Food and Agriculture Organization of the United Nations

Indian Ocean Tuna Commission
Commission des Thons de l'Ocean Indien
iotc ctoi

[IOTC-2026- SC29-12]

USING FISHERIES DATA TO SUPPORT THE IDENTIFICATION OF IMPORTANT SHARK AND RAY AREAS: OPPORTUNITIES FOR COLLABORATION WITH REGIONAL FISHERY BODIES

RIMA W. JABADO, CHRISTOPH A. ROHNER, EMILIANO GARCÍA-RODRÍGUEZ

Purpose, expectation and action intended

Discussions (for information and open discussion):

The paper presents opportunities for existing fisheries datasets to support the identification and refinement of Important Shark and Ray Areas (ISRAs), building on the discussion at WPEB22, as set out in Sections 1–5.

Feedback (to collect input and suggestions)

The paper seeks advice on relevant datasets, analytical opportunities, and mechanisms for participation by the Secretariat, interested CPC scientists, and authorised data holders within existing data-access arrangements, as set out in Section 5.

Recommendation (to ask the meeting to endorse a recommendation)

The paper seeks support for the collaboration encouraged by WPEB22 to explore existing datasets across species and areas, and for a progress update to WPEB in 2027, as set out in Sections 5 and 6.

USING FISHERIES DATA TO SUPPORT THE IDENTIFICATION OF IMPORTANT SHARK AND RAY AREAS: OPPORTUNITIES FOR COLLABORATION WITH REGIONAL FISHERY BODIES

Rima W. Jabado, Christoph A. Rohner, Emiliano García-Rodríguez

IUCN Species Survival Commission Shark Specialist Group, P.O. Box 29588, Dubai, United Arab Emirates

ABSTRACT

Understanding where chondrichthyans (sharks, rays, and chimaeras) undertake important life-history functions is fundamental to effective conservation and fisheries management, yet spatial ecological information remains limited for many species. Fisheries-dependent data collected by Regional Fishery Bodies (RFBs), national fisheries agencies, research programmes, and observer schemes represent a potentially important but underused source of information on the spatial and temporal occurrence of these species.

Important Shark and Ray Areas (ISRAs) are discrete, three-dimensional portions of habitat that are important for the persistence of chondrichthyans. They are identified using standardised, science-based criteria. ISRA identification is based on the ecological and biological importance of an area and provides an advisory spatial evidence base for decision-makers.

The paper presented to WPEB22 explored how fisheries data can contribute to identifying areas that meet specific ISRA Criteria. Relevant information may include spatially and temporally referenced species occurrence and catch records, fishing effort, size, sex, maturity, and reproductive status. These data may provide evidence of the regular or predictable occurrence of range-restricted species (Criterion B), reproductive areas (Sub-criterion C1), and recurrent aggregations (Sub-criterion C5). The scientific explanation and examples from that paper are retained here.

Following the encouragement of WPEB22, we propose a collaborative, data-holder-led approach to explore existing datasets across the IOTC area of competence. Relevant analyses can be undertaken within existing data-governance arrangements. The ISRA team can support scientists in identifying suitable species and datasets, developing analytical approaches, interpreting spatial patterns, and preparing candidate ISRA proposals. The Eastern Agulhas Front ISRA illustrates the potential of fisheries records within this broader approach. The authors propose to report progress to WPEB in 2027.

Follow-up to WPEB22

This paper updates IOTC–2026–WPEB22(AS)–31 for consideration by the Scientific Committee. WPEB22 encouraged the Secretariat, CPC scientists, and data holders to explore existing datasets for ISRA identification and refinement, and encouraged a pilot collaboration to develop appropriate data-access, ownership, and confidentiality arrangements (IOTC, 2026, para. 139). It also encouraged collaboration on ISRAs in areas beyond national jurisdiction (para. 143). Sections 5 and 6 set out the proposed next steps, building on the scientific basis and examples in Sections 1–4.

1. INTRODUCTION

Sharks, rays, and chimaeras (chondrichthyans) play important ecological roles in aquatic ecosystems, yet many species are increasingly threatened by overfishing, habitat degradation, and other anthropogenic pressures (Dulvy et al. 2021; Dedman et al. 2024). Effective conservation strategies require an improved understanding of where these species occur and where they undertake important life-history functions, such as parturition, early development, reproduction, and aggregation (Hyde et al. 2022). However, for many chondrichthyan species, particularly those that occur in offshore or data-poor regions, information on the location of important habitats remains limited (e.g., García-Rodríguez et al. 2025).

A growing number of scientific tools and datasets have been used to identify areas of particular importance for marine species, including telemetry, fisheries dependent or independent surveys, visual observations, and habitat suitability models (e.g., Corrigan et al. 2014; IUCN 2016). For chondrichthyans, however, such information can often be unevenly distributed across taxa and regions. Many species remain poorly studied, and the available information is often insufficient to support spatial planning or to identify habitats that are critical to their persistence (Hyde et al. 2022). As a result, there is a need to make better use of additional sources of spatial and biological information.

Fisheries-dependent data represent one such source. Data collected by Regional Fishery Bodies (RFBs), national fisheries agencies, observer programs, and research initiatives may provide valuable information on the spatial and temporal occurrence of chondrichthyans as well as on their size, sex, maturity, and reproductive status (e.g., Lopetegui-Eguren et al. 2022). Although many such datasets are primarily collected to support fisheries assessments and management, they may also provide evidence relevant to the identification of relevant important habitats, especially where fishery- independent ecological data are lacking. This is particularly true where data are collected over long periods of time, span broad geographic areas, and can be interpreted in relation to species' life-history characteristics. Fisheries datasets require careful consideration of fleet behavior, fishing effort, gear selectivity, reporting resolution, and the extent to which observed patterns reflect species distribution rather than the distribution of fishing activity (e.g., Gilman et al. 2017; Ducharme-Barth et al. 2022; Lopetegui-Eguren et al. 2022). In most cases, raw data are also confidential or sensitive and cannot be easily shared beyond the institutions that are responsible for collecting or managing them (Gilman et al. 2017). These challenges have limited the extent to which fisheries-dependent information has been used to understand habitat use for chondrichthyans.

Important Shark and Ray Areas (ISRAs) provide a standardised framework for identifying critical habitats that are important for the persistence of chondrichthyans (Hyde et al.

