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LETTER

Two thirds of species in a global shark fin trade hub are threatened with extinction: Conservation potential of international trade regulations for coastal sharks

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Abstract

One third of chondrichthyan species (sharks, rays, and chimeras) are threatened with extinction, mainly due to unsustainable fishing. Large accessible international markets for meat and luxury products like dried fins can help drive overfishing by encouraging targeted capture or retention of high-value export species. If this is common, then species in international trade could have heightened extinction risk. Here, we examined the species composition of the Hong Kong shark fin market from 2014 to 2018, finding that traded species disproportionately occur in threatened categories (70.9%) and all premium value species are threatened. A small number of cosmopolitan species dominate the trade, but noncosmopolitan coastal species are still traded at concerning levels given their limited distribution. These coastal species are not generally subject to retention prohibitions, fisheries management, or international trade regulations and without management many could become extinct. The conservation potential of international trade regulations alone for coastal chondrichthyans depends on the extent to which overfishing is driven by export markets; socioeconomic studies of coastal fishing communities are needed to make this determination. Nonetheless, adding international trade regulations for more coastal shark species that are in the fin trade could prompt broad engagement with overfishing in nations lacking effective management.

KEYWORDS

CITES, governance, Hong Kong, international shark trade, management, shark conservation

1 INTRODUCTION

Cartilaginous fishes (i.e., sharks, rays, and chimeras; chondrichthyans) are among the most threatened class of vertebrates assessed by the International Union for the Conservation of Nature Red List of Threatened Species (IUCN; Dulvy et al., 2021). The number of species in threatened categories (i.e., Vulnerable [VU], Endangered [EN], and Critically Endangered [CR]) has doubled between global assessments in 2014 and 2021; Dulvy et al., 2014, 2021). Most changes in species status between the two assessments are due to new information (94.2%) and are not considered genuine changes (i.e., changes in status based on population declines or increased threats; Dulvy et al., 2021). Nonetheless, over a third of all chondrichthyans species (37.5%) are now estimated as being threatened with extinction, fomenting a conservation crisis (Dulvy et al., 2021).

Unsustainable fishing is the immediate cause of the threatened status of many chondrichthyans ("proximate threat"), but the drivers of unsustainable fishing ("ultimate threats") are complex. Chondrichthyans can be caught in a variety of fishing gear types (primarily longline, gillnet, and trawls), incidentally or targeted, in fisheries from industrial to artisanal scale (Thorpe & Frierson, 2009; Gilman et al., 2016; Appleyard et al., 2018; Guzman et al., 2020). Chondrichthyan products range in market value from relatively inexpensive meat for local consumption to high-value export products, such as dried fins (Dell'Apa et al., 2014). Large, accessible international markets can encourage fishing to supply external luxury markets (e.g., fins) or demand for meat beyond what is required to satisfy local and national needs (e.g., Jaiteh et al., 2016; Sabbagh & Hickey, 2019; Pincinato et al., 2022). If international trade is commonly the ultimate driver of unsustainable fishing, we expect that species subject to international trade would tend to be at higher risk of extinction than species primarily caught for domestic consumption, or not fished at all because of the greater incentive to target or retain high-value export species. If this is true, then internationally traded species, especially the most highly valued ones, should disproportionately occur in threatened IUCN categories.

Unsustainable chondrichthyan fishing is also likely to be associated with a lack of effective management (MacNeil et al., 2020). Management is a complex endeavor that requires legislative, monitoring, research, assessment, and enforcement investments (Techera & Klein, 2014). Some nations, hereafter referred to as "high-capacity nations" have made these investments for chondrichthyans (e.g., the United States, Australia, and New Zealand; Simpfendorfer & Dulvy, 2017), while other "low-capacity nations" have not, with potential barriers, including a lack of political will, technical capacity, and/or economic resources for implementation (Cardeñosa et al., 2019). Chondrichthyan species subject to international trade with a global distribution that mainly occur outside of high-capacity nations are, therefore, likely to be undermanaged and threatened.

While the species composition of the international chondrichthyan meat trade remains opaque because species are frequently aggregated in trade statistics (Dent & Clarke, 2015; Niedermüller et al., 2021), there is enough information on the species composition of some globally important dried fin trade hubs to determine if species in the dried fin trade are disproportionately threatened with extinction (Fields et al., 2018; Cardeñosa et al., 2020b; Liu et al., 2021). The Hong Kong Special Administrative Region of the Peoples Republic of China (hereafter referred to as Hong Kong) is one of the largest shark fin trade hubs in the world, serving as an importer, re-exporter, and consumer of fins derived from over 80 nations annually (Dent & Clarke, 2015; Eriksson & Clarke, 2015; Shea & To, 2017). The species composition was partially documented in 1999–2000 and documented in 2014–2015 (Clarke et al., 2006a; Fields et al., 2018). Previous studies in Hong Kong have emphasized the large proportional contribution of a small number of cosmopolitan shark species (Clarke et al., 2006a; Fields et al., 2018), which we define here as species that have a global distribution occupying > 8 major FAO fishing regions, including at least one in each of the Atlantic, Indian, and Pacific Ocean basins. Although the cosmopolitan distribution of these species does not appear to reduce their extinction risk (McClenachan et al., 2016; Dulvy et al., 2017), the dominance of these species in trade has overshadowed the prevalence of non-cosmopolitan species (defined here as ones that have a global distribution occupying < 8 major FAO fishing regions). These may be threatened by the dried fin trade, even if they are traded in lower volumes.

