Muncar has benefited from Sharks for decades, here is the history of shark fisheries according to an interview with the leader of the fisher community (Figure 2).

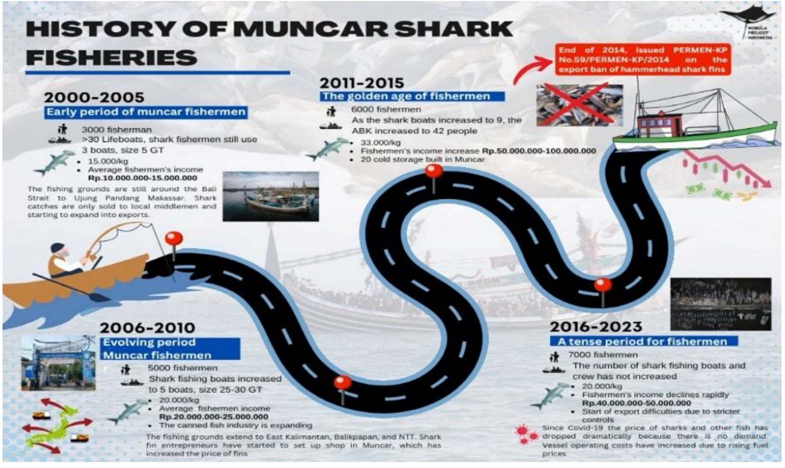

Fig. 2. The History of Muncar Shark Fisheries.

3.1.1 Period 2000–2005 (approximately 3,000 fishers)

During this early phase, shark fishing activities were primarily concentrated in the waters around Ujung Pandang (Makassar). Fishers typically spent around 10 days at sea, with the flexibility to land their catch at the nearest fishing port. Landings were either transported back to Muncar or sold directly to intermediaries offshore. The hammerhead shark (*Sphyrna* spp.) was the dominant species targeted. Vessels during this time were relatively small, averaging 5 Gross Tons (GT), and generated gross incomes between IDR 10,000,000 and 15,000,000 per trip. Shark fins were a key export product, while smoked shark meat was sold to long-established traders. Hammerhead shark was valued at approximately IDR 15,000 per kilogram. Individual fishers earned about IDR 6,000,000, whereas vessel owners and crew members (ABK) received around IDR 1,000,000 each. Skipjack tuna was commonly landed as bycatch. At the time, seven fish-canning facilities, predominantly operated by Chinese-Indonesian businesses, were active. Fishing activities remained unregulated, with no restrictions on fishing gear or licensing. Shark fins were collected weekly or monthly by traders from Surabaya. The local community also continued its cultural tradition of the annual "Pesta Laut" ceremony to express gratitude for the ocean's bounty.

3.1.2 Period 2006–2010 (around 5,000 fishers)

Fishing operations expanded significantly during this period, with fishing grounds reaching East Kalimantan, Balikpapan, Bontang, Mamuju, Ujung Pandang, and East Nusa Tenggara (NTT). Fishing trips now extended to 10–13 days, with hammerhead sharks remaining the primary target. The fleet grew to include five vessels between 25 and 30 GT. Gross earnings rose to IDR 20,000,000–25,000,000 per trip, and shark prices increased to IDR 20,000 per kilogram. Fisher's income rose to approximately IDR 10,000,000, while crew members earned IDR 2,000,000. Skipjack tuna continued as a common bycatch. However, the rise in industrial processing led to greater marine pollution from factory waste. Processing and marketing methods remained unchanged, and shark fins remained the primary export product. Though there were subsidies for fishing gear, they were inconsistently applied, and vessel licensing remained accessible. During this period, a shark fin trader opened an office in Muncar, and the value of fins continued to climb.

3.1.3 Period 2011–2015 (around 6,000 fishers) – peak years until early 2014

Fishing grounds remained consistent with the previous period, though environmental degradation worsened due to increasing pollution from households and canning factory discharge. Trip duration and frequency stayed the same, but the fleet expanded to include seven vessels—five between 25 and 30 GT and two under 10 GT. This period marked the peak of shark fishery productivity in Muncar. Shark prices surged to IDR 33,000 per kilogram, and gross earnings per trip reached IDR 50,000,000–100,000,000. Fisher-owners could earn between IDR 40,000,000 and 50,000,000 per trip, with crew receiving IDR 4,000,000–5,000,000. Alongside existing canneries, about 20 cold storage units were established by entrepreneurs from Madura and Muncar. While traditional processing methods and export markets (China, Australia, Japan, and the U.S.) remained, changes began in 2014 with the establishment of the Marine and Fisheries Resources Surveillance Agency (PSDKP). This introduced stricter administrative procedures for vessel licensing and fisheries documentation.

