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Supplementary information

Half a century of global decline in oceanic sharks and rays

Supplementary Methods 1

Correction of nominal longline and seine fishing effort to effective fishing effort

We used the technological efficiency, or 'creep factor', following eqn. 2 and 3 from [67], to adjust the fishing effort of longline and seine gears, the two industrial gears that catch most oceanic sharks, from [36] to adjust for the progressive increase in the effectiveness of fishing gear due to vessel and gear technological improvements.

Supplementary Methods 2

The details of generation time (GT) were presented to the workshop for review and the final choices were used in the published IUCN Red List assessments and associated supplementary material for each species. We encountered nine situations and describe the quality of data in order of increasing confidence.

1. No suitable age and GT estimates were available, even from related species, for the Megamouth Shark.
2. Age and GT were borrowed from a related species, e.g. we assumed the Longfin Mako GT was the same as the Shortfin Mako, the Smooth hammerhead GT was the same as the Scalloped Hammerhead, the Giant Manta Ray is similar to the Reef Manta Ray, the Shortfin, Atlantic, Pygmy, Sicklefin, and Bentfin Devilray are based on the Giant Devilray and hence are overestimates.
3. For many species there were no or few choices as there was only a single, unvalidated, age and growth estimate, e.g. Crocodile Shark, Whale Shark, Basking Shark, and Pelagic Stingray.
4. Female median age-at-maturity and maximum age are estimated from aquarium-held specimens and mark-recapture data, e.g. Reef Manta Ray.
5. Female median age-at-maturity and maximum age varies slightly between regions and it was not clear which study was 'better' or more representative and neither study is validated, e.g. Pelagic Thresher and Blue Shark. Pelagic Thresher shark GT is 16.5 years in Taiwan and 20.6 years in Indonesia and the average of both was used in the Red List assessment was 18.5 years.
6. Female median age-at-maturity and maximum age varies between regions and the more conservative, precautionary observed age estimate was chosen, e.g. Silky Shark, Oceanic Whitetip Shark, and Blue Shark.

7. Female median age-at-maturity and maximum age varies between regions and different regional estimates were used in the estimation of population reduction for the Red List Assessment, e.g. Salmon Shark, Great Hammerhead, and Dusky Shark.
8. The growth curve available encompassed a narrow range of sizes than that observed elsewhere in the geographic distribution, and the growth curve was extrapolated to yield a more plausible maximum age (A_{max}). In the Bigeye Thresher the observed female age-at-maturity is 12–13 years and maximum age 20 years in Taiwan, Northwest Pacific[68]. These Taiwanese age data were used to generate growth curves that encompass a wider age and size range than the observed data, and thus were used to estimate female A_{mat} of 9 years and A_{max} of 28 years resulting in GT of 18.5 years[69].
9. There was a bomb radiocarbon validated estimate for one region and this was assumed to be valid for the species range, e.g. Common Thresher and White Shark.

Supplementary Table

Table S1. Description of the 57 time-series of the 18 oceanic sharks and rays. [Associated time-series dataset available at www.sharkipedia.org and at https://zenodo.org/badge/latestdoi/307472870[70]]

Max. size: maximum size as total length, or *disc width in centimeters. CPUE: Catch Per Unit Effort. SPUE: Sightings Per Unit Effort. GT: Generation time in years.