We need to understand the drivers of status (i.e., proximate and ultimate threats) on a species and population-specific basis in order to formulate effective responses to the global chondrichthyan conservation crisis. We also need to understand which of these species and populations are yet to be subject to effective management. Here, we provide an updated characterization of the status of chondrichthyan species in the Hong Kong dried fin trade from 2014 to 2018 based on recently updated IUCN assessments. Our objective was to test the hypothesis that these internationally traded species disproportionately occur in threatened categories. We also examined the relationships between species status, geographic distribution, fin value, and their incidence in trade. Our final objective was to broadly assess whether threatened species in the dried fin trade are generally subject to management and discuss how national management and international trade regulation could be better employed for the conservation of internationally traded chondrichthyan species.

2 | METHODOLOGY

Our sampling has been described previously (Fields et al., 2018), but in brief, we randomly select 10 out of ~ 300 dried seafood vendors on a semimonthly (February 2014–January 2015) or monthly (February 2015–June 2018) basis. From each vendor two bags of "shark fin trimmings," small pieces of fin that have been trimmed from the primary fins (i.e., dorsal fin, pectoral fins, and lower caudal fin) were purchased. Fin trimmings are derived from fins occurring in the retail market but also from fins that are re-exported or sold wholesale, thus providing a proxy of the species composition of the entire Hong Kong trade (Cardeñosa et al., 2018; Fields et al., 2018). We randomly selected 10 fin trimmings per bag and use DNA mini-barcoding of the cytochrome oxidase I gene to identify them to lowest taxon possible (Cardeñosa et al., 2017). We calculated the proportion of these species in threatened categories to compare to the proportion observed in chondrichthyans generally (i.e., 37.5%; Dulvy et al., 2021). We also calculated the proportion of threatened species in species known to provide the highest value fins ("premium species") based on Clarke et al. (2007). These are hammerhead sharks (*Sphyrna* sp.), fusiform rays (Families Rhinidae, Rhinobatidae, and Glaucostegidae), and mako sharks (*Isurus* sp.).

To better understand the relationships between species occurrence in trade, their IUCN status, and their geographic distribution, we calculated the percentage of all sampling events, defined here as a visit to one vendor (N = 20 trimming samples), in which each species was detected at least once (i.e., incidence). We then plotted the relationship between species incidence and distribution, expressed as the number of FAO major fishing areas, where they occur taken from the IUCN Red List website. Species complexes and samples identified to the genus level were not included because we could not pinpoint their distribution. The only exception was the river sharks (*Glyphis* spp.) because the genus overall has a very restricted distribution (i.e., three FAO major fishing areas).

We further examined the species occurring in the Hong Kong market to determine if threatened species in the trade are subject to prohibitions, fisheries management, or international trade regulations. We define "prohibition" here being that the species is banned from landings by domestic legislation (prohibited nationally; Table 1) across > 50% of the countries where it occurs based on the geographic range list of countries from the IUCN Red List or by Regional Fisheries Management Organizations (RMFOs) (prohibited regionally; Table 1). Specific conservation actions or prohibitions were searched in the IUCN Red List webpage for each individual species under "Conservation Actions." A species was assumed to be prohibited nationally if it occurred within a Shark Sanctuary nation (e.g., Bahamas). "Fisheries management" was defined here as fisheries for the species are known to be managed for sustainability in > 50% of the FAO major fishing areas, where it occurs based on Simpfendorfer and Dulvy (2017), and "international trade regulation" defined here as species is listed on the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) Appendix I or II (Table 1). CITES is a multilateral environmental agreement that prohibits or regulates international trade in threatened species listed under Appendix I or Appendix II, respectively.

3 | RESULTS

A total of 86 chondrichthyan species or species complexes were detected in the market over this 4.5-year period (N = 9820 trimmings identified). Of these, 61 species (70.9%) are assessed as being threatened with extinction (Figure 1; please see Figure S1 for a colorblind version of this figure). This is around twice the proportion of species that were classified as threatened in the 2014–2015 survey of this hub (Fields et al., 2018). All species with premium value fins in Hong Kong occur in threatened categories, mainly EN and CR (Figure 1b).

Threatened species exhibited a broad range of incidence in the trade (Figures 1c and 2). The species with the highest incidence is the Near Threatened (NT) blue shark (*Prionace glauca*) but nine of the remaining top 10 most encountered species are listed as threatened (Figure 1c). Species market incidence was positively correlated with their geographic distribution ($R^2 = 0.224$, $p < 0.001$): noncosmopolitan species are less commonly encountered in the shark fin trade than most cosmopolitan species (Figure 2; please see Figure S2 for a colorblind version of this figure). There are a few pelagic or coastal species with very high incidences ranging from 10% to 100% and these tend to have a cosmopolitan distribution. There is a larger number of threatened coastal, primarily noncosmopolitan, species with incidences in trade from 0.1% to 12% (Figure 2).

