Green Engineering: Journal of Engineering and Applied Science

E-ISSN: 3063-6833
P-ISSN: 3063-6841

Research Article

Blue Shark Bycatch and Conservation Gaps in Indonesian and Eastern Indian Ocean Fisheries: A Systematic Review of Spatial Risk, Fisheries Pressure, and Management Evidence

Dewi Shinta Achmad

[1] Aquaculture, Faculty of Science and Technology, Muhammadiyah University of Gorontalo, Indonesia
* Corresponding Author: e-mail : dewishintaachmad@umgo.ac.id

Abstract. Blue sharks (Prionace glauca) are among the most frequently encountered pelagic sharks in oceanic fisheries, yet their conservation risk remains unevenly understood in Indonesian and eastern Indian Ocean waters. This systematic literature review synthesizes evidence on spatial risk, fisheries pressure, bycatch exposure, biological vulnerability, and conservation gaps relevant to blue shark management. Following a systematic search and thematic extraction strategy, the review organized peer-reviewed studies into four evidence domains: spatial distribution and habitat suitability; longline fisheries interaction and bycatch exposure; biological vulnerability, mortality, and population-level risk; and conservation measures, monitoring, and governance gaps. The synthesis shows that blue shark risk is not reducible to species presence or catch frequency. Instead, risk emerges from dynamic overlap between environmentally structured habitat, pelagic longline effort, demographic vulnerability, uncertain post-release survival, and weak species-specific monitoring. Evidence from Indian Ocean and Indo-Western Pacific studies indicates important seasonal and demographic variation, but Indonesia-specific data remain limited. This gap constrains stock assessment, spatial planning, and evaluation of bycatch mitigation. Conservation measures are further weakened where static protected areas, incomplete observer coverage, and trade monitoring are not integrated with regional fisheries governance. The review concludes that blue shark conservation in Indonesian and eastern Indian Ocean fisheries requires a risk-based framework linking habitat modelling, CPUE standardization, observer and electronic monitoring, post-release mortality studies, gear mitigation, and transboundary management under regional fisheries organizations.

Keywords: Blue Shark; Bycatch Risk; Eastern Indian Ocean; Fisheries Management; Prionace Glauca.

Received: Januari 21, 2026
Revised: Marech 24, 2026
Accepted: May 11, 2026
Publish: July 24, 2026
Curr. Ver.: July 24, 2026

Copyright: © 2025 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (https://creativecommons.org/licenses/by-sa/4.0/)

1. Introduction

Oceanic sharks are increasingly recognized as sentinels of pelagic ecosystem health and as species whose population trajectories are strongly shaped by industrial fishing pressure. The blue shark (Prionace glauca) is one of the most widely distributed and frequently captured pelagic sharks, occurring across tropical, subtropical, and temperate oceans and interacting extensively with tuna and swordfish fisheries. Its broad geographic range and relatively high encounter frequency have sometimes encouraged the perception that blue shark conservation is less urgent than that of rarer pelagic sharks. However, recent ecological, fisheries, and genetic evidence indicates that this interpretation is too simplistic. Blue shark risk is structured by size, sex, seasonal habitat use, oceanography, fishing effort, gear selectivity, post-capture fate, and management coverage (Druon et al., 2022; Coelho et al., 2018; Maxwell et al., 2019).

Blue shark conservation is especially challenging because the species occupies dynamic pelagic habitats that rarely align neatly with fixed jurisdictional or protected-area boundaries. Habitat suitability varies with temperature, productivity, fronts, oxygen conditions, and prey fields, while vertical movement can alter vulnerability to longline gear in ways that depend on

water-column structure and diel behaviour (Vedor et al., 2021; Elliott et al., 2022). Seasonal distribution modelling for the Indo-Western Pacific further indicates that high-suitability habitats are not fully covered by existing conservation areas, supporting the argument that conservation gaps are spatial, temporal, and institutional rather than only biological (Zhang et al., 2024).

The fisheries dimension of blue shark risk is equally important. Industrial and semi-industrial pelagic longline fisheries produce repeated interactions with blue sharks, and bycatch outcomes are shaped by hook type, bait, leader material, soak time, handling practice, retention decisions, and discard mortality. Studies of shark discards and retention policies show that landings alone cannot capture true fishing impact, because many sharks are released, discarded, retained opportunistically, or reported inconsistently (Jordaan et al., 2020; Gilman et al., 2016; Campana et al., 2016). Global longline analyses demonstrate that shark interactions cluster into identifiable hotspots, emphasizing that fishing pressure must be evaluated spatially rather than treated as a uniform ocean-basin phenomenon (Burns et al., 2023).

Indonesia and the eastern Indian Ocean represent a strategically important but under-synthesized context for blue shark conservation. Indonesia is a major maritime and fisheries nation positioned at the interface of tropical Indo-Pacific and Indian Ocean pelagic systems, including tuna fisheries that may overlap with blue shark habitat. Yet the blue shark evidence base remains dominated by global, Atlantic, Pacific, Mediterranean, and broad Indian Ocean studies. Indian Ocean observer and stock-assessment work highlights data limitation, demographic variability, and uncertainty in stock status (Huynh et al., 2025), while age and growth research provides essential life-history inputs for assessment but remains insufficiently connected to Indonesia-specific fisheries monitoring (Andrade et al., 2019).

Conservation gaps therefore need to be understood as mismatches between risk and response. These gaps include limited species-specific bycatch reporting, uneven observer coverage, incomplete post-release mortality estimates, weak integration of habitat models into fisheries management, uncertain population structure, and limited traceability in shark product supply chains (Fields et al., 2018; Cardeñosa et al., 2020; Alvarenga et al., 2024). For highly migratory sharks, static marine protected areas may contribute to conservation only when combined with fisheries controls, dynamic spatial management, regional coordination, and reliable monitoring (Gilman et al., 2020; Shea et al., 2023).

This systematic literature review addresses these issues by synthesizing evidence on blue shark spatial risk, fisheries pressure, bycatch exposure, biological vulnerability, and conservation gaps relevant to Indonesian and eastern Indian Ocean fisheries. The review asks: what evidence exists on blue shark distribution and habitat risk in the Indian Ocean and adjacent Indonesian waters; how pelagic fisheries, especially longlines, create bycatch exposure; which biological and mortality processes affect vulnerability; and what conservation, monitoring, and governance gaps remain. The contribution of the review is an integrated spatial-risk and governance-gap framework that translates fragmented blue shark literature into priorities for data-limited and transboundary fisheries management.

2. Methods

Search Strategy

This review followed systematic-review logic to identify, screen, extract, and synthesize literature relevant to blue shark bycatch and conservation in Indonesian and eastern Indian Ocean fisheries. The reporting structure was informed by PRISMA 2020, which emphasizes transparent documentation of why a review was conducted, what was done, and what was found (Page et al., 2021). Because the evidence base includes ecological modelling, fisheries observer analyses, biological studies, genetic studies, bycatch mitigation experiments, trade monitoring, and policy-related research, guidance on review typologies and evidence mapping was also considered to ensure that the synthesis remained systematic while accommodating heterogeneous study designs (Grant and Booth, 2009; Tricco et al., 2018; Peters et al., 2024).

