

## The thin edge of the wedge: extremely high extinction risk in wedgefishes and giant guitarfishes

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1 **Abstract**

- 2 1. The process of understanding the rapid global decline of sawfishes (Pristidae) has revealed  
3 great concern for their relatives, the wedgefishes (Rhinidae) and giant guitarfishes  
4 (Glaucostegidae), not least because all three families are targeted for their high-value and  
5 internationally-traded ‘white’ fins.
- 6 2. The objective of this study was to assess the extinction risk of all 10 wedgefishes and 6 giant  
7 guitarfishes by applying the International Union for Conservation of Nature (IUCN) Red List  
8 Categories and Criteria, and to summarise their biogeography and habitat, life history,  
9 exploitation, use and trade, and population status.
- 10 3. Wedgefishes and giant guitarfishes have overtaken sawfishes as the most imperilled marine  
11 fish families globally, with all but one of the 16 species facing an extremely high risk of  
12 extinction due to a combination of traits – limited biological productivity, presence in shallow  
13 waters overlapping with some of the most intense and increasing coastal fisheries in the  
14 world, and over-exploitation in target and bycatch fisheries driven by the need for animal  
15 protein and food security in coastal communities and trade in meat and high-value fins.
- 16 4. Two species with very restricted ranges, the Clown Wedgefish (*Rhynchobatus cooki*) of the  
17 Indo-Malay Archipelago and the False Shark Ray (*Rhynchorhina mauritaniensis*) of Mauritania  
18 may be very close to extinction.
- 19 5. Only the Eyebrow Wedgefish (*Rhynchobatus palpebratus*) is not assessed as Critically  
20 Endangered, due to it occurring primarily in Australia where fishing pressure is low, and some  
21 management measures are in place. Australia represents a ‘lifeboat’ for the three wedgefish  
22 and one giant guitarfish species occurring there.
- 23 6. To conserve populations and permit recovery, a suite of measures will be required which will  
24 need to include species protection, spatial management, bycatch mitigation, and harvest and  
25 international trade management, all of which will be dependent on effective enforcement.

26 **Key words:** elasmobranchs, fisheries, IUCN Red List, shark-like rays, threatened species, wildlife  
27 trade

28

## 29 1 INTRODUCTION

30 One of the defining features of the Anthropocene will be the loss of biodiversity, both on land and in  
31 the oceans (Dirzo et al., 2014; McCauley et al., 2015). The oceans face a wide range of threats but our  
32 understanding of how these drive population decline and extinction in individual species remains  
33 poor. There has long been concern for the extent of marine declines but relatively few local, regional,  
34 and global extinctions have been documented (Dulvy, Sadovy, & Reynolds, 2003; Dulvy, Pinnegar, &  
35 Reynolds, 2009; McCauley et al., 2015). Nevertheless, the challenges of monitoring marine species, in  
36 particular those that do not surface to breathe or do not return to land to breed (such as marine  
37 mammals, reptiles, and seabirds), may mean that marine extinctions are underestimated, and indeed  
38 humanity may be on the cusp of witnessing a marine extinction pulse (McCauley et al., 2015).  
39 Systematically evaluating extinction risk in marine species is therefore critical to understand patterns  
40 of decline and to drive management and conservation measures in an attempt to limit extinction.

41 The chondrichthyan fishes – sharks, rays, and ghost sharks (i.e. chimaeras) (hereafter referred to as  
42 ‘sharks and rays’) are a marine group with elevated extinction risk; an estimated quarter of species  
43 are threatened globally (Dulvy et al., 2014). This extinction risk assessment reveals that sawfishes,  
44 wedgefishes, and guitarfishes are amongst the most threatened families and are of global  
45 conservation concern (Dulvy et al., 2016; Jabado, 2018; Moore, 2017). Recent advances in taxonomy  
46 and phylogenetics have resolved some of the complex relationships of these rays (Faria et al., 2013;  
47 Last, Séret, & Naylor, 2016b; Last et al., 2016c) enabling a new assessment of their status. The order  
48 Rhinopristiformes was resurrected by Last et al. (2016b) and is now considered to consist of the  
49 sawfishes (family Pristidae), wedgefishes (Rhinidae), giant guitarfishes (Glaucostegidae), guitarfishes  
50 (Rhinobatidae), and banyo rays (Trygonorrhinidae). Collectively, these groups can be referred to as  
51 the ‘shark-like rays’ given their phylogenetic position as rays, but morphological similarities to sharks  
52 (in particular the shark-like posterior body, including dorsal and caudal fins).