Overall, very few threatened species in the fin trade are adequately prohibited, managed, or their trade regulated as we defined these terms (Table 1). Some of the cosmopolitan threatened species are prohibited from landings by certain RFMOs. Only the oceanic whitetip shark (*Carcharhinus longimanus*) is prohibited in RFMOs

TABLE 1 Species or species groups in the Hong Kong shark fin markets with prohibition at national and regional governance levels, sustainable fisheries, international trade regulations, habitat, range (cosmopolitan vs. noncosmopolitan), and threat assessment by the IUCN Red List of Threatened Species

Species	Prohibited Nationally[b]	Prohibited Regionally[b]	Sustainably managed[c]	CITES listed	Habitat	Cosmopolitan	Threatened
Alopias vulpinus	3.1% (3/98)	13.3% (2/15)	No (US)	Yes	Oceanic	Yes	Yes
Carcharhinus obscurus	10.5% (4/38)	0% (0/15)	No	No	Coastal	Yes	Yes
Galeocerdo cuvier	9.6% (11/114)	0% (0/15)	No	No	Coastal	Yes	No
Hexanchus griseus	2.7% (2/73)	0% (0/15)	No	No	Coastal	Yes	No
Isurus oxyrinchus	7.0% (11/157)	33.3% (5/15)	No	Yes	Oceanic	Yes	Yes
Prionace glauca	6.1% (11/179)	0% (0/15)	No	No	Oceanic	Yes	No
Alopias superciliosus	5.7% (7/122)	57.2% (8/14)	No	Yes	Oceanic	Yes	Yes
Carcharhinus plumbeus	6.1% (7/115)	0% (0/14)	No	No	Coastal	Yes	Yes
Isurus paucus	9.4% (12/127)	0% (0/14)	No	Yes	Oceanic	Yes	Yes
Sphyrna mokarran	6.2% (8/129)	50% (7/14)	No	Yes	Coastal	Yes	Yes
Sphyrna zygaena	4.1% (5/122)	42.9% (6/14)	No	Yes	Coastal	Yes	Yes
Blacktip complex[a]	4.8% (6/126)	0% (0/13)	No (US; AUS)	No	Coastal	Yes	Yes
Carcharhinus falciformis	8.4% (11/131)	75% (9/12)	No	Yes	Oceanic	Yes	Yes
Carcharhinus leucas	7.1% (8/112)	0% (0/12)	No	No	Coastal	Yes	Yes
Carcharhinus longimanus	8.4% (11/131)	100% (12/12)	No	Yes	Oceanic	Yes	Yes
Carcharias taurus	4.5% (3/66)	9.1% (1/11)	No	No	Coastal	Yes	Yes
Centroscymnus coelolepis	2.4% (1/42)	27.3% (3/11)	No	No	Deep-benthic	Yes	No
Dalatias licha	3.3% (1/30)	9.1% (1/11)	No	No	Deep-benthic	Yes	Yes
Lamna nasus	0% (0/47)	18.2% (2/11)	No	Yes	Oceanic	Yes	Yes
Sphyrna lewini	5.9% (7/119)	63.6% (7/11)	No	Yes	Coastal	Yes	Yes
Squalus acanthias	0% (0/55)	0% (0/11)	No (US)	No	Coastal	Yes	Yes
Carcharhinus brachyurus	0% (0/24)	0% (0/10)	No	No	Coastal	Yes	Yes
Carcharhinus brevipinna	1.6% (1/63)	0% (0/10)	No	No	Coastal	Yes	Yes
Galeorhinus galeus	0% (0/51)	10% (1/10)	No (NZ)	No	Coastal	Yes	Yes
Alopias pelagicus	10% (8/80)	28.6% (2/7)	No	Yes	Oceanic	No	Yes
Centrophorus squamosus	0% (0/21)	42.9% (3/7)	No	No	Deep-benthic	No	Yes
Negaprion brevirostris	7.8% (5/64)	0% (0/7)	No	No	Coastal	No	Yes
Rhizoprionodon acutus	0% (0/59)	0% (0/7)	No	No	Coastal	No	Yes
Carcharhinus albimarginatus	13.3% (4/30)	0% (0/6)	No	No	Coastal	No	Yes
Carcharhinus amboinensis	0% (0/40)	0% (0/6)	No	No	Coastal	No	Yes
Triaenodon obesus	11.1% (7/63)	0% (0/6)	No	No	Coastal	No	Yes
Loxodon macrorhinus	2.5% (1/40)	0% (0/5)	No	No	Coastal	No	No
Carcharhinus amblyrhynchos	10.1% (7/69)	0% (0/4)	No	No	Coastal	No	Yes
Carcharhinus isodon	0% (0/4)	0% (0/4)	No (US)	No	Coastal	No	No
Carcharhinus macloti	3.3% (1/30)	0% (0/4)	No	No	Coastal	No	No
Carcharhinus melanopterus	9.9% (7/71)	0% (0/4)	No	No	Coastal	No	Yes
Carcharhinus porosus	7.1% (1/14)	0% (0/4)	No	No	Coastal	No	Yes
Carcharhinus sorrah	0% (0/39)	0% (0/4)	No (AUS)	No	Coastal	No	No
Centrophorus isodon	0% (0/4)	0% (0/4)	No	No	Coastal	No	Yes
Chiloscyllium plagiosum	0% (0/14)	0% (0/4)	No	No	Coastal	No	No
Deania profundorum	0% (0/21)	75% (3/4)	No	No	Deep-benthic	No	No

