

## PERSPECTIVE OPEN ACCESS

# Applying the Key Biodiversity Area Standard to Important Sites for Sharks

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**Received:** 27 August 2024 | **Revised:** 23 April 2025 | **Accepted:** 29 May 2025

**Funding:** The Important Shark and Ray Areas project is funded by the Shark Conservation Fund, a philanthropic collaborative pooling expertise and resources to meet the threats facing the world's sharks and rays. The Shark Conservation Fund is a project of Rockefeller Philanthropy Advisors.

**Keywords:** conservation planning | Global Biodiversity Framework | Important Shark and Ray Areas | ISRAs | KBAs | marine spatial planning | protected areas

## ABSTRACT

The Kunming-Montreal Global Biodiversity Framework commits nations to conserving 30% of coastal and marine areas, “especially areas of particular importance for biodiversity.” Key Biodiversity Areas (KBAs) provide a standardized approach for recognizing sites holding a significant proportion of the global population or extent of species or ecosystems. However, concerns about the relevance of this approach for broadly distributed and/or highly mobile aquatic vertebrates prompted development of parallel approaches focused on critical areas for life-history processes, including Important Shark and Ray Areas (ISRAs). We examine these approaches and assess whether important areas for sharks, rays, and chimaeras (“sharks”) can qualify as KBAs, by applying the KBA criteria to ISRAs. One fifth of ISRAs could be recognized as KBAs. KBAs could be recognized for three quarters of globally threatened and two thirds of non-threatened restricted-range sharks based on published range maps. For broadly distributed species, additional information (e.g., on aggregations) is needed to recognize important sites as KBAs. Our results show that these approaches are complementary, highlighting the potential for ISRAs to contribute to KBA assessments while ensuring important sites for sharks are mapped and available to inform government actions to meet global commitments for conserving biodiversity in coastal and marine areas.

## 1 | Introduction

Rapid declines in global biodiversity threaten ecosystem functions and services and people who depend on them (IPBES 2019). In response, governments have adopted the Kunming-Montreal Global Biodiversity Framework (GBF; CBD 2022). Much attention has focused on Target 3 (the “30×30” commitment), which requires governments to effectively conserve and manage at least

30% of their terrestrial, inland water, coastal, and marine areas by 2030.

The success of the GBF will depend on whether these efforts encompass areas that contribute significantly to the global persistence of biodiversity (Plumptre et al. 2024). Indeed, Target 3 emphasizes “areas of particular importance for biodiversity and ecosystem functions and services” (CBD 2022), turning the

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spotlight on how “areas of particular importance for biodiversity” should be recognized.

The global biodiversity crisis has seen the development of multiple approaches for recognizing important sites for species (e.g., Alliance for Zero Extinction sites (Ricketts et al. 2005), Important Bird and Biodiversity Areas (Donald et al. 2019). The Key Biodiversity Area (KBA) Standard was designed to harmonize approaches to recognizing important sites across all biodiversity, at genetic, species and ecosystem levels (IUCN 2016). It was formally adopted by the International Union for Conservation of Nature (IUCN) and other conservation partners in 2016.

Recognizing important sites is especially challenging for broadly distributed and/or highly mobile species in aquatic systems, including many species of sharks, rays, and chimaeras (hereafter “sharks”). Many globally threatened shark species have relatively broad distributions, but some areas are more important than others. Important Shark and Ray Areas (ISRAs) were designed to recognize and map critical areas that support reproduction, feeding, and other key life-history processes (Hyde et al. 2022).

Here, we summarize and compare the KBA Standard (IUCN 2016) and ISRA Criteria (Hyde et al. 2022). We assess whether important areas for sharks recognized as ISRAs can qualify as KBAs based on the KBA Standard. We then discuss the complementary nature of these approaches in the context of global conservation efforts.

## 2 | Approaches for Recognizing Important Sites for Sharks

The fundamental difference between the KBA Standard and ISRA Criteria is that KBAs are designed to recognize important sites across all taxonomic groups and ecosystem types in marine, freshwater, terrestrial, and subterranean systems, whereas ISRAs are tailored specifically for sharks. This underpins significant differences in design features, including the focus of KBAs on recognizing important sites based on the proportion of a species’ global population size (or an ecosystem’s global extent) held at a site versus the ISRA focus on recognizing portions of habitat that sustain particular life-history processes.