The search strategy was organized around four concept blocks: species, geography, fisheries interaction, and conservation or risk. The species block included “blue shark” and “Prionace glauca.” The geographic block included “Indian Ocean,” “eastern Indian Ocean,” “Indonesia,” “Indonesian waters,” “Indo-Pacific,” and related regional terms. The fisheries block included “bycatch,” “longline,” “tuna longline,” “pelagic fisheries,” “fishing pressure,” “fishing effort,” “fishing mortality,” “catch,” “CPUE,” and “exploitation.” The conservation

block included "management," "conservation gap," "spatial risk," "habitat suitability," "stock assessment," "vulnerability," "protected area," and "bycatch mitigation." The primary database was Scopus, supported conceptually by known systematic-review standards and reference checking from highly relevant studies. The core search string was: TITLE-ABS-KEY("blue shark")

Eligibility Criteria

Studies were eligible when they provided substantive evidence on blue shark biology, distribution, habitat suitability, movement, fisheries interaction, bycatch, mortality, post-release survival, stock assessment, ecological risk, conservation policy, trade monitoring, or management. Studies were included when they directly addressed blue sharks or provided transferable methods and findings for pelagic shark bycatch and conservation. Studies were excluded if they mentioned blue sharks only incidentally, lacked species-specific information, focused on unrelated taxa without clear relevance, or provided insufficient metadata or methodological detail. Peer-reviewed articles were prioritized, while methodological and governance references were used to strengthen the review framework.

Screening, Selection, and Risk-of-Bias Analysis

Data extraction focused on bibliographic information, region, study type, data source, fisheries gear, ecological or management focus, key findings, indicators used, limitations, and relevance to Indonesian and eastern Indian Ocean waters. Fisheries studies were coded for catch-rate indicators, observer data, effort distribution, gear type, discard or retention information, and mortality estimates. Habitat studies were coded for spatial scale, environmental predictors, modelling approach, validation, and conservation interpretation. Biological studies were coded for life-history parameters, maturity, growth, sex or size structure, stock differentiation, and demographic relevance. The importance of recording modelling choices was informed by evidence that GLM, GLMM, and GEE approaches can yield different interpretations of blue shark catch rates (Coelho et al., 2020), and by guidance for estimating bycatch from sparse observer data (Yin et al., 2024).

Data Extraction and Synthesis Strategy

Quality and relevance appraisal considered sampling design, spatial and temporal coverage, reliability of species identification, observer coverage, analytical transparency, treatment of uncertainty, and transferability to the target region. Tagging studies were interpreted with attention to tag retention and availability bias, while spatial models were assessed for their data inputs, environmental predictors, and management applicability (Nykänen et al., 2018; Mas et al., 2022; Bowlby et al., 2024). The synthesis was thematic rather than meta-analytic because the included literature used heterogeneous outcomes and methods. Four themes structured the results: spatial distribution and habitat-risk evidence; fisheries pressure and bycatch exposure; biological vulnerability and population-level risk; and conservation measures, management evidence, and governance gaps.

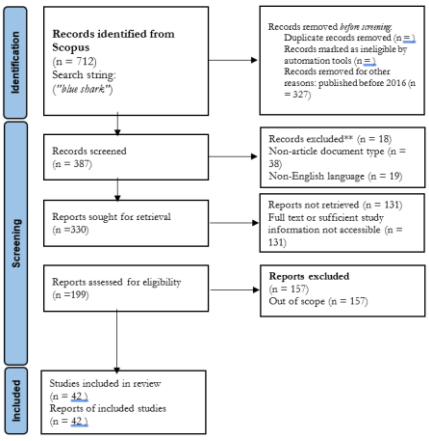

Figure 1. PRISMA flow diagram illustrating identification, screening, eligibility assessment, and final inclusion of literature. The final visual PRISMA diagram should be inserted after screening counts are finalized.

3. Theoretical Background.

Spatial Ecology and Habitat-Risk Frameworks

Blue shark conservation requires a theoretical framework that links spatial ecology, fisheries exposure, life-history vulnerability, and governance capacity. The first component is spatial ecology. Blue sharks are highly mobile pelagic predators, but their distribution is not random. Habitat suitability is shaped by temperature, productivity, prey fields, frontal systems, dissolved oxygen, and vertical water-column structure. Global habitat modelling by size and sex shows that blue shark distributions are demographically differentiated, implying that juveniles, adult males, and adult females may not experience the same exposure to fishing pressure (Druon et al., 2022). Seasonal spatial segregation evidence further supports the need to treat risk as dynamic across time and demographic groups (Maxwell et al., 2019).

Habitat-risk theory is especially relevant for pelagic sharks because vulnerability emerges when suitable habitat overlaps with fishing effort. Blue shark movement and diving behaviour can determine whether individuals encounter longline hooks at particular depths, while behavioural thermoregulation and foraging may drive vertical movements through the water column (Elliott et al., 2022; Watanabe et al., 2021). Diel vertical movement varies with temperature and productivity, meaning that the same gear can produce different capture risk across oceanographic contexts (Vedor et al., 2021). This supports dynamic ocean management, where spatial or depth-related risk mitigation responds to environmental conditions rather than relying only on fixed areas.

Fisheries Pressure, Bycatch Exposure, and Life-History Vulnerability

The second theoretical component is fisheries exposure. Pelagic longline fisheries create recurring blue shark interactions because target species and blue sharks often use overlapping pelagic habitats. Exposure is not equivalent to mortality, however. It includes encounter probability, hooking probability, injury, handling, retention, discarding, at-vessel mortality, and delayed post-release mortality. Bait, hook type, leader material, fishing depth, soak time, and crew handling can all affect bycatch outcomes (Gilman et al., 2020; Huang et al., 2016; Santos et al., 2024). Therefore, blue shark risk should be treated as a chain from encounter to population consequence rather than a simple count of captures.

The third component is life-history and demographic vulnerability. Blue sharks may be more productive than some other oceanic sharks, but their growth, maturity, reproduction, and population structure remain important determinants of resilience. Indian Ocean age and growth studies provide necessary inputs for assessing recovery potential (Andrade et al., 2019), while reproductive and maturity studies show that biological parameters can vary by region and method (Viducic et al., 2022; Carbonara et al., 2026). Regional age and growth studies in the North Pacific, Ecuadorian Pacific, and southern Brazil reinforce the need for local or basin-specific biological parameters rather than uncritical transfer of life-history assumptions (Fujinami et al., 2019; Nicole et al., 2024; Marquez et al., 2024).