53 An accurate assessment of extinction risk requires the delineation of taxonomic units. The sawfishes  
54 have historically been plagued by poor taxonomic resolution and species delineation (Faria et al.,  
55 2013), and similarly, the status of wedgefishes has been challenging to understand because of  
56 uncertain species identification (Jabado, 2019). The ‘whitespotted wedgefish’ (i.e. *Rhynchobatus*  
57 *djiddensis*) species-complex has been poorly-defined with the name ‘*Rhynchobatus djiddensis*’ used  
58 widely for wedgefishes across the Indo-West Pacific Ocean region prior to clarification of species  
59 distributions and recognition that *R. djiddensis* is in fact restricted to the Western Indian Ocean (Last  
60 et al., 2016c). Additionally, several new wedgefish species have been recently described (Last, Ho, &  
61 Chen, 2013; Last, Kyne, & Compagno, 2016a; Séret & Naylor, 2016), and while species identification

62 remains an issue in the field, species taxonomic boundaries and geographical distributions are now  
63 well enough defined to allow a more accurate assessment of global extinction risk.

64 The international trade in shark fin for the Asian soup market has incentivised targeting and retention  
65 of sharks and shark-like rays (Dent & Clarke, 2015). Sawfishes, wedgefishes, and giant guitarfishes all  
66 have 'white' fins, amongst the best quality and highest value in the fin trade (Dent & Clarke, 2015;  
67 Hau, Abercrombie, Ho, & Shea, 2018; Moore, 2017; Suzuki, 2002). Domestically, the meat is also an  
68 important protein source, linking the status of these species to livelihoods in developing tropical  
69 countries (Jabado, 2018; Moore, 2017; Moore, Séret, & Armstrong, 2019). Sawfishes, wedgefishes,  
70 and guitarfishes were previously common in soft-bottom habitats of shallow, warm waters, but have  
71 been heavily exploited from exposure to intensive trawl and gillnet fisheries in these habitats (Jabado,  
72 2018; Moore, 2017).

73 Conservation and management measures have lagged resource exploitation in the shark-like rays.  
74 Considerable progress has recently been made in raising awareness and implementing management  
75 for sawfishes following the release of a global conservation strategy (Fordham, Jabado, Kyne, Charvet,  
76 & Dulvy, 2018; Harrison & Dulvy, 2014), and urgency has been declared for action on wedgefishes and  
77 giant guitarfishes (Moore, 2017). High levels of exploitation and the increasing pattern of targeting for  
78 the international trade has led to concern that wedgefishes and giant guitarfishes are at extinction  
79 risk levels similar to sawfishes (Hau et al., 2018; Jabado, 2018; Moore, 2017). Extinction risk  
80 assessments for sawfishes were reviewed in 2013; these highlighted rapid declines, local extinctions,  
81 and the need for serious investment in conservation and management (see Dulvy et al., 2016; Harrison  
82 & Dulvy, 2014). Extinction risk was previously assessed for most wedgefishes and giant guitarfishes  
83 between 2003 and 2007.

84 A global reassessment of extinction risk of all sharks and rays is being undertaken through the  
85 International Union for the Conservation of Nature (IUCN) Species Survival Commission Shark  
86 Specialist Group's Global Shark Trends Project. Wedgefishes and giant guitarfishes were prioritised for  
87 reassessment given the issues outlined above. Here, the IUCN Red List Categories and Criteria are  
88 applied to wedgefishes and giant guitarfishes globally. First, pertinent background information  
89 (biogeography and habitat; life history; and, exploitation, use, and trade) is reviewed before  
90 summarizing population trends and IUCN Red List categories.

## 91 **2 METHODS**

### 92 **2.1 Taxonomic scope**

93 The taxonomic scope of this study are the 10 recognised species of wedgefishes (Rhinidae) and six  
94 giant guitarfishes (Glaucostegidae) of the order Rhinopristiformes following Last et al. (2016c) (Tables  
95 1 & 2).

## 96 **2.2 Application of the IUCN Red List Categories and Criteria**

97 The IUCN Red List Categories and Criteria (Version 3.1) were applied following the Guidelines for Using  
98 the IUCN Red List Categories and Criteria (IUCN, 2012; IUCN Standards and Petitions Subcommittee,  
99 2017). Assessments were undertaken at the global level, i.e. for the entire global population of each  
100 species. For each species, data on taxonomy, distribution, population status, habitat and ecology,  
101 major threats, use and trade, and conservation measures were collated from the peer-reviewed  
102 literature, fisheries statistics, grey literature, and consultation with species and fisheries experts.

103 Draft assessments were prepared in the IUCN Species Information Service (SIS) online database. Each  
104 assessment was peer-reviewed by at least two reviewers who were trained in the application of the  
105 IUCN Red List Categories and Criteria and who were familiar with shark-like rays and the fisheries  
106 interacting with them. A summary of the assessments was also provided to the entire IUCN Species  
107 Survival Commission Shark Specialist Group (SSG) for their consultation and input (174 members).  
108 Assessments were then submitted to the IUCN Red List Unit (Cambridge, UK) where they underwent  
109 further review and quality checks before being accepted for publication on the IUCN Red List (version  
110 2019-2, July 2019, [www.iucnredlist.org](http://www.iucnredlist.org); IUCN, 2019).