(Continues)

TABLE 1 (Continued)

Species	Prohibited Nationally[b]	Prohibited Regionally[b]	Sustainably managed[c]	CITES listed	Habitat	Cosmopolitan	Threatened
Hemipristis elongata	0% (0/28)	0% (0/4)	No	No	Coastal	No	Yes
Negaprion acutidens	10.8% (7/65)	0% (0/4)	No	No	Coastal	No	Yes
Rhizoprionodon oligolinx	0% (0/22)	0% (0/4)	No	No	Coastal	No	No
Rhina ancylostoma	10.6% (5/47)	0% (0/4)	No	Yes	Coastal	No	Yes
Rhynchobatus australiae	7.9% (3/38)	0% (0/4)	No	Yes	Coastal	No	Yes
Scoliodon laticaudus	0% (0/5)	0% (0/4)	No	No	Coastal	No	No
Sphyrna tiburo	15.4% (4/26)	0% (0/4)	No (US)	No	Coastal	No	Yes
Stegostoma tigrinum	11.4% (4/35)	0% (0/4)	No	No	Coastal	No	Yes
Chiloscyllium punctatum	0% (0/14)	0% (0/3)	No	No	Coastal	No	No
Eusphyra blochii	0% (0/21)	0% (0/3)	No	No	Coastal	No	Yes
Glaucostegus cemiculus	0% (0/42)	33.3% (1/3)	No	Yes	Coastal	No	Yes
Hemigaleus microstoma	0% (0/14)	0% (0/3)	No	No	Coastal	No	Yes
Lamiopsis temminckii	0% (0/4)	0% (0/3)	No	No	Coastal	No	Yes
Lamna ditropis	0% (0/8)	0% (0/3)	No	No	Coastal	No	No
Mustelus canis	11.1% (4/36)	0% (0/3)	No (US)	No	Coastal	No	No
Mustelus mustelus	0% (0/48)	0% (0/3)	No	No	Coastal	No	Yes
Rhynchobatus laevis	6.7% (2/15)	0% (0/3)	No	Yes	Coastal	No	Yes
Callorhinchus callorynchus	0% (0/6)	0% (0/2)	No	No	Coastal	No	Yes
Glaucostegus granulatus	14.3% (2/14)	0% (0/2)	No	Yes	Coastal	No	Yes
Glyphis spp.	60% (3/5)	0% (0/2)	No	No	Coastal	No	Yes
Hemigaleus australiensis	0% (0/2)	0% (0/2)	Yes	No	Coastal	No	No
Mustelus henlei	0% (0/5)	0% (0/2)	No	No	Coastal	No	No
Mustelus mosis	0% (0/21)	0% (0/2)	No	No	Coastal	No	No
Mustelus punctulatus	0% (0/19)	0% (0/2)	No	No	Coastal	No	Yes
Rhizoprionodon porosus	11.9% (5/42)	0% (0/2)	No	No	Coastal	No	Yes
Rhizoprionodon longurio	9.1% (1/11)	0% (0/2)	No	No	Coastal	No	Yes
Rhizoprionodon taylori	0% (0/2)	0% (0/2)	Yes	No	Coastal	No	No
Sphyrna tudes	15.4% (2/13)	0% (0/2)	No	No	Coastal	No	Yes
Carcharhinus acronotus	11.1% (5/45)	0% (0/1)	No	No	Coastal	No	Yes
Carcharhinus dussumieri	0% (0/11)	0% (0/1)	No	No	Coastal	No	Yes
Glyphis glyphis	50% (1/2)	0% (0/1)	No	No	Coastal	No	Yes
Hydrolagus novaezealandiae	0% (0/1)	0% (0/1)	Yes	No	Coastal	No	No
Mustelus californicus	0% (0/2)	0% (0/1)	No	No	Coastal	No	No
Mustelus lunulatus	0% (0/7)	0% (0/1)	No	No	Coastal	No	No
Mustelus schmitti	33.3% (1/3)	0% (0/1)	No	No	Coastal	No	Yes
Mustelus sinusmexicanus	0% (0/2)	0% (0/1)	No	No	Coastal	No	No
Rhynchobatus djiddensis	0% (0/19)	0% (0/1)	No	Yes	Coastal	No	Yes
Rhynchobatus springeri	0% (0/7)	0% (0/1)	No	Yes	Coastal	No	Yes
Squatina californica	0% (0/3)	0% (0/1)	No	No	Coastal	No	No

[a]Blacktip complex denotes the species complex comprised of *Carcharhinus limbatus*, *C. amblyrhinchoides*, *C. leiodon*, and *C. tilstoni*.