### 2.1 | Key Biodiversity Areas (KBAs)

KBAs are defined as “sites contributing significantly to the global persistence of biodiversity” (IUCN 2016). For species, the KBA Standard recognizes sites where populations are geographically concentrated, either year-round or seasonally. For broadly distributed aquatic vertebrates such as sharks, the most frequently used criteria are Criterion A1 (threatened species), B1 (individual geographically concentrated species), B2 (co-occurring restricted-range species), and D1 (demographic aggregations). Hereafter, we focus only on these four criteria.

### 2.2 | Important Shark and Ray Areas (ISRAs)

ISRAs are defined as discrete three-dimensional portions of habitat, important for one or more shark species, that have the

potential to be managed for conservation (Hyde et al. 2022). Areas are assessed against criteria for threatened species (Criterion A), range-restricted species (B), life history (C; encompassing reproduction, feeding, resting, movement, and undefined aggregations), and special attributes (D; encompassing distinctiveness and high diversity). Threatened species (Criterion A) must trigger at least one additional criterion (B, C, or D), describing how the species uses the area (Hyde et al. 2022).

## 2.3 | Comparison of the KBA Standard and ISRA Criteria

### 2.3.1 | Scale and Manageability

Both the KBA Standard and ISRA Criteria aim to inform conservation and management processes, by recognizing areas of particular importance for biodiversity based primarily on ecological data, although KBA delineation procedures take manageability into account.

KBAs are specifically defined as “sites”, where a “site” is actually or potentially manageable as a unit (IUCN 2016). This is intended to strengthen prospects for effective area-based conservation and serves as a context-dependent constraint on the size of KBAs. Some marine KBAs are relatively large, especially in offshore areas: the median size of marine KBAs is ~57 km<sup>2</sup>, the 95th percentile is ~7,960 km<sup>2</sup>, and the largest is the Proposed Central Pacific World Heritage Site (Kiribati) at ~712,510 km<sup>2</sup> (<https://www.keybiodiversityareas.org/kba-data>).

Similarly, ISRAs have no minimum or maximum size limits and ISRA size varies widely: the median size is ~560 km<sup>2</sup>, the 95th percentile is ~89,050 km<sup>2</sup>, and the largest is the Eastern Tropical Pacific Marine Corridor at ~3,000,000 km<sup>2</sup> (Table S1). For large areas, appropriate management responses may focus on policy measures to reduce threats (e.g., measures to reduce incidental catch (bycatch) through improved fisheries management), rather than management as a single protected or conserved area.

### 2.3.2 | Threatened Species

Both the KBA Standard and ISRA Criteria use the IUCN Red List of Threatened Species ([www.iucnredlist.org](http://www.iucnredlist.org)) to identify threatened species.

### 2.3.3 | Geographical Restriction

Species may be geographically restricted in various ways. For KBA Criterion B2, any shark species with a global range ≤50,000 km<sup>2</sup> is considered restricted-range; ~25% of shark species qualify as restricted-range based on this definition (Table S2). A site must hold at least 1% of the global population size of two or more restricted-range sharks to qualify as a KBA under this criterion (IUCN 2016). For ISRA Criterion B, range-restriction is defined as having a distribution limited to one Large Marine Ecosystem (LME) or two adjoining LMEs (Hyde et al. 2022). LMEs are relatively large coastal areas, approximately 200,000 km<sup>2</sup> or greater (Sherman and Alexander 1986).

### 2.3.4 | Thresholds

The KBA Standard includes quantitative thresholds to ensure that important sites are recognized consistently across taxonomic groups. For species, thresholds are mostly defined in terms of the proportion of the global population size regularly found at a site. For example, a site recognized as a KBA under Criterion B1 must hold at least 10% of a species' global population size. Ideally, these thresholds are assessed using data on the distribution of mature individuals at global and site levels. However, such data are unavailable for most species, so various other assessment parameters can be used as proxies (e.g., area of occupancy, extent of suitable habitat, or global range). Most species assessed for the IUCN Red List have global range maps, facilitating KBA recognition for many data-limited species.

The ISRA approach uses a mix of qualitative and quantitative thresholds (Hyde et al. 2022). The criteria can be applied using a wide range of observed data types appropriate to sharks (e.g., fisheries, surveys, telemetry, underwater video, citizen science, Indigenous and local knowledge). These data are only required at a local level (not the global level), providing greater flexibility for assessing data-limited species.