111 The IUCN Red List applies eight extinction risk categories: Extinct (EX), Extinct in the Wild (EW),  
112 Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern  
113 (LC), and Data Deficient (DD) (IUCN, 2012; Mace et al., 2008). A species is considered EX ‘when there  
114 is no reasonable doubt that the last individual has died’; EW ‘when it is known only to survive in  
115 cultivation, in captivity or as a naturalised population (or populations) well outside the past range’;  
116 CR, EN, and VU species are considered to be facing an extremely high, very high, or high risk of  
117 extinction in the wild, respectively; NT species do ‘not qualify for CR, EN or VU now, but is close to  
118 qualifying for or is likely to qualify for a threatened category in the near future’; LC species do not  
119 qualify for CR, EN, VU, or NT; finally, DD species have ‘inadequate information to make a direct, or  
120 indirect, assessment of its risk of extinction based on its distribution and/or population status (IUCN,  
121 2012).

122 Each species was assessed against the five Red List criteria: A – population size reduction; B –  
123 geographic range size; C – small population size and decline; D – very small or restricted population;  
124 and, E – quantitative analysis (for example, population viability analysis) (see IUCN, 2012; IUCN

125 Standards and Petitions Subcommittee, 2017; Mace et al., 2008). To qualify for one of the three  
126 threatened categories (CR, EN, or VU), a species has to meet a quantitative threshold for that category  
127 in any of the five criteria listed above (A–E). A collation and review of available information indicated  
128 that there were no data available to assess species under criteria C, D, or E, and these criteria are  
129 therefore not considered further here. All species were assessed under criterion A, with some  
130 consideration of criterion B for range restricted species.

131 Criterion A applies a set of quantitative thresholds to consider population reduction scaled over a  
132 period of three generation lengths (3 GL) (IUCN Standards and Petitions Subcommittee, 2017; Mace  
133 et al., 2008). While there are a range of demographic approaches to calculating generation length  
134 (IUCN Standards and Petitions Subcommittee, 2017), these are generally data intensive and have not  
135 been applied to any wedgfish or giant guitarfish. Therefore, to derive generation length (GL), a simple  
136 measure that requires only female age-at-maturity and maximum age was used:

$$137 \quad GL = ((\text{maximum age} - \text{age-at-maturity})/2) + \text{age-at-maturity}$$

138 This value represents the median age of parents of the current cohort. To derive population reduction  
139 over 3 GL, the proportional decline over the x years of available catch rate or landings datasets was  
140 calculated and this was used to calculate annual proportional change, which was then scaled across  
141 the 3 GL period.

### 142 **2.3 Distribution mapping**

143 A global distribution map (Appendix I) was generated for each species, primarily following the ranges  
144 in Last et al. (2016c), with some minor modifications based on new records. Ranges were clipped to  
145 the maximum depth of each species, and for those wedgfishes without known depth ranges, these  
146 were set to the maximum confirmed depth of the family (70 m; Table 1). To determine global patterns  
147 of biodiversity, species richness maps were produced for all species combined, wedgfishes only, and  
148 giant guitarfishes only. All maps were prepared using ArcMap 10.4 (ESRI, 2016).

### 149 **2.4 Calculation of a Red List Index**

150 A Red List Index (RLI) was calculated based on the number of species in each Red List category at each  
151 of three time periods. The index was calculated as the weighted sum of species status scaled by the  
152 number of species. An 'equal-step' weighting was used where the weight ( $W_i$ ) equals zero for LC, 1 -  
153 NT, 2 - VU, 3 - EN, 4 - CR, and 5 - EX or EW. Hence, a species moving from LC to NT will contribute as  
154 much to the index as a species moving from EN to CR. The RLI is scaled to range from 1 (where all

155 species are LC) to 0 (where all species are EX), and is calculated as:

$$156 \quad RLI_t = \frac{M - T_t}{M} \quad (1)$$

157 where  $M$  is the maximum threat score, which is the number species multiplied by the maximum weight  
158 assigned to EX species (here, a value of 5), and in this case for 16 species is  $16 \times 5 = 80$ . The current  
159 threat score ( $T_t$ ) is the sum of the number of species in each threat category in year  $t$  ( $N_{c(t)}$ ), times the  
160 category weight ( $W_c$ ).

$$161 \quad T_t = \sum_c N_{c(t)} W_c \quad (2)$$

162 Hence, the threat score for the current assessment would be calculated as the  $N_{c(t)} = 15$  species that  
163 are Critically Endangered ( $W_c = 4$ ), giving  $4 \times 15 = 60$ , summed with the one Near Threatened species  
164 ( $W_c = 1$ ). Thus, the current threat score  $T_{t=2019}$  is  $60 + 1 = 61$  and the  $RLI_{t=2019} = (80 - 61) / 80 = 0.2375$ .

