



## [CONSERVATION AND MANAGEMENT GAPS FOR HAMMERHEAD SHARKS (*SPHYRNIDAE*) IN THE INDIAN OCEAN.]

[Benedict K. Kiilu and Dr. Iris M. Ziegler]

Purpose, expectation and action intended (select one or more and include corresponding text)

Discussions (for information and open discussion):

The paper is to inform meeting members on the conservation needs of hammerhead shark and specifically *S. lewini* in the Indian Ocean, at IOTC and at national level and discusses data gaps and other uncertainties in stock status and total removals requiring a precautionary approach; opportunities are discussed for all key areas of hammerhead sharks, in the High Seas, breeding areas and nurseries with juveniles being of specific conservation concern

Feedback (to collect input and suggestions)

[The paper is to request review and comments on..., as set out in Section X]

Conclusion (to record a concluded position or summary)

[The paper is to seek confirmation that..., as set out in Section X]

Recommendation (to ask the meeting to endorse a recommendation)

[The paper concludes that a precautionary approach is urgently needed and proposes measures for adoption and implementation for both IOTC and for CPCs to reduce mortality and also align with members obligations as a party or cooperating non party to the CMS convention after listing of *S. lewini* and *S. mokarran* on CMS App I]



Decisions (to request formal approval of actions)

[The paper asks the WPEB to discuss and endorse the recommendations recommending them to the SC for recommendation to the Commission to consider at its next meeting in 2027]

## Abstract

Hammerhead sharks in the Indian Ocean reveal a widening gap between their threatened status, limited biological and fisheries data, and inadequate regional management action. Confirmed Indian Ocean species include the scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*S. mokarran*), smooth hammerhead (*S. zygaena*) and winghead shark (*Eusphyra blochii*). All are threatened or of conservation concern, with *S. lewini* and *S. mokarran* of particular concern because they are Critically Endangered and exposed to both coastal and offshore fisheries. However, information on biology, distribution, stock structure, catch composition and fishery mortality remains incomplete. Available evidence shows that hammerheads are caught by industrial, semi-industrial and artisanal fleets using longlines, purse seines, gillnets, trawls and coastal gears, while reported catches remain sparse, inconsistent and often aggregated as *Sphyrnidae*, *Sphyrna spp.*, “hammerheads not elsewhere included” or “sharks not elsewhere included”.

Species identification remains a major constraint on both science and compliance. Juvenile hammerheads are difficult to distinguish because diagnostic head shape, fin shape and body proportions are less pronounced than in adults, and small individuals are often landed together with other juvenile sharks. Identification and reporting are further weakened because local landing-site names often refer to broad shark groups rather than scientific species. These issues undermine catch statistics, CITES non-detriment findings and stock assessments. At the same time, international governance is moving toward stronger protection: CITES Appendix II requires species-level non-detriment findings for all *Sphyrnidae*, CMS Appendix I listings require Range State Parties to prohibit the taking of *Sphyrna lewini* and *S. mokarran*, and ICCAT has prohibited hammerhead retention since 2011, as have several IOTC member states.

IOTC Resolution 25/08 strengthens shark conservation within IOTC but does not introduce hammerhead-specific measures such as a retention ban, mortality limit, rebuilding plan, or mandatory best-handling and release requirements. It does, however, require the Scientific Committee to review the status of other shark species that may need conservation measures, explicitly including hammerhead sharks.

This paper therefore summarises gaps in existing management and conservation measures at both IOTC and coastal-country levels, using Kenya to illustrate why coordinated action is needed at both scales. Research on Kenyan artisanal fisheries shows that landings include threatened species, including Critically Endangered scalloped hammerheads; that most landed sharks are neonates or immature individuals; and that gillnets are a primary gear type. The paper presents complementary regional and national recommendations, including an IOTC-level non-retention measure for *S. lewini* and *S. mokarran*, with all other hammerheads treated as look-alike species to support monitoring and compliance.

### Kenyan Case Study:

The scalloped hammerhead shark (*Sphyrna lewini*) is a highly vulnerable elasmobranch whose slow growth, late maturity and low reproductive productivity limit its capacity to withstand sustained fishing mortality. In coastal Kenya, assessment of its status is constrained by multispecies fisheries, incomplete species-specific catch records and limited long-term monitoring. This study synthesizes fisheries-dependent observations, historical catch information, length-frequency data and ecological risk assessments to evaluate the exploitation status and vulnerability of *S. lewini* in Kenyan coastal and adjacent Exclusive Economic Zone waters. Evidence from artisanal and semi-industrial fisheries shows that *S. lewini* is an important component of coastal shark catches. In the artisanal fishery, 955 individuals were recorded during the study period, with a mean sex ratio of 0.7 males:female, while 773 specimens used for length-weight analysis ranged from 37.3 to 92.1 cm total length, with a mean length of  $55.0 \pm 10.1$  cm. Semi-industrial prawn-trawl catches included 78 *S. lewini* individuals ranging from 46.0 to 63.7 cm TL. Most sampled individuals were immature, indicating strong selection of juveniles by coastal fisheries. Productivity–Susceptibility Analysis classified *S. lewini* as medium vulnerability in prawn trawls ( $V = 3.10$ ), gillnets ( $V = 2.91$ ) and ringnets ( $V = 2.77$ ), but low vulnerability to handlines ( $V = 2.38$ ). Importantly, length-based assessment estimated an F/M ratio of 4.85 and an SPR of approximately 1%, indicating severe depletion of reproductive potential. These findings demonstrate that apparently moderate gear-specific PSA scores can coexist with severe demographic depletion. The results support precautionary, species-specific management focused on reducing juvenile mortality, protecting nursery habitats and improving species-level monitoring of *S. lewini* in Kenyan fisheries.



**Key Words:** *Sphyrna lewini*; *Sphyrnidae*; conservation status, industrial and artisanal fishing pressure; Indian Ocean; Kenya; overfishing; data gaps; CITES; CMS; productivity-susceptibility-analysis; juvenile fishing mortality

# Conservation and Management Gaps for Hammerhead Sharks (*Sphyrnidae*) in the Indian Ocean

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## 1.0. Introduction and Background

Chondrichthyes are identified as a class of major conservation concern, second only to amphibians. IUCN highlights a global shark and ray crisis, with 418 species threatened with extinction and more than one third of known elasmobranch species threatened (IUCN 2026-1; Dulvy et al. 2021, Dulvy et al. 2024, Dulvy et al. 2026). Sphyrnidae have experienced some of the most rapid population declines globally and across all ocean basins: since 1970, global hammerhead shark abundance has declined by 67% owing to an 18-fold increase in fishing pressure (Pacoureau et al 2021).

Eight Sphyrnidae species are listed on the IUCN Red List in 2026, seven in *Sphyrna* and one in *Eusphyra*; the 2020 assessment also listed *Sphyrna gilberti* as a cryptic, Data Deficient species in the Northwest Atlantic (VanderWright et al 2020). Six of the eight species are Critically Endangered, including *Sphyrna mokarran*, *Sphyrna lewini* and *Eusphyra blochii*; *Sphyrna tiburo* is Endangered and *Sphyrna zygaena* Vulnerable. Four species occur in the Indian Ocean: *S. lewini*, *S. mokarran*, *S. zygaena* and *E. blochii*, assessed by IUCN in 2019 and 2025 respectively.

The Indian Ocean includes major shark and ray fishing and trading nations, with reported landings of about 155,738 t in 2020, or 18.1% of global FAO-reported shark and ray landings. Key shark fishing nations include India, Iran, Yemen, Sri Lanka and Oman (Fahrni Mansur et al 2024). As an endemism hotspot, it has also shown steep Red List Index declines since 1970, with RLI values of 0.8 in the Western Indian Ocean and 0.85 in the Eastern Indian Ocean, negatively correlated with mean annual shark and ray catch (Dulvy et al. 2026). Fisheries capture threatens 99.6% of threatened chondrichthyans, mostly through retained bycatch, and overfishing remains the main driver of shark declines (Dulvy et al. 2024b). Hammerhead shark fins collectively accounted for 4% of fins imported in Hong Kong (Fields et al. 2018).

Worm et al. identified coastal environments in the northern Indian Ocean, including waters of Indonesia, Malaysia, Papua New Guinea and the Philippines, as shark fishing mortality hotspots overlapping high biodiversity richness (Worm et al 2024).

The smooth hammerhead shark is generally more temperate than the scalloped and great hammerhead sharks, and its range is less exposed to intense artisanal fisheries; this contributed to its Vulnerable assessment and to a small, non-significant CPUE increase in the South Indian Ocean for 1978–2014. It is nevertheless frequently misidentified as scalloped hammerhead, particularly where habitats overlap and dried fins are hard to distinguish (Rigby et al 2019c).

The scalloped hammerhead shark has declined sharply, with a median reduction of 76.9–97.3% and the highest probability of reductions exceeding 80% over the past three generations across its warm-temperate and tropical coastal range (Rigby et al 2019a). Its migratory behaviour, slow growth and long gestation make it highly vulnerable to overexploitation in High Seas areas, oceanic congregation sites and coastal pupping grounds (Gallagher and Klimley 2018).

The great hammerhead shark is a highly migratory coastal-pelagic tropical species but, unlike the scalloped hammerhead, is a solitary migrant not known to form aggregations. Only Atlantic and Indo-Pacific subpopulations are reported (Testerman 2014), and Indian Ocean CPUE declined by 6.5% annually from 1978 to 2003, equivalent to a 99.3% reduction over three generations (Dudley and Simpfendorfer 2006; Rigby et al 2019b).