Latin name **Common name**	**N°**	**Start**	**End**	**Region of dataset**	**Data type**	**Geographical zone**	**Max. size**	**GT**	**References**
A. Carcharhiniformes: Carcharhinidae									
Carcharhinus falciformis Silky Shark	1.	1992	2013	North Atlantic	Standardized CPUE	Tropical	371	15	Lynch et al. 2018[71]
	2.	1995	2017	North Pacific	Standardized CPUE	Tropical	371	15	Lennert-Cody et al. 2018[72]
	3.	1995	2016	South Pacific	Standardized CPUE	Tropical	371	15	Clarke et al. 2018[73]
Carcharhinus longimanus Oceanic Whitetip Shark	4.	1992	2015	North Atlantic	Standardized CPUE	Tropical	395	20.4	Young et al. 2016[74]
	5.	2004	2010	South Atlantic	Standardized CPUE	Tropical	395	20.4	Tolotti et al. 2013[75]
	6.	1998	2011	Indian Ocean	Standardized CPUE	Tropical	395	20.4	Ramos-Cartelle et al. 2012[76]
	7.	1995	2010	North Pacific	Standardized CPUE	Tropical	395	20.4	Brodziak and Walsh 2013[77]
	8.	1996	2014	North Pacific	Updated standardized CPUE	Tropical	395	20.4	Rice et al. 2015[78]
	9.	1995	2009	North and South Pacific	Stock assessment	Tropical	395	20.4	Tremblay-Boyer et al. 2019[51]
Carcharhinus obscurus Dusky Shark	10.	1960	2015	North Atlantic	Stock assessment	Temperate	420	29.8	SEDAR 2016[24]
	11.	1978	2003	Indian Ocean	Nominal CPUE	Temperate	420	38	Dudley and Simpfendorfer 2006[79]
	12.	1975	2005	Indian Ocean	Standardized CPUE	Temperate	420	38	Braccini and O'Malley 2018[80]
	13.	2006	2015	Indian Ocean	Standardized CPUE	Temperate	420	38	Braccini and O'Malley 2018[80]
Prionace glauca Blue Shark	14.	1971	2013	North Atlantic	Stock assessment	Temperate	380	10	ICCAT 2016[81]
	15.	1971	2013	South Atlantic	Stock assessment	Temperate	380	10	Carvalho and Winker 2015[82]
	16.	1949	2016	Indian Ocean	Stock assessment	Temperate	380	10.5	Rice 2017[83]
	17.	1971	2015	North Pacific	Stock assessment	Temperate	380	10.5	ISC 2017[84]
	18.	1994	2014	South Pacific	Stock assessment	Temperate	380	10.5	Takeuchi et al. 2016[66]

Latin name **Common name**	**N°**	**Start**	**End**	**Region of dataset**	**Data type**	**Geographical zone**	**Max. size**	**GT**	**References**
B. Carcharhiniformes: Sphyrnidae									
Sphyrna lewini Scalloped Hammerhead	19.	1995	2017	North Atlantic	Nominal CPUE	Tropical	420	24.1	J.K. Carlson and W.B. Driggers unpubl. data
	20.	1994	2017	North Atlantic	Standardized CPUE	Tropical	420	24.1	J.K. Carlson and W.B. Driggers unpubl. data
	21.	1981	2005	North Atlantic	Stock assessment	Tropical	420	24.1	Jiao et al. 2011[28]
	22.	1978	2003	Indian Ocean	Standardized CPUE	Tropical	420	24.1	Dudley and Simpfendorfer 2006[26]
	23.	1996	2006	South Pacific	Catch	Tropical	420	24.1	Noriega et al. 2011[85]
	24.	1964	2004	South Pacific	Standardized CPUE	Tropical	420	24.1	Simpfendorfer et al. 2011[86,‡]
Sphyrna mokarran Great Hammerhead	25.	1995	2017	North Atlantic	Nominal CPUE	Tropical	610	24.75	J.K. Carlson and W.B. Driggers unpubl. data
	26.	1994	2017	North Atlantic	Standardized CPUE	Tropical	610	24.75	J.K. Carlson and W.B. Driggers unpubl. data
	27.	1981	2005	North Atlantic	Stock assessment	Tropical	610	24.75	Jiao et al. 2011[28]
	28.	1978	2003	Indian Ocean	Standardized CPUE	Tropical	610	23.7	Dudley and Simpfendorfer 2006[26]
Sphyrna zygaena Smooth Hammerhead	29.	1981	2005	North Atlantic	Stock assessment	Tropical	400	24.1	Jiao et al. 2011[28]
	30.	1992	2017	North Atlantic	Standardized CPUE	Tropical	400	24.1	J.K. Carlson US pelagic fisheries unpubl. data
	31.	1978	2014	Indian Ocean	Nominal CPUE	Tropical	400	24.1	Dicken et al. 2018[87]
	32.	1950	2009	South Pacific	Standardized CPUE	Tropical	400	24.1	Reid et al. 2011[88]
C. Lamniformes: Alopiidae									
Alopias pelagicus Pelagic Thresher	33.	1967	1987	Indian Ocean	Nominal CPUE	Tropical	365	18.5	E. Romanov unpubl. data, Southern Scientific Research Institute of Marine Fisheries and Oceanography, Kerch, Crimea.
	34.	1996	2014	North and South Pacific	Standardized CPUE	Tropical	365	18.5	Rice et al. 2015[78,†]
Alopias superciliosus	35.	1992	2013	North Atlantic	Standardized CPUE	Tropical	484	18.5	Young et al. 2016[89]