2022; García-Rodríguez et al. 2025; Bettcher et al. 2026). ISRAs are identified using a set of peer-reviewed, science-based criteria and best available data. They are advisory and biocentric, meaning that they identify areas of ecological importance to species irrespective of any subsequent management response. ISRAs are not marine protected areas, do not confer legal status, and do not in themselves impose management measures. Instead, they provide a spatial evidence base that can inform conservation planning, marine spatial planning, fisheries management, and other decision-making processes.

This paper explores how fisheries-dependent data can contribute to the identification of ISRAs and how collaboration with RFBs and their scientific communities can support this process. In particular, we highlight the types of fisheries information most relevant to specific ISRA Criteria, including Criterion B (Range Restricted), Sub-criterion C1 (Reproductive Areas), and Sub-criterion C5 (Undefined Aggregations). We also outline a collaborative, data-holder-led approach through which analyses can be undertaken within existing data-governance arrangements, without requiring the routine transfer of confidential raw datasets. By doing so, we aim to demonstrate that fisheries data, when interpreted carefully and collaboratively, can make an important contribution to identifying areas that are significant for the persistence of chondrichthyan species.

2. IMPORTANT SHARK AND RAY AREAS (ISRAS)

Important Shark and Ray Areas (ISRAs) were developed in 2022 by the IUCN Species Survival Commission Shark Specialist Group (IUCN SSC SSG) as a standardised approach for identifying 'discrete, three-dimensional portions of habitat that are important for one or more sharks, rays, and chimaeras species, and that have the potential to be managed for conservation' (Hyde et al. 2022). The process is explicitly biocentric: areas are identified based on the ecological and biological requirements of chondrichthyans, independently of political, socioeconomic, or management considerations. Identification of an area as an ISRA therefore does not confer legal protection, establish a marine protected area, or prescribe restrictions on fisheries or other activities (Rohner et al. 2025). Rather, ISRAs provide a spatial evidence base that can subsequently be considered by governments, RFBs, conservation organisations, and other decision- makers alongside other ecological and socioeconomic information.

ISRAs are identified through four non-hierarchical criteria incorporating seven sub-criteria covering species vulnerability (Criterion A), range restriction (Criterion B), life-history activities including reproduction, feeding, resting, movement, and undefined aggregations (Criterion C), and special attributes including distinctiveness and diversity (Criterion D) (Hyde et al. 2022; Figure 1; Annex I). Criterion A must be applied in

association with another criterion. For most criteria, demonstrating that an occurrence or activity is regular and/or predictable is central to establishing the importance of an area.

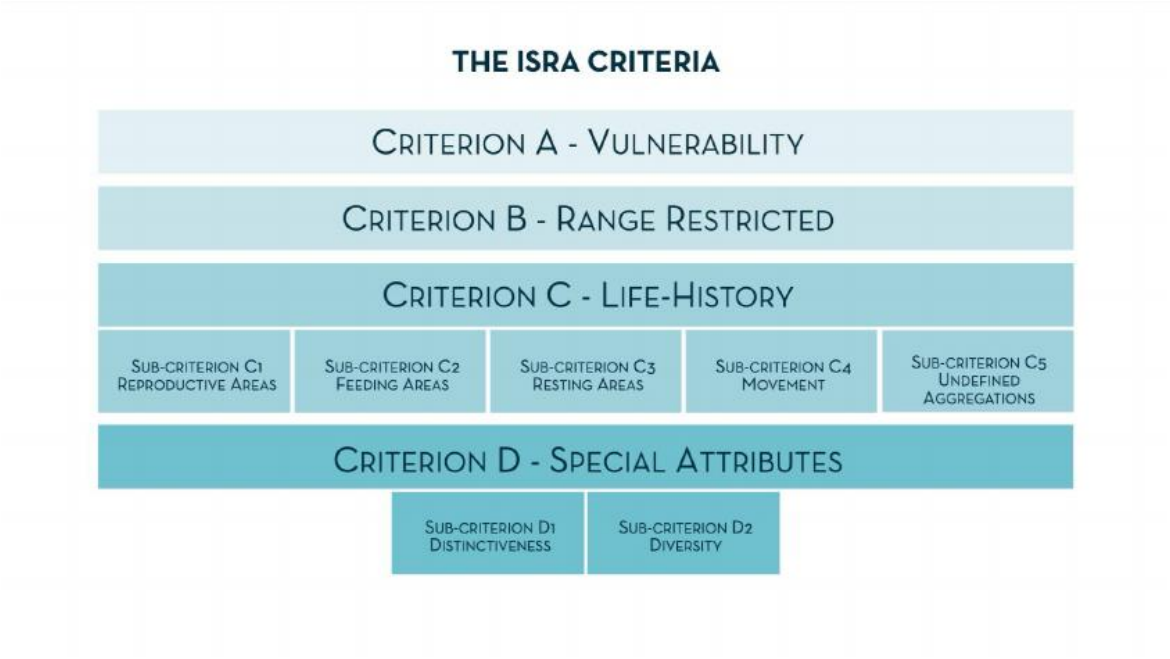


Fig. 1. The Important Shark and Ray Areas (ISRA) Criteria. Additional details are provided in Annex I.

Potential areas are proposed by experts using the best available scientific information and assessed during regional workshops. Candidate ISRAs are subsequently evaluated by an Independent Review Panel, and only areas with sufficient evidence to meet the relevant criteria are accepted as ISRAs. Published ISRAs include their spatial boundaries, qualifying species, criteria, supporting evidence, and references.

The precision of an ISRA boundary depends on the evidence available. Coarse spatial information may be sufficient to demonstrate that an important area exists but can result in broad boundaries, whereas finer-resolution information can allow the habitat supporting the qualifying species or activity to be delineated more precisely.

3. FISHERIES DATA RELEVANT TO THE IDENTIFICATION OF ISRAS

Fisheries datasets can provide evidence relevant to several ISRA Criteria. Species-level identification, capture location, and date provide a basic record of spatial and temporal occurrence, while effort, numbers of individuals, individual size, sex, maturity, and

reproductive condition considerably increase the ecological information that can be derived.

Long-term or repeatedly sampled datasets can demonstrate whether patterns recur among years or seasons, while datasets with broad geographic coverage allow candidate areas to be compared with surrounding locations. This regional context is often important for demonstrating that an area is disproportionately important rather than simply reflecting the general distribution of a species or the footprint of a fishery.

This paper focuses on three criteria that are particularly amenable to fisheries information: Criterion B (Range Restricted), Sub-criterion C1 (Reproductive Areas), and Sub-criterion C5 (Undefined Aggregations). Fisheries data may contribute to other ISRA Criteria where appropriate information is available.