The winghead shark was formerly widespread across the Indo-West Pacific but is now possibly extinct in northern Southeast Asia and uncertain across much of the Arabian Sea, Bay of Bengal and southern Southeast Asia. It occurs from estuarine and inshore habitats to the continental shelf and 127 m depth, and outside Australia faces intense commercial and small-scale fishing pressure from gillnets, trawls and lines. Its fins are sporadically observed in the global shark fin market, yet populations have declined substantially and remain uncertain across much of the former range (Cardeñosa et al 2020; Cardeñosa et al 2022; Lewis et al 2025).

Growing concern over declining hammerhead populations and fin-market driven overexploitation led to the listing of *Sphyrna lewini*, *S. mokarran* and *S. zygaena* on CITES Appendix II on September 14, 2014, following CoP16, to regulate international trade (CITES 2013). The winghead shark was included in CITES Appendix II on February 23, 2023, together with all remaining small hammerhead species at CoP19, thereby covering the entire family and including look-alike species to avoid conservation gaps caused by misidentification (CITES 2022).

CITES Appendix I includes species threatened with extinction and prohibits trade, but until 2024 no shark had been listed on App I, despite many sharks, including hammerheads, being critically endangered or endangered and subject to fin-driven overfishing and overexploitation (Rigby et al 2019a). *Carcharhinus longimanus* and *Rhincodon typus* were the first sharks listed on App. I at CoP20 in Uzbekistan in 2025 (CITES 2025).

CITES Appendix II covers species not necessarily threatened with extinction but requiring trade control to avoid overutilization incompatible with survival. Effectiveness depends on competent and compliant local authorities issuing permits. Where concerns arise that unsustainable legal trade continues, the CITES Animals Committee may initiate a Review of Significant Trade (RST), potentially leading to trade suspension. The first RST for endangered and critically endangered sharks and rays began in 2023 and included trade in *Sphyrna lewini* by Mexico, Indonesia, China, Kenya, Nicaragua, Oman, Sri Lanka and Yemen and *Sphyrna mokarran* by Mexico (CITES 2023). Alarming trade levels, mismatched records indicating under-reporting, mislabelling and masking of illegal activities were presented at the 2024 CITES Animals Committee (Dulvy et al. 2026).

In 2025 the IUCN World Congress adopted a motion recommending that “*CITES Parties, in line with national processes as appropriate, consider the transfer of the scalloped hammerhead shark (Sphyrna lewini) and further hammerhead shark species as appropriate from Appendix II to Appendix I, in accordance with CITES Resolution Conf. 9.24 (Rev. CoP17) and that Parties explore increased protection measures for scalloped hammerhead shark (Sphyrna lewini) and its look-alike species, the smooth hammerhead shark (S. zygaena) and the great hammerhead shark (S. mokarran).*” The motion states that current conservation and management measures focus only on remediation, which, although valuable, should not replace catch avoidance as the most effective conservation strategy (IUCN 2025).

While CITES regulates international trade, the Convention on Migratory Species (CMS) requires Range State parties to strictly protect migratory species listed on Appendix I by prohibiting their taking, conserving and, where appropriate, restoring habitats, protecting or restoring migration and controlling other endangering factors. Appendix II lists migratory species with unfavourable conservation status requiring international agreements or benefiting significantly from such cooperation.

*Carcharodon carcharias* was the first shark listed on CMS App I in 2002, and five more followed by 2024: *Rhincodon typus*, *Cetorhinus maximus*, *Squatina squatina*, *Carcharhinus longimanus* and *Carcharias taurus*. The App I listing of *Carcharhinus longimanus* triggered retention bans by Range State Parties, Cooperating non-Parties and internationally at all four major tuna RFMOs (CMS 2002). WCPFC and ICCAT also banned whale shark retention. IOTC Res 25/08 lists whale sharks for prohibited retention from 2026, while ICCAT recently banned retention of great white and basking sharks in its area of competence (ICCAT 2025).

In 2026, at COP15 in Brazil, CMS adopted further Appendix amendments, adding all three thresher sharks, the great hammerhead shark and the scalloped hammerhead shark to App. I (CMS 2026), thereby requiring parties to strictly protect these critically endangered species.

Table 1 provides an overview about the CITES and CMS status of all Indian Ocean *Sphyrnidae*

| Species                 | Common name          | IUCN Red List status  | Geographic range in Indian Ocean                                                                                                                                    | CITES             | CMS               |
|-------------------------|----------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|
| <i>Sphyrna lewini</i>   | Scalloped hammerhead | Critically Endangered | Confirmed throughout tropical and subtropical Indian Ocean waters, including the Western Indian Ocean, Arabian Sea, Bay of Bengal, Indonesia and Western Australia. | App II since 2014 | App I since 2026  |
| <i>Sphyrna mokarran</i> | Great hammerhead     | Critically Endangered | Confirmed in the Indian Ocean, including coastal, shelf and semi-oceanic waters.                                                                                    | App II since 2014 | App I since 2026  |
| <i>Sphyrna zygaena</i>  | Smooth hammerhead    | Vulnerable            | Confirmed, particularly in temperate to subtropical parts of the Indian Ocean, including southern African and Australian waters.                                    | App II since 2014 | App II since 2020 |
| <i>Eusphyra blochii</i> | Winghead shark       | Critically Endangered | Confirmed in the northern Indian Ocean and Indo-West Pacific, including shallow coastal and estuarine habitats.                                                     | App II since 2022 | n/a               |

**Table 1:** Overview on the conservation status of hammerhead shark species in the Indian Ocean and applicable international governance

The General Fisheries Commission for the Mediterranean (GFCM) banned the retention of scalloped hammerhead sharks in 2012 together with 23 other elasmobranch species listed on the Barcelona Convention Annex II. (GFCM 2012) and many Atlantic and Pacific region countries are already protecting hammerhead sharks in parts or in their complete EEZs in recognition of their threatened state, high vulnerability to fisheries and the need to remove commercial incentives from catching these species by fisheries. (CMS 2025)

ICCAT Recommendation 10-08 prohibits retaining, transshipping, landing, storing, selling or offering for sale hammerhead sharks of the family Sphyrnidae, except *Sphyrna tiburo*, caught in association with ICCAT fisheries, requires prompt release and reporting of discards and releases. The conservation measure also recognises the difficulty to differentiate between the various species of hammerhead sharks without taking them on board and that such action might jeopardize the survival of the captured individuals. The measure nevertheless exempts developing coastal states that may continue retaining hammerhead sharks if ensuring those catches are for local consumption only and do not enter international trade (ICCAT 2010).

Banning retention alone does, however, not automatically reduce mortality if not accompanied by other mitigation measures as requested by the bycatch mitigation hierarchy and for being effective also requires consistent implementation, monitoring and enforcement (Juan-Jordá et al 2022; Feitosa et al 2025). Nevertheless, retention bans are an essential prerequisite for the adoption and implementation of further bycatch mitigation measures (Ziegler 2025) to avoid, reduce and remediate fishing related hammerhead shark mortality. This systematic bycatch mitigation hierarchy has internationally been recognised as the state-of-the-art approach for effective mortality mitigation (Booth et al 2019; Cronin et al 2022) but has so far been widely ignored by most RFMOs including at IOTC.

As commercial incentives from bycaught sharks prevail bycatch mitigation measures have mostly been limited to the request for improved reporting and the conduct of further research. While both are important those should be the last in a cascading hierarchy or factually accompany other mitigation measures but have continued being the predominant or often only measures adopted at tuna RFMOs (Cronin et al 2022). No measurable progress has thus been made in reducing shark mortality over the last two decades at tuna RFMOs and chances have been missed to rebuild potentially overfished stocks as scientists refer to uncertainty of abundance and total fishing related mortality as the root cause (Ziegler 2024) despite the evident urgency to reduce shark mortality and do so specifically at the tuna

RFMOs when  $\frac{3}{4}$  of all pelagic sharks and rays are threatened by extinction and 50% of them are already critically endangered (Pacoureau et al. 2021). Pelagic sharks and rays are specifically vulnerable to fisheries in tuna RFMOs due to the high overlap of their habitats with fishing activities and the use of mostly unselective gear for fishing of tuna and tuna like species.

## 2.0. Methods

This paper combines an ocean wide review of existing literature and data on both the population status of hammerhead sharks and existing conservation measures at IOTC and at CPC level, comparing these efforts with increasing obligations from international governance such as CMS for the conservation of those highly vulnerable species and rebuilding of the severely depleted populations in the Indian Ocean.

Findings from published studies by e.g. Kiilu et. at (2019) which focused on artisanal fisheries in Kenya's territorial and EEZ waters are further highlights the urgent need for actions to provide solutions and guidance. This study is also applicable, to most other artisanal and semi-industrial fisheries, including specific recommendations for those fisheries, mainly addressing the conservation needs for juveniles.

Then, the paper reviews the current state of bycatch mitigation knowledge and related conservation measures at IOTC level. It presents an overview on missed opportunities for stepping up hammerhead conservation and address the drivers for IOTC's past inability for progress on the conservation and management of these pelagic sharks, despite ample warnings, international expectations and existing best practice.

Finally, the paper proposes a five-year action plan for IOTC to adopt in order to reverse the severe threat of extinction for these important top predators and ecosystem engineers in the Indian Ocean. Recommendations are provided at IOTC level and following the outcome of the Kenyan Case Study also specifically directed to coastal nations

## 3.0. Findings and Discussion

### 3.1. Occurrence and fishery interactions of *Sphyrna lewini* in Kenya's marine fishery waters

In the study by Kiilu et al 2019, *Sphyrna lewini* was consistently identified as an important hammerhead shark interacting with Kenya's coastal fisheries. The species was recorded in artisanal fisheries using gillnets, handlines and ringnets, as well as in the semi-industrial prawn-trawl fishery. The broader fisheries inventory also records interactions with offshore longline fisheries. *S. mokarran* was also recognized as occurring in Kenyan waters, but the available quantitative datasets were insufficient for an equivalent species-specific assessment; consequently, subsequent analyses focused on *S. lewini*.