Latin name **Common name**	**N°**	**Start**	**End**	**Region of dataset**	**Data type**	**Geographical zone**	**Max. size**	**GT**	**References**
Bigeye Thresher	36.	1966	1986	Indian Ocean	Nominal CPUE	Tropical	484	18.5	E. Romanov unpubl. data, Southern Scientific Research Institute of Marine Fisheries and Oceanography, Kerch, Crimea.
	37.	1995	2014	North and South Pacific	Standardized CPUE	Tropical	484	18.5	Fu et al. 2018[90]
Alopias vulpinus Common Thresher	38.	1992	2013	North Atlantic	Standardized CPUE	Temperate	573	25.5	Young et al. 2016[89]
	39.	1981	2013	North Pacific	Nominal CPUE	Temperate	573	25.5	Teo et al. 2016[91]
D. Lamniformes: Lamnidae									
Carcharodon carcharias White Shark	40.	1961	2008	North Atlantic	Standardized relative abundance	Temperate	640	53	Curtis et al. 2014[43]
	41.	1961	2010	North Atlantic	Standardized relative abundance	Temperate	640	53	Curtis et al. 2014[43]
	42.	1978	2012	Indian Ocean	Standardized CPUE	Temperate	640	53	Dudley and Simpfendorfer 2006[26]
	43.	1980	2010	North Pacific	Nominal CPUE	Temperate	640	53	Dewar et al. 2013[92]
	44.	1950	2009	South Pacific	Standardized CPUE	Temperate	640	53	Reid et al. 2011[88]
Isurus oxyrinchus Shortfin Mako	45.	1950	2017	North and South Atlantic	Stock assessment	Temperate	445	25	ICCAT 2019[25]
	46.	1971	2015	Indian Ocean	Preliminary stock assessment	Temperate	445	24	Brunel et al. 2018[93]
	47.	1975	2016	North Pacific	Stock assessment	Temperate	445	24	ISC 2018[94]
	48.	1995	2013	South Pacific	Standardized CPUE	Temperate	445	24	Francis et al. 2014[95]
Isurus paucus Longfin Mako	49.	1992	2015	North Atlantic	Standardized CPUE	Tropical	427	25	J.K. Carlson US pelagic fisheries unpubl. data
Lamna nasus Porbeagle	50.	1926	2009	North Atlantic	Stock assessment	Temperate	357	19.5	ICCAT 2010[96]
	51.	1961	2009	North Atlantic	Stock assessment	Temperate	357	19.5	ICCAT 2010[96]
	52.	1962	2009	North Atlantic	Stock assessment	Temperate	357	19.5	Campana et al. 2013[97]
	53.	1962	2015	South Atlantic, South Pacific and Indian Ocean	Risk assessment	Temperate	233	38.25	Hoyle et al. 2017[98]
D. Myliobatiformes: Dasyatidae									
Pteroplatytrygon violacea Pelagic Stingray	54.	2004	2015	North Atlantic	Standardized CPUE	Temperate	90*	6.5	J.K. Carlson US pelagic fisheries unpubl. data

Latin name **Common name**	**N°**	**Start**	**End**	**Region of dataset**	**Data type**	**Geographical zone**	**Max. size**	**GT**	**References**
E. Myliobatiformes: Mobulidae									
Mobula alfredi Reef Manta Ray	55.	2003	2018	Indian Ocean	Nominal SPUE	Tropical	500*	29	A. Marshall Marine Megafauna Foundation unpubl data.
Mobula birostris Giant Manta Ray	56.	2003	2018	Indian Ocean	Nominal SPUE	Tropical	700*	29	A. Marshall Marine Megafauna Foundation unpubl data.
Mobula kuhlii Shortfin Devilray	57.	2003	2018	Indian Ocean	Nominal SPUE	Tropical	135*	12.8	A. Marshall Marine Megafauna Foundation unpubl data.

† *Alopias* species-complex was used to represent catches from the Pacific for *Alopias pelagicus* in this species Red List assessment and in this analysis. The three thresher shark species A. pelagicus, A. *superciliosus,* and *A. vulpinus,* were combined by [78] due to a lack of species-specific data. These data are most likely to comprise the two first species[99,100, E. Romanov unpubl. data], however the proportion of the two species in this data is not defined[78], and these data are used only as a possible indication of *Alopias pelagicus* trends.

‡ These data comprise catches of *Sphyrna lewini* and *S. mokarran*. As the proportion of *S. mokarran* was low (less than a 15%; see [101]), these data represent *S. lewini* in this species Red List assessment and in this analysis.