Importantly, fisheries catches cannot be interpreted independently of how the data were collected. Fishing effort, gear selectivity, fleet behaviour, targeting, and sampling coverage should be considered wherever relevant. High catches or CPUE alone do not necessarily demonstrate that an area meets an ISRA Criterion.

4. ILLUSTRATIVE EXAMPLES

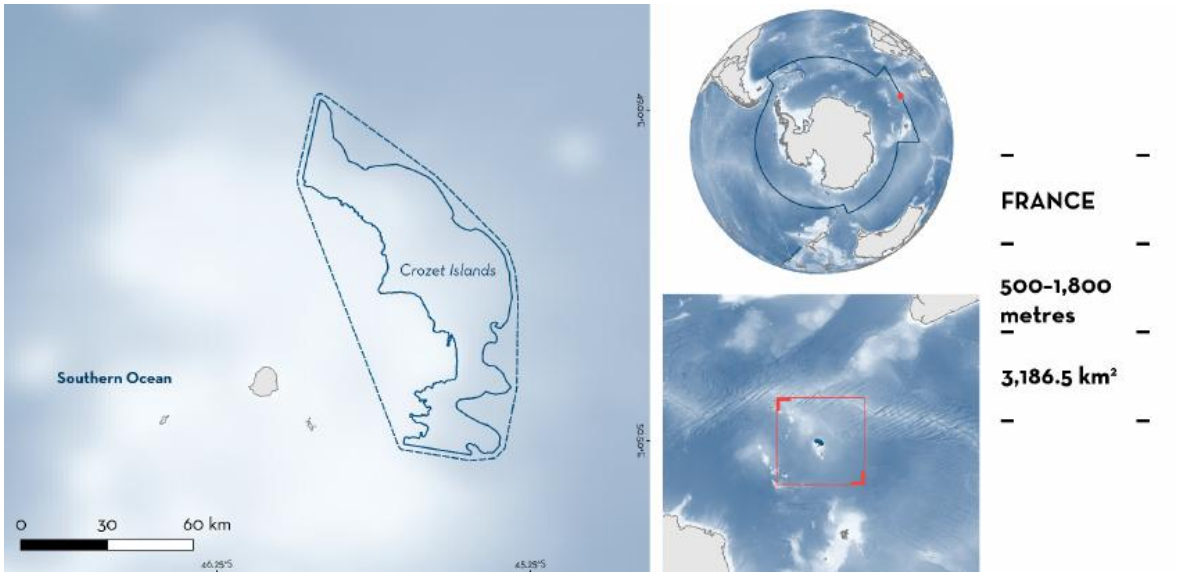
The following examples of ISRAs illustrate how fisheries-dependent and fisheries- associated datasets can support the application of the ISRA Criteria. They also demonstrate how the spatial resolution and biological detail of available data influence the precision within which candidate ISRAs can be identified and delineated.

Criterion B – Range Restricted

Definition: Areas holding a regular and/or predictable presence of range-restricted sharks which are occupied year-round or seasonally. The distribution of chondrichthyans can be restricted to that habitat geographically or by environmental conditions.

Purpose: This criterion applies only to species that meet the ISRA definition of range restriction; commonly encountered wide-ranging pelagic species, such as Blue Shark Prionace glauca or mobulid rays (Mobulidae), do not qualify under this criterion. The ISRA team maintains the list of species eligible for assessment under Criterion B. This criterion highlights peak abundance areas for species with a small range.

Example ISRA: Crozet Islands, France, identified for the range-restricted Whiteleg Skate Amblyraja taaf in the Southern Ocean (Jabado et al. 2024)



https://sharkrayareas.org/portfolio-item/crozet-islands-isra/

The Crozet Islands ISRA was identified as an area of comparatively high abundance for the Whiteleg Skate. Regional information indicated that only two broad sites supported notably high abundances of the species, allowing the Crozet Islands to be distinguished as an important portion of its restricted range.

Available evidence: Regional comparisons were possible using information presented in Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) reports, which allowed broad-scale patterns in abundance to be assessed across the species' range.

Data limitation: The available information was presented at a spatial resolution of 100 x 100 km grid cells, and only a subset of catches with spatial information was represented in the published maps (CCAMLR 2023; Figure 2). Raw spatial data were not available for the ISRA assessment.

Application to ISRA delineation: The published map was georeferenced to identify the grid cell associated with peak abundance around Crozet Islands. Because the available fisheries information was spatially coarse, the candidate area was subsequently refined using the known global depth range of the species and bathymetric information.

Relevance to RFB collaboration: Access to analyses based on the original higher- resolution spatial data could allow the area of highest interest to be identified more precisely and reduce reliance on coarse grid cells or secondary habitat-based refinement.