165 Retrospective assessments were developed for two earlier time periods, which were chosen as 2005  
166 and 1980 (with the current assessments set at 2020). Prior to this current reassessment, all six giant  
167 guitarfishes and seven of the wedgefishes had assessments published on the IUCN Red List  
168 (wedgefishes: 1 EN, 6 VU; giant guitarfishes: 1 EN, 5 VU). All changes in Red List category were  
169 considered to be non-genuine changes as a result of new information (IUCN Standards and Petitions  
170 Subcommittee, 2017). In other words, if what is currently understood was known during the previous  
171 assessments, it is likely that the assigned status of those species would have been different. 'Back  
172 casting' is undertaken by retrospectively assigning status based on current understanding of the  
173 spatial and temporal pattern of coastal human population growth, the development of general fishing  
174 pressure, an understanding of the availability of fishing gear capable of capturing sharks and rays, and  
175 the development of the international trade demand for shark and shark-like ray fins (e.g. Blaber et al.,  
176 2019; Clarke, Milner-Gulland, & Bjorndal, 2007; Cripps, Harris, Humber, Harding, & Thomas, 2015;  
177 Sousa, Marshall, & Smale, 1997; Stewart et al., 2010).

178 Red List Indices were also calculated for the two main oceanic regions, the Indo-West Pacific Ocean  
179 region (hereafter, 'Indo-West Pacific'), and the Eastern Atlantic Ocean and Mediterranean Sea region  
180 (hereafter, 'Eastern Atlantic'), as well as individually for each of the 87 countries containing some  
181 proportion of at least one of the 16 species assessed here. Threat scores applied to the two oceanic  
182 regions followed the equal-step weighting outlined above. For disaggregating the global RLI to the  
183 national level, the equation is amended such that:

$$184 \quad RLI_{(t,u)} = 1 - \left[ \frac{\sum (W_{(t,s)} \times \frac{r_{SU}}{R_S})}{W_{EX} \times \sum (\frac{r_{SU}}{R_S})} \right] \quad (3)$$



185 where  $t$  is the year of assessment,  $u$  is the country and  $W_{(t,s)}$  is the Red List threat at year  $t$  for each  
186 species, multiplied by  $\frac{r_{su}}{R_s}$ , which represents the proportion of each species' total range found within  
187 the Exclusive Economic Zone (EEZ) of each country. This is summed across all species found in each  
188 country's EEZ and divided by the maximum threat score ( $WEX = 5$ ), multiplied by the sum of  
189 proportional species' ranges. The final RLI value is derived from subtracting by 1 so that higher RLI  
190 values indicate less negative changes in Red List status across species and vice versa (as with the global  
191 RLI). Finally, the national conservation responsibility for all species were calculated separately for each  
192 of the two oceanic regions, based on the sum of all threat scores across species within a country  
193 multiplied by each of the species' proportional ranges for that country. Resulting national  
194 responsibility values were normalized to range between 0 and 1 for both regions.

### 195 **3 RESULTS**

196 Here, summaries of (1) biogeography and habitat; (2) life history; (3) exploitation, use and trade; (4)  
197 population status; (5) IUCN Red List Categories; (6) the possible extinction of two wedgefish species;  
198 and, (7) the Red List Index for wedgefishes and giant guitarfishes, are presented.

#### 199 **3.1 Biogeography and habitat**

200 The Indo-West Pacific is the centre of diversity for wedgefishes (8 species) and giant guitarfishes (5  
201 species), with the remaining three species occurring in the Eastern Atlantic (including the  
202 Mediterranean Sea for the Blackchin Guitarfish (*Glaucostegus cemiculus*)) (Tables 1 & 2, Figure 1,  
203 Appendix I). Distributions range from extremely widespread, i.e. Bowmouth Guitarfish (*Rhina*  
204 *ancylostoma*) and Bottlenose Wedgefish (*Rhynchobatus australiae*) to the very restricted, i.e.  
205 Taiwanese Wedgefish (*Rhynchobatus immaculatus*), Clown Wedgefish (*Rhynchobatus cooki*), and  
206 False Shark Ray (*Rhynchorhina mauritaniensis*) (Appendix I). These latter three species are known only  
207 from fish landing sites in northern Taiwan, Singapore and Jakarta, and Mauritania, respectively (Last  
208 et al., 2013; 2016a; Séret & Naylor, 2016), and therefore their exact distributions remain undefined.  
209 *Rhynchorhina mauritaniensis* is potentially the most range-restricted species, as it is currently only  
210 known from a single location, the Banc d'Arguin National Park in Mauritania (Séret & Naylor, 2016).