[b]In parenthesis, the number of countries/FAO major fishing areas, where protection is given versus the total number of countries/FAO major fishing areas, where each species occurs.

[c]In parenthesis, the countries where sustainable fisheries occur.

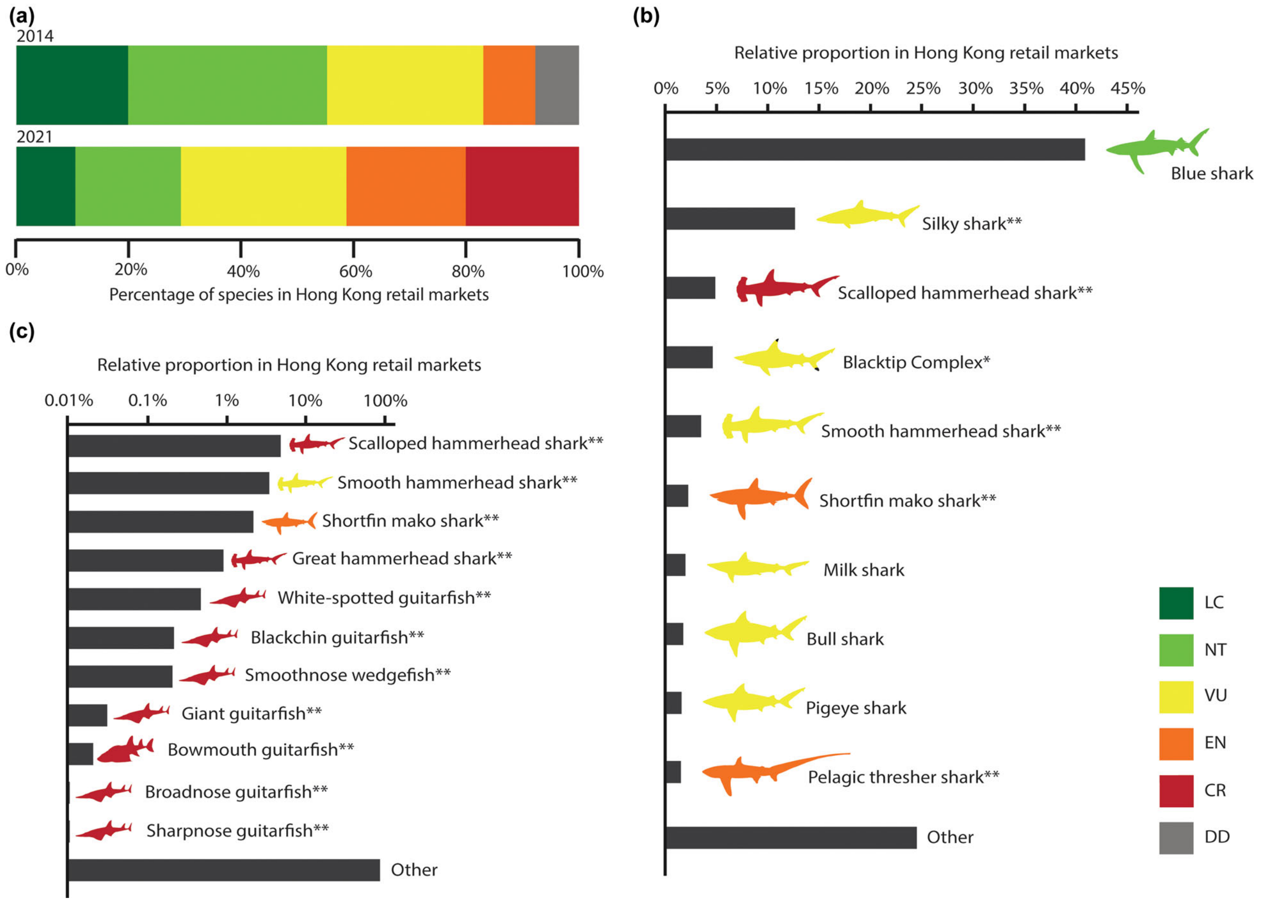

FIGURE 1 (a) Bar-plot showing the elevated contribution of threatened species to the shark fin trade between the first (2014) and last (2021) IUCN assessments of the conservation status of chondrichthyans, mainly due to new information and analyses. (b) Bar-plot showing the relative contribution of the top 10 species to the shark fin trimmings sampled in Hong Kong. All species are color-coded to depict their IUCN Red List status. *Blacktip complex denotes the species complex comprised of *Carcharhinus limbatus*, *C. amblyrhynchoides*, *C. leiodon*, and *C. tilstoni*. (c) Bar-plot showing the relative contribution of the premium value species. ** Denotes CITES Appendix II listed species. CR, Critically Endangered; DD, Data Deficient; EN, Endangered; LC, Least Concern; NT, Near Threatened; VU, Vulnerable