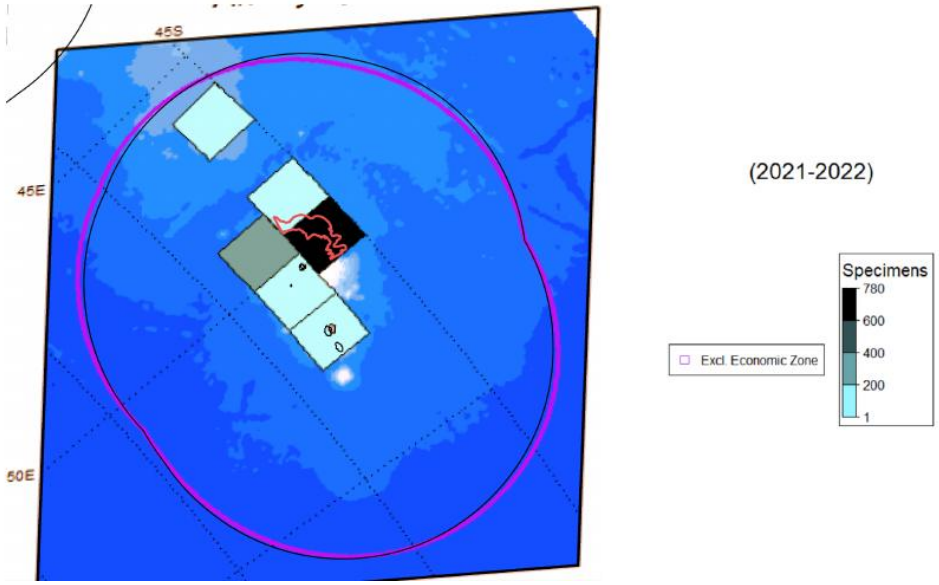


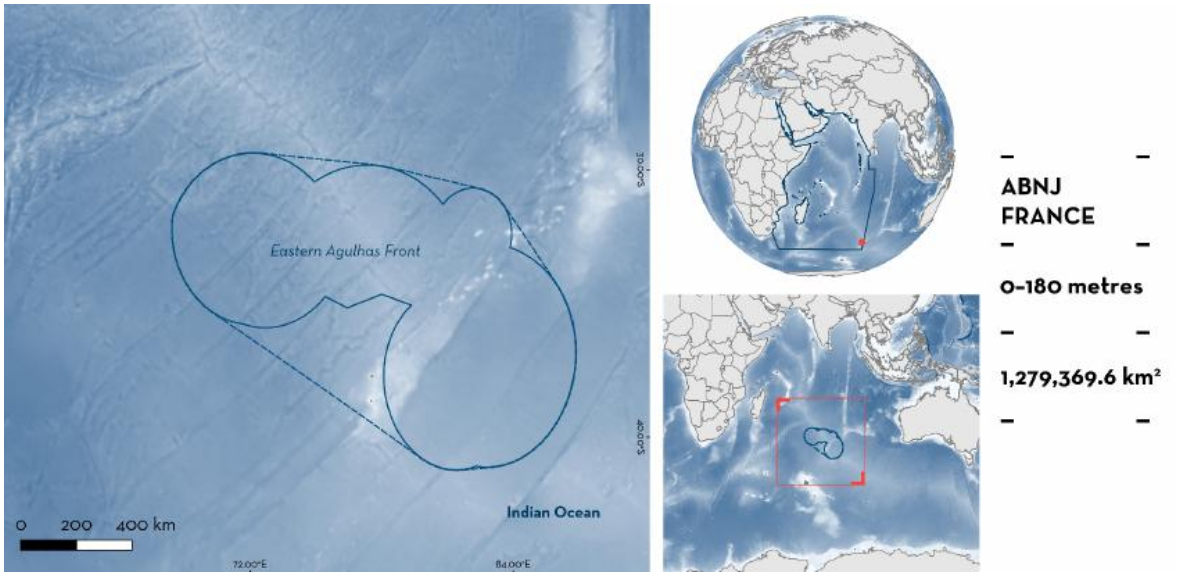
Fig. 2. Whiteleg Skate incidental catch in the CCAMLR Patagonian Toothfish longline fishery around the Crozet Islands (2021–2022), reported in 100 × 100 km grid cells and shaded by number of specimens (CCAMLR 2023). The ISRA (red) was placed on the grid cell of peak abundance within the Crozet Islands EEZ (magenta) and refined using bathymetry based on the global depth range of the species.

Sub-Criterion C1 – Reproductive Areas

Definition: Areas which are important for sharks to mate, gestate, give birth, lay eggs, or provide refuge or other advantages to the young.

Purpose: Considering fisheries-dependent data, this sub-criterion will mainly highlight areas important for neonate, young-of-the-year (YOY), or pregnant individuals. The key for this sub-criterion is individual size data. Along with published size-at-birth and size-at- 1-year, locations with high proportions of neonates and YOY can be identified. Important late-gestation areas can be delineated if observer data on reproductive status is available.

Example ISRA: Eastern Agulhas Front ISRA for neonate and YOY Porbeagle Lamna nasus in the Indian Ocean (Jabado et al. 2023).



https://sharkrayareas.org/portfolio-item/eastern-agulhas-front-isra/

Regional information showed that only two areas with high abundance of neonate and YOY Porbeagle were evident in the Indian Ocean. The Eastern Agulhas Front ISRA is one of these two areas and it was delineated based on a paper using longline data.

Available evidence: Regional maps of Porbeagle catch-per-unit-effort (CPUE) split by life-stage were available for the Indian Ocean (Semba et al. 2013; Figure 3), allowing the identification of the two important areas. Crucially, maps also showed locations with no catch, so the area reflects the actual distribution of neonates and YOY rather than the footprint of the fishery.

Data limitation: The maps only showed aggregated data in very coarse 5°×5° grid cells, leading to a large, unrefined ISRA boundary. Higher resolution maps or the raw spatial data were not available for the ISRA delineation.

Application to ISRA delineation: The map panel for the neonate and YOY Porbeagles was georeferenced and a large buffer was used around the central points due to the very coarse resolution. The boundary could not be further refined (Figure 4).

Relevance to RFB collaboration: Access to analyses based on the original higher- resolution spatial data could allow the area of highest interest to be identified more precisely and reduce reliance on coarse grid cells.

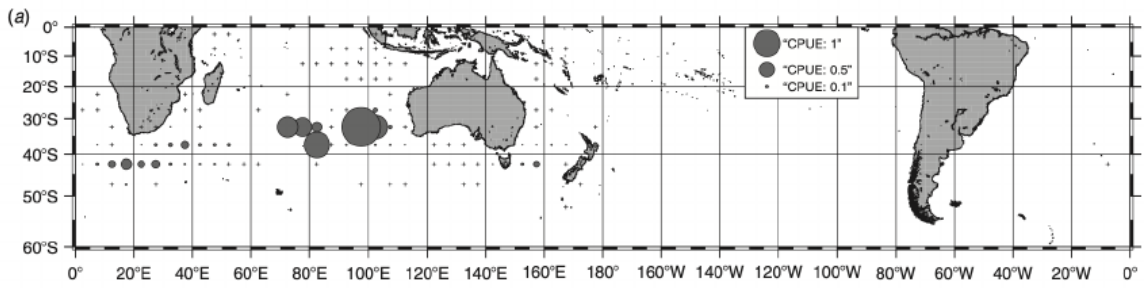


Fig. 3. *The regional overview map showed the fishing footprint as well as the broad area in the southern Indian Ocean where early life-stage Porbeagle were relatively abundant (Semba et al. 2013).*