211 Both families primarily occur in tropical to warm temperate waters from close inshore to the mid  
212 continental shelf, although two species (*R. ancylostoma*, *R. australiae*) are also known to occur around  
213 island chains far from continental landmasses; wedgefishes occur to a maximum depth of at least 70  
214 m (although exact depth ranges are unknown for three species) and giant guitarfishes to a maximum  
215 of 120 m (Tables 1 & 2; Last et al., 2016c). Some species have been recorded from the estuarine  
216 reaches of rivers and the Broadnose Wedgefish (*Rhynchobatus springeri*) is thought to be a habitat



217 specialist of shallow brackish coastal and estuarine waters (Compagno & Last, 2010), while others can  
218 be associated with coral reefs (e.g. *R. ancylostoma*).

### 219 **3.2 Life history**

220 The life history of wedgefishes and giant guitarfishes is generally very poorly known, with only a  
221 limited number of dedicated studies on aspects of their biology and ecology, with the exception of *G.*  
222 *cemiculus*. Wedgefishes are large species, with most species reaching >200 cm total length (TL) and  
223 up to 310 cm TL in the Whitespotted Wedgefish (*Rhynchobatus djiddensis*), although *R. cooki* is an  
224 exceptionally small species (81 cm TL), while maximum size is unknown for *R. immaculatus* (the largest  
225 collected specimen was still immature at 99 cm TL) (Table 1). Giant guitarfishes reach 300 cm TL  
226 (Clubnose Guitarfish, *Glaucostegus thouin*) with most species >200 cm TL, except the Halavi Guitarfish  
227 (*Glaucostegus halavi*; 187 cm TL) and the Widenose Guitarfish (*Glaucostegus obtusus*; 93 cm TL). Size-  
228 at-maturity and size-at-birth are poorly-known with data gaps for most species (Tables 1 & 2).

229 Reproduction is lecithotrophic viviparous in both families with generally small, but variable litter sizes:  
230 in the wedgefishes, from as low as 2 pups per litter in *R. ancylostoma* (range: 2–11) and the African  
231 Wedgefish (*Rhynchobatus luebberti*) (2–5), to as high as 19 pups per litter in *R. australiae* (7–19), and  
232 in the giant guitarfishes, from a low of 4 pups per litter in *G. obtusus* (4–10) to as high as 24 pups per  
233 litter in *G. cemiculus* (Tables 1 & 2). *Glaucostegus cemiculus* exhibits some regional variation with 16–  
234 24 pups per litter in Senegal and 5–12 in Tunisia. Litter sizes are available for only 4 of 10 wedgefishes  
235 and 4 of 6 giant guitarfishes. Reproductive periodicity is suspected to be annual in *G. cemiculus*  
236 (Capapé & Zaouali, 1994), but periodicity, and therefore annual fecundity, are largely unknown across  
237 the two families.

238 There is a general lack of age and growth data. For wedgefishes, the only study (White, Simpfendorfer,  
239 Tobin, & Heupel, 2014) was based on mixed samples of *R. australiae* and the Eyebrow Wedgefish  
240 (*Rhynchobatus palpebratus*), and therefore has limited biological meaning. Maximum observed age  
241 was 12 years (female of 183 cm TL) (White et al., 2014) which would be well below longevity given  
242 that *R. palpebratus* reaches 262 cm TL and *R. australiae* reaches ~300 cm TL. For giant guitarfishes, a  
243 maximum observed age for the Giant Guitarfish (*Glaucostegus typus*) of 19 years (250 cm TL female)  
244 was reported by White et al. (2014) and while age-at-maturity was not reported, it can be estimated  
245 from the growth curve as 7 years (by reading the corresponding age at 165 cm TL, the mid-point of  
246 size-at-maturity; Last et al., 2016c). This estimate is not sex-specific as the growth curve of White et  
247 al. (2014) was based on combined sexes. For *G. cemiculus*, a maximum observed age of 15 years (198

248 cm TL female), a male of age-at-maturity of 2.9 years, and a female age-at-maturity of 5.1 years was  
249 reported by Enajjar, Bradai, & Bouain (2012).

250 An estimate of generation length (GL) for *G. cemiculus* of 9.5 years based on the age data of Enajjar et  
251 al. (2012) is likely an underestimate given maximum observed age was for an individual well below  
252 maximum size (198 vs 265 cm TL). This GL estimate does, however give a suitable estimate for smaller  
253 (<200 cm TL) wedgefsh and giant guitarfish species. A GL estimate for *G. typus* of 13 years based on  
254 the age data of White et al. (2014) is a reasonable estimate given that maximum observed age was for  
255 an individual close to maximum size (250 vs. 270 cm TL) (White et al., 2014). To ensure consistency  
256 across IUCN Red List Assessments, 15 years was applied as an estimated GL to large ( $\geq 200$  cm TL)  
257 species, and 10 years for smaller species (<200 cm TL).