throughout its distribution. A small number of threatened species have fisheries known to be managed sustainably in some parts of their range within high-capacity nations (Table 1). CITES listings for sharks have to date been focused on threatened cosmopolitan species that are very common (> 8% incidence) in the dried fin trade and one group of noncosmopolitan coastal rays (i.e., wedgefish [Family Rhinidae] and giant guitarfish [Family Glaucostegidae]; collectively < 5% incidence, Figure 2). Some cosmopolitan coastal sharks, including bull shark (*Carcharhinus leucas*), sandbar shark (*C. plumbeus*), dusky shark (*C. obscurus*), spinner shark (*C. brevipinna*), and the blacktip complex (*C. limbatus*, *C. tilstoni*, *C. leiodon*, and *C. amblyrhynchoides*), are threatened, very common in the dried fin trade, but are not currently listed on CITES (Table 1 and Figure 2). Threatened, noncosmopolitan coastal sharks, which contribute 39.5% of the species in Hong Kong markets, are not generally subject to prohibitions, fisheries management, or international trade regulations as we broadly define these terms (Table 1 and Figure 2).

4 | DISCUSSION

Our results indicate that over two thirds of the species present in the Hong Kong dried fin trade are threatened with extinction based on recently updated IUCN Red List assessments. Species in the dried fin trade are, therefore, almost twice as likely to be threatened with extinction than chondrichthyans as a group. Cosmopolitan pelagic and coastal species exhibit the highest trade incidence, but there is a larger number of noncosmopolitan coastal species that are each less common in trade (Cardeñosa et al., 2018, 2020b). Yet, the contribution of these species to this very large trade (i.e., ~ 6000 tons of fins are imported into Hong Kong each year; Dent & Clarke, 2015) could indicate unsustainable catches (Clarke et al., 2006b),

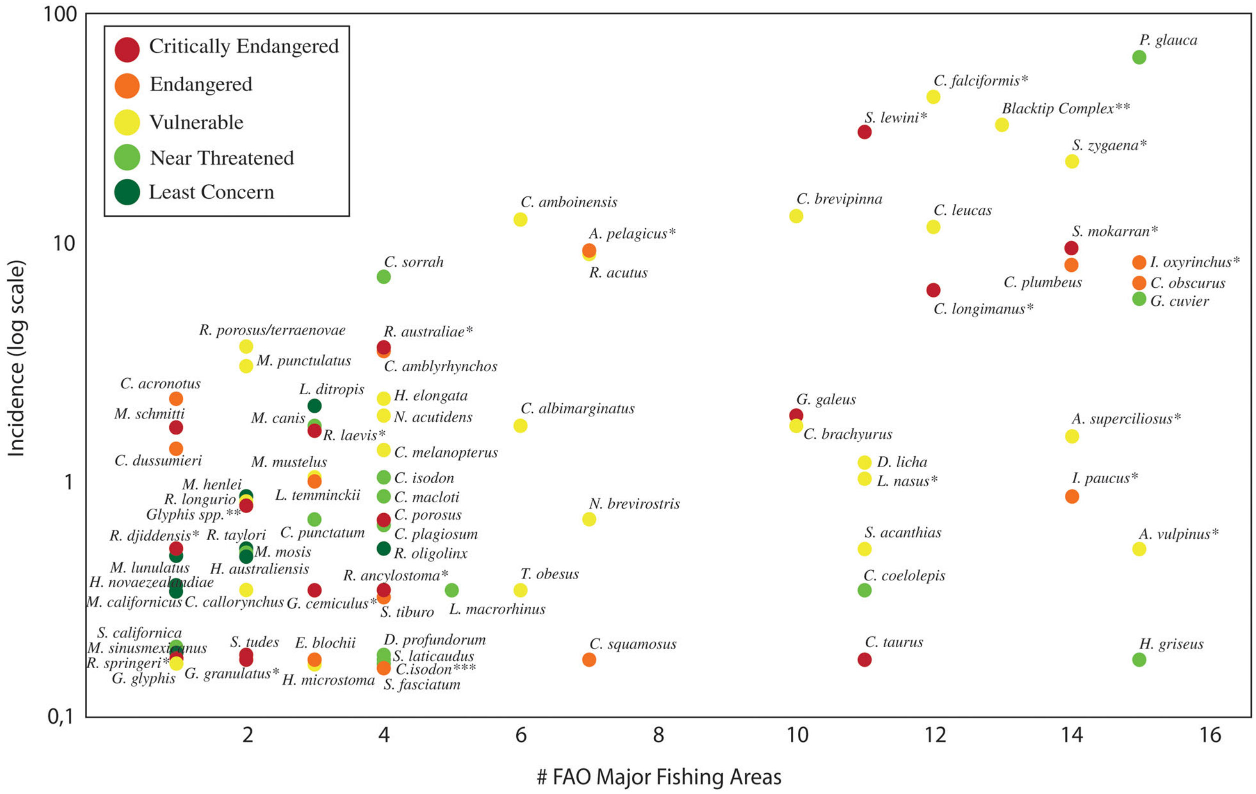

FIGURE 2 Plot of observed incidence in the Hong Kong shark fin retail markets by species and their distribution represented by the number of major FAO fishing areas, where each species is present. * Denotes CITES-listed species. ** Blacktip complex denotes the species complex comprised of *Carcharhinus limbatus*, *C. amblyrhynchoides*, *C. leiodon*, and *C. tilstoni*. *** *C. isodon* corresponds to *Centrophorus isodon* not *Carcharhinus isodon*