In the artisanal fishery, *S. lewini* had the highest reported catch rate among the principal shark species sampled, at 2.46 kg fisher<sup>-1</sup> day<sup>-1</sup>. Catch rates were higher during the southeast monsoon (SEM) period than the northeast monsoon (NEM) period, although the available analysis did not demonstrate a significant overall seasonal difference in shark catch rates.

In the semi-industrial prawn-trawl fishery, *S. lewini* was also prominent. The historical trawl dataset comprised 78 individuals, with lengths ranging from 46.0 to 63.7 cm TL, and a mean catch rate of approximately 0.73 kg h<sup>-1</sup>. The species had the highest catch rate among the hammerhead species recorded in this fishery.

| Type of fishery             | Species caught                     | Number of Individual s, n | Total Length Range (cm) | Total Weight (Kg) | Mean Catch Rates (Kghr <sup>-1</sup> ) | Standard Deviation of catch rates |
|-----------------------------|------------------------------------|---------------------------|-------------------------|-------------------|----------------------------------------|-----------------------------------|
| Semi-Industrial Prawn Trawl | <i>Sphyrna lewini</i>              | 78                        | 46- 63.7                | 77.1              | 0.73                                   | ±1.6                              |
|                             | <i>Charcharhinus amblyrhynchos</i> | 83                        | 25- 186                 | 80.6              | 0.77                                   | ±1.99                             |
|                             | <i>Carcharhinus melanopterus</i>   | 2                         | 113- 144                | 27                | 0.26                                   | ±1.05                             |
|                             | <i>Carcharhinus leucas</i>         | 1                         | 156                     | 20                | 0.2                                    | ±1.11                             |
|                             | <i>Sphyrna zygaena</i>             | 69                        | 47- 69                  | 66.2              | 0.6                                    | ±1.07                             |
|                             | <i>Stegostoma fasciatum</i>        | 3                         | 33- 36.4                | 2.5               | 0.24                                   | ±0.112                            |
|                             | <i>Charcharhinus galapensis</i>    | 2                         | 40- 42                  | 2.94              | 0.028                                  | ±0.16                             |
|                             | <i>Pristis pristis</i>             | 2                         | 70- 95                  | 2.86              | 0.03                                   | ±0.11                             |
|                             | <i>Galeocerdo cuvier</i>           | 1                         | 80                      | 1.45              | 0.014                                  | ±0.08                             |
|                             | <i>Squalus acanthias</i>           | 7                         | 62- 97                  | 21.8              | 0.21                                   | ±1.9                              |
|                             | <i>Pseudocarcharias kamoharai</i>  | 3                         | 55- 98                  | 7.1               | 0.1                                    | ±0.4                              |
|                             | <i>Carcharhinus longimanus</i>     | 1                         | 93                      | 3.6               | 0.03                                   | ±0.2                              |

**Table 2:** Summary of *S. lewini* occurrence and fishery-specific catch information, including fishery/gear, sample size, length range and catch rate.

| Species                                                          | Number of individuals, n | Total length range (cm) | Total landed weight (Kg) |       | Total fishing days |       | Catch rates (Kg/fisher/day) |      |
|------------------------------------------------------------------|--------------------------|-------------------------|--------------------------|-------|--------------------|-------|-----------------------------|------|
|                                                                  |                          |                         | NEM                      | SEM   | NEM                | SEM   | NEM                         | SEM  |
| <i>Sphyrna lewini</i>                                            | 877                      | 28.8- 92.5              | 233.0                    | 435.1 | 125                | 147   | 1.86                        | 2.96 |
| <i>Charcharhinus amblyrhynchos</i>                               | 148                      | 30- 56.1                | 61.6                     | 64.4  | 125                | 147   | 0.49                        | 0.44 |
| <i>Carcharhinus melanopterus</i>                                 | 57                       | 28- 78.8                | 9.9                      | 21.9  | 125                | 147   | 0.08                        | 0.15 |
| <i>Carcharhinus leucas</i>                                       | 31                       | 36.6- 85.5              | 60.0                     | 16.5  | 125                | 147   | 0.48                        | 0.11 |
| <i>Carcharhinus limbatus</i>                                     | 487                      | 28.2- 90.1              | 159.5                    | 99.5  | 125                | 147   | 1.28                        | 0.68 |
| <i>Carcharodon carcharias</i>                                    | 1                        | 379.2                   | -                        | 600.0 | -                  | 272   | -                           | 2.21 |
| Overall mean (□) seasonal landings and catch rates (all species) | -                        | -                       | 87.3                     | 206.2 | 104.2              | 167.8 | 0.84                        | 1.23 |

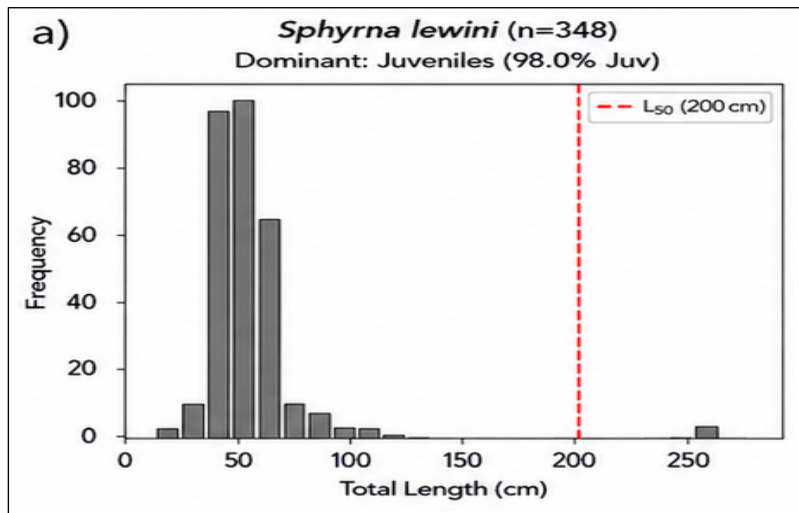
**Table 3:** Sample characteristics of shark species in the artisanal fisheries in coastal Kenya. NEM- north east monsoon season; SEM- southeast monsoon season.

### 3.2. Size structure of *Sphyrna lewini*

Markedly small size classes characterized *S. lewini* in the available coastal fishery samples. In the artisanal fishery, individuals ranged from 28.8 to 92.1 cm TL, with a modal length class of 50.0–54.9 cm TL for both males and females. The source study reported that all *S. lewini* specimens sampled from the artisanal fishery were below the size at maturity used in that assessment.

The size distribution in the semi-industrial prawn-trawl fishery was narrower, ranging from 46.0 to 63.7 cm TL, with a modal class of 52.0–53.9 cm TL. The distribution was described as approximately normally distributed, but all sampled individuals were also classified as immature relative to the maturity reference used in the source study.

The larger artisanal dataset used for length–weight analysis contained 773 *S. lewini* specimens, ranging from 37.3 to 92.1 cm TL, with a mean length of  $55.0 \pm 10.1$  cm TL and mean weight of  $0.80 \pm 0.45$  kg. There was no statistically significant difference between male and female length-frequency distributions in the artisanal sample (Kolmogorov–Smirnov test:  $D = 0.20$ ,  $p = 0.901$ ).



**Figure 1:** Length-frequency distributions of *S. lewini* sampled in Kenyan artisanal and trawl fisheries, showing maturity thresholds ( $L_{50}$ ) and juvenile proportions.

For the main integrated length-based assessment, the available *S. lewini* length composition comprised 348 individuals, with a mean observed length of 68.1 cm TL. The estimated asymptotic length was 310 cm TL, while the length at 50% maturity ( $L_{50}$ ) was 210 cm TL.

### 3.3. Productivity and susceptibility of *Sphyrna lewini*

The PSA demonstrated that the vulnerability of *S. lewini* varied among fishing gears, although the species was consistently identified as vulnerable in several coastal fisheries.

For the semi-industrial prawn-trawl fishery, *S. lewini* had a productivity score of 2.47, susceptibility score of 1.87, and overall vulnerability index of 3.10, corresponding to the medium-risk category.

Within the artisanal fishery, the PSA produced a productivity score of 2.35, susceptibility score of 1.72, and vulnerability index of 2.91 for gillnets, also corresponding to medium risk. For ringnets, *S. lewini* recorded a productivity score of 2.18, susceptibility score of 1.72, and vulnerability index of 2.77, placing it in the medium-risk category.

In contrast, the handline fishery produced a productivity score of 1.65, susceptibility score of 1.72, and vulnerability index of 2.38, classified as low risk under the PSA framework.

Thus, among the four evaluated gears, the highest vulnerability index occurred in the prawn-trawl fishery, followed by gillnet, ringnet and handline fisheries.

| Fishery/Gear | Species                | P-score | S-score | V-risk value | Risk category |
|--------------|------------------------|---------|---------|--------------|---------------|
| Gillnet      | <i>Sphyrna lewini</i>  | 2.35    | 1.72    | 2.91         | Med           |
| Gillnet      | <i>Sphyrna zygaena</i> | 2.35    | 1.62    | 2.86         | Med           |
| Handline     | <i>Sphyrna lewini</i>  | 1.65    | 1.72    | 2.38         | Low           |
| Ringnet      | <i>Sphyrna lewini</i>  | 2.18    | 1.72    | 2.77         | Med           |

**Table 4:** Productivity (P) and Susceptibility (S) scores, and Overall vulnerability (V) risk categories from results of PSA done on *S. lewini* by fishing gear

### 3.4. Length-based spawning potential ratio and fishing pressure

The LBSPR assessment indicated substantial depletion of the spawning potential of *S. lewini*. Using the observed length composition and biological parameters, the model estimated a relative fishing mortality (F/M) of 4.85 and a spawning potential ratio (SPR) of approximately 1%. The resulting SPR was below the limit reference point adopted in the source assessment and was classified as severely overfished.