Population structure adds another layer of complexity. Blue sharks are highly migratory, but genetic and isotopic evidence suggests that connectivity, residency, and demographic structure may not be uniform across oceans. Genetic studies have alternately suggested large-scale connectivity, regional differentiation, or difficulty detecting structure in a mobile species (Bailleul et al., 2018; Veríssimo et al., 2017; González et al., 2023). Isotopic evidence of regional residency in North Pacific blue sharks challenges the assumption that broad mobility automatically produces panmictic management units (Madigan et al., 2021). For the Indian Ocean, such uncertainty means that stock assessment and conservation should avoid overconfidence in broad spatial assumptions.

Conservation Governance and Evidence Gaps

The fourth component is governance. Blue shark movements cross national jurisdictions, exclusive economic zones, and high seas areas, making management dependent on national regulation, regional fisheries management organizations, observer programs, trade monitoring, and compliance systems. Conservation gaps arise when management instruments do not correspond to ecological risk, fisheries exposure, or demographic vulnerability. DNA-based trade monitoring and shark fin market surveys show that species identity can be obscured after landing, weakening traceability and accountability (Fields et al., 2018; Cardeñosa et al., 2020; Alvarenga et al., 2024). Therefore, blue shark conservation must

integrate fisheries-dependent monitoring, biological evidence, spatial-risk modelling, and trade surveillance.

Taken together, these theoretical components imply that blue shark conservation in Indonesian and eastern Indian Ocean fisheries cannot be reduced to a single solution such as protected-area designation or gear modification. A more defensible framework is risk-based, spatially explicit, and governance-aware. It asks where blue sharks are likely to occur, which fisheries overlap with them, which demographic groups are exposed, what mortality follows capture, whether populations can compensate for removals, and whether institutions can monitor and respond to risk. This framework guides the synthesis in the results section.

4. Results

Spatial Distribution, Habitat Suitability, and Blue Shark Risk Hotspots

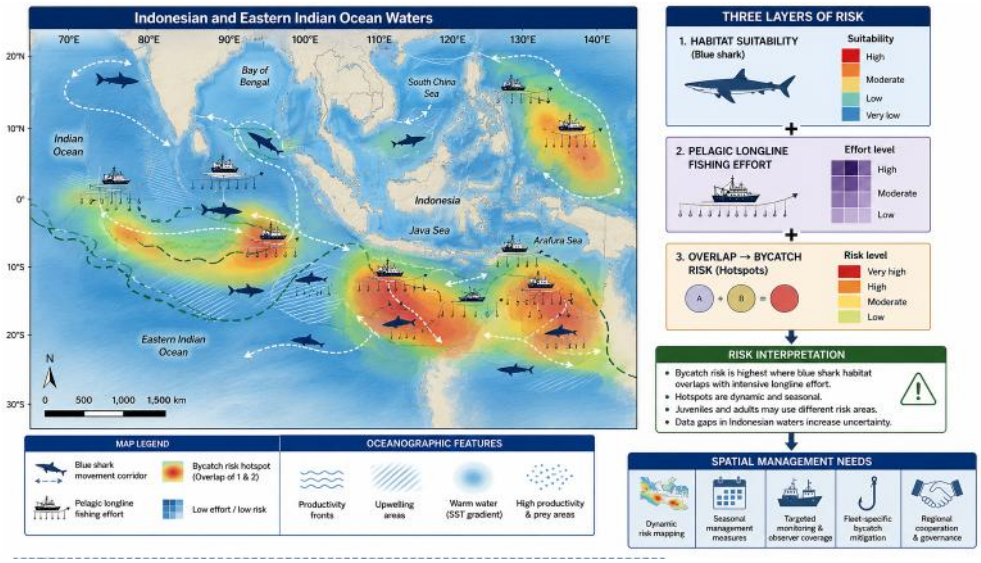

Figure 2. This is a figure. Schemes follow the same formatting.

Figure 1 summarizes the spatial logic underlying blue shark bycatch risk. The figure shows that blue shark risk is generated through the overlap of habitat suitability and fishing effort rather than through species presence alone. Habitat suitability is shaped by dynamic oceanographic conditions, including temperature, productivity, prey availability, and vertical habitat structure. Pelagic longline fishing effort adds a second layer of exposure, especially where tuna and swordfish fishing grounds intersect with blue shark movement corridors. The overlap between these two layers creates bycatch-risk hotspots, which may shift seasonally and differ across demographic groups. This interpretation is important for Indonesian and eastern Indian Ocean waters because local blue shark evidence remains limited, while regional and global studies suggest that habitat-risk models can help identify where monitoring and mitigation should be prioritized. The figure therefore supports a transition from static species-distribution thinking toward dynamic, spatially explicit fisheries-risk assessment.

The first evidence domain shows that blue shark spatial risk is strongly structured by environmental conditions, demographic class, and season. Global and ocean-basin studies consistently indicate that blue sharks do not occupy pelagic space uniformly; instead, their habitat suitability varies with temperature, productivity, prey availability, vertical structure, and demographic status (Druon et al., 2022; Coelho et al., 2018; Maxwell et al., 2019). Indo-Western Pacific modelling is especially important for this review because it shows that seasonal high-suitability areas are not fully represented by existing conservation coverage (Zhang et al., 2024).

Table 1 summarizes ten studies that collectively support a spatial-risk interpretation of blue shark bycatch. Four of the ten entries are directly situated in the Indian Ocean, Indo-Western Pacific, or global longline context, while others provide transferable methods such as telemetry, satellite tagging, climate-vulnerability modelling, and spatial machine learning. The key implication is that Indonesian and eastern Indian Ocean management should prioritize habitat-risk mapping rather than relying only on broad distribution records. The

evidence also suggests that future risk assessments should separate demographic groups where possible because sex- and size-specific habitat use can shape differential exposure

Table 1. This is a table. Tables should be placed in the main text near to the first time they are cited. Consists of three horizontal lines.

References	Region	Method	Key findings	Relevance
Druon et al. (2022)	Global oceans	Large occurrence dataset and environmental modelling	Habitat suitability varied by size and sex; temperature, productivity fronts, and micronekton helped explain distribution.	Provides transferable habitat-risk logic for Indonesian and Indian Ocean pelagic waters.
Zhang et al. (2024)	Indo-Western Pacific	Species distribution modelling	Seasonal blue shark distributions were not fully matched by conservation coverage.	Directly relevant to the Indo-Western Pacific and eastern Indian Ocean interface.
Coelho et al. (2018)	Atlantic and Indian Oceans	Multi-source fisheries and survey records	Records varied by region, season, size, and sex, indicating demographic and spatial heterogeneity.	Supports careful regionalization of basin-scale blue shark assessments.
Huynh et al. (2025)	Indian Ocean	Observer length data and stock-assessment synthesis	Observer data revealed spatial, seasonal, size, and sex-ratio variability and stock uncertainty.	Highly relevant to Indian Ocean and Indonesia-facing fisheries risk.
Maxwell et al. (2019)	Northeast Pacific	Satellite tracking and boosted regression trees	Seasonal segregation by sex and size class produced demographic-specific spatial risk.	Methodological model for dynamic management in data-poor regions.
Vandeperre et al. (2016)	North Atlantic	Telemetry and habitat inference	Juvenile blue sharks used essential pelagic habitats linked to survival and recruitment.	Supports identification of juvenile-use areas in future Indian Ocean studies.
Vedor et al. (2021)	Global/oceanic context	Climate-vulnerability modelling	Climate-driven deoxygenation may elevate fishing vulnerability by compressing habitat.	Highlights the need to consider future environmental change in risk models.
Elliott et al. (2022)	Southwest Pacific	Satellite tagging	Movement and diving behaviour showed how habitat use influences exposure to fishing gears.	Supports integration of tagging and fisheries data in Indonesia.
Burns et al. (2023)	Global longline fisheries	Machine learning and RFMO data	Longline shark interaction hotspots occurred across ocean basins and were strongly spatial.	Provides a model for identifying priority monitoring zones.
Xia et al. (2025)	Western and Central Pacific	Longline bycatch spatial analysis	Shark bycatch distribution varied spatially and temporally across longline fisheries.	Relevant analog for dynamic bycatch management in tuna fisheries.