3.1.4 Period 2016–2023 (Around 7,000 Fishers)

Fishing areas continued to follow previous patterns, though conditions became more challenging due to worsening environmental pollution from domestic and industrial sources. Trip frequency and duration remained unchanged, but operational difficulties increased due to rising fuel and living costs. Shark prices fell back to IDR 20,000 per kilogram—similar to levels from 2006–2010—causing gross earnings to drop to IDR 40,000,000–50,000,000 per trip. Captains earned about IDR 6,000,000, and crew members received around IDR 1,000,000. Canning facilities remained at six, and cold storage infrastructure was unchanged. Shark product processing methods remained traditional, but stricter regulations on shark fin exports were introduced. The COVID-19 pandemic (2020–2022) significantly disrupted fisheries, reducing market prices and limiting export opportunities. Despite these constraints, fishing continued under tight monitoring. Regulations required fishers to report all shark landings, and post-pandemic supervision by the navy remained in effect to protect against overfishing of vulnerable species. Even with these constraints, the local community upheld its cultural tradition by holding the "Pesta Laut" festival annually on October 10. Increasing regulatory pressure, combined with high operating costs, led many fishers to sell their vessels or leave the industry, leaving only a few still engaged in shark fishing.

3.2 Top ten of Shark landing in Muncar (2023-2024)

The status of Sharks that landed in Muncar was vulnerable, near threatened, endangered, least concerned, and critically endangered based on the ICUN red list (Table 1).

Table 1. Species and status in IUCN red list in 2024 (https://www.iucnredlist.org).

Name of Species	Status (IUCN Red List)
Carcharhinus brevipinna	Vulnerable
Carcharhinus falciformis	Vulnerable
Carcharhinus melanopterus	Vulnerable
Galeocerdo cuvier	Near Threatened
Gymnura zonura	Endangered
Mobula thurstoni	Endangered
Neotrygon orientalis	Least Concern
Rhinobatos jimbaranensis	Critically Endangered
Sphyrna lewini	Critically Endangered
Taeniura lymma	Least Concern

Source: Mobula Project Indonesia

The reported landing data from Muncar in 2024 aligns with trends seen for several vulnerable and critically endangered shark species. In particular, *Carcharhinus brevipinna* (spinner shark) is classified as vulnerable [6], while *Rhinobatus jimbaranensis* (Jimbaran guitarfish) and *Sphyrna lewini* (scalloped hammerhead) are considered critically endangered according to the IUCN Red List. Despite regulations to protect these critically endangered species, enforcement remains a challenge, with fishers continuing to catch them due to economic dependencies and insufficient monitoring, as documented by recent studies and conservation organization. Despite their protective status, the ongoing fishing of these species underscores the need for stricter regulations and alternative livelihood programs to reduce fishing pressure on these populations. The persistence of such practices in Muncar highlights gaps in effective regulatory enforcement, a critical area that calls for attention to ensure sustainable conservation practices.

3.3 Income analysis of Muncar Shark fishermen (October 2023- October 2024)

The number of trips made by fishermen in one year was identified based on landing data. As illustrated in the figure, the highest number of trips recorded was 5, while most fishermen undertook 2 trips. This discrepancy may be attributed to underreporting by the enumerator team, which has resulted in the appearance of fewer trips per vessel (Figure 3).