The very low SPR was accompanied by a substantial difference between observed and mature size. The mean observed length of 68.1 cm TL was considerably below the estimated L50 of 210 cm TL, indicating that the length composition used in the assessment was strongly concentrated below the size associated with 50% maturity.

The estimated F/M ratio of 4.85 was substantially greater than one, indicating high relative fishing pressure under the assumptions of the length-based model. The source assessment therefore identified *S. lewini* among the coastal elasmobranch species showing the strongest evidence of depletion in the LBSPR analysis.

From the LBSPR results *S. lewini* shows clear signs of severe depletion in Kenyan and wider Indian Ocean waters. From the dataset, the mean length of sampled individuals was only 68.1 cm compared to an asymptotic length ( $L_{\infty}$ ) of 310 cm, indicating that most of the catch is composed of juveniles. The maturity length (L50) is estimated at 210 cm, yet the population is being harvested well below this threshold.

The very high fishing mortality relative to natural mortality ( $F/M = 4.85$ ) reflects intense exploitation pressure, while the spawning potential ratio (SPR) is critically low at just 1%. Together, these indicators confirm that the stock is below the limit reference point (LRP) and is severely overfished, with recruitment overfishing evident from the dominance of immature individuals in the catch. This situation underscores the urgent need for precautionary management, including protection of nursery grounds and strict regulation of gillnet and trawl fisheries that overlap with juvenile habitats.

### 3.5. Review of Hammerhead Sharks in the Indian Ocean

#### 3.5.1. Local Fishing Pressure and Conservation Efforts for Hammerhead Sharks in the Indian Ocean

Studies across the Indian Ocean have documented persistent and excessive fishing pressure on critically endangered hammerhead sharks, particularly from artisanal fisheries. Moazzam (2022) reports that scalloped hammerhead sharks averaged about 7% of Pakistan's pelagic shark landings between 2008 and 2019, with summer landings reaching 2,000–6,000 kg in 2017–2019. Their contribution had reached up to 25% in the 1970s–1990s but declined after 2000. Protection began in 2016, although implementation remained weak.

Haque et al (2021) counted 86,111 scalloped hammerheads at four landing sites in the Bay of Bengal, Bangladesh, between 15 January and 21 June 2017, representing 19.29% of all landed sharks and about

31,041.5 kg. Almost all were juveniles, with mean lengths below 40 cm. The authors called for urgent conservation measures, including prohibiting catch and trade and requiring live release of bycaught sharks.

Findings by Thomas et al (2021) report that four hammerhead species in Indian marine fisheries, average annual hammerhead shark landings of 639 t during 2007–2018, and *S. lewini* comprising 95% of landings. Most individuals measured 30–100 cm, indicating high juvenile catch rates. Suggested measures include strict implementation of a 220 cm minimum legal size, identification and protection of juvenile aggregation grounds through spatial or seasonal closures, gear restrictions and education programmes.

Geng et al (2022) used IOTC nominal catch data for 1986–2020 in demographic modelling and a preliminary stock assessment with Monte Carlo simulations to address biological uncertainty. The study concluded that recent average catches were below MSY but that the stock was overfished; data-limited methods are recommended for the next assessment because reported catch remains highly uncertain.

Hartati et al (2023) report that scalloped hammerheads in Lampung Bay, Indonesia, are mainly caught in bottom gillnets and that 2020 samples consisted mostly of very small juveniles, with a mean length of 47 cm. Fishing mortality exceeded natural mortality and spawning biomass was depleted to levels unable to replenish the population, requiring management such as mesh-size adjustment, seasonal changes and avoidance of nursery areas. Osmaleli et al (2024) sampled shark landings in East Java from 2020–2023 and found that *S. lewini* made up 9–14% of landed sharks, with a strong female prevalence and catch peaks in August and December. Catches by small-scale gillnet and longline fisheries consisted largely of juveniles and subadults, leading the authors to recommend spatial-temporal closures to protect juveniles and improve sustainability.

Nugraha et al (2023) examined biological parameters, exploitation rates and spawning potential ratio of scalloped hammerheads from bottom-gillnet catches in Lampung Bay. Based on 332 individuals sampled in 2020, mostly very small sharks with a mean length of 47 cm, the study found fishing mortality above natural mortality, a fully exploited stock and signs of recruitment overfishing. Recommended measures include mesh-size adjustment, shifting fishing seasons and avoiding nursery areas.

van Beuningen et al (2026) compared *S. lewini* landings from surveys in Mozambique and Kenya between 2018 and 2024. Scalloped hammerheads were a substantial component of coastal artisanal shark landings: in Mozambique, *S. lewini* made up at least 83% of landed hammerheads and *Sphyrnidae* accounted for 58% of all landed sharks; in Kenya, *S. lewini* accounted for 17% of landed sharks. Conservation concerns for Mozambique include a male-skewed sex ratio of 1:1.7 and landings dominated by neonates and young-of-the-year animals under 100 cm, mostly 40–60 cm. In Madagascar, *S. lewini* comprised about 30% of artisanal catch, mostly juveniles (Humber et al. 2017). Gillnets, shark nets and other nets dominate these coastal catches, while additional landings by three CPCs come from semi-industrial or industrial fleets in EEZ and high-seas waters, showing that effective conservation requires connected coastal and regional measures.

Rigby (2023) proposed a preliminary Indian Ocean recovery plan with nine objectives over eight years to rebuild overfished scalloped hammerheads above biomass levels able to sustain MSY with 70% certainty. However, the objectives remain broad approaches rather than advising IOTC to take specific measures.

Among CPCs already seeking stronger protection, non-retention remains the prevailing approach. The Maldives introduced a nationwide shark fishing ban in 2010, including a prohibition on retaining bycaught sharks and therefore covering also all hammerhead species (Ali and Sinan, 2015), although the 2025 reopening of deep-water gulper shark fishing under strict licences somewhat weakened the Indian Ocean's only shark sanctuary. Spain has prohibited retention of all hammerhead sharks of the genera *Sphyrna* and *Eusphyra* and all thresher sharks of the genus *Alopias* in all its fisheries since 2010,

following ICCAT SCRS advice to release bycaught animals in the water rather than bringing them on board to improve survival. (Spain 2010) South Africa has prohibited retention of hammerhead sharks (*Sphyrna* spp.) in its large pelagic longline fishery since 2011 and extended this to other commercial fisheries in 2015 (South Africa 2015; da Silva et al. 2015). Pakistan banned retention of all *Sphyrnidae* spp., together with all *Carcharhinidae*, *Lamnidae*, *Alopiidae* and *Rhincodontidae*, in all its mechanised fishing crafts and licensees within its EEZ in February 2025, requiring live animals to be released promptly and as unharmed as possible. (Pakistan 2025). Zanzibar announced full protection for 34 elasmobranch species in its coastal waters in June 2026, including hammerhead sharks, thresher sharks and the endemic Zanzibar guitarfish, during the Our Ocean Conference in Mombasa. (Zanzibar 2026)

Several coastal CPCs of the IOTC have also strengthened their shark conservation measures by banning the shark-fin trade, as has India in 2015 and Pakistan in 2025, while India also banned exports of all CITES-listed species. Others, including Sri Lanka, Madagascar and Indonesia, have identified conservation gaps and the need to improve hammerhead shark landing reports through National Plans of Action for Sharks, mainly to support CITES Non-Detriment Findings however, specific measures to reduce hammerhead mortality have remained largely absent

### **3.5.2. Lacking Conservation for Hammerhead Sharks at IOTC**

In 2013 and 2014, the European Union proposed precautionary protection for hammerhead sharks because available data were insufficient to assess their abundance. Both proposals sought to prohibit retention of *Sphyrnidae* and require release without bringing animals on board, but neither was adopted. No hammerhead-specific conservation and management measure has subsequently been adopted by IOTC (Prop G, IOTC 2013; Prop C, IOTC 2014).

The IOTC designates only *Sphyrna lewini*—not *S. mokarran* or *S. zygaena*—as a key shark species for which stock assessments (IOTC 2025c) are attempted and annual conservation summaries provided. The 2025 summary reported 1,537 mt of *S. lewini* in 2024 and an annual average of 766 mt during 2020–2024, but classified stock status as unknown. Reported catches remain incomplete because hammerheads are also recorded at genus level as *Sphyrna* spp. (SPN), family level as *Sphyrnidae* (SPY), or within highly aggregated shark categories (SHK). Although species-level reporting has improved, including recent reporting by Kenya and Tanzania, this may partly explain the apparent increase in *S. lewini* catches. Despite the species' known vulnerability and uncertain stock status, management advice has repeatedly recommended only that the Commission “consider taking a cautious approach,” without specifying measures or effectively improving compliance with reporting requirements (IOTC SC 2020; IOTC SC 2025a).

Resolution 15/01 requires authorised vessels fishing for IOTC-managed species to use data-recording systems but exempts vessels under 24 m from developing CPCs when operating solely within national EEZs, subject only to progressive implementation. It mandates reporting of hammerheads only as *Sphyrna* spp. and only for longline and gillnet fisheries; reporting is not required for purse seines, trolling or handlines. Consequently, the broader requirements of Resolution 15/02 to report catches by species and gear, including retained catch and discards where possible, do not produce complete species-level mortality estimates. Information on elasmobranch catches and discard mortality therefore remains too fragmented for robust stock assessment or informed management. Precautionary non-retention has been adopted for oceanic whitetip sharks, thresher sharks and mobulid rays, but not for hammerheads (IOTC 2015a; IOTC 2015b).