Table S2. IUCN Red List Status of the 18 oceanic sharks and rays.

CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern.

Retrospective Red List assessment based on 2018 IUCN Species Survival Commission Shark Specialist Group workshop participants' expert judgement are blue when no assessment was available and green when assessment(s) was available.

*Previous assessment(s) refers to a different species concept.

Latin name		**IUCN Red List Status**		**Red List Status for RLI**		
Common name	**Pre2000s**	**2000s**	**2010s**	**1980***	**2005**	**2018**
A. Carcharhiniformes: Carcharhinidae						
Carcharhinus falciformis Silky Shark		LC$_{2000}$; NT$_{2007}$	NT$_{2015}$; VU$_{2017}$	NT	NT	VU
Carcharhinus galapagensis Galapagos Shark		NT$_{2003}$	LC$_{2018}$	LC	LC	LC
Carcharhinus longimanus Oceanic Whitetip Shark		NT$_{2000}$; VU$_{2006}$	CR$_{2018}$	VU	VU	CR
Carcharhinus obscurus Dusky Shark	EN$_{1996}$	NT$_{2000}$; VU$_{2007}$	EN$_{2018}$	LC	VU	EN
Prionace glauca Blue Shark		NT$_{2000}$; NT$_{2005}$	NT$_{2018}$	LC	NT	NT
B. Carcharhiniformes: Sphyrnidae						
Sphyrna lewini Scalloped Hammerhead		NT$_{2000}$; EN$_{2007}$	CR$_{2018}$	VU	EN	CR
Sphyrna mokarran Great Hammerhead		DD$_{2000}$; EN$_{2007}$	CR$_{2018}$	VU	EN	CR
Sphyrna zygaena Smooth Hammerhead		NT$_{2000}$; VU$_{2005}$	VU$_{2018}$	NT	VU	VU
C. Lamniformes: Alopiidae						
Alopias pelagicus Pelagic Thresher		VU$_{2004}$	EN$_{2018}$	VU	VU	EN
Alopias superciliosus Bigeye Thresher		VU$_{2007}$	VU$_{2018}$	VU	VU	VU
Alopias vulpinus Common Thresher		DD$_{2000}$; DD$_{2002}$; VU$_{2007}$	VU$_{2018}$	VU	VU	VU
D. Lamniformes: Cetorhinidae						
Cetorhinus maximus Basking Shark	VU$_{1996}$	VU$_{2000}$; VU$_{2005}$	EN$_{2018}$	EN	EN	EN

Latin name **Common name**	**IUCN Red List Status**			**Red List Status for RLI**		
	Pre2000s	**2000s**	**2010s**	**1980***	**2005**	**2018**
E. Lamniformes: Lamnidae						
Carcharodon carcharias White Shark	VU$_{1996}$	VU$_{2000}$; VU$_{2005}$	VU$_{2018}$	VU	VU	VU
Isurus oxyrinchus Shortfin Mako		NT$_{2000}$; VU$_{2004}$	EN$_{2018}$	LC	VU	EN
Isurus paucus Longfin Mako		VU$_{2006}$	EN$_{2018}$	LC	VU	EN
Lamna ditropis Salmon Shark		DD$_{2000}$; LC$_{2008}$	LC$_{2018}$	LC	LC	LC
Lamna nasus Porbeagle	VU$_{1996}$	NT$_{2000}$; VU$_{2006}$	VU$_{2018}$	VU	VU	VU
F. Lamniformes: Megachasmidae						
Megachasma pelagios Megamouth Shark		DD$_{2000}$; DD$_{2005}$	LC$_{2015}$	LC	LC	LC
G. Lamniformes: Odontaspididae						
Odontaspis noronhai Bigeye Sand Tiger		DD$_{2000}$; DD$_{2005}$	LC$_{2018}$	LC	LC	LC
H. Lamniformes: Pseudocarchariidae						
Pseudocarcharias kamoharai Crocodile Shark		NT$_{2000}$; NT$_{2005}$	LC$_{2018}$	LC	LC	LC
I. Orectolobiformes: Rhincodontidae						
Rhincodon typus Whale Shark	DD$_{1996}$	VU$_{2000}$; VU$_{2005}$	EN$_{2016}$	LC	VU	EN
J. Myliobatiformes: Dasyatidae						
Pteroplatytrygon violacea Pelagic Stingray		LC$_{2007}$	LC$_{2018}$	LC	LC	LC
K. Myliobatiformes: Mobulidae						
Mobula alfredi Reef Manta Ray		VU$_{2010}$	VU$_{2018}$	LC	VU	VU
Mobula birostris Giant Manta Ray		VU$_{2000}$	EN$_{2018}$	LC	VU	EN
Mobula eregoodoo Longhorned Pygmy Devilray		NT$_{2003}$	EN$_{2018}$	LC	VU	EN
Mobula hypostoma Atlantic Devilray		DD$_{2008}$	EN$_{2018}$	LC	VU	EN
Mobula kuhlii Shortfin Devilray		DD$_{2007}$	EN$_{2018}$	LC	VU	EN