Fisheries Pressure, Longline Interaction, and Bycatch Exposure

The second evidence domain confirms that pelagic longline fisheries are the central pathway through which blue sharks interact with fisheries. Blue sharks are repeatedly reported in fisheries targeting tuna and swordfish, but the meaning of bycatch differs across studies because some sharks are discarded, some released, some retained, and some enter trade pathways (Coelho et al., 2018; Jordaan et al., 2020). Consequently, fisheries pressure should be defined broadly to include fishing effort, CPUE, hooking, at-vessel mortality, post-release survival, discard rate, and reporting quality.

Table 2 synthesizes ten studies on fisheries pressure and bycatch exposure. The studies show that operational factors such as bait, hook type, handling, retention bans, and observer

coverage can affect catch composition and mortality outcomes (Gilman et al., 2016; Gilman et al., 2020; Campana et al., 2016; Massey et al., 2022). Methodological evidence also shows that sparse observer data can still generate annual bycatch estimates when treated through structured estimation workflows (Yin et al., 2024). For Indonesia and the eastern Indian Ocean, this indicates that monitoring design is not a secondary technical issue but a core determinant of conservation knowledge.

Table 2. Essential summary of findings on fisheries pressure, longline interaction, and blue shark bycatch exposure.

References	Fishery/Gear	Region	Key findings	Management relevance
Coelho et al. (2018)	Pelagic longline and survey data	Atlantic and Indian Oceans	Blue sharks were frequently captured in pelagic fisheries targeting tuna and swordfish.	Longline fisheries are central to blue shark exposure.
Jordaan et al. (2018)	Pelagic longliners	Southern Africa	Reporting inconsistency and market demand affected abundance indices.	Monitoring quality strongly affects fisheries interpretation.
Jordaan et al. (2020)	Selective and mixed-species longlines	Pelagic fisheries	Discard patterns varied across fisheries and cannot be inferred from landings alone.	Discard and release data are essential for estimating mortality.
Gilman et al. (2016)	Pelagic longline fishery	Palau	A shark-retention ban affected standardized catch and survival rates.	Regulations must be evaluated with catch and survival data.
Campana et al. (2016)	Pelagic longline fishery	Canada/North Atlantic	Hooking, discards, and post-release mortality influenced realized bycatch impact.	Release policies should consider delayed mortality.
Gilman et al. (2020)	Pelagic longline fisheries	Global synthesis	Bait type influenced species selectivity in longline fisheries.	Operational gear choices may reduce shark bycatch.
Massey et al. (2022)	Monitored longline experiments	Pelagic fisheries	At-vessel mortality was influenced by capture and handling conditions.	Handling protocols and fishing practices are mitigation priorities.
Carbonara et al. (2023)	Drifting longlines	South Adriatic Sea	Circle hooks modified target and bycatch outcomes.	Hook design can be tested as a mitigation option.
Doherty et al. (2022)	Tuna longline fishery	Pelagic fisheries	A shark bycatch mitigation device was experimentally evaluated.	Technological solutions require field validation.
Yin et al. (2024)	Observer-data fisheries	General fisheries context	Sparse observer data can be converted into annual bycatch estimates through structured workflows.	Highly relevant for data-limited monitoring in Indonesia.

Biological Vulnerability, Mortality, and Population-Level Risk

The third evidence domain links capture exposure with biological vulnerability and population-level consequences. Blue sharks may be encountered more frequently than many pelagic sharks, but their conservation risk depends on growth, maturity, reproductive output, demographic structure, population connectivity, and mortality after capture. Indian Ocean age and growth data are important because they provide region-specific parameters for assessment (Andrade et al., 2019), while observer data reveal demographic patterns and assessment uncertainty in Indian Ocean blue sharks (Huynh et al., 2025).

Table 3 presents ten studies that clarify biological vulnerability and mortality. Age and growth studies from multiple regions show that life-history estimates vary and should not be transferred uncritically across ocean basins (Fujinami et al., 2019; Nicole et al., 2024; Marquez

et al., 2024). Genetic and isotopic studies challenge simple assumptions about unrestricted population mixing, demonstrating that highly migratory sharks may still require regional management units (Bailleul et al., 2018; González et al., 2023; Madigan et al., 2021). These findings imply that blue shark conservation in Indonesia should include biological sampling and stock-structure research, not only catch reporting.

Table 3. Essential summary of findings on biological vulnerability, mortality, and population-level risk of blue sharks.

References	Focus	Region	Key findings	Risk interpretation
Huynh et al. (2025)	Population structure and stock uncertainty	Indian Ocean	31,404 observer length records showed demographic variation and declining fork length over time.	Direct evidence of data-limited Indian Ocean stock-assessment needs.
Andrade et al. (2019)	Age and growth	Indian Ocean	Provided region-specific growth parameters for blue sharks.	Essential for productivity and stock-assessment inputs.
Viducic et al. (2022)	Reproduction	North Atlantic	Documented reproductive characteristics relevant to maturity and productivity.	Supports assessment of resilience under fishing mortality.
Fujinami et al. (2019)	Age and growth	Western North Pacific	Provided region-specific age and growth estimates.	Shows need for regional life-history data.
Nicole et al. (2024)	Age and growth	Ecuadorian Pacific	Bayesian multimodel approach represented uncertainty in growth estimation.	Useful for data-limited biological modelling.
Bailleul et al. (2018)	Population genetics	Global	Suggested large-scale panmixia or genetic lag-time effects.	Warns against simple assumptions about stock connectivity.
González et al. (2023)	Population genetics	Southeastern Pacific/global	Examined regional genetic patterns and global phylogeography.	Supports evaluation of regional management units.
Dolfo et al. (2024)	Demographic history and effective size	Mediterranean Sea	Revealed population-structure and demographic insights for a vulnerable regional population.	Shows conservation relevance of genomic approaches.
Madigan et al. (2021)	Movement and residency	North Pacific	Isotopic tracers suggested limited trans-oceanic movement and regional residency.	Challenges assumptions of fully mixed ocean-basin populations.
Massey et al. (2022)	At-vessel mortality	Pelagic longline fisheries	Operational and handling drivers affected mortality.	Connects capture process to population-level risk.