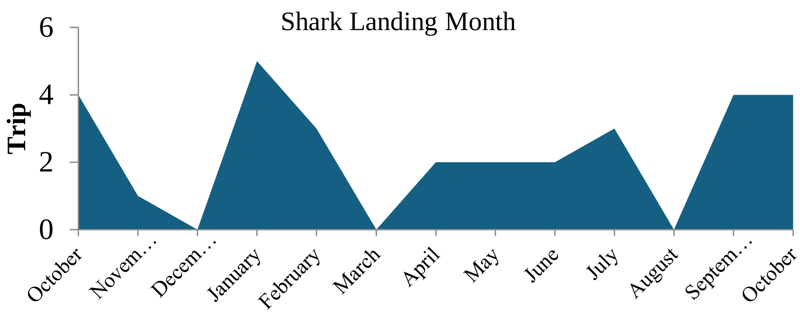

Fig. 3. Trips of the fisher to catch the sharks (October 2023-October 2024).

Fishermen in Muncar generally determine their main catch based on the fishing season; their primary target is not always sharks. The peak shark fishing season, which fishermen eagerly anticipate, occurs from September to October, along with other seasonal variations. Moreover, income disparities are attributed to landing locations outside Muncar, such as Tanjung Luar in Lombok, which may not be fully captured in the enumerator team's data. Income per vessel varies significantly and is subject to fluctuations, with each vessel conducting trips of differing frequencies. For instance, vessels that completed 8 trips were recorded more frequently compared to others. This variation can be observed in Figure 4.

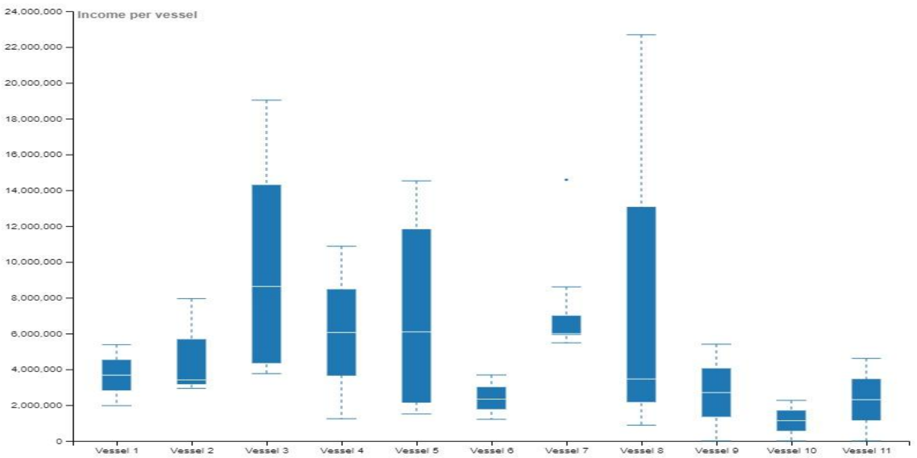

Fig. 4 Income per vessel (Oct 2023-Oct 2024).

Based on Fig. 4, vessel 10 is the one that generated the least income, which can be attributed to the fact that vessel 8 only conducted one trip. Income per captain can be observed in the figure below.

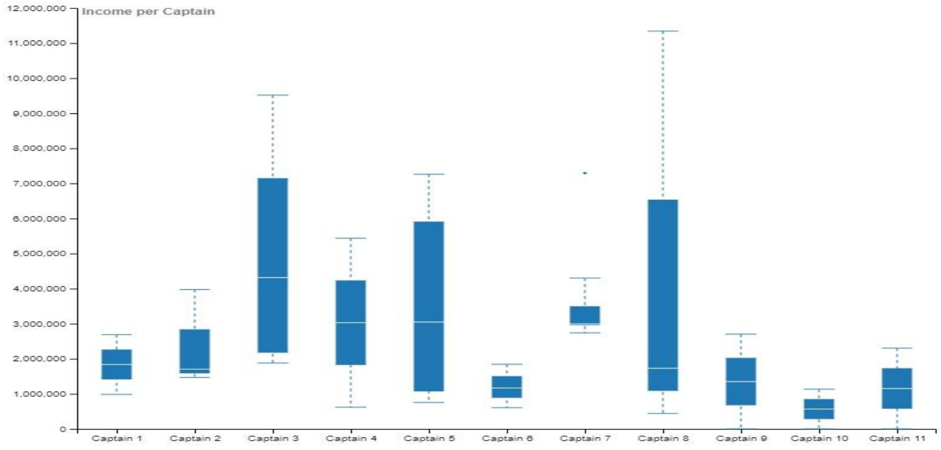

Fig. 5 Income per Captain (Oct 2023-Oct 2024).