Latin name **Common name**	**IUCN Red List Status**			**Red List Status for RLI**		
	Pre2000s	**2000s**	**2010s**	**1980***	**2005**	**2018**
Mobula mobular Giant Devilray			EN$_{2018}$	LC	VU*	EN
Mobula munkiana Pygmy Devilray		NT$_{2006}$	VU$_{2018}$	LC	NT	VU
Mobula tarapacana Sicklefin Devilray		DD$_{2006}$	VU$_{2016}$; EN$_{2018}$	LC	NT	EN
Mobula thurstoni Bentfin Devilray		NT$_{2006}$	NT$_{2016}$; EN$_{2018}$	LC	VU	EN

Table S3. Description of the 15 stock assessment outputs of 8 species used in the Figure 4d and Extended Figure 9.

MSY: Maximum Sustainable Yield. SSB: Stock Spawning Biomass. B: Biomass. N: Abundance

*no global fishing mortality trajectory was available for this stock assessment.

The Blue Shark stock assessment[66] couldn’t be included because no estimates of MSY-related quantities were possible.

Genus	**species**	**Type**	**References**	**Source**
Carcharhinus	*longimanus*	SSB/SSB$_{MSY}$	Tremblay-Boyer et al. 2019[51]; Mean weighted run between all models	Given by Tremblay-Boyer
Carcharhinus	*obscurus*	SSFec/SSFec$_{MSY}$	SEDAR 2016[24]; Base run page 42 table 3.7	From report
Isurus	*oxyrinchus*	B/B$_{MSY}$	Brunel et al. 2018[93]; page 14 figure 6 (panel B and C)	From report
Isurus	*oxyrinchus*	SSFec/SSFec$_{MSY}$	ICCAT 2019[25]; base 3; run 3	Given by Winker
Isurus	*oxyrinchus*	SSB/SSB$_{MSY}$	ISC 2018[94]; page 82 figure 15 (black line/blue line); modeling period (1975-2016)	From report
Lamna	*nasus*	SSN/SSN$_{MSY}$	Campana et al. 2013[97]*; page 38 table 12 and page 35 table 9; model 1	From report
Lamna	*nasus*	B/B$_{MSY}$	ICCAT 2010[96]; page 1996 figure 23; C; NeastEAtl	From report
Lamna	*nasus*	B/B$_{MSY}$	ICCAT 2010[96]; page 1992 figure 17; D; NWestAtl	From report
Prionace	*glauca*	B/B$_{MSY}$	Carvalho et al. 2015[82]; Run 2	Given by Winker
Prionace	*glauca*	SSF/SSF$_{MSY}$	ICCAT 2016[81]; page 35 figure 13 and figure 14; Run 6	From report
Prionace	*glauca*	SSB/SSB$_{MSY}$	ISC 2017[84]; Reference case model	Given by Winker
Prionace	*glauca*	SB/SB$_{MSY}$	Rice et al. 2017[83]	Given by Winker
Sphyrna	*lewini*	N/N$_{MSY}$	Jiao et al. 2011[28]; Average between all 7 models	Given by Jiao
Sphyrna	*mokarran*	N/N$_{MSY}$	Jiao et al. 2011[28]; Average between all 7 models	Given by Jiao
Sphyrna	*zygaena*	N/N$_{MSY}$	Jiao et al. 2011[28]; Average between all 7 models	Given by Jiao