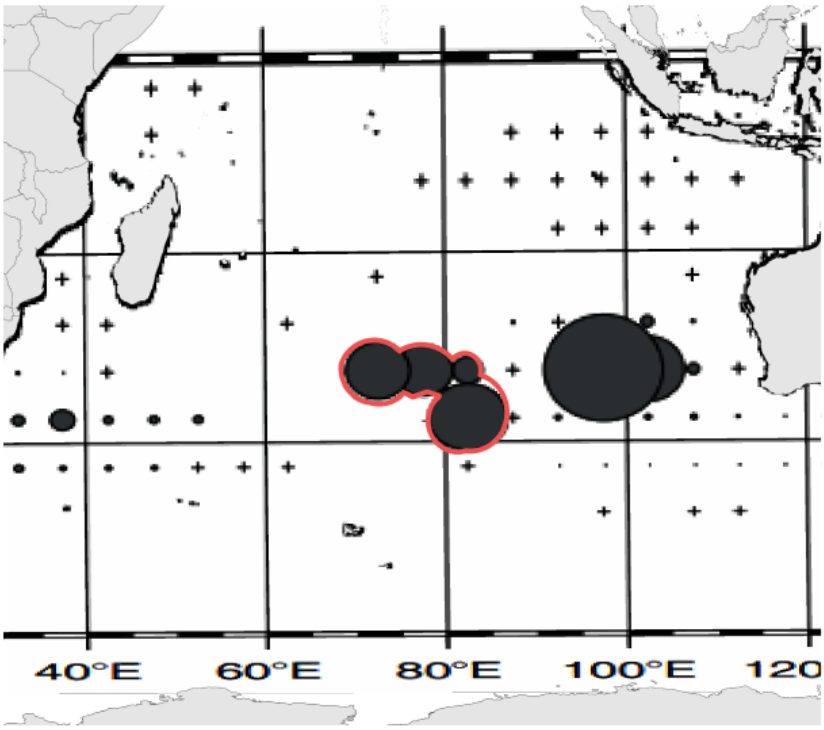


Fig. 4. *The zoomed map highlights the main challenge of delineating this ISRA: the very coarse 5°×5° spatial resolution led to the delineation of a large and approximate ISRA boundary (in red; Semba et al. 2013).*

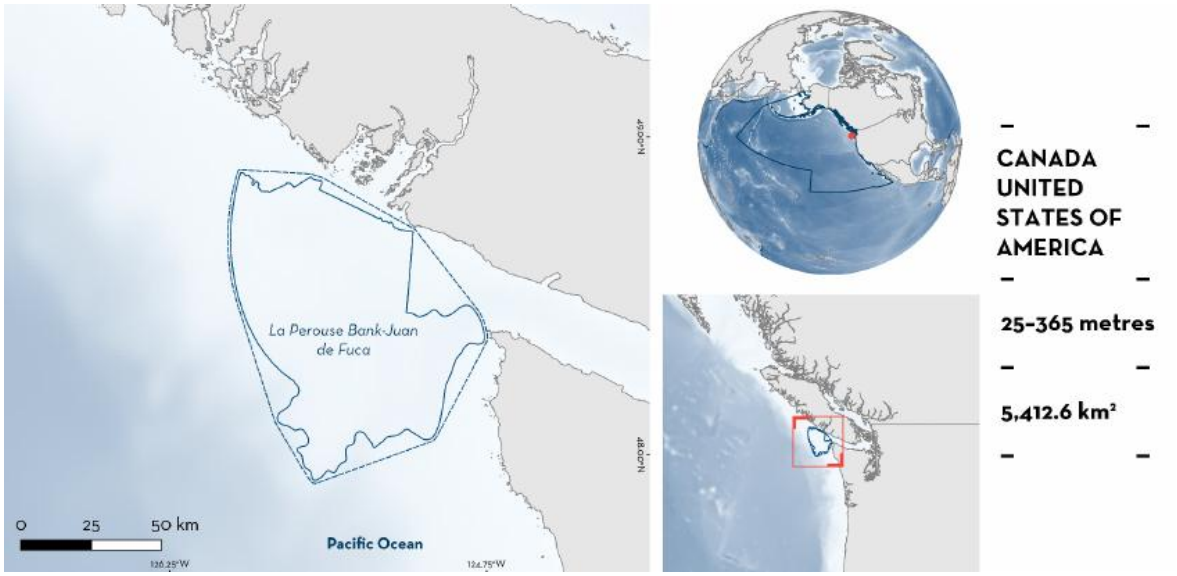
boundary (in red; Semba et al. 2013).

Sub-Criterion C5 – Undefined Aggregations

Definition: Areas where an aggregation or assemblage of sharks regularly and/or predictably occur, year-round or seasonally, but the function of the aggregation or assemblage is currently either unknown or falls outside the other sub-criteria.

Purpose: Considering fisheries-dependent data, this sub-criterion identifies areas where a species aggregates, even where the function of the aggregation is not understood. The key is to demonstrate aggregation, which is best achieved with per-set or per-haul counts of individuals that show many animals occupying the same place at the same time, rather than with catch-per-unit-effort (CPUE).

Example ISRA: La Perouse Bank - Juan de Fuca ISRA for North Pacific Spiny Dogfish Squalus suckleyi and White-spotted Ratfish Hydrolagus colliei in the northwestern Pacific (Jabado et al. 2026).



https://sharkrayareas.org/portfolio-item/la-perouse-bank-juan-de-fuca-isra

The La Perouse Bank-Juan de Fuca ISRA was identified for undefined aggregations of North Pacific Spiny Dogfish and Whitespotted Chimaera, which reach exceptionally high local abundance on this section of shelf near the Juan de Fuca Canyon.

Available evidence: Two fishery-independent survey datasets were available. The International Pacific Halibut Commission (IPHC) setline survey (1998–2025) provided per- set catches and CPUE for North Pacific Spiny Dogfish at individual station locations coast- wide. The West Coast Groundfish Bottom Trawl Survey (WCGBTS) provided per-tow catches for both species. Both record whole-set or whole-tow counts of individuals, so aggregation could be demonstrated directly rather than inferred from density alone.

Data limitations: None in this case. The survey data are fine-scale and, for the IPHC, publicly available. To show the effect of the high-resolution spatial data compared to

the coarser resolution typically released by RFBs, we aggregated the fine-scale North Pacific Spiny Dogfish CPUE data to a 1°×1° grid and repeated the analysis.

Application to ISRA delineation: At the regional scale, the broader North Pacific Spiny Dogfish hotspot along the shelf was apparent whether the CPUE data were viewed per station or aggregated to 1°×1° cells. Delineating the ISRA within that regional hotspot, however, depended on the fine-scale data. The boundary was placed on the highest station-level mean CPUE along the shelf, refined to the shelf and depth range, with the Whitespotted Chimaera distribution also considered. At 1°×1° resolution this was not possible: the area is smaller than a single grid cell, straddles three of them, and its cell is indistinguishable in value from its neighbours, so the aggregation could not be located or delineated.