Conservation Measures, Management Evidence, and Governance Gaps

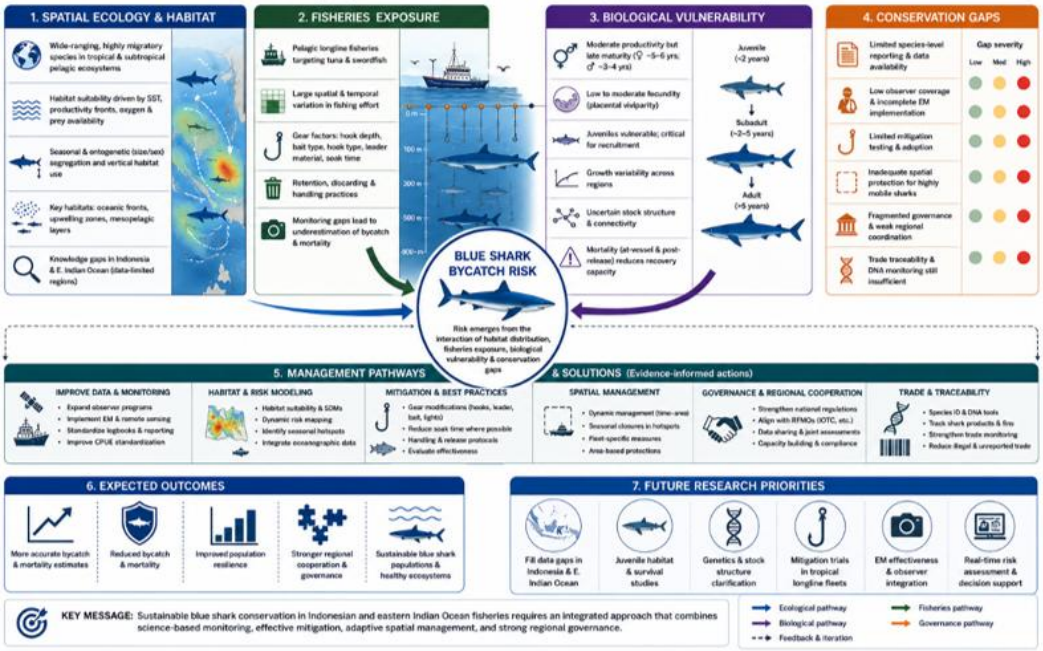

Figure 2. Conservation Measures, Management Evidence, and Governance Gaps.

Figure 6 translates the review findings into a conservation-gap framework. It shows that blue shark management gaps occur at multiple levels, from data collection to regional governance. Data gaps include limited Indonesia-specific records, weak biological sampling, uncertain mortality estimates, and unresolved stock structure. Monitoring gaps arise when observer coverage, logbooks, electronic monitoring, and species-specific reporting are insufficient to estimate true bycatch and mortality. Mitigation gaps occur when gear modifications, handling protocols, or post-release survival measures are not tested or implemented across relevant fisheries. Governance gaps reflect the mismatch between the transboundary movement of blue sharks and fragmented national or regional management systems. The figure also identifies corresponding management pathways, including standardized monitoring, habitat-risk modelling, dynamic spatial management, bycatch mitigation, trade traceability, and regional cooperation. This framework supports the review's central conclusion that blue shark conservation in Indonesian and eastern Indian Ocean waters requires coordinated action across science, fisheries operations, and policy.

The fourth evidence domain identifies conservation gaps across spatial protection, monitoring, trade surveillance, precautionary management, and participatory bycatch mitigation. The available evidence shows that conservation measures often do not fully align with blue shark habitat dynamics or fisheries exposure. Seasonal conservation-gap modelling in the Indo-Western Pacific and mortality evidence from shark sanctuaries both indicate that protected-area designation is not sufficient unless it is connected to fisheries effort, enforcement, and bycatch monitoring (Zhang et al., 2024; Shea et al., 2023).

Table 4 summarizes ten management-relevant studies. The evidence indicates three recurring gaps: limited alignment between spatial protection and dynamic pelagic habitat, incomplete fisheries monitoring and stock assessment, and weak traceability in shark trade pathways (Huynh et al., 2025; Fields et al., 2018; Cardeñosa et al., 2020; Alvarenga et al., 2024). The table also shows that precautionary management and fisher knowledge can support decision-making where data remain incomplete (Koehler et al., 2022; Roberson et al., 2025). For Indonesian and eastern Indian Ocean fisheries, these findings support a governance strategy that connects observer data, electronic monitoring, mitigation experiments, trade surveillance, and regional fisheries coordination.

Table 4. Essential summary of findings on blue shark conservation measures, management evidence, and governance gaps.

References	Management focus	Region/Scale	Key findings	Identified implication
Zhang et al. (2024)	Conservation-gap assessment	Indo-Western Pacific	High-suitability habitats were not fully protected by existing areas.	Spatial protection should be seasonally adaptive.
Huynh et al. (2025)	Stock and conservation assessment	Indian Ocean	Stock assessment remains uncertain despite observer-derived insights.	Improved observer data and demographic monitoring are needed.
Gilman et al. (2020)	Blue-water MPAs	Large-scale pelagic systems	MPA effects require evaluation against mobile species and fisheries distributions.	MPAs should be integrated with fisheries management.
Shea et al. (2023)	Shark sanctuaries and mortality	Western Pacific	Longline bycatch mortality occurred even within shark sanctuary contexts.	Spatial protection alone is insufficient.
Kerry et al. (2025)	MPA and former longline fishery	Large-scale MPA	Historical longline activity offers lessons for pelagic protection.	Boundary effects and historical effort should inform MPA design.
Koehler et al. (2022)	Precautionary management	Mediterranean Sea	Precaution is necessary where elasmobranch data are incomplete.	Supports precautionary action in data-limited regions.
Alvarenga et al. (2024)	Trade monitoring	Elasmobranch trade	DNA tools improved monitoring and conservation surveillance.	Species-level traceability should complement fisheries data.
Cardeñosa et al. (2020)	Fin market composition	Mainland China	Retail market surveys revealed multi-species shark fin composition.	Trade data can obscure fishery-specific removals.
Fields et al. (2018)	International shark fin trade	Hong Kong	Retail-market analysis showed diverse shark species in trade.	Monitoring must connect catch, landing, and market chains.
Roberson et al. (2025)	Fisher tactics and bycatch	Fisheries management	Skilled fishers' tactics can inform persistent bycatch challenges.	Participatory mitigation can improve compliance and feasibility.