especially if they have a limited distribution. Fishing pressure behind these inputs into Hong Kong markets (Dent & Clarke, 2015; Niedermüller et al., 2021) might, therefore, be large enough to jeopardize the continued survival of some of these species. We identified a group of shark species that likely fit this criterion because they are both threatened and relatively common in trade when considering their noncosmopolitan ranges. These species are primarily coastal carcharhiniform sharks in the Families Carcharhinidae and Triakidae, which are the dominant sharks landed in tropical and temperate coastal fisheries, respectively (Yokota & Lessa, 2006; Walker, 2007; Carlson et al., 2012; Yates et al., 2015). Carcharhinids and triakids fulfill ecological roles as mid-level and apex predators in these ecosystems, suggesting that broader ecological effects may be initiated when they are removed (Heupel et al., 2014; Roff et al., 2016).

Some of the most highly traded cosmopolitan pelagic species are prohibited or restricted from landings in RMFOs and listed on Appendix II of CITES. Whether this is effective or not remains to be seen for most species, as CITES-listed species remain among the most common in the shark fin markets and illegal trade volumes are suspected to remain high (Cardeñosa et al., 2018). Recent evidence suggests high compliance of silky shark retention and landing bans by range nations of the International Commission for the Conservation of Atlantic Tuna (ICCAT; Cardeñosa et al., 2020a). However, the oceanic whitetip is prohibited in all RMFOs where it occurs and CITES Appendix II listed, yet its incidence in the dried fin trade is still relatively high (6.6%; Figure 2). Compounding with management implementation issues for pelagic species, there are serious management gaps for coastal chondrichthyans in the dried fin trade. Some cosmopolitan (sandbar shark, dusky shark, spinner shark, bull shark, blacktip complex, tope shark [*Galeorhinus galeus*], and copper shark [*Carcharhinus brachyurus*]) and noncosmopolitan (milk shark [*Rhizoprionodon acutus*], other sharpnose sharks [*Rhizoprionodon* spp.], blacknose shark [*C. acronotus*], lemon shark [*Negaprion brevirostris*], sicklefin lemon shark [*N. acutidens*], pigeye shark [*C. amboinensis*], and the reef sharks [silvertip [*C. albimarginatus*], grey reef [*C. amblyrhynchos*], and blacktip reef [*C. melanopterus*]) coastal species have populations that are being actively managed in one or more high-capacity nations (i.e., the United States, Australia, or New Zealand). At present, the tope shark in New Zealand, the blacktip shark in the United States, and the spinner, pigeye, and blacktip sharks in Australia are recognized to be fished sustainably (Simpfendorfer & Dulvy, 2017), but the remainder are subject to management, and current catches are low and suspected to be at sustainable levels in one or more of these nations (Kyne et al., 2021; https://www.fisheries.noaa.gov/insight/understanding-atlantic-shark-fishing). Populations of these species are likely to be secure in these nations, reducing the likelihood of global species extinction (Kyne et al., 2021); https://www.fisheries.noaa.gov/insight/understanding-atlantic-shark-fishing). Nonetheless, populations of these species that occur outside of these nations are at risk of extirpation, raising the possibility of broad regional extinction. This is especially so for tropical species, in which the core distribution occurs outside of these high-capacity nations. At greatest risk of global extinction are the threatened and traded species that do not occur or have marginal populations in the high-capacity nations. Recent chondrichthyan extinctions involved coastal species that only occurred in heavily fished jurisdictions outside of high-capacity nations (White et al., 2019; Dulvy et al., 2021). Several species in the dried fin trade fit this risk profile (e.g., smalltail shark [*C. porosus*], broadfin shark [*Lamiopsis temminckii*], whitecheek shark [*C. dussumieri*], smoothhound sharks [*Mustelus* spp.], and river sharks [*Glyphis* spp.]). Without effective management, this group of species is likely to form the next series of chondrichthyan extinctions.

The IUCN Red List uses a threat classification scheme generic to animals, plants, and fungi that focuses on the proximate threats faced by different species (e.g., fishing and harvesting aquatic resources; https://www.iucnredlist.org/resources/classification-schemes). The proximate threat identified in Red List assessments for most chondrichthyan species is unsustainable fishing. The disproportionate occurrence of threatened species in the dried fin trade suggests that for some species and populations, the ultimate threat could be driven in part by their value for international trade (e.g., Jaiteh et al., 2016; Sabbagh & Hickey, 2019; Pincinato et al., 2022). Supporting this, 100% of species that have the premium-priced fins in Hong Kong (Clarke et al., 2007) are in threatened categories and all but one are in the highest threat categories (i.e., EN and CR). For species with smaller and less valuable fins that are also threatened with extinction (e.g., small tail shark [*C. porosus*], blacknose shark [*C. acronotus*], and river sharks [*Glyphis* sp.]), the question then becomes: to what extent is the international fin trade the ultimate driver of overfishing? Fins of these coastal species can be small (i.e., < 10 cm), are commonly found in the Hong Kong markets (Cardeñosa et al., 2020c), and arrive to Hong Kong in containers with millions of fins (D. Cardeñosa, personal observation). Therefore, even though individual fins from many of these species do not fetch particularly high commercial value, in large quantities, low-value fins still provide a lucrative enterprise, potentially creating incentive to retain bycatch or even target these species (Ba et al., 2015; Santana et al., 2020; Quinlan et al., 2021). Whether a high- or low-value species, our study indicates that international trade is potentially an ultimate threat.