### 2.3.5 | Movement Patterns

Along migratory corridors, KBAs should only be recognized for stop-over or bottleneck sites (under Criterion D1) rather than the entire corridor (IUCN 2016), as the scale of such corridors is typically much larger than an individual site.

In contrast, ISRAs may include migratory corridors along coastlines and even trans-oceanic crossings between areas used for different life-history functions. For highly mobile species, only core movement areas are delineated (IUCN SSC Shark Specialist Group 2024); nevertheless, some of the largest ISRAs correspond to migratory corridors (e.g., the Banda Arc at ~100,000 km<sup>2</sup>, and the Eastern Tropical Pacific Marine Corridor at ~3,000,000 km<sup>2</sup>).

### 2.3.6 | Confirmation of Presence

Both approaches require recent confirmation of species presence. Several KBA thresholds require the regular occurrence of a minimum number of "reproductive units" at sites where breeding occurs, or equivalent numbers of mature individuals at sites where breeding does not occur. When using area-based parameters such as range, this ensures that the site holds nontrivial numbers of mature individuals as well as the threshold proportion of the global range. ISRAs focus on the "regular and/or predictable" contemporary occurrence of species (within the last 15 years).

## 2.4 | Identification and Delineation Process

KBAs are identified and delineated by local and national experts. KBA National Coordination Groups (KBA NCGs) coordinate the process, where they exist, often holding workshops to integrate information across taxonomic groups and ecosystems to

generate a single, comprehensive set of manageable sites with nonoverlapping boundaries. Elsewhere, local/national experts can initiate KBA proposals by reaching out to the relevant KBA Regional Focal Point (Figure 1). KBA proposals may be sent for review by additional experts to ensure they are based on the best available data, and are subject to a final validation check by the KBA Secretariat to confirm that nominated sites meet the KBA Standard.

Candidate ISRAs are proposed by contributors from around the world and agreed upon by consensus at regional expert workshops. An independent review panel with a broad global knowledge of shark ecology makes the final decision on whether proposed areas are confirmed as ISRAs. This panel is critical for ensuring consistency in the application of the ISRA Criteria across regions.

## 3 | Applying the KBA Standard to Important Sites for Sharks

We assessed whether sites recognized as important for sharks through the ISRA process could also be recognized as KBAs based on the KBA Standard. We focused on ISRA Qualifying Species (i.e., species that satisfy one or more of the ISRA Criteria) in four regions, encompassing ~29% of the world's oceans: Central and South American Pacific, Mediterranean and Black Seas, Western Indian Ocean, and Asia. We classified species into three groups based on geographical restriction, further subdivided by global extinction risk (threatened or non-threatened):

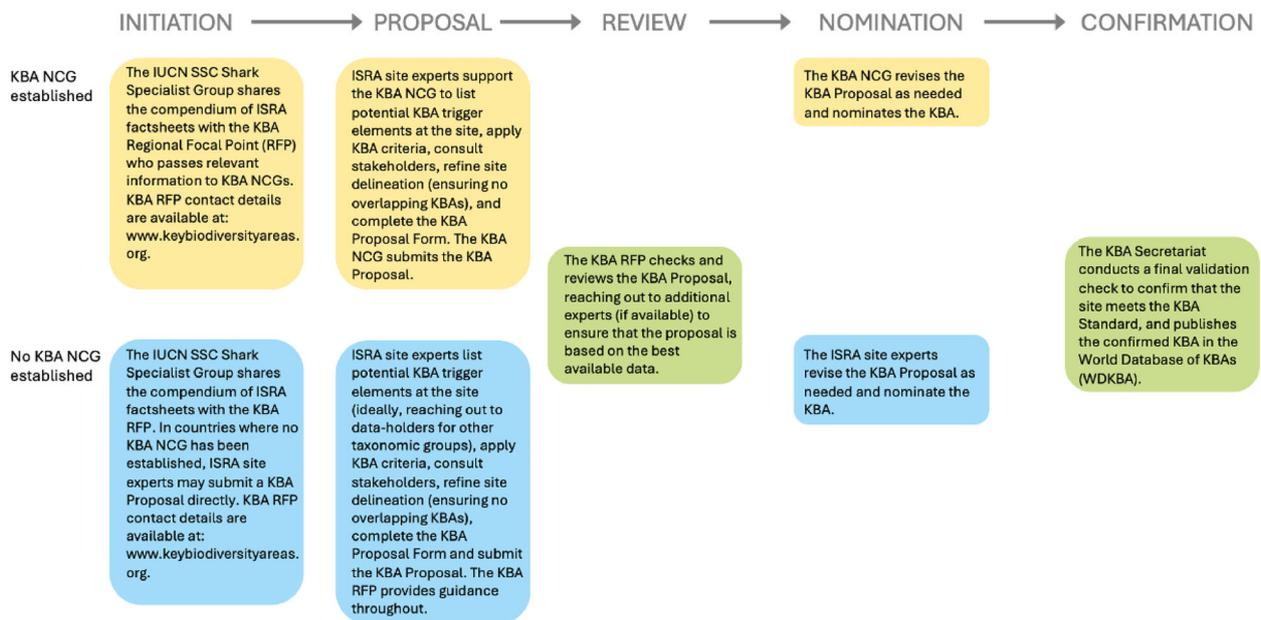
- (i) Restricted-range based on the KBA definition.
- (ii) Range-restricted based on the ISRA definition.
- (iii) Not geographically restricted (by either definition).