Supplementary Discussion 1

Conservative Living Planet Index for oceanic sharks and rays

Our analysis is intentionally conservative. There are three reasons why the true abundance trend index values are likely to be lower and the calculated percent declines worse than estimated here. First, our baseline for 1970 likely represents the already depleted state for several species compared to unfished levels[27]. Some shark populations were fished down prior to 1970, often due to incidental catch in fisheries targeting highly valued large oceanic teleosts (primarily tunas and billfishes). Some, notably the Porbeagle in the Northwest Atlantic, had already collapsed by the 1960s[102]. We also estimated a 25% chance that species were already below MSY by the 1970s, underscoring that fishing levels were already unsustainable half a century ago. Therefore, our LPI is likely to be a conservative estimator of the degree of decline. Second, unreported catches (landings and/or discards) are not included in our time-series dataset, which can result in underestimates of relative abundance (although trends in abundance may be unaffected if the under-reporting rate remains constant)[103]. Third, very high mortality of Shortfin Mako in the Northwest Atlantic revealed using satellite telemetry suggests that traditional stock assessments could underestimate fishing mortality for this species, and that this problem may be more widespread[44].

Supplementary Discussion 2

Are steep declines of devil rays in Mozambique exceptional, or a rare window on the history of exploitation in the Indian Ocean?

Over the past decade or so, steep declines in devil rays have been recorded by scientists in many countries[104]. While large body size is usually correlated with sensitivity to overexploitation in sharks, the relatively small-bodied devil rays tend to have very low annual reproductive output (typically one pup per year or every other year)[19] and small localized populations, leaving them also particularly ill-equipped to withstand fishing pressure[7]. A key discussion point at the IUCN Red List workshop was whether these declines are unique, one-off occurrences or whether they are the synecdoche — the part that reflects the whole. Mozambique and Sri Lanka both recently came out of longstanding civil wars — Mozambique (spanning 1977 to 1992), Sri Lanka (1983 to 2009). Fishing and international trade was limited during these conflicts but rapidly resumed and expanded once the conflicts ceased[105]. Hence, both places have only relatively recently seen improved access to fishing gears that allow incidental capture of these large oceanic rays and, to some degree, exposure to industrialized fisheries and to the growing Chinese market demand for highly valued gill plates. Consequently, a range of devil ray species were subject to target and by-catch fisheries in both countries[106,107]. The participants felt that a valid working hypothesis was that steep declines in these two countries occurred at a time sufficiently recent to have been observed and tracked by local scientists. The rapidity of decline in Mozambique given limited fishing effort, coupled with ongoing declines in Sri Lanka as catching intensity grows, suggests that similar steep declines may have occurred in other Indian Ocean countries a decade or two previously, prior to scientific observation of these species and their fisheries[108,109]. These declines also match declines reported in other areas with intense fishing pressure, like Indonesia[106,110]. There are plenty of anecdotal clues from other regions that suggest that populations of devil rays have declined in similar ways in other areas as well, but these most recently studies have been documented more comprehensively. One way to test this hypothesis would be to undertake traditional ecological knowledge surveys of the occurrence of species aggregations, the timing of appearance of gillnets, and the start of gill plate exports resulting in the onset of fisheries targeting and retaining bycatch of these species around the Indian Ocean[106,107].

Supplementary Discussion 3

Details on tuna Regional Fishery Management Organizations management progress

The world's four major Regional Fishery Management Organizations focused on tunas (tRFMOs) have, to varying degrees, prohibited retention of inherently sensitive oceanic shark species that are also of relatively low value to the associated pelagic fisheries, e.g., (1) Bigeye Thresher (*Alopias superciliosus*) in the Atlantic, (2) devil rays in the Pacific and Indian Oceans (with some exceptions), (3) the Oceanic Whitetip Shark in all major ocean basins (see [51,74–78]), and (4) species taken mainly in fisheries not affected by the management action (e.g. hammerhead sharks *Sphyrna* spp., with the exception of *S. tiburo* in select Atlantic pelagic fisheries of developed countries). The first and still only international shark fishing quotas (for Atlantic Blue Sharks, *Prionace glauca*) were not adopted until late 2019. For the other shark species making up a significant portion of high seas fleets' catch, the tRFMOS have set only a few species-specific measures (e.g., as suite of landing condition options for Atlantic Shortfin

Mako, bycatch limits for Silky Sharks (*Carcharhinus falciformis*) in the Eastern Tropical Pacific, and gear restrictions in the Western and Central Pacific), in addition to finning bans. While Ecosystem-Based Fisheries Management (EBFM) is often touted as a remedy for bycatch problems, tRFMOs' efforts to manage sharks using EBFM have been evaluated as inadequate with respect to scientific advice and implementation[41,42]. Moreover, sharks, particularly Shortfin Mako and Blue Sharks, are increasingly targeted or welcomed as secondary catch by high seas longliners.

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