Resolution 25/08 acknowledges the importance of species-specific catch, discard and trade data and directs the Scientific Committee to improve reporting of shark interactions, including those involving all *Sphyrnidae*. In 2025, the Working Party on Ecosystems and Bycatch recommended mandatory species-level reporting of scalloped, smooth and great hammerheads across all gears, explicitly including purse seines, and improved reporting from artisanal fisheries. The Scientific Committee endorsed these proposals, together with related improvements for other sharks and rays. However, they

were not considered at the 2026 Commission meeting because no CPC proposed amendments to Resolution 15/01 (IOTC WPEB 2025; IOTC SC 2025a).

An indicator assessment for *S. lewini* was planned for 2026, but poor catch data and the general absence of discard records may prevent reliable estimation of total mortality even with data-limited methods. Resolution 25/08 requires annual scientific review and permits recommendations to prohibit utilisation of additional vulnerable shark species. Given the major uncertainty in mortality, the Scientific Committee should apply a precautionary approach and recommend that all *Sphyrnidae* be added to the species covered by the prohibition on retention, transshipment, landing and storage under paragraph 3 of Resolution 25/08 (IOTC 2025).

Resolution 25/08 also required review of its Minimum Standards for Safe Handling and Live Release Procedures by the end of 2025. Although the Working Party developed gear-specific revisions to maximise survival and the Scientific Committee recommended their adoption, no CPC submitted them for consideration in 2026. These standards are important because hammerheads interact with numerous gears and often experience high at-vessel mortality, which varies by species, gear and handling practice (Coelho et al. 2012; Gulak et al. 2015; Braccini and Waltrick 2019).

A family-level precautionary approach is further justified by international conservation and trade obligations, aggregated reporting and identification difficulties, particularly where coastal nursery habitats of *Sphyrna* overlap with *Eusphyra blochii*. Species-level landing data remain broadly unavailable, *S. lewini* and *S. zygaena* are frequently confused, and stock assessments are therefore constrained (Maguire et al. 2006). Meanwhile, depletion of other shark taxa in the fin trade has increased demand and prices for hammerhead fins, including juvenile fins (Fields et al. 2018). *S. lewini* represented 5.95% of fins in a recent market survey, indicating substantial international trade in fins derived from juveniles caught in coastal nurseries (Cardeñosa et al. 2024).

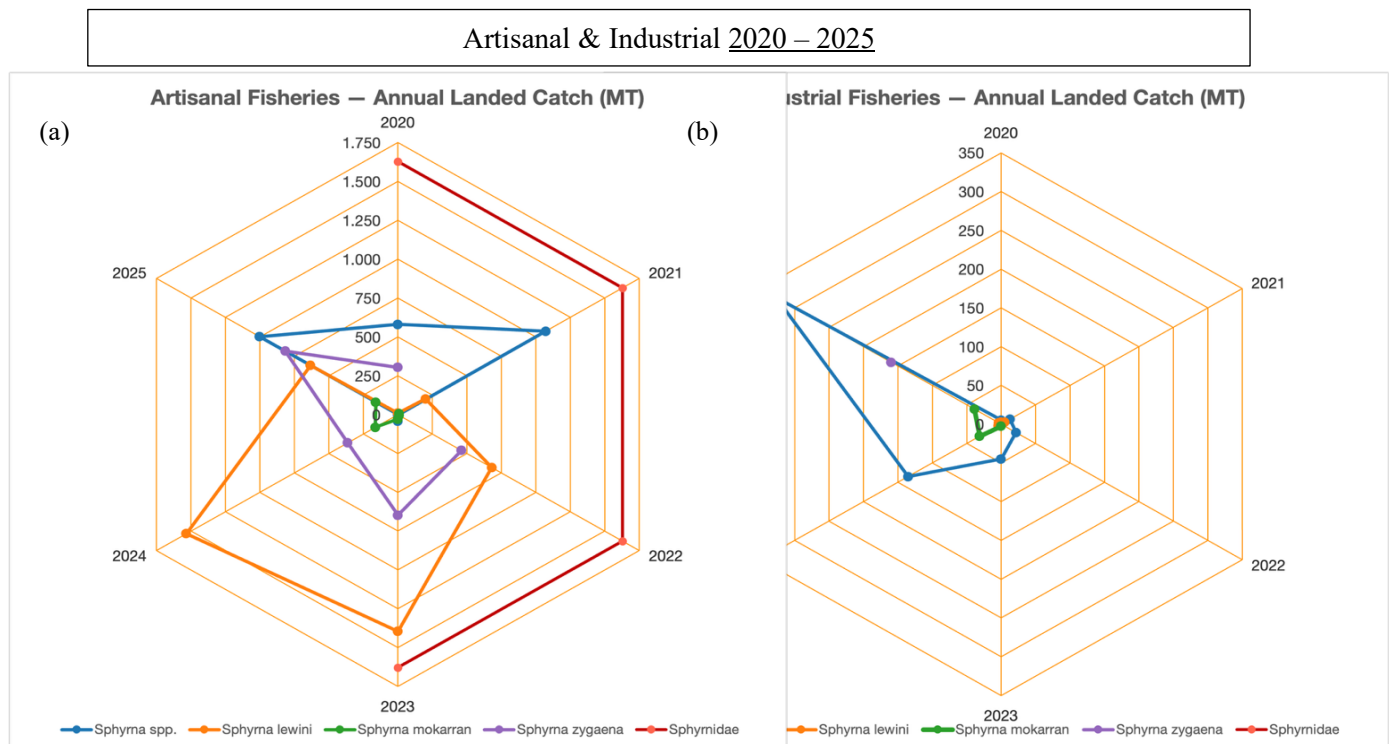
Reported increases in IOTC hammerhead landings may thus reflect both sustained demand and improved reporting. In 2024, 1,537 mt of *S. lewini* were reported, compared with an annual average of 766 mt during 2020–2024, but aggregated SPN and SHK records totalled 15,694 mt in 2024 and averaged 24,976 mt over the same period. These categories prevent assessment of actual hammerhead mortality and may include *S. mokarran*, *S. zygaena* and other unidentified sharks. Comparable inconsistencies occurred in earlier years: 19 mt of *S. lewini* and 35,758 mt of unidentified sharks were reported in 2018, whereas 1,397 mt of *S. lewini* and 30,108 mt of unidentified sharks were reported in 2023 (IOTC SC 2019; IOTC SC 2024). The persistence of aggregated reporting, incomplete discard data and absent hammerhead-specific measures therefore constitutes a substantial conservation gap at IOTC.

### **3.5.3. An Analysis of the Ambiguity of reported Hammerhead Mortality at IOTC**

A review of publicly available IOTC datasets shows increasing reported landings of *S. lewini* and other hammerhead species since 2022 and reporting at genus (*Sphyrna* spp.; SPN) and/or family (*Sphyrnidae*; SPY) levels remain substantial, with records fluctuating markedly among years as shown in Figure 2 and Figure 3 or both, artisanal and industrial landings.

The datasets IOTC-2026-WPEB22-DATA03 available on the WPEB22 Meeting website (Figure 2) and IOTC-DATASETS-2026-08-13-RC-RAW-1950-2025, downloaded on 15 August 2026 from the [IOTC website](#) (Figure 3), differ substantially in reported landings for the same recent years. The latter includes family-level records of approximately 1,000–2,000 mt annually, mainly from Madagascar’s artisanal fisheries through to 2023, whereas these records are completely absent in the IOTC-2026-WPEB22-DATA03 dataset and overall past landings were substantially lower. Previous datasets DATASETS-2025-03-12-NC-ALL\_1950-2023 (downloaded from IOTC website on 02.09.2024), had also shown total annual hammerhead landings of approximately 2,000–3,000 mt distributed among species-, genus-

and family-level categories and thus in a similar range as IOTC-DATASETS-2026-08-13-RC-RAW-1950-2025.

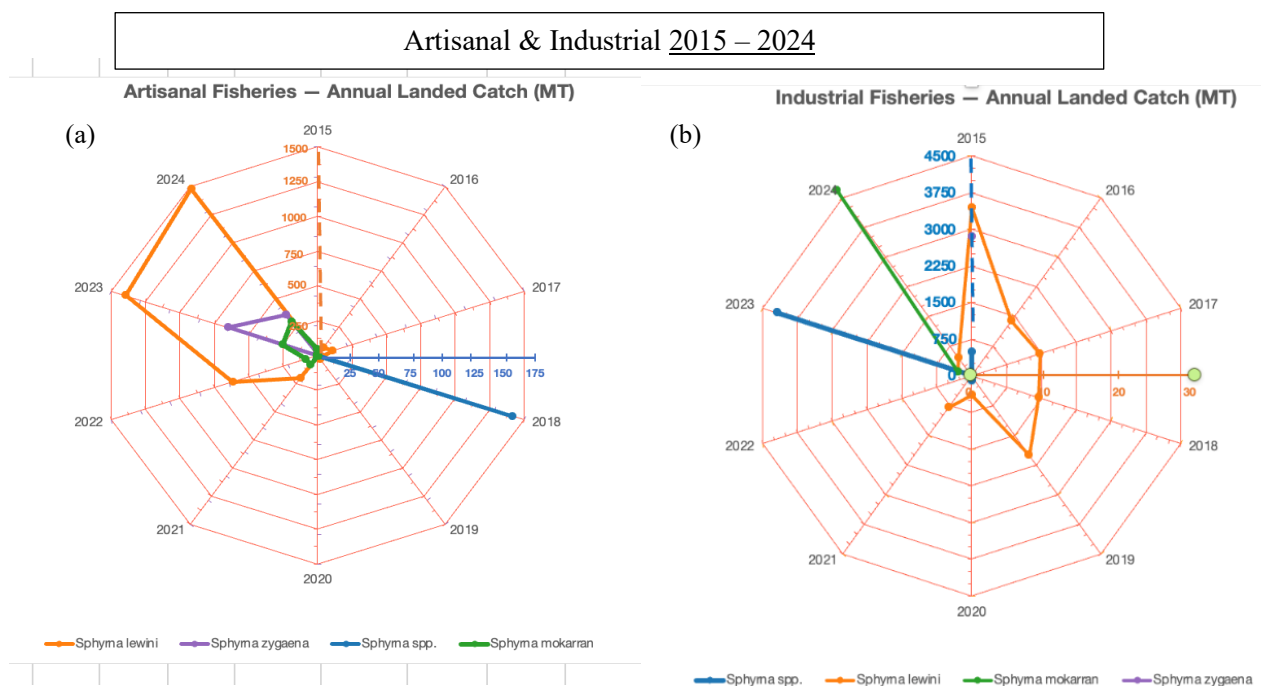


**Figure 2:** Reported landings of Hammerhead sharks from artisanal (a) and industrial (b) fleets between 2015 and 2024; based on data from Dataset DATASETS-2026-08-13-RC-RAW-1950-2025 up to 2025 which includes also landings at family level of Sphyrnidae.