### 258 **3.3 Exploitation, use, and trade**

259 Globally, wedgefshes and giant guitarfishes are subject to intense fishing pressure on their coastal  
260 and shelf habitats (Stewart et al., 2010) that is unregulated across the majority of their distributions.  
261 They are captured in industrial, artisanal, and subsistence fisheries with multiple fishing gears,  
262 including gillnet, trawl, hook and line, trap, and seine net and are generally retained for their meat  
263 and fins (Bonfil & Abdallah, 2004; Jabado, 2018; Moore, 2017). There is a high level of fisheries  
264 resource use and increasing fishing pressure which has resulted in the over-exploitation or depletion  
265 of demersal coastal fisheries resources in significant areas of the Indo-West Pacific and the Eastern  
266 Atlantic, including West Africa, India, and Southeast Asia (FAO, 2018b; Mohamed & Veena, 2016; Pauly  
267 & Chuenpagdee, 2003; Stewart et al., 2010; Stobutzki et al., 2006). The major exception is Australia  
268 where fishing pressure is considerably lower (this is also the case for some smaller range states such  
269 as New Caledonia, and South Africa which are at the geographic limit of the range of a small number  
270 of species).

271 In general, fishing effort and the number of fishers has increased in recent decades across the range  
272 of these species, with demand for shark and ray products increasing over the same period due to the  
273 shark fin trade (Chen, 1996; Diop & Dossa, 2011; Jabado et al., 2017). Several examples of this increase  
274 from across the global range of wedgefshes and giant guitarfishes include (1) Mauritania which has  
275 seen a significant increase in fishing effort since the second half of the 20th Century: in 1950 there  
276 were 125 pirogues (small-scale fishing boats), rising to nearly 4,000 in 2005 (Belhabib et al., 2012); (2)  
277 Senegal, where the number of artisanal pirogues rose from  $\sim 5,000$  in 1982 to 12,699 in 2006, although  
278 it has since fallen slightly to 11,889 in 2013 (ANSD, 2016; FAO, 2008); (3) Madagascar, where the  
279 number of pirogues rose from  $\sim 5,000$  in 1983 to  $\sim 22,000$  in 1996 (Cooke, 1997); (4) the Red Sea, where

280 the number of traditional boats tripled from 3,100 to 10,000 from 1988 to 2006 (Bruckner, Alnazry, &  
281 Faisal, 2011); and, (5) the Indian state of Gujarat, where the number of trawlers increased from about  
282 6,600 in the early 2000s to 11,582 in 2010 (CMFRI, 2010; Jabado et al., 2017; Zynudheen, Ninan, Sen,  
283 & Badonia, 2004). This increasing fishing effort has put significant pressure on all species.  
284 Furthermore, the high value of fins is driving retention and trade of wedgefishes and giant guitarfishes  
285 globally, with these species targeted in the Mediterranean Sea, West Africa, East Africa, India, and the  
286 Indo-Malay Archipelago, among other places (Barrowclift, Temple, Stead, Jiddawi, & Berggren, 2017;  
287 Diop & Dossa, 2011; IOTC, 2005; Jabado, 2018; Lteif, 2015; Moore, 2017; Newell, 2016; Seisay, 2005).

288 Both the meat and fins drive utilisation and trade. The high-quality meat is consumed by many coastal  
289 communities in tropical countries and it is also dried, salted, and consumed locally or traded  
290 internationally (e.g. Moore, 2017; Jabado, 2018). Large whole wedgefishes (>200 cm total length; TL)  
291 have been traded for a high value of up to US\$680 each (e.g. Jabado, 2018). Prices for the highly-  
292 valued 'white' fins of large shark-like rays are reportedly as high as US\$964/kg (Jabado, 2019). Other  
293 reported prices include US\$396/kg for wedgefes fish fins (Chen, 1996) and an average price of US\$276/kg  
294 and US\$185/kg for *Qun chi* (fins from shark-like rays) in Guangzhou (mainland China) and Hong Kong,  
295 respectively (Hau et al., 2018). In addition to meat and fins, other uses include the skin which may be  
296 dried and traded internationally as a luxury leather product (Haque, Biswas, & Latifa, 2018), the eggs  
297 which are sometimes dried and consumed locally, the heads which may be dried and used as either  
298 fish meal or fertilizer (Haque et al., 2018; R.W. Jabado, unpubl. data), and the snout of giant  
299 guitarfishes are considered a delicacy in Singapore where they are steamed, and the gelatinous filling  
300 consumed.