Figure 5 shows that Captain 8 also received the highest income, as they conducted 5 trips during the period from October 2023 to October 2024. Subsequently, vessel 3 and vessel 5 ranked second and third, respectively, in terms of income generated. The income per individual crew member can be observed in Figure 6.

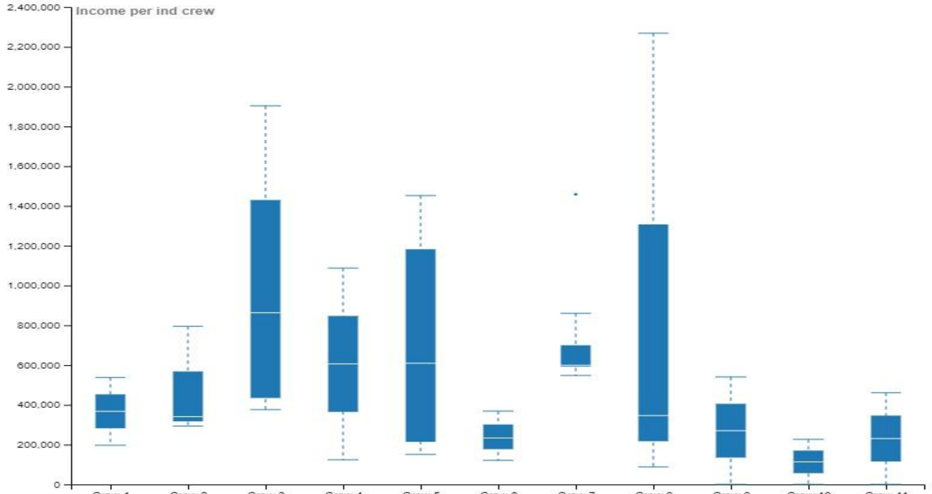

Fig 6. Income per Individual Crew (Oct 2023-Oct 2024).

Figure 6 illustrates that the crew aboard Vessel 8 earned the highest income, reflecting the vessel's overall earnings. Income distribution among the crew is determined by a pre-established agreement: the captain and vessel owner each receive two shares, while the remaining shares are divided among the crew members. With five crew members, each receives a portion of the collective share, often insufficient to meet basic needs. According to the national minimum wage standard (UMR) in East Java Province, set at IDR 2,600,000 per month, the income earned by the crew members falls below this threshold, categorizing them as economically disadvantaged [12]. This income disparity highlights the need for more equitable profit-sharing mechanisms and better economic support for the crew members to improve their livelihoods and ensure fair compensation for their labor.

Discrepancies in fishing trip data can arise from underreporting, often due to limited observer coverage, manual recording errors, or other logistical challenges. For instance, the

National Oceanic and Atmospheric Administration (NOAA) Fisheries has noted that underreporting can skew trip frequency and catch data, especially when monitoring resources are sparse and observers cannot be consistently assigned to every vessel trip. Similarly, research from Portuguese coastal fisheries found that aligning trip frequency with other vessel metrics, like gear type and fishing duration, provided a more accurate reflection of fishing activity and highlighted common underreporting issues that impacted management decisions. To mitigate such discrepancies, fisheries management agencies often recommend adopting electronic monitoring or increasing observer coverage to improve the reliability of landing data.

Muncar's shark fishery, along with similar fisheries in Indonesia and globally, offers insights into shared challenges and unique adaptations that emerge in shark fisheries. Notably, Muncar's shark fishery history—from its rapid economic growth phases to later periods marked by declining profitability and increased regulations—mirrors trends observed in many developing countries' small-scale shark fisheries. This broader comparison reveals common patterns and offers lessons on how communities can adapt sustainably to regulatory pressures and economic shifts.

Shark fisheries in Indonesia exhibit similar trends across regions, often starting as lucrative, largely unregulated industries that expand rapidly due to strong international demand for shark fins and other products. For instance, in East Nusa Tenggara and North Sulawesi, shark fisheries grew substantially throughout the early 2000s, driven by high shark fin prices and a lack of catch limits, similar to Muncar's experience [13]. Like Muncar, these regions also reported increasing vessel sizes and expanded fishing grounds as fishermen ventured farther for higher-value catches. This pattern reflects a typical cycle in which fisheries, initially unregulated, grow quickly until they begin to face ecological pressures and depletion risks, which later lead to regulatory intervention [14].