Industrial records are even more sporadic, with high reported quantities in individual years followed by little or no catch from the same fishery.

However, all datasets highlight that the vast majority of reported landings has consistently been made and continues to come from artisanal fisheries of coastal CPCs, whose vessels are generally not included in the IOTC Record of Authorised Vessels (RAV). Since 2020, reporting of *S. lewini* has increased, particularly from Kenya, Mozambique, Sri Lanka and Indonesia, exceeding 1,000 mt annually. Reported *S. zygaena* landings have also increased, although quantities differ substantially among dataset versions.

Depending on the dataset, combined artisanal and industrial landings between 2015 and 2022 had ranged between 100 and 600 mt (Figure 2) which appears to be too low in view of the reported landings by India alone (Haque et al. 2021; Thomas et al. 2021) making the 2,000 – 3,000 mt in Figure 3 appear more realistic. Aggregated reporting also increased, including more than 4,000 mt of *Sphyrna* spp. attributed to industrial fisheries in 2023 in Figure 3b, while artisanal fisheries simultaneously reported substantial species-level quantities of *S. lewini*, *S. mokarran* and *S. zygaena*. Because previously reported records have disappeared or changed during subsequent dataset revisions, these apparent peaks may not persist in future releases as has evidently happened to reported landings from artisanal fisheries which have been substantially higher for the period of 2015 – 2024 Figure 2a) compared to Figure 3a). The resulting discrepancies demonstrate that retrospective reclassification among species, genus and family codes materially changes estimated hammerhead landings.



**Figure 3:** Reported landings of Hammerhead sharks from artisanal (a) and industrial (b) fleets between 2015 and 2024; based on data from Dataset IOTC-2026-WPEB22-DATA03 up to 2024 which includes no landings at family level of Sphyrnidae; due to the huge differences between years and species the species data are displayed on 2 axes for clarity:

**Artisanal (a)** displays *S. lewini* and *S. zygaena* on the primary axis and *S. mokarran* and *Sphyrna spp.* on the secondary axis in green.

**Industrial (b)** displays *Sphyrna spp.* on the primary axis in blue and all others on the secondary axis in orange

However, both reviewed datasets indicate higher reported landings since 2022, generally around 2,000 mt annually. This may reflect improved species-level reporting by additional CPCs, but it also confirms continuing fishing pressure on highly vulnerable hammerhead species. Persistent retrospective revisions result from the absence of comprehensive binding species-level reporting requirements and continuing poor compliance with IOTC shark-reporting obligations, despite repeated initiatives and capacity-building programmes directed particularly at artisanal fisheries.

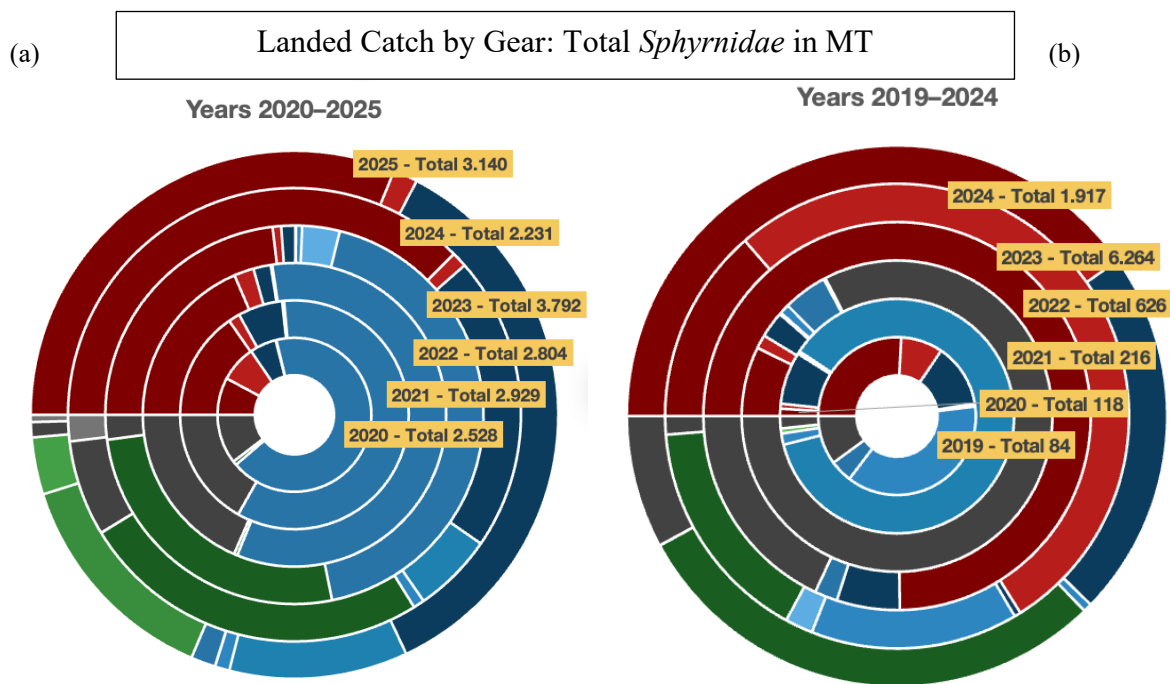
Reliable estimates of total mortality remain unavailable. Discard quantities, release condition and post-release mortality are rarely reported, impairing stock assessments and potentially preventing completion of the planned 2026 indicator assessment for *S. lewini*. Vessels under 24 m from developing coastal CPCs operating exclusively within national EEZs remain subject to reporting exemptions, while artisanal catches are dispersed among numerous small landing sites and frequently recorded under broad local shark categories. Total mortality, particularly of juvenile hammerheads, is therefore likely underestimated (Haque et al. 2021; Thomas et al. 2021; Hartati et al. 2023; Osmaleli et al. 2024; van Beuningen et al. 2026). Misidentification is especially likely where juvenile hammerheads are landed with *E. blochii* and small carcharhinid sharks, or where local names do not correspond to scientific taxa. Consequently, the mortality information available to the IOTC Scientific Committee does not provide a robust estimate of total hammerhead mortality.

### 3.5.4. Gear dependent Mortality of Hammerhead Sharks?

IOTC datasets report gear information for all landings, enabling an estimate of landed catch composition by gear group and year, as shown in Figure 4 for 2019–2025. Total reported Sphyrnidae landings from

artisanal and industrial fleets are combined and treated as 100% per year, allowing comparison of relative gear contributions despite annual variation in reported total amounts. Gear groups and types are colour coded and show that landings historically came mainly from gillnet and longline fisheries, while since 2023 beach seine, purse seine and ringnet fisheries together account for almost one third of reported landings. This may reflect changes in fisheries, reporting CPCs or both. Because discard data and consistent reporting remain limited, this paper does not assess CPC-specific contributions to mortality.

The gear split shows that hammerheads are vulnerable across gear types. Conservation measures should therefore apply to all fisheries and prioritise catch avoidance over minimisation and remediation, consistent with recognised bycatch mitigation approaches (Milner-Gulland et al 2018; Cronin et al 2023), while also requiring mandatory best-handling and release standards to reduce mortality and maximise post-release survival when hammerheads are not retained.



**Figure 4:** Combined reported landings from artisanal and industrial fleets per year split between gear groups and gear types and depicted as percentage of the total amount reported for each year; legend for colour codes for each gear are in Table 5

(a) Dataset IOTC-2026-WPEB22-DATA03 used for 2019 –2024 data and

(b) Dataset IOTC-DATASETS-2026-08-13-RC-RAW-1950-2025 used for 2020 – 2025

Hammerhead sharks are not only caught by gill nets and longlines but likely by a wide range of gear types applied by fisheries fishing in the IOTC area of competence. However, mortality information still relies only on reported landings from fisheries that retain them as bycatch or secondary catch, because discard data remain largely unavailable. The analysis of publicly available IOTC hammerhead landing data thus shows the need for improved species-specific reporting of retained catch and discard reporting, and for improved monitoring of the catch and mortality levels for each species, while at this time no reliable mortality estimates let alone projections are possible.