### 301 **3.4 Population status**

#### 302 **3.4.1 Data availability**

303 Where rhinoprystoid rays have been targeted or exploited as incidental catch, severe declines,  
304 population depletions, and localised disappearances have occurred (e.g. Dulvy et al., 2016; Jabado,  
305 2018; Moore, 2017; Tous, Ducrocq, Bucal, & Feron, 1998). However, there are no species-specific  
306 time-series data available that can be used to calculate population reduction in wedgefishes and giant  
307 guitarfishes. Despite this, there are a number of relevant historical accounts and contemporary  
308 datasets for landings and catch rates. All of these accounts and datasets are from the Indo-West Pacific  
309 (from Iran to Indonesia), but can also be considered informative for understanding population  
310 reduction in wedgefishes and giant guitarfishes more broadly where they are under heavy  
311 exploitation, including in the Eastern Atlantic. The five contemporary datasets are available for

312 landings data or catch rates at varying levels of taxonomic resolution (e.g. 'guitarfishes', 'whitespotted  
313 wedgefishes' etc.) from Iran, Pakistan, western and eastern India, and Indonesia. These datasets likely  
314 include various species of wedgefishes and giant guitarfishes and in each case, probable species are  
315 listed below. One dataset (Raje & Zacharia, 2009) does not include rhinoprists but rather presents  
316 landings data for myliobatoid rays (stingrays, eagle rays, butterfly rays, and devil rays). However, this  
317 can be used to infer declines in wedgefishes and giant guitarfishes given overlapping distributions,  
318 habitat, and susceptibility to capture in the same fishing gear. A summary of these datasets and  
319 corresponding proportional decline over 3 GL is provided in Table 3.

### 320 **3.4.2 Indo-West Pacific**

#### 321 **3.4.2.1 Historical accounts**

322 Research trawl survey data from the Gulf of Thailand showed a 93% decline in catch rates of  
323 'Rhinobathidae' (a name that is likely to include wedgefishes and guitarfishes broadly) over a short  
324 time period from peak catches in 1968 to a low in 1972 (Pauly, 1979, Ritragasa, 1976). Similarly, catch  
325 rates of 'rays' declined by 92% from 1963 to 1972. Secondly, the Indonesian Aru Islands wedgefisch  
326 gillnet fishery rapidly expanded from its beginnings in the mid-1970s to reach its peak in 1987 with  
327 more than 500 boats operating before catches then declined very rapidly leading to only 100 boats  
328 left fishing in this area in 1996 (Chen, 1996). In all likelihood, the fleet redistributed to other areas as  
329 wedgefishes were depleted and catch rates declined. Thirdly, investors in Indonesia withdrew from a  
330 wedgefisch fishery in the Maluku and Arafura Seas because the resource had been overfished by 1992  
331 resulting in limited returns for their investment (Suzuki, 2002). Lastly, research trawl surveys in the  
332 Java Sea showed the decline of 'rays' between 1976 and 1997 by 'at least an order of magnitude' (i.e.,  
333 a decline of at least 90%) (Blaber et al., 2009). It is worth noting that recent trawl surveys in the Java  
334 Sea recorded only a single individual *Rhynchobatus* (Tirtadanu, Suprpto, & Suwarso, 2018), and in  
335 the North Natuna Sea (north of the Java Sea), trawl surveys recorded only two individuals (Yusup,  
336 Priatna, & Wagiyo, 2018).

#### 337 **3.4.2.2 Iran landings dataset**

338 Landings data for the 'giant guitarfish' category are available from Iran for 1997–2016 (20 years; FAO,  
339 2018a; Table 3). This grouping likely includes all rhinids (wedgefishes) and glaucostegids (giant  
340 guitarfishes) occurring locally, including *R. ancylotoma*, *R. australiae*, *R. djiddensis*, Smoothnose  
341 Wedgefisch (*Rhynchobatus laevis*), Sharpnose Guitarfish (*Glaucostegus granulatus*), and *G. halavi*.  
342 Landings declined by 67% over this period, the equivalent of an 81% and 91% population reduction  
343 over the last 3 GL of smaller species (30 years) and larger species (45 years), respectively.