When international trade is the ultimate threat to any of these species, then international trade regulation has direct conservation potential. CITES listings of additional threatened coastal sharks in the dried fin trade could compel range states to improve management of these species. This is because the treaty requires nations to certify that exports are legal, traceable, and sustainable, the latter based on a nondetriment finding that exports are not a threat to the survival of the species in the wild (Vincent et al., 2014). Nations that fail to comply with this can face trade sanctions, incentivizing species-specific management attention (Foster & Vincent, 2021). Some of these sanctions include species-specific embargos that ban all commercial trade of a particular CITES species outside the sanctioned CITES Party, or general embargos that invalidate all export permits and make them inadmissible anywhere in the world, suspending all CITES-related trade from the sanctioned Party (Sand, 2013). Whether conservation potential is realized depends on whether CITES listing triggers an upstream reduction in fishing mortality to sustainable levels. This is most likely in situations where shark fishing is primarily targeted and driven by the export market, which could be so for some larger species that have especially high-value fins and the capture of which requires specialized heavy gear or expending fishing effort in specific habitats (Jaiteh et al., 2016; Campbell et al., 2020). Listings need to be followed by robust implementation efforts that target mortality reduction not just export control or trade suspension (Foster & Vincent, 2021). Species that are taken incidentally in mixed teleost-chondrichthyan fisheries or primarily for domestic consumption with fins being a byproduct are less likely to be directly affected by international trade regulations. Socioeconomic studies of shark fisheries, markets, coastal communities, and their interactions with threatened coastal sharks are needed to better understand the conservation potential of CITES listings on a nation-by-nation basis (Jaiteh et al., 2016; Sabbagh & Hickey, 2019; Pincinato et al., 2022). Even if CITES listing by itself does not have high conservation potential for a species or population because international trade is not the ultimate threat, there is indirect conservation potential because management is required to govern the international component of trade that requires CITES permits.

How can low-capacity nations with political will improve the status of threatened and internationally traded coastal sharks? marine protected areas (MPAs) over coral reefs tend to harbor relatively robust populations of reef shark species when they encompass a large enough area (Dwyer et al., 2020; MacNeil et al., 2020). However, coastal shark species with wider individual movements across multiple habitats are unlikely to remain within MPAs and require broader national-scale and international management (Clementi et al., 2021). National prohibition on targeted catch and trade of certain threatened species or all sharks (i.e., "shark sanctuaries") are unlikely to work by themselves in nations where longlines, gillnets, and trawls are widely used to fish for other taxon, as it will likely result in dead discard or illegal retention rather than substantially reduced mortality. Mortality reduction can be achieved in several ways, including gear modifications, to reduce shark catch (e.g., Senko et al., 2022) or targeted spatial or time-area closure for longline, gillnets, and trawls in specific areas, where threatened shark species are caught (e.g., Flowers et al., 2022). Although applying stock assessment-based catch limits may be challenging in some low-capacity nations, recent advances and expanding efforts in documenting catch (Jaiteh et al., 2016; Quinlan et al., 2021), conducting data limited stock assessments (Cortés & Brooks, 2018), and implementing scalable shark abundance surveys (MacNeil et al., 2020) suggest that catch limits-based management could be more tractable in low-capacity nations than is popularly assumed. Nations with political will and fisheries governance capacity in place, therefore, have a variety of fishery management options to improve the status of threatened coastal sharks if resources are invested to implement them.

5 | CONCLUSIONS

Chondrichthyans in the international dried fin trade are disproportionately threatened with extinction, especially high-value species. There are clear management gaps for coastal species, especially noncosmopolitan species that are less common in trade than the dominant cosmopolitan species but still traded at concerning levels. We need to better understand how much the export market for dried fins and other products drives fishing mortality within nations to assess the conservation potential of international trade regulations for coastal species. Nonetheless, CITES listings for more coastal sharks, starting with Carcharhinids and Triakids in the dried fin trade, could create political will for (i.e., to avoid sanctions) and provide a framework for broader engagement with this issue in nations currently lacking effective shark fisheries management. This is especially needed for species lacking any secure populations in high-capacity nations. While domestic species prohibitions or MPAs could work in a subset of nations or for some species, there are a range of domestic fisheries management options that could be engaged to improve the status of many of the coastal sharks that are threatened by fisheries supplying international markets.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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