| LANDED CATCH (MT) PER GEAR AND YEAR - ARTISANAL + INDUSTRIAL |                               |                              |                |                |                |                |                |                |                    |
|--------------------------------------------------------------|-------------------------------|------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------|
| Colour                                                       | Group                         | Gear type                    | 2020           | 2021           | 2022           | 2023           | 2024           | 2025           | Total 2020–2025 MT |
|                                                              | Gillnet gears                 | Gillnet                      | 198            | 449            | 519            | 878            | 835            | 979            | 3,858              |
|                                                              |                               | Gillnet offshore             | 193            | 47             | 59             | 28             | 25             | 47             | 399                |
|                                                              | Longline / Troll line gears   | Coastal longline             | 141            | 185            | 52             | 46             | 470            | 1,110          | 2,004              |
|                                                              |                               | Handline and troll line      | 0.5            | 0.4            | none           | none           | none           | none           | 0.9                |
|                                                              |                               | Longline deep-freezing       | 0.3            | 4              | 2              | 2              | 128            | 344            | 480.3              |
|                                                              |                               | Longline fresh               | 3              | 4              | 3              | 20             | 18             | 28             | 76                 |
|                                                              |                               | Longline targeting swordfish | none           | none           | none           | none           | none           | 0.3            | 0.3                |
|                                                              |                               | Set longline                 | none           | none           | none           | 122            | none           | none           | 122                |
|                                                              |                               | Troll line                   | 1,708          | 1,747          | 1,640          | 1,628          | none           | 47             | 6,770              |
|                                                              | Seine / Ringnet / Trawl gears | Beach seine                  | 21             | none           | none           | 989            | 561            | none           | 1,571              |
|                                                              |                               | Purse seine                  | none           | none           | none           | none           | none           | none           | none               |
|                                                              |                               | Ringnet                      | none           | 0.1            | 10             | 0.1            | none           | 431            | 441.2              |
|                                                              |                               | Ringnet offshore             | none           | none           | none           | none           | 0.2            | 110            | 110.2              |
|                                                              |                               | Trawl                        | 0.8            | 0.3            | none           | 0.1            | none           | none           | 1.2                |
|                                                              | Handline / Harpoon gears      | Handline                     | 262            | 492            | 518            | 80             | 152            | 29             | 1,533              |
|                                                              |                               | Handline and troll line      | 0.5            | 0.4            | none           | none           | none           | none           | 0.9                |
|                                                              |                               | Harpoon                      | none           | none           | none           | none           | 42             | 14             | 56                 |
|                                                              | <b>Total reported catch</b>   |                              | <b>2,728.1</b> | <b>2,929.2</b> | <b>2,803.0</b> | <b>3,793.2</b> | <b>2,231.2</b> | <b>3,186.3</b> | <b>17,671.0</b>    |

**Table 5:** Split of reported catches between gear; IOTC-DATASETS-2026-08-13-RC-RAW-1950-2025 showing 2020 to 2025 data; colour coding per gear type for Figure 4

### 3.5.5. International Trade as a major Driver for Mortality of Hammerhead Sharks

Because most reported landings come from developing coastal CPCs and artisanal or coastal fleets subject to lower IOTC reporting scrutiny, including exemptions from species-level hammerhead reporting in some gillnet and purse-seine fisheries, information on the destination of products is needed to understand catch incentives and the likely effectiveness of additional conservation measures.

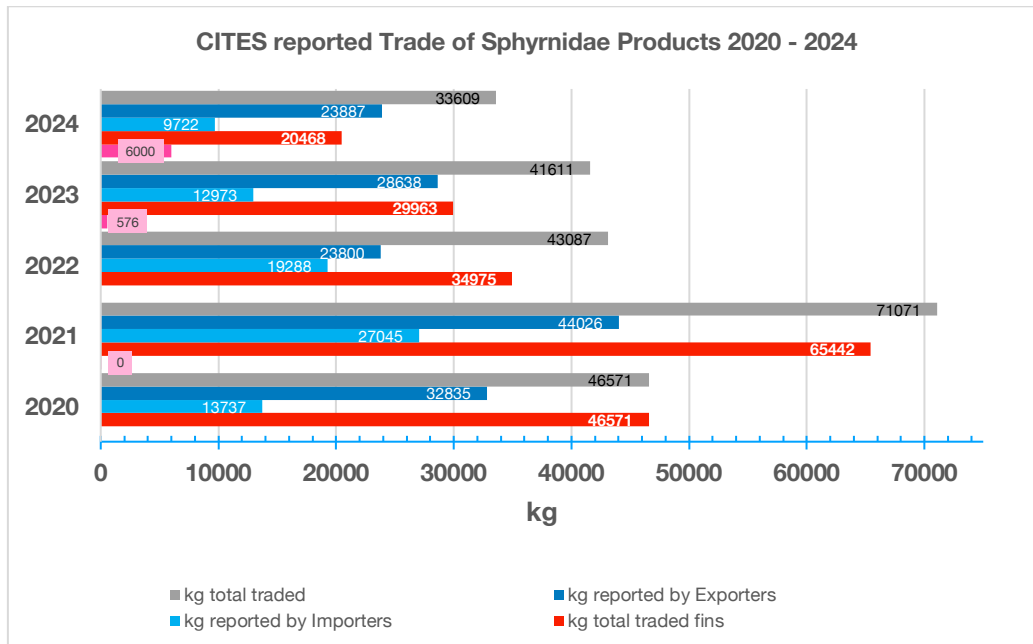
The CITES Trade Database (CITES Trade Database 2026) was therefore searched for reported trade in Appendix II Sphyrnidae products, which require export certification confirming legal acquisition and a science-based non-detriment finding. Table 6 summarises reported exports and imports from 2020–2024, the most recent available period, for CPCs with reported Sphyrnidae landings between 2015 and 2024 at species, genus or family level. Records also include *Eusphyra blochii*, but only for 2024 because its listing became effective only in 2023.

CITES trade data often show discrepancies between importer- and exporter-reported quantities (CITES Database Guide), also evident here, with differences in both directions. Export records were available only from Australia, Indonesia, Oman, Sri Lanka, Kenya, Taiwan, Seychelles, Mauritius and Tanzania; none were found for Mozambique, Madagascar, Malaysia, Comoros or India. Imports were mainly reported by Hong Kong, Singapore, the USA and China, as well as other countries including several in Europe and Switzerland. Table 6 therefore, shows that the database has limited ability to trace exact product destinations, but annual traded quantities of 20–30 MT confirm that hammerhead sharks caught by IOTC fisheries enter international trade in substantial amounts.

| Species                 | Year   | 2020     | 2021     | 2022     | 2023     | 2024     |
|-------------------------|--------|----------|----------|----------|----------|----------|
| <i>Sphyrna lewini</i>   | Export | 6,305.1  | 9,836.8  | 12,103.4 | 5,460.4  | 8,500.7  |
|                         | Import | 7,642.3  | 14,655.9 | 10,281.0 | 12,431.8 | 18,091.8 |
| <i>Sphyrna mokarran</i> | Export | 347.8    | 10,122.1 | 5,812.7  | 6,042.3  | 760.8    |
|                         | Import | 1,080.5  | 12,656.2 | 5,902.7  | 2,655.0  | 2,059.6  |
| <i>Sphyrna zygaena</i>  | Export | 64.6     | 1,454.7  | 842.4    | 1,376.0  | 361.1    |
|                         | Import | 76.0     | 10,113.8 | 7,010.7  | 8,256.7  | 1,735.8  |
| <i>Sphyrna spp.</i>     | Export | 7,019.1  | 5,631.2  | 0.0      | 0.0      | 0.0      |
|                         | Import | 24,036.1 | 6,600.2  | 0.0      | 5,200.0  | 0.0      |
| <i>Eusphyra blochii</i> | Export | n/a      | n/a      | n/a      | 0.0      | 99.1     |
|                         | Import | n/a      | n/a      | n/a      | 0.0      | 2,000.0  |
| <i>Sphyrnidae spp.</i>  | Export | 0.0      | 0.0      | 221.4    | 94.4     | 0.0      |
|                         | Import | 0.0      | 0.0      | 605.4    | 94.4     | 0.0      |

**Table 6:** CITES database downloaded for Sphyrnidae on August 22<sup>nd</sup> filtering for CPCs with reported catch of Sphyrnidae since 2015 (Australia, Comoros, India, Iran, Indonesia, Kenya, Madagascar, Mauritius, Mozambique, Oman, Seychelles, Sri Lanka, Somalia, Tanzania, Taiwan); Imports and exports are pooled across all countries that reported exports to CITES while not all CPCs did report their exports under CITES; all available datasets are in kg and include all available product categories (fins, meat, bones, skins, live, teeth, skulls, bodies) if reported in kg; reports in number of species were not included:

Figure 5 combines trade flows reported as exports and trade flows reported as imports (mostly by Hong Kong) for graphical visualisation of the extent of international trade of shark products and demonstrates that the international trade is clearly dominated by shark fins traded either as dried or without further specification, meaning it could be fresh or frozen. Between 100% and two thirds of the traded products being fins clearly shows that the value of fins from these species in the international fin trade market provides the main incentive of retaining hammerhead sharks in IOTC fisheries. Meat is only reported as a small amount and mainly dominated by exported quantities of *E. blochii* from Australia in 2024, while shark meat may be consumed domestically or be traded on national markets or with neighbouring countries without CITES reporting although all Introductions From the Sea (IFS) of CITES listed sharks also require reporting as exports even if they are landed in the flag country of vessels by which they were caught (Schatz and Kachelriess 2026). However, these data appear to be absent from the CITES database as otherwise trade of substantial amounts of meat or bodies would have been expected.



**Figure 5:** Reported trade of *Sphyrnidae* products in total reported exports and reported imports of all *Sphyrnidae* codes and products are included but only when reported in kg; meat was only reported in 2024 in significant amounts by Australia as the exporter; fin, meat and body data include both reported exports and reported imports combined as imports and exports are mostly not reported in a correlated way.

## 4.0. Discussion and Summary

### 4.1. Summary of Gaps in the Conservation and Management of Hammerhead Sharks at IOTC

Hammerhead sharks have undergone some of the steepest declines among oceanic and coastal sharks and global abundance has fallen sharply as fishing pressure expanded, while the scalloped and great hammerhead shark are assessed as critically endangered and the smooth hammerhead shark as vulnerable. Four *Sphyrnidae* occur in the Indian Ocean, where slow growth, long gestation, migratory behaviour and use of coastal pupping grounds create persistent exposure to both industrial and artisanal fisheries. Species identification is particularly difficult for juveniles and processed fins, making look-alike treatment important for enforceable rules. CITES now regulates trade across the family and CMS Appendix I requires strict protection of scalloped and great hammerheads, but equivalent IOTC catch controls remain absent. The conclusion is that catch avoidance and a precautionary family-level approach are more defensible than waiting for complete stock assessments (Pacoureau et al. 2021; Rigby et al. 2019a; CMS 2026).