We applied KBA Criteria A1 (threatened species), B1 (individual geographically concentrated species), and B2 (co-occurring restricted-range species) to global range maps published on the IUCN Red List. KBA Criterion D1 (demographic aggregations) also targets sites important for life-history processes, but cannot be assessed using range so is discussed below.

### 3.1 | Data Preparation

We downloaded IUCN Red List categories, criteria, and range maps for all sharks from the IUCN Red List (IUCN 2024). We downloaded ISRA shapefiles from the ISRA e-Atlas (<https://sharkrayareas.org/e-atlas/>) and intersected range polygons (coded presence = extant; origin = native) with ISRA polygons (excluding proposed buffers).

We calculated the global range size and the size of the intersection between each ISRA Qualifying Species and ISRA polygon using the World Cylindrical Equal-Area projection (i.e., ESRI: 54034). For each intersection, we then estimated the proportion of the global range size within the ISRA, and compared this proportion to thresholds for KBA Criteria A1, B1, and B2. For this analysis, we assumed that the KBA reproductive-units threshold was met for all ISRA Qualifying Species, but this should be evaluated



**FIGURE 1** | Alternative pathways for channeling ISRA results into the KBA network, depending on whether a KBA National Coordination Group (KBA NCG) has been established.

case-by-case for KBA proposals. This protocol excluded ISRA Qualifying Species without published range maps on the IUCN Red List. We also excluded species that only qualify based on ISRA Sub-criterion C4 (Movement Areas), as KBA Criterion D1 is the criterion designed to capture sites important for movement.

We excluded exceptionally large ISRAs (specifically, the largest 5% of ISRAs, > 89,048 km<sup>2</sup>), as these might not qualify as “sites” based on the KBA definition and could exaggerate the proportion of ISRAs potentially qualifying as KBAs. In practice, manageability is assessed on a case-by-case basis by the relevant KBA NCG.

### 3.2 | Results

A total of 659 shark species (i.e., 53% of the global total) are confirmed to occur in the four ISRA regions assessed here (Figure 2), excluding vagrants and species of unconfirmed taxonomic validity.

A total of 377 ISRAs have been delineated for 280 Qualifying Species across these regions, encompassing a total area of ~12,400,000 km<sup>2</sup> or 3.5%–18.1% of each region (Figure 2).