However, Muncar's fisheries community was unique in its integration of traditional practices, such as the "Pesta Laut," which emphasises a connection between fishermen and marine resources and encourages a degree of informal stewardship. Similar customary practices have also been documented in Raja Ampat and parts of East Nusa Tenggara, where traditional fishing communities perform rituals to honor the sea and regulate their harvests informally. These practices can play a complementary role to formal regulations, contributing to a conservation-oriented mindset among local fishers. However, in Muncar, the increased commercialisation and external market forces overpowered traditional practices, which were insufficient alone to counteract overfishing pressures.

Globally, shark fisheries that started under little to no regulation have faced similar economic trajectories and ecological challenges. In Baja California, Mexico, for example, unregulated shark fisheries saw peak years similar to those in Muncar, with high shark fin demand driving rapid industry expansion during the early 2000s. Mexican shark fisheries, like those in Muncar, later encountered tighter regulations due to mounting ecological concerns, leading to economic declines as fishers faced challenges complying with new catch restrictions and reporting requirements. Comparable declines in income and participation, alongside increased regulatory costs, prompted some Mexican fishermen to leave the industry or downscale operations, mirroring the recent struggles of Muncar's fishermen [14].

Another parallel can be drawn with Sri Lanka's shark fisheries, which saw rapid growth in response to high demand for shark fins and meat, similar to Muncar's. Sri Lankan fisheries also experienced a period of economic downturn as restrictions tightened, including limits on gear and stricter reporting requirements, which reduced the economic viability of shark fishing. Similar to Muncar, regulatory costs and increased permit requirements discouraged Sri Lankan fishers, resulting in declining shark catches and income.

These global and regional comparisons highlight several pathways for sustainable adaptation. For instance, countries with advanced regulatory frameworks, like Australia, have implemented quotas, reporting requirements, and community incentives that both protect shark populations and provide economic alternatives for fishermen. Australia's establishment of marine protected areas (MPAs) has helped balance conservation with commercial interests by providing fishers with supplementary income sources through tourism and government subsidies for gear transitions.

In Indonesia, similar approaches could help communities like Muncar adapt by integrating income alternatives and ecological incentives. Programs encouraging shifts to sustainable fisheries, aquaculture, or ecotourism can alleviate economic pressures on small-scale shark fisheries , enhancing market access for bycatch species, such as skipjack tuna, could diversify income sources, reducing fishers' reliance on shark catch profits. The experiences of Muncar's shark fishery resonate with those of other shark fisheries in Indonesia and globally, underscoring the importance of balanced regulations, economic support systems, and alternative income streams. Lessons from other regions suggest that sustainable adaptation in Muncar would benefit from reinforcing both traditional practices, like "Pesta Laut," and formal regulatory efforts, possibly through establishing MPAs.

4. Conclusion

The socio-economic and ecological dynamics of shark fisheries in Muncar, Banyuwangi, highlight the pressing need for an integrated approach to sustainable fisheries management. While shark fishing has long been a vital economic activity supporting local livelihoods, the growing threat of overfishing and the decline of apex predator populations jeopardize both marine biodiversity and community resilience. This study demonstrates the heavy dependence of local fishers on shark fisheries for income and food security, despite facing significant challenges such as reduced catch volumes and increased operational pressures. These findings underscore the importance of implementing robust conservation policies and regulatory frameworks that simultaneously address environmental sustainability and socio-economic welfare. Engaging local communities in the development and enforcement of conservation strategies, alongside the promotion of alternative livelihoods, is crucial to reducing pressure on vulnerable shark species while maintaining economic stability. A balanced approach—one that harmonizes ecological preservation with economic needs—will be essential to ensuring long-term sustainability in Muncar and other coastal regions with similar profiles. Future research should assess the impact of current regulatory interventions and explore innovative, community-based fisheries management models that incorporate traditional knowledge. Through inclusive governance and collaborative efforts among government bodies, conservation organizations, and local stakeholders, a more sustainable and equitable future for shark fisheries can be achieved.

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