5. Discussion

The synthesis indicates that blue shark conservation in Indonesian and eastern Indian Ocean fisheries is best understood as an integration problem. Strong evidence exists on blue shark habitat, fisheries exposure, life history, and management tools, but these evidence streams are rarely connected into a regionally operational management framework. Spatial studies show that blue shark habitats are dynamic, demographically differentiated, and environmentally structured; fisheries studies show repeated interaction with pelagic longline gear; biological studies show the importance of growth, maturity, mortality, and population structure; and governance studies show persistent gaps in monitoring, trade traceability, and spatial protection. The main conservation challenge is therefore not simply insufficient information, but insufficient integration of available and emerging evidence.

One major implication is that Indonesia-facing blue shark conservation should move from presence-based to risk-based assessment. Species occurrence records are necessary but insufficient because bycatch risk depends on overlap between habitat suitability and fishing effort. Seasonal distribution and global niche studies indicate that blue sharks can shift across habitats and that different demographic groups may use different portions of the pelagic environment (Druon et al., 2022; Zhang et al., 2024; Maxwell et al., 2019). Dynamic bycatch patterns in longline systems further show that hotspots vary spatially and temporally (Xia et al., 2025). For Indonesia and the eastern Indian Ocean, the priority is to overlay blue shark habitat predictions with tuna longline effort, CPUE, hook-depth information, and seasonal oceanography.

A second implication concerns monitoring quality. Fisheries pressure cannot be interpreted reliably where records are inconsistent, where discards are poorly reported, or where bycatch fate is unknown. Inconsistent reporting and market shifts can distort abundance indices (Jordaan et al., 2018), while shark discard studies show that removals cannot be inferred from landings alone (Jordaan et al., 2020). Sparse observer data can still support annual bycatch estimation when handled systematically (Yin et al., 2024), but this requires standardized data fields, species identification, gear information, effort metrics, and uncertainty reporting. Indonesia's oceanic fisheries would therefore benefit from expanded observer coverage, electronic monitoring, and species-level shark reporting linked to regional databases.

A third implication is that mitigation should be evaluated as an evidence-based portfolio rather than a single technical fix. Gear modifications, hook design, bait type, leader material, light attractors, and bycatch mitigation devices have all been tested in different longline contexts (Huang et al., 2016; Gilman et al., 2020; Carbonara et al., 2023; Doherty et al., 2022; Santos et al., 2024; Afonso et al., 2021). However, some interventions may have uncertain or limited effects, as shown by evidence that ferrite magnets did not deter blue sharks from bait strikes (Lucas et al., 2025). This means that mitigation in Indonesian and eastern Indian Ocean fisheries should be experimentally validated under local fleet conditions and evaluated for target-catch retention, shark survival, cost, and fisher compliance.

A fourth implication relates to mortality and vulnerability. Capture frequency is not equivalent to conservation impact unless linked with at-vessel mortality, delayed mortality, life-history parameters, and population status. Monitored longline experiments show that at-vessel mortality is influenced by operational and handling factors (Massey et al., 2022), while post-release mortality evidence demonstrates that release does not guarantee survival (Campana et al., 2016). The Indian Ocean evidence base remains data-limited even though observer data reveal size and sex-ratio patterns and possible changes in fork length (Huynh et al., 2025). Consequently, biological sampling, post-release survival studies, and stock-assessment refinement should be treated as management priorities rather than purely academic needs.

A fifth implication concerns spatial protection. The review suggests that static marine protected areas alone are unlikely to resolve blue shark bycatch risk unless they coincide with dynamic habitat and fishing-effort patterns. Blue-water MPAs can produce ecological responses, but their effectiveness for highly migratory species depends on location, enforcement, fishing displacement, and habitat dynamics (Gilman et al., 2020). Evidence from shark sanctuaries and historical longline activity in protected areas shows that spatial designation may coexist with continuing or displaced bycatch risk (Shea et al., 2023; Kerry et al., 2025). For blue sharks, spatial protection should therefore be complemented by effort controls, dynamic closures, gear rules, release protocols, and monitoring.

Governance gaps are particularly important in Indonesia and the eastern Indian Ocean because blue sharks cross national and regional management boundaries. The Indian Ocean requires coordination among national fisheries agencies, tuna fisheries management systems, market controls, and regional assessment processes. Trade monitoring studies show that species identification can be lost along supply chains, making DNA tools and market surveillance important complements to fisheries observer programs (Fields et al., 2018; Cardeñosa et al., 2020; Alvarenga et al., 2024). Precautionary elasmobranch management is justified when data are incomplete and uncertainty is high (Koehler et al., 2022), especially where bycatch risk is plausible but local estimates remain limited.

The review also highlights the value of fisher knowledge and participatory mitigation. Skilled fishers often understand when, where, and under what conditions shark interactions occur, and such knowledge can help refine mitigation strategies (Roberson et al., 2025). Combined approaches using fisher knowledge and risk assessment can support endangered-

species management where formal monitoring is incomplete (De Santis et al., 2025). In the Indonesian context, integrating fisher observations with observer data, electronic monitoring, and habitat models may accelerate risk identification while improving compliance and practicality.

Several limitations should be recognized. First, the evidence base remains geographically uneven, with many high-quality studies from the Atlantic, Pacific, and Mediterranean rather than Indonesia-specific waters. Second, methods differ across studies, making quantitative meta-analysis inappropriate for the present synthesis. Third, some evidence is transferable only with caution because gear configuration, fleet behaviour, oceanography, and governance capacity vary across regions. Fourth, the review depends on published and indexed literature, which may underrepresent local datasets, agency records, or unpublished observer information. Despite these limitations, the synthesis offers a defensible framework for prioritizing blue shark conservation research and management in the eastern Indian Ocean

6. Conclusion

This review shows that blue shark conservation in Indonesian and eastern Indian Ocean fisheries requires an integrated understanding of spatial risk, fisheries pressure, biological vulnerability, and governance capacity. The literature demonstrates that blue sharks are highly exposed to pelagic longline fisheries, but bycatch risk is not defined by catch frequency alone. It emerges from dynamic overlap between habitat suitability, fishing effort, gear configuration, demographic structure, capture mortality, and post-release survival. Indian Ocean evidence is improving, yet Indonesia-specific information remains limited, particularly for observer coverage, CPUE standardization, size and sex composition, mortality estimation, and spatial habitat-risk modelling. The review also shows that conservation gaps are institutional as well as ecological. Static protected areas, general shark policies, or retention rules are unlikely to be sufficient unless connected with species-specific reporting, mitigation testing, trade traceability, and regional fisheries governance. Theoretically, the review contributes a spatial-risk and governance-gap framework for highly migratory pelagic sharks in data-limited fisheries. Practically, it identifies priority actions for Indonesia and the eastern Indian Ocean: strengthen monitoring, develop dynamic risk maps, evaluate gear and handling mitigation, improve biological sampling, and align national shark management with Indian Ocean regional fisheries processes. Future research should focus on Indonesia-specific blue shark bycatch, survival, population connectivity, and operational mitigation so that conservation decisions can move from precautionary inference toward evidence-based management.