Relevance to RFB collaboration: ISRA boundary delineation is resolution-sensitive. Coarse, grid-aggregated data can reveal broad regional hotspots but are generally too coarse to delineate a discrete aggregation area. Fine-scale, per-set or per-haul data, as provided here by an RFB survey, allow boundary refinement; where only coarse data are shared, an aggregation may be detectable in principle but cannot be delineated with useful precision.

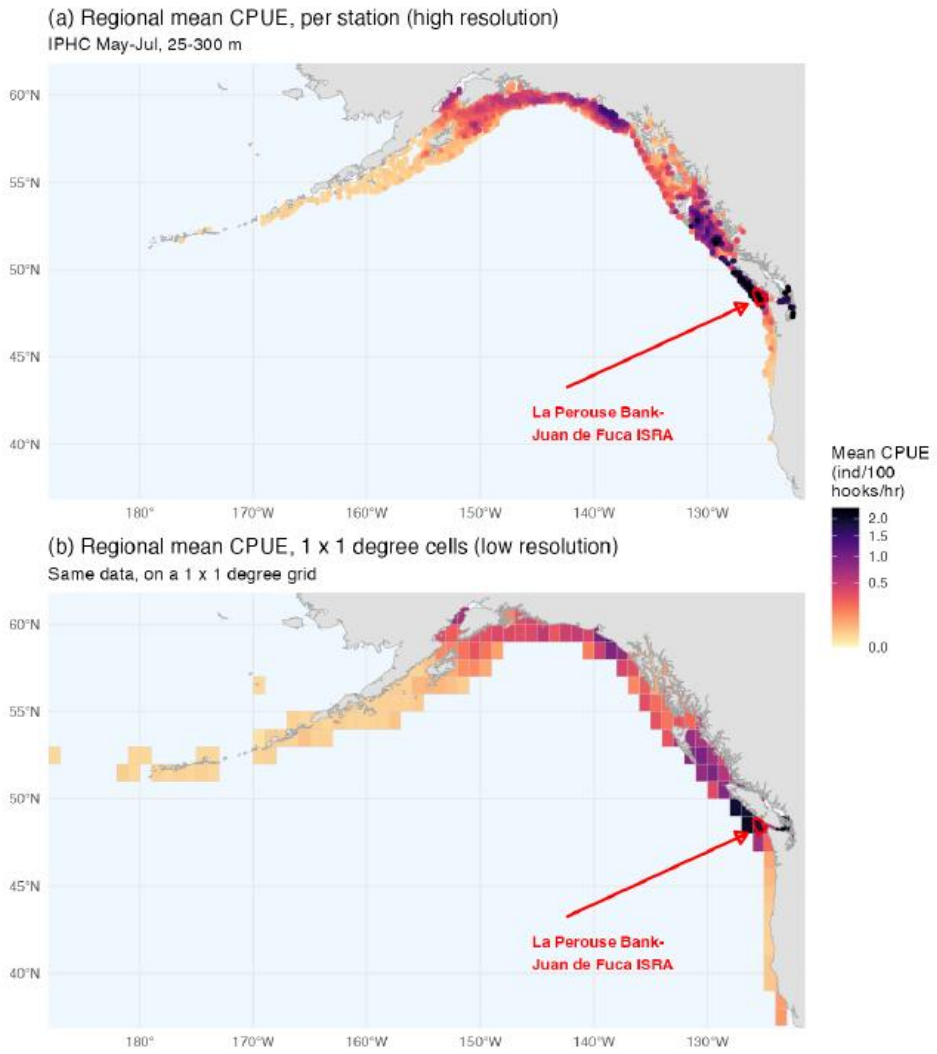


Fig. 5. Mean CPUE of North Pacific Spiny Dogfish from the IPHC setline survey at high resolution (per station, top) and aggregated to a 1°×1° grid (bottom). The broad regional hotspot is evident at both resolutions.