Evidence from Bangladesh, India, Indonesia, Kenya, Mozambique and Madagascar consistently shows that coastal landings are dominated by neonates, young-of-the-year and other immature scalloped hammerhead sharks, frequently taken in gillnets, bottom gillnets, longlines and mixed artisanal gears. These catches remove animals before reproduction and indicate repeated fishing within nursery or aggregation areas. Measures at national level differ substantially, several CPCs prohibit retention or at least all trade, while others rely mainly on plans, licensing or general shark rules like finning prohibitions with limited enforcement. Due to the highly migratory behaviour of these sharks and their high vulnerability to various fisheries throughout their lifecycle aligned and combine measures at regional and national level are important, including non-retention and release rules with CPC-led mapping and seasonal or spatial protection of nursery areas, backed by landing-site monitoring (Haque et al. 2021; Thomas et al. 2021; van Beuningen et al. 2026).

IOTC has considered but not adopted hammerhead non-retention proposals, in the past and lacks species- or family-specific measures such as mortality limit, rebuilding objective and mandatory release regime. Resolution 25/08 directs annual review of vulnerable sharks and permits additional species to be added to the utilisation prohibition and requests adding improved safe-handling standards. The Scientific Committee had already recommended at species-level reporting of scalloped, smooth and great hammerheads across all gears, yet no CPC proposal carried that advice into the 2026 Commission meeting. Given unknown stock status, weak discard information and existing international obligations, the Commission should not make protection conditional on a conventional assessment. A realistic first package for adoption in 2027 is therefore non-retention, mandatory live release and updated handling standards (IOTC 2013; IOTC 2025; IOTC SC 2025b).

Public IOTC datasets provide materially different estimates for the same years because records move among species, genus, family and unidentified shark categories when datasets are revised. Artisanal fisheries account for much of the reported catch but vessels below 24 m operating within developing CPC EEZs remain incompletely bound, while discards and release condition are rarely available. Consequently, apparent recent increases in *S. lewini* may partly reflect improved coding rather than a true change in catch, and total hammerhead mortality—especially juvenile mortality—remains underestimated. This uncertainty prevents a credible assessment of fishing impact and should trigger a precautionary approach rather than delay action. Mandatory species-level catch, discard, release-condition and post-release mortality reporting across all gears and fleet sizes should be adopted early and supported by identification tools and verification (IOTC 2015a; IOTC SC 2025a; Geng et al. 2022).

Reported landings were historically dominated by gillnet and longline fisheries, but recent records also attribute substantial shares to beach seines, ringnets and purse-seine-related categories. The changing distribution may reflect both real fishing patterns and reporting changes, yet it confirms that hammerhead interactions are relevant across all gear. At-vessel mortality varies by species, gear configuration, and handling, and bringing the animals onboard can further reduce survival. IOTC should therefore apply rules to every fishery under its mandate and follow the mitigation hierarchy: avoid interactions first, minimise unavoidable capture second, and maximise survival through mandatory release protocols. Gear-specific trials and improved observer or electronic monitoring are essential (Booth et al. 2019; Coelho et al. 2012; Gulak et al. 2015).

CITES records confirm continued international trading of hammerhead shark products, with fins forming most reported trade by weight and therefore providing the clearest commercial incentive for retention. Export and import declarations frequently differ and introductions from the sea are not visible; the available totals therefore cannot be treated as a complete account of products originating in IOTC fisheries. Genetic market surveys also detect scalloped hammerheads and juvenile-derived fins in major trade hubs. Fisheries and trade controls are currently separated even though they describe the same mortality chain. (Fields et al. 2018; Cardenosa et al. 2024; CITES Trade Database 2026).

#### **4.2. Population dynamics and vulnerability of *Sphyrna lewini* to fisheries**

The findings by Kiilu et al (2019) indicate that *Sphyrna lewini* is exposed to substantial fishing pressure in coastal Kenya, with vulnerability arising from the interaction between low biological productivity and recurrent exposure to several fishing gears. The PSA classified *S. lewini* as medium risk in the prawn-trawl, gillnet and ringnet fisheries, while handlines produced a comparatively low-risk score. Importantly, these gear-specific classifications should not be interpreted as evidence of a healthy population. Rather, PSA provides a relative assessment of vulnerability to particular fishing activities, and its interpretation must be considered alongside independent evidence of demographic depletion. The Kenyan PSA results therefore support the conclusion that *S. lewini* warrants precautionary management despite differences in vulnerability among gears.

The highest vulnerability score was recorded for the Malindi–Ungwana Bay prawn-trawl fishery ( $V = 3.10$ ), followed by artisanal gillnets ( $V = 2.91$ ) and ringnets ( $V = 2.77$ ). The comparatively lower handline score ( $V = 2.38$ ) suggests that the magnitude of interaction is strongly influenced by gear characteristics and fishing operation. Prawn trawling is of particular concern because *S. lewini* occurs in the shallow coastal environment sampled by this fishery. Historical trawl observations recorded *S. lewini* as the dominant shark species in the semi-industrial prawn fishery, with 78 individuals measuring 46 - 63.7 cm TL, demonstrating that this fishery interacts predominantly with small individuals.

The demographic evidence provides stronger indication of population-level concern than the PSA classification alone. More than 90% of *S. lewini* landed in the Kenyan artisanal fishery were reported to be below the size at maturity, while the available length-frequency data showed that all sampled artisanal specimens were smaller than the maturity threshold. This predominance of immature individuals indicates that fishing mortality is disproportionately affecting individuals before they contribute substantially to reproduction. The extremely low spawning-potential ratio estimated for *S. lewini* ( $SPR \approx 1.0\%$ ), together with an estimated  $F/M > 2$ , provides additional evidence of severe demographic depletion, although these length-based estimates should be interpreted within the assumptions and limitations of the assessment method.

The observed pattern is consistent with the broader trajectory of elasmobranch exploitation in Kenya. Reconstructed national landings increased to approximately 3,100 t in the late 1970s but subsequently declined to approximately 640 t in the mid-1980s and 490 t in the early 2000s, followed by a temporary increase around 2014 and a subsequent decline to approximately 750 t by 2020. Although these data represent sharks and rays collectively and therefore cannot be attributed directly to *S. lewini*, the decline in large-bodied coastal sharks and increasing dominance of smaller species provide contextual evidence of sustained fishing pressure and possible serial depletion. Species-level interpretation nevertheless remains constrained by the historical aggregation of landings into broad categories such as “sharks” and “rays.”

The concentration of juvenile *S. lewini* in coastal fisheries has important management implications. Artisanal fisheries operate extensively in shallow coastal habitats, and gillnets and related gears can retain immature sharks. The documented capture of predominantly immature *S. lewini* in Kenyan artisanal fisheries has previously been interpreted as evidence of growth and recruitment overfishing. Thus, management focused only on reducing total fishing effort may be insufficient if fishing continues to overlap spatially with habitats used by juvenile hammerheads. Protection of important juvenile habitats, combined with gear-specific bycatch mitigation, would provide a more direct mechanism for reducing mortality before maturity.

A further concern is that coastal depletion does not necessarily eliminate fishing pressure on the remaining population. Industrial fisheries operating offshore continue to interact with pelagic sharks, while migratory species can move across national jurisdictional boundaries. Consequently, effective conservation of *S. lewini* requires coordination between coastal fisheries management and regional fisheries governance. Kenya has already engaged with regional tuna-fisheries measures and international conservation instruments, but the thesis identifies continuing limitations in species-specific regulations, landing-site identification, monitoring and enforcement.

Overall, the evidence suggests that *S. lewini* in Kenyan waters is experiencing substantial demographic pressure despite moderate gear-specific PSA scores. The convergence of high juvenile representation, very low estimated spawning potential, multi-gear interactions and long-term declines in the broader coastal elasmobranch assemblage supports a precautionary management approach. Priority should therefore be given to reducing mortality of immature hammerheads in coastal fishing grounds, improving species-specific monitoring, and integrating PSA with length-based demographic indicators rather than relying on either assessment approach independently.

## 5.0. Recommendations

Based on the unsustainable exploitation levels of *S. lewini* as evidenced from the presented studies, management should adopt a precautionary approach that prioritizes reducing fishing mortality, the following measures are recommended.

1. Adopt a precautionary non-retention rule for all *Sphyrnidae* for the IOTC area of competence including prohibitions on transshipment, landing, storage and sale by including all *Sphyrnidae* in §3 of Resolution 25/08.
2. Require CPCs to map nursery and pupping areas, implement spatial or seasonal protection where juvenile catch peaks occur and report effectiveness back to the Scientific Committee.
3. Amend Resolution 25/08 to update Annex III requiring Minimum Standards for gear specific live release and safe handling practices as developed by the WPEB in 2025 in the Appendix XVVII. These include inter alia avoid bringing any shark bycatch on board, unless unavoidable and in such case releasing them back to the water within less than 5 min applying the safe handling practices as advised depending on the gear, vessel size and size of the animal.
4. Update Resolution 15/01 to make species-level reporting of all hammerhead shark catch and discards, including release condition and estimated post-release mortality mandatory for all gears and fleets.
5. Adopt an across-gear five-year hammerhead recovery plan applying the principles of the “Avoid–Minimise–Remediate–Compensate and Research Hierarchy” including a research program to identify migratory pathways for specific protection and to develop gear / fishery specific solutions to minimise bycatch and mortality of hammerheads and to inform additional mitigation measures in the future.

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