Declarations

Declaration of Competing Interest: The authors certify that there are no financial conflicts or personal relations that could have influenced the study reported in this paper.

Funding: This research received no funding.

Data availability: Data are available from the corresponding author upon reasonable request.

Declaration of Generative AI and AI-assisted technologies in the writing process: During the preparation of this work, the authors used ChatGPT to enhance the clarity of the writing. After using ChatGPT, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

References

Adams, G. D., Flores, D., Flores, O. G., Aarestrup, K., Svendsen, J. C., & Nasby-Lucas, N. (2016). Spatial ecology of blue shark and shortfin mako in southern Peru: Local abundance, habitat preferences and implications for conservation. Endangered Species Research. https://doi.org/10.3354/esr00744

Afonso, A. S., et al. (2021). The effect of light attractor color in pelagic longline fisheries. Fisheries Research. https://doi.org/10.1016/j.fishres.2020.105822

Alvarenga, M., et al. (2024). Fifteen years of elasmobranchs trade unveiled by DNA tools: Lessons for enhanced monitoring and conservation actions. Biological Conservation. https://doi.org/10.1016/j.biocon.2024.110543

Andrade, I., et al. (2019). Age and growth of the blue shark (Prionace glauca) in the Indian Ocean. Journal of Fish Biology. https://doi.org/10.1111/jfb.14025

Bailleul, D., et al. (2018). Large-scale genetic panmixia in the blue shark (Prionace glauca): A single worldwide population, or a genetic lag-time effect of the grey zone of differentiation? Evolutionary Applications. https://doi.org/10.1111/eva.12591

Barreto, R., et al. (2017). Rethinking use and trade of pelagic sharks from Brazil. Marine Policy. https://doi.org/10.1016/j.marpol.2017.08.016

Besnard, L., et al. (2021). Foraging depth depicts resource partitioning and contamination level in a pelagic shark. Environmental Pollution. https://doi.org/10.1016/j.envpol.2021.117066

Boldrocchi, G., et al. (2021). Data-mining social media platforms highlights conservation action for the Mediterranean critically endangered blue shark Prionace glauca. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.3690

Bowlby, H., et al. (2024). Global habitat predictions to inform spatiotemporal fisheries management. Marine Policy. https://doi.org/10.1016/j.marpol.2024.106155

Burns, E. S., et al. (2023). Global hotspots of shark interactions with industrial longline fisheries. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2022.1062447

Campana, S. E., et al. (2016). Discards, hooking, and post-release mortality of porbeagle, shortfin mako, and blue shark in the Canadian pelagic longline fishery. ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsv234

Carbonara, P., et al. (2023). Mitigating effects on target and by-catch species fished by drifting longlines using circle hooks in the South Adriatic Sea. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2023.1124093

Carbonara, P., et al. (2026). From hormones to habitat: A new framework for assessing maturity in the Central-Eastern Mediterranean blue shark population. Marine Environmental Research. https://doi.org/10.1016/j.marenvres.2025.107745

Cardeñosa, D., et al. (2020). Species composition of the largest shark fin retail-market in mainland China. Scientific Reports. https://doi.org/10.1038/s41598-020-69555-1

Choy, C. A., et al. (2022). What is in your shark fin soup? Probably an endangered shark species and a bit of plastic. Animals. https://doi.org/10.3390/ani12070802

Coelho, R., et al. (2018). Distribution patterns and population structure of the blue shark (Prionace glauca) in the Atlantic and Indian Oceans. Fish and Fisheries. https://doi.org/10.1111/faf.12238

Coelho, R., et al. (2020). Comparing GLM, GLMM, and GEE modeling approaches for catch rates of bycatch species: A case study of blue shark fisheries in the South Atlantic. Fisheries Oceanography. https://doi.org/10.1111/fog.12462

De Santis, V., et al. (2025). Fishers' knowledge and risk assessment: A combined approach to studying endangered species in fisheries. Reviews in Fish Biology and Fisheries. https://doi.org/10.1007/s11160-025-09930-1

Ding, P., et al. (2025). Ontogenetic and sex-specific isotopic niches of blue sharks (Prionace glauca) in the northwestern Pacific. Fishes. https://doi.org/10.3390/fishes10080402

Doherty, P. D., et al. (2022). Efficacy of a novel shark bycatch mitigation device in a tuna longline fishery. Current Biology. https://doi.org/10.1016/j.cub.2022.09.003

Dolfo, G., et al. (2024). New insights into population structure, demographic history, and effective population size of the critically endangered blue shark Prionace glauca in the Mediterranean Sea. PLOS ONE. https://doi.org/10.1371/journal.pone.0305608

Druon, J.-N., et al. (2022). Global-scale environmental niche and habitat of blue shark (Prionace glauca) by size and sex: A pivotal step to improving stock management. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2022.828412

Elliott, S. A. M., et al. (2022). Satellite tags describe movement and diving behaviour of blue sharks Prionace glauca in the southwest Pacific. Marine Ecology Progress Series. https://doi.org/10.3354/MEPS14037

Fields, A. T., et al. (2018). Species composition of the international shark fin trade assessed through a retail-market survey in Hong Kong. Conservation Biology. https://doi.org/10.1111/cobi.13043

French, I., & Wainwright, B. J. (2022). DNA barcoding identifies endangered sharks in pet food sold in Singapore. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2022.836941

Fujinami, Y., et al. (2019). Age determination and growth of the blue shark (Prionace glauca) in the western North Pacific Ocean. Marine and Freshwater Research. https://doi.org/10.1071/MF18160

Gilman, E., et al. (2016). Standardized catch and survival rates, and effect of a ban on shark retention, Palau pelagic longline fishery. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.2599

Gilman, E., et al. (2020). Ecological responses to blue water MPAs. PLOS ONE. https://doi.org/10.1371/journal.pone.0235129

Gilman, E., et al. (2020). Effect of pelagic longline bait type on species selectivity: A global synthesis of evidence. Reviews in Fish Biology and Fisheries. https://doi.org/10.1007/s11160-020-09612-0

Gilman, E., et al. (2024). Evidence from interpretable machine learning to inform spatial management of Palau's tuna fisheries. Ecosphere. https://doi.org/10.1002/ecs2.4751

Gonzalez-Pestana, A., et al. (2016). Shark fisheries in the Southeast Pacific: A 61-year analysis from Peru. F1000Research. https://doi.org/10.12688/F1000RESEARCH.4412.2

González, M. T., et al. (2023). Regional population genetics and global phylogeography of blue shark and shortfin mako. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.3987

Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. Health Information & Libraries Journal, 26(2), 91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x

Howey, L. A., et al. (2017). Biogeophysical and physiological processes drive movement patterns in a marine predator. Movement Ecology. https://doi.org/10.1186/s40462-017-0107-z

Huang, H.-W., et al. (2016). Influence of hook type on catch of commercial and bycatch species in an Atlantic tuna fishery. Marine Policy. https://doi.org/10.1016/j.marpol.2015.12.016