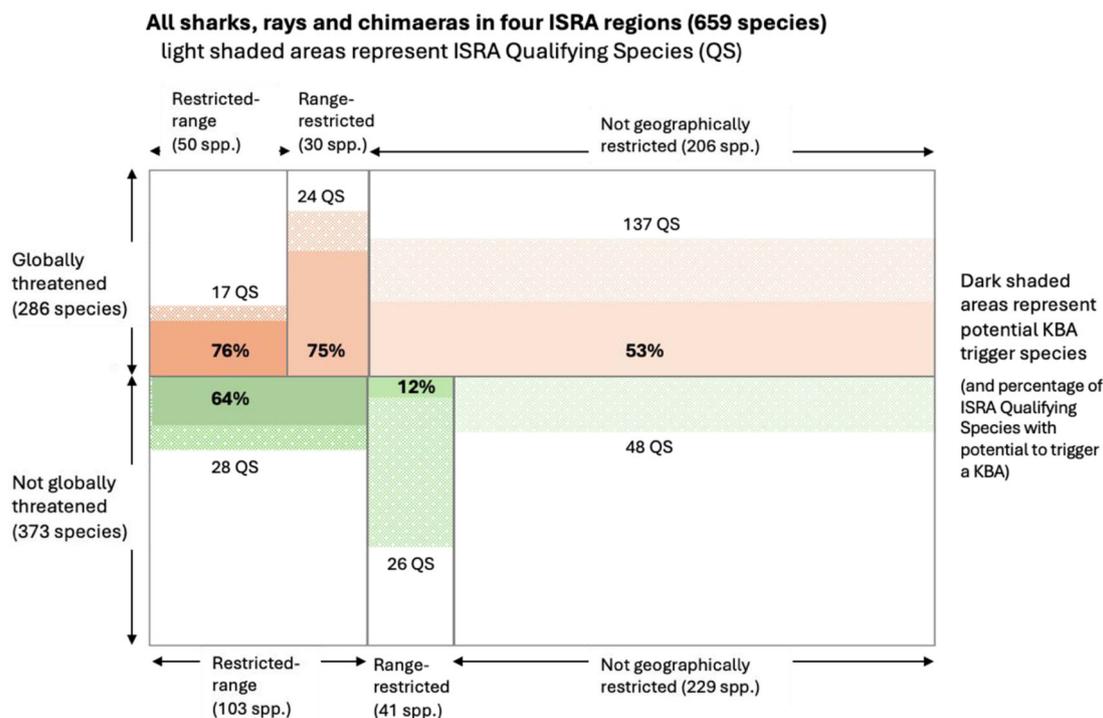
Overall, one fifth of these ISRAs (70 ISRAs, 19%) have the potential to be recognized as KBAs for sharks, encompassing an area of ~652,000 km<sup>2</sup> or 0.1%–5.0% of each region. Also, 125 ISRA Qualifying Species were identified as potential KBA trigger species (i.e., 45%; Figure 2). The main reasons why ISRA Qualifying Species might not trigger a KBA are because no ISRA falls within range maps published on the IUCN Red List (29 species; 10%) or because they do not meet KBA Criterion A1, B1, or B2 in any ISRA based on range (123 species; 44%). Only three species (1%) were excluded because they only qualify in very large ISRAs or based on ISRA Sub-criterion C4 (Movement Areas).

For three quarters of globally threatened restricted-range sharks ( $n = 17$ ), important sites recognized as ISRAs can also be recognized as potential KBAs by applying KBA Criteria A1, B1, or B2 to range maps (Figure 2). This reflects the relatively low KBA thresholds for globally threatened species under KBA Criterion A1 ( $\leq 1\%$  of the global population size) and relatively small range sizes of restricted-range species based on the KBA definition. Similarly, ISRAs can be recognized as potential KBAs for three quarters of globally threatened range-restricted sharks ( $n = 24$ ) when using the ISRA definition of range restriction (Figure 2). In comparison, ISRAs can be recognized as potential KBAs for one half of broadly distributed globally threatened species ( $n = 137$ ) (Figure 2).

Important sites recognized as ISRAs can also be recognized as potential KBAs for two thirds of non-threatened restricted-range species based on the KBA definition ( $n = 28$ ; Figure 2). The lower proportion compared to threatened restricted-range species reflects the higher thresholds for non-threatened species ( $\geq 1\%$  of the global population size). In contrast, ISRAs can be recognized as potential KBAs for just one eighth of non-threatened range-restricted sharks ( $n = 26$ ) when using the ISRA definition (Figure 2) as these species are not eligible to trigger KBA Criterion B2 (threshold: 1% of the global population size). Nevertheless, these species have relatively small ranges and so a greater propensity to trigger KBAs than broadly distributed non-threatened species. No ISRAs were recognized as potential KBAs for broadly distributed non-threatened species ( $n = 48$ ) in this analysis (Figure 2).

### 4 | Discussion

Our results indicate that the KBA Standard can be used to recognize important sites for globally threatened and/or restricted-range sharks. For ISRA Qualifying Species, three quarters of glob-



**FIGURE 2** | Shark, ray, and chimaera species, ISRA Qualifying Species, and ISRA Qualifying Species with potential to trigger a KBA across four ISRA regions: Central and South American Pacific, Mediterranean and Black Seas, Western Indian Ocean, and Asia (<https://sharkrayareas.org/isra/regions/>). Restricted-range species are identified based on the KBA definition:  $\leq 50,000$  km<sup>2</sup>. Range-restricted species are identified based on the ISRA definition: restricted to 1 or 2 adjacent Large Marine Ecosystems (excluding restricted-range species to avoid duplication). ISRA Qualifying Species are those that satisfy one or more of the ISRA Criteria. See Tables S3 and S4 for further details.

ally threatened geographically restricted sharks and two thirds of non-threatened restricted-range sharks have the potential to trigger KBAs at sites recognized as ISRAs, compared to one half of globally threatened but broadly distributed species. Conversely, just one eighth of non-threatened non-restricted-range species have the potential to trigger KBAs based on Criterion A1, B1, or B2 applied to published range maps.