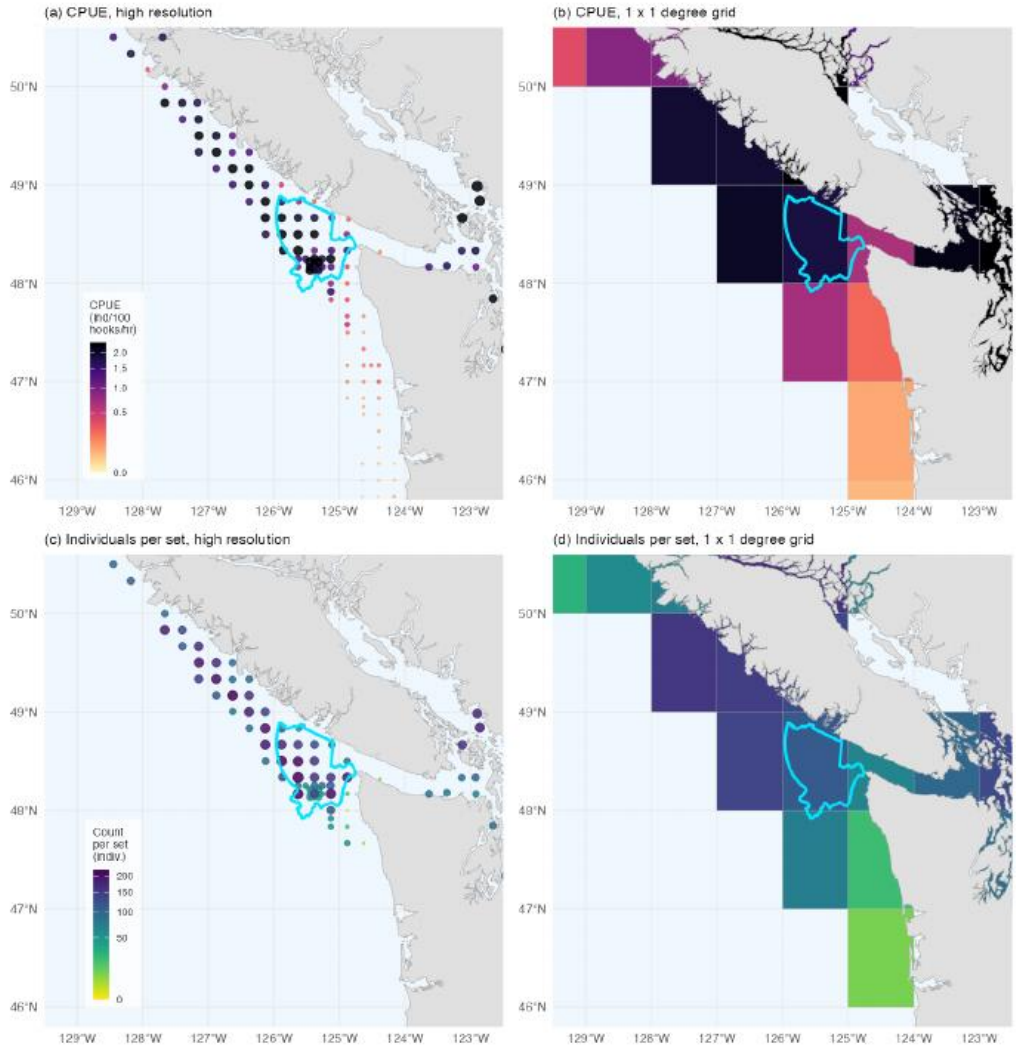


Fig. 6. North Pacific Spiny Dogfish at the La Pérouse Bank-Juan de Fuca ISRA (cyan) from the IPHC setline survey (1998–2025, May–July). Top: mean CPUE; bottom: mean individuals per set (whole-haul sets). Left: high resolution (per station); right: aggregated to a 1°×1° grid. Both metrics resolve the aggregation at high resolution but not at the coarse grid, where the ISRA is smaller than a single cell and its cell is indistinguishable from its neighbours.

Together, these examples demonstrate two complementary roles for fisheries information. First, broad-scale and aggregated datasets can be sufficient to identify candidate areas and establish their importance within a regional context. Second, finer- scale spatial and biological information can substantially improve both the strength of the evidence and the precision with which ISRA boundaries are delineated. Importantly, use of finer-resolution information does not require those data to become publicly available.

5. OPPORTUNITIES FOR COLLABORATION WITH IOTC SCIENTISTS AND DATA HOLDERS

5.1 Objectives and scope

The objective is to explore how existing datasets held by the IOTC, CPCs, national agencies, observer programmes, and associated scientific institutions can contribute to the identification and refinement of ISRAs across the IOTC area of competence. The collaboration would consider the species, areas, and periods represented in participating datasets. A single dataset may provide evidence relevant to several species or areas, allowing analyses to proceed together where feasible. The examples in Section 4 illustrate potential applications, including Eastern Agulhas Front.

5.2 Participation and data governance

RFBs, national fisheries agencies, observer programmes, and associated scientific institutions hold datasets that may contain information relevant to ISRA identification. However, much of this information is subject to confidentiality, ownership, or access provisions. The proposed approach therefore does not assume that raw datasets will be transferred to the ISRA team.

In many cases, the first stage can occur entirely at the national, institutional, or RFB level. The ISRA team can provide lists of potentially relevant species, guidance on the applicable ISRA Criteria, biological reference information, and suggested analytical approaches. Scientists with authorised access to the data can then screen their own datasets for spatial patterns that may indicate range-restricted species hotspots, reproductive areas, aggregations, or other potentially qualifying areas.

Where such patterns are identified, derived outputs, such as maps, summary statistics, spatial comparisons, or descriptions of biological composition, can be discussed with the ISRA team to assess whether the available evidence is likely to meet an ISRA Criterion and what additional analyses may be useful. Subsequent analyses can continue to be undertaken by the data holder, with technical input from the ISRA team as required.

Transfer of raw or finer-resolution data to the ISRA team is therefore optional. Where a data holder wishes to share such information, this would occur only with the appropriate permissions and, where required, under agreed confidentiality or data-use arrangements.

Once analyses indicate that sufficient evidence may exist, the ISRA team can take a more active role in supporting the development of a candidate proposal, including interpretation of the evidence, literature review, mapping and boundary refinement, preparation of proposal text, and navigation of the ISRA review process. Scientists and institutions contributing the underlying data and expertise remain directly involved in proposal development and are recognised as contributors.

This model allows RFBs and their members to retain control over sensitive fisheries information while making greater use of those data for spatial ecological assessments. It also allows analyses to use finer spatial resolution than may be available in publicly released datasets, resulting in boundaries that more accurately reflect the habitat supported by the evidence.

5.3 Implementation and expected outputs

As a first step, the Secretariat and interested CPC scientists could identify relevant datasets or ongoing analyses and the institutions authorised to work with them. The ISRA team would help relate the available species records and biological observations to ISRA Criteria, drawing on the approaches described in Sections

3 and 4. Scientists could identify promising questions from the full geographic and species coverage of their datasets.

Participating scientists would then select feasible analyses, considering species identification, spatial precision, fishing effort, observer coverage, gear selectivity, and changes in sampling or reporting. The interpretation of recurrent concentrations would take these factors into account. The ISRA team can provide biological reference information and technical guidance, discuss derived outputs, and help identify additional analyses needed to assess the evidence.

Where sufficient evidence emerges, the ISRA team and contributing scientists could prepare proposals for new areas or refine existing delineations through the established ISRA review process. Participants would agree on the outputs suitable for sharing, attribution, and any conditions on their use. The pace of individual analyses would depend on data availability and participating institutions' capacity.

The authors propose to prepare an update with participating scientists for WPEB in 2027. This would describe datasets identified, their geographic and species coverage, the scientific questions they can address, and progress with analyses or proposal development. It would also identify limitations and further work required. Findings across several datasets, species, and areas could be considered in the same update.

6. CONCLUSION AND WAY FORWARD

Fisheries datasets represent an important and currently underused source of information on the spatial ecology of chondrichthyans. Their geographic extent, temporal coverage, and associated biological information can provide evidence for identifying range-restricted species hotspots, reproductive areas, and recurrent aggregations, including in offshore regions where other ecological data are limited.

Collaboration with the ISRA process does not require data holders to relinquish control of confidential information. Initial exploration and analysis can remain with national scientists, RFB Secretariats, or other authorised data holders, with the ISRA team providing guidance and subsequently supporting interpretation and proposal development. Where finer-resolution data can be analysed internally, they can also contribute to more precise ISRA delineation without requiring those data to be released.

The Scientific Committee is invited to support the collaboration encouraged by WPEB22 and to encourage the Secretariat, interested CPC scientists, and authorised data holders to explore existing datasets with the ISRA team for the identification and refinement of ISRAs across the IOTC area of competence. The Committee is invited to provide guidance on appropriate mechanisms for collaboration under existing data-access, ownership, and confidentiality arrangements, and to invite a progress update to WPEB in 2027.