Huynh, Q. C., et al. (2025). Blue shark conservation in the Indian Ocean: Data-limited insights on population structure, distribution, and stock assessments. Global Ecology and Conservation. https://doi.org/10.1016/j.gecco.2025.e03433
Jordaan, G. L., et al. (2018). Effects of inconsistent reporting, regulation changes and market demand on abundance indices of sharks caught by pelagic longliners off southern Africa. PeerJ. https://doi.org/10.7717/peerj.5726
Jordaan, G. L., et al. (2020). Shark discards in selective and mixed-species pelagic longline fisheries. PLOS ONE. https://doi.org/10.1371/journal.pone.0238595
Kerry, C., et al. (2025). The former pelagic longline fishery of a large-scale marine protected area. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.70076
Kindong, R., et al. (2022). How well do catch-only assessment models capture catch time series start years and default life history prior values? Animals. https://doi.org/10.3390/ani12111386
Koehler, H. R., et al. (2022). The application of precaution in elasmobranch conservation and management in the Mediterranean Sea. Marine Policy. https://doi.org/10.1016/j.marpol.2021.104830
Le Croizier, G., et al. (2022). Mercury stable isotopes suggest reduced foraging depth in oxygen minimum zones. Marine Pollution Bulletin. https://doi.org/10.1016/j.marpolbul.2022.113892
Leone, A., et al. (2024). Population genomics of the blue shark, Prionace glauca, reveals different population patterns. Evolutionary Applications. https://doi.org/10.1111/eva.70005
Li, Y., et al. (2023). Blue shark (Prionace glauca) distribution in the Pacific Ocean: A look at core habitat and environmental drivers. Water. https://doi.org/10.3390/w15071324
Lima, F. D., et al. (2023). Effects of gear modifications in a North Atlantic pelagic longline fishery: Target, bycatch and vulnerable species. PLOS ONE. https://doi.org/10.1371/journal.pone.0292727
Lucas, J., et al. (2025). Ferrite magnets do not deter blue sharks (Prionace glauca) from bait strikes. Fisheries Research. https://doi.org/10.1016/j.fishres.2025.107561
Madigan, D. J., et al. (2021). Isotopic tracers suggest limited trans-oceanic movements and regional residency in North Pacific blue sharks. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2021.653606
Marquez, J. F., et al. (2024). Size structure, age, and growth of the blue shark, Prionace glauca, in southern Brazil. Fisheries Research. https://doi.org/10.1016/j.fishres.2024.106970
Mas, F., et al. (2022). Shedding rates and retention performance of conventional dart tags in large pelagic sharks. Fisheries Research. https://doi.org/10.1016/j.fishres.2022.106462
Massey, B. R., et al. (2022). Drivers of at-vessel mortality of the blue shark and oceanic whitetip shark assessed from monitored pelagic longline experiments. Canadian Journal of Fisheries and Aquatic Sciences. https://doi.org/10.1139/cjfas-2021-0273
Maxwell, S. M., et al. (2019). Seasonal spatial segregation in blue sharks by sex and size class in the Northeast Pacific Ocean. Diversity and Distributions. https://doi.org/10.1111/ddi.12941
Nikolic, N., et al. (2023). Stepping up to genome scan allows stock differentiation in the worldwide distributed blue shark. Molecular Ecology. https://doi.org/10.1111/mec.16822
Nunes, D. M., et al. (2019). Survivorship of species caught in a longline tuna fishery in the western equatorial Atlantic. Latin American Journal of Aquatic Research. https://doi.org/10.3856/vol47-issue5-fulltext-9
Nykänen, M., et al. (2018). Using tagging data and aerial surveys to incorporate availability bias in the abundance estimation of blue sharks. PLOS ONE. https://doi.org/10.1371/journal.pone.0203122
Page, M. J., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71
Parra, H., et al. (2023). The Portuguese industrial pelagic longline fishery in the Northeast Atlantic. Fisheries Research. https://doi.org/10.1016/j.fishres.2023.106730
Peters, M. D. J., et al. (2024). Scoping reviews. In JBI Manual for Evidence Synthesis. JBI. https://doi.org/10.46658/JBIMES-24-09
Piovano, S., et al. (2017). Effects of a hook ring on catch and bycatch in a Mediterranean swordfish longline fishery. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.2689
Roberson, L. A., et al. (2025). Opportunity to leverage tactics used by skilled fishers to address persistent bycatch challenges. Fish and Fisheries. https://doi.org/10.1111/faf.12873
Santana-Morales, O., et al. (2020). Artisanal elasmobranch fisheries of northwestern Baja California, Mexico. Ciencias Marinas. https://doi.org/10.7773/cm.v46i1.3023
Santos, M. N., et al. (2024). Leader material and bait effects on target and bycatch species caught in a pelagic longline fishery. Fisheries Research. https://doi.org/10.1016/j.fishres.2024.107093
Shea, S. K. H., et al. (2023). Quantifying longline bycatch mortality for pelagic sharks in western Pacific shark sanctuaries. Science Advances. https://doi.org/10.1126/sciadv.adg3527
Tricco, A. C., et al. (2018). PRISMA extension for scoping reviews: Checklist and explanation. Annals of Internal Medicine. https://doi.org/10.7326/M18-0850
Vandeperre, F., et al. (2016). Essential pelagic habitat of juvenile blue shark (Prionace glauca) inferred from telemetry data. Limnology and Oceanography. https://doi.org/10.1002/lno.10321
Vedor, M., et al. (2021). Climate-driven deoxygenation elevates fishing vulnerability for the ocean's widest ranging shark. eLife. https://doi.org/10.7554/eLife.62508
Veríssimo, A., et al. (2017). World without borders: Genetic population structure of a highly migratory marine predator, the blue shark. PeerJ. https://doi.org/10.7717/peerj.4112
Viducic, K., et al. (2022). Reproductive characteristics for the blue shark (Prionace glauca) in the North Atlantic Ocean. Fishery Bulletin. https://doi.org/10.7755/FB.120.1.3

Watanabe, Y. Y., et al. (2021). Behavioural thermoregulation linked to foraging in blue sharks. Marine Biology. https://doi.org/10.1007/s00227-021-03971-3

Xia, Y., et al. (2025). The spatial distribution dynamics of shark bycatch by the longline fishery in the western and central Pacific Ocean. Journal of Marine Science and Engineering. https://doi.org/10.3390/jmse13020315

Yin, Y., et al. (2024). A roadmap for generating annual bycatch estimates from sparse at-sea observer data. ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsae110

Yokoi, H., et al. (2017). Impact of biology knowledge on the conservation and management of large pelagic sharks. Scientific Reports. https://doi.org/10.1038/s41598-017-09427-3

Zhang, Y., et al. (2024). Seasonal distribution patterns and conservation gaps of blue sharks in the Indo-Western Pacific Ocean. Diversity and Distributions. https://doi.org/10.1111/ddi.13828