For sharks, range is generally the only parameter available for KBA assessment. However, range maps provide imperfect information on population distributions, especially for species that are unevenly distributed within their range. Nevertheless, most globally threatened geographically restricted sharks have the potential to trigger KBAs, given relatively small global range sizes combined with relatively low thresholds. In contrast, range is less useful for recognizing important sites for non-threatened broadly distributed species—more detailed information on locations that regularly/predictably hold unusually high population densities is required. For species that aggregate at particular sites, for example, additional information on the largest known aggregations may be used to pinpoint sites that qualify as KBAs under Criterion D1.

Moreover, some ISRAs might not qualify as KBAs for sharks even if perfect information on population distributions were available. KBAs are defined as sites that are actually or potentially manageable as a unit, whereas ISRAs may include much larger areas of importance for sharks (e.g., migratory corridors). The KBA Standard is designed to recognize sites important for avoiding biodiversity loss (e.g., species extinctions or population declines)

(IUCN 2016). The ISRA Criteria are broader, also capturing areas important for maintaining healthy and resilient populations of non-threatened broadly distributed species and sites that support an exceptional diversity of sharks (Hyde et al. 2022).

## 5 | Conclusion

There are clear synergies between the ISRA and KBA approaches for recognizing important sites for sharks and other species.

The ISRA process is an effective tool for mapping important areas for broadly distributed aquatic species and can serve as a model for other taxonomic groups. Here, we identified 70 ISRAs with the potential to qualify as KBAs in 35 countries plus areas beyond national jurisdiction. We therefore recommend that efforts to channel the results of ISRA processes into KBA assessments (as per Figure 1) continue. Institutional partnerships and dedicated resources will be needed to support the process of proposing ISRAs as KBAs.

For ISRAs that qualify as KBAs, recognizing a site as a KBA can strengthen conservation efforts, especially in countries where KBA NCGs are working to incorporate KBAs into national conservation planning processes and promote long-term monitoring and conservation.

As governments address their commitments to biodiversity conservation under the GBF (including the '30x30' commitment), they will need to integrate data on important sites across all bio-

diversity. The KBA Standard provides a transparent mechanism for achieving this (Jones et al. 2024).

One third of shark species are considered threatened with extinction (IUCN 2024). Recognizing and safeguarding important areas for sharks is essential for preventing further loss of shark diversity and enabling recovery of threatened species (Hyde et al. 2022). Considering the urgency of conservation action for sharks, the ISRA and KBA processes should work together to ensure that important areas for sharks are mapped and this information is provided to decision-makers to guide site conservation and broader-scale policy measures designed to address specific threats to sharks.

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### Author Contributions

CB and RJ conceptualized the study. CB analyzed the data and drafted the manuscript. RC, EGR, AGP, PK, GNS, CR, and RJ reviewed and edited the manuscript. All authors approved the final version.

### Acknowledgments

We would like to thank the Shark Conservation Fund for supporting this work. We are extremely grateful to all contributors (>730 experts from 78 countries and territories) for their support in delineating ISRAs across the four regions. We would also like to thank A. Battle-Morera, S. Butchart, O. Crowe, A. Haines, J. Handley, J. Lamoreux, A. Plumptre, and an anonymous reviewer for their useful comments and contributions to this work.

Open access publishing facilitated by James Cook University, as part of the Wiley - James Cook University agreement via the Council of Australian University Librarians.

### Conflicts of Interest

The authors declare no conflicts of interest.

### Data Availability Statement

No new data were generated for this paper. Sources of data used in the analysis are referenced in the paper and are freely available online.

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### Supporting Information

Additional supporting information can be found online in the Supporting Information section.

**Table S1.** Size distribution of ISRAs by region. **Table S2.** List of shark, ray and chimaera species. **Table S3.** Number of shark species by ISRA region.

**Table S4.** Number of Qualifying Species x ISRA intersections by region.