The proposed collaboration would strengthen the spatial biological evidence available to IOTC scientists and identify where further work is needed. Its initial scope would be guided by the coverage and suitability of participating datasets and the scientific questions that those data can address.

Additional reference for this update

IOTC. 2026. Report of the 22nd Session of the IOTC Working Party on Ecosystems and Bycatch. Saint-Pierre, La Réunion, 14–18 September 2026. IOTC–2026–WPEB22(AS)–R.

REFERENCES

Bettcher VB, Batlle-Morera A, Kyne PK, et al. 2026. Prioritizing shark, ray, and chimaera conservation in rapidly changing polar waters. Global Change Biology. 32, 8: e71041. https://doi.org/10.1111/gcb.71041

CCAMLR Secretariat. 2023. Fishery report 2022: Dissostichus eleginoides at Crozet Island French EEZ (Subarea 58.6). Hobart: Commission for the Conservation of Antarctic Marine Living Resources. Available at: https://fishdocs.ccamlr.org/FishRep_CI_TOP_2022.html

Corrigan CM, Ardron, JA, Comeros-Raynal MT, et al. 2014. Developing important marine mammal area criteria: learning from ecologically or biologically significant areas and key biodiversity areas. Aquatic Conservation Marine and Freshwater Ecosystems 24(Suppl. 2), 166–183. https://doi.org/10.1002/aqc.2513

Dedman S, Moxley JH, Papastamatiou YP, et al. 2024. Ecological Roles and Importance of Sharks in the Anthropocene Ocean. Science 385, no. 6708: adl2362. https://doi.org/10.1126/science.adl2362

Ducharme-Barth ND, Grüss A, Vincent MT, et al. 2022. Impacts of fisheries-dependent spatial sampling patterns on catch-per-unit-effort standardization: A simulation study and fishery application. Fisheries Research 246: 106169. https://doi.org/10.1016/j.fishres.2021.106169

Dulvy NK., Pacoureau N, Rigby CL, et al. 2021. Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. Current Biology 31, 21: 4773–4787.e8. https://doi.org/10.1016/j.cub.2021.08.062

García-Rodríguez E, Gonzalez-Pestana A, Charles R, et al. 2025. Mapping Important Shark and Ray Areas (ISRAs) in the Central and South American Pacific: Existing knowledge and data needs. PLoS One 20, no. 5: e0322445. https://doi.org/10.1371/journal.pone.0322445

Gilman E, Weijerman M, Suuronen P. 2017. Ecological data from observer programmes underpin ecosystem-based fisheries management. ICES Journal of Marine Science 74: 1481–1495. https://doi.org/10.1093/icesjms/fsx032

Hyde CA, Notarbartolo di Sciara G, Sorrentino L, et al. 2022. Putting sharks on the map: A global standard for improving shark area-based conservation. Frontiers in Marine Science 9: 968853. https://doi.org/10.3389/fmars.2022.968853

International Pacific Halibut Commission (IPHC). 2025. Fishery-Independent Setline Survey (FISS) data, 1998–2025.

IUCN. 2016. A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0, IUCN-2016-048.vi.37, 1st Edn. Gland: IUCN.

Jabado RW, Kyne PM, García-Rodríguez E, et al. 2023. Western Indian Ocean: A regional compendium of Important Shark and Ray Areas. Dubai: IUCN SSC Shark Specialist Group. https://doi.org/10.59216/ssg.isra.2023.r7

Jabado RW, García-Rodríguez E, Kyne PM, et al. 2024. Polar Waters: A regional compendium of Important Shark and Ray Areas. Dubai: IUCN SSC Shark Specialist Group. https://doi.org/10.59216/ssg.isra.2024.r1

Jabado RW, García-Rodríguez E, Bettcher Brito V, et al. 2026. North American Pacific: A regional compendium of Important Shark and Ray Areas. Dubai: IUCN SSC Shark Specialist Group. https://doi.org/10.59216/ssg.isra.2026.r11

Lopetegui-Eguren L, Poos JJ, Arrizabalaga H., et al. 2022. Spatio-temporal distribution of juvenile oceanic whitetip shark incidental catch in the Western Indian Ocean. Frontiers in Marine Science 9. https://doi.org/10.3389/fmars.2022.863602

Rohner CA, Richardson AJ, García-Rodríguez E, et al. 2025. Important Shark and Ray Areas can inform conservation planning in the Mediterranean and Black Seas. iScience 28: 113192. https://doi.org/10.1016/j.isci.2025.113192.

Semba Y, Yokawa K, Matsunaga H, Shono H. 2013. Distribution and trend in abundance of the porbeagle (Lamna nasus) in the southern hemisphere. Marine and Freshwater Research 64: 518–529. https://doi.org/10.1071/MF12272

ANNEX I – Definitions of the Important Shark and Ray Areas (ISRA) Criteria

CRITERIA	DESCRIPTION
Criterion A Vulnerability	Areas important to the persistence and recovery of threatened sharks. *(This criterion must be associated with an additional criterion.)*
Criterion B Range Restricted	Areas holding the regular and/or predictable presence of range-restricted sharks, that are occupied year round or seasonally.
Criterion C Life-History	Areas that are important to sharks for carrying out vital functions across their life-cycle (i.e., reproduction, feeding, resting, movement, or undefined aggregations).
Sub-criterion C1 Reproductive Areas	Areas that are important for sharks to mate, give birth, lay eggs, or provide refuge and other advantages to the young.
Sub-criterion C2 Feeding Areas	Areas that are important for shark nutrition at one or more life-cycle stages.
Sub-criterion C3 Resting Areas	Areas that are important for sharks to conserve energy, often related to environmental conditions or temporal factors.
Sub-criterion C4 Movement	Areas used by sharks regularly or predictably during their movements, such as migrations, which contribute to connectivity of other functionally important areas.
Sub-criterion C5 Undefined Aggregations	Areas where an aggregation or assemblage of sharks regularly and/or predictably occur, year round or seasonally, but the function of the aggregation or assemblage is currently unknown.
Criterion D Special Attributes	Areas important for sharks considered for distinct biological, behavioral, or ecological attributes (unique or associated with a unique habitat type), or which support an important diversity of species.
Sub-criterion D1 Distinctiveness	Areas with sharks that display distinct biological, behavioral, or ecological characteristics.
Sub-criterion D2 Diversity	Areas that sustain an important diversity of sharks.