#### 344 **3.4.2.3 Pakistan landings dataset**

345 Landings data for the 'rhinobatid' category are available from Pakistan for 1993–2011 (19 years)  
346 covering the country's two coastal provinces (data collated from Pakistan Government records; M.A.  
347 Gore, unpubl. data; Table 3). This grouping likely includes all rhinids and glaucostegids occurring  
348 locally, including *R. ancylostoma*, *R. australiae*, *R. laevis*, *G. granulatus*, *G. halavi*, and *G. obtusus*, as  
349 well as rhinobatids (guitarfishes) including Bengal Guitarfish (*Rhinobatos annandalei*). Data from Sindh  
350 province showed a 72% decrease from peak landings in 1999 to a low in 2011, the equivalent of a 95%  
351 and 99% population reduction over the last 3 GL of smaller species (30 years) and larger species (45  
352 years), respectively. Data from Balochistan province showed an 81% decrease from peak landings in  
353 1994 to the last data point in 2011, the equivalent of a 94% and 98% population reduction over the  
354 last 3 GL of smaller species (30 years) and larger species (45 years), respectively. No wedgefish or giant  
355 guitarfish were observed during surveys of southwest Balochistan fish landings between 2007 and  
356 2010 (M.A. Gore and U. Waqas, unpubl. data).

#### 357 **3.4.2.4 Western India ray catch rate dataset**

358 Catch rate data for myliobatoid rays (this includes a variety of demersal rays, but does not include  
359 rhinopristsoids) are available from Maharashtra, western India for 1990–2004 (15 years; Raje and  
360 Zacharia, 2009; Table 3). The catch rate declined by 63% over this period (despite fishing effort  
361 doubling during this time), the equivalent of an 86% and 95% population reduction over the last 3 GL  
362 of smaller species (30 years) and larger species (45 years), respectively.

#### 363 **3.4.2.5 Eastern India landings dataset**

364 Landings data for 'guitarfishes' are available from Tamil Nadu, eastern India for 2002–2006 (5 years;  
365 Mohanraj, Rajapackiam, Mohan, Batcha, & Gomathy, 2009). This grouping was reported in the paper  
366 to include *R. ancylostoma*, '*R. djiddensis*' (which would therefore include *R. australiae* and *R. laevis*,  
367 since *R. djiddensis* does not occur in this area), *G. granulatus*, and *G. obtusus*, but was also likely to  
368 include *G. thoun* and *G. typus*. Landings declined by 86% over this period. Furthermore, species-  
369 specific trawl landings data were reported for '*R. djiddensis*' (i.e. *R. australiae* and *R. laevis*), with a  
370 decline of 87% over this period. This time-period is however too short to derive an equivalent  
371 population reduction over three generations.

#### 372 **3.4.2.6 Indonesia landings dataset**

373 Landings data for 'whitespotted wedgefishes' are available from Indonesia for 2005–2015 (11 years;  
374 DGCF, 2015; 2017; Table 3). This grouping likely includes *R. ancylostoma*, *R. australiae*, *R. cooki*, *R.*  
375 *palpebratus*, and *R. springeri*. It may also include giant guitarfishes, but in any case, the trends can be  
376 considered representative of giant guitarfishes occurring locally due to overlapping habitat and  
377 catchability (i.e. *G. obtusus*, *G. thouin*, and *G. typus*). Landings declined by 88% over this period, the  
378 equivalent of >99% population reduction over the last 3 GL of both smaller species (30 years) and  
379 larger species (45 years). An additional data point available for 2016 is excluded from this analysis.  
380 This datum suggests a massive increase in reported landings which is an artefact of the inclusion of a  
381 wider range of rays in the reported figure (DGCF, 2017; Muhammad Anas, pers. comm., 11/2/2019).

#### 382 **3.4.2.7 East Africa anecdotal reports**

383 The above information spans Iran to Southeast Asia, with less information available from East Africa  
384 in the Western Indian Ocean. Anecdotal reports from this region suggest that artisanal longline fishing  
385 led to declines in *R. djiddensis* in southern Mozambique (which was one of the main target species of  
386 the fishery) as this species was abundant on reefs before longline fisheries began in the early 2000s  
387 and subsequently, are only seen in low numbers (Pierce et al., 2008). In Zanzibar, fisher interviews  
388 indicated that there were perceived declines in wedgefish or that they are rare (Schaeffer, 2004);  
389 wedgefishes were a retained bycatch of commercial prawn trawling in Tanzania (Rose, 1996). Intense  
390 fishing pressure across the Tanzanian shelf has likely resulted in population reduction, mirroring those  
391 outlined above for the Indo-West Pacific more broadly. In Madagascar, there was a decrease in the  
392 size of wedgefish caught in artisanal fisheries over time (Humber et al., 2017), though this could be  
393 due, in part, to the targeting of larger individuals. A steep decline in catch-per-unit-effort (CPUE) can  
394 be inferred from reported catch reductions from 10–20 sharks per day in 1992 to 1–3 sharks per day  
395 in 1995 in Morondava, West Madagascar, with fishers subsequently moving further afield to fish  
396 (Cooke, 1997). Wedgefish, a high-value target species, would likely have declined by a similar order of  
397 magnitude as sharks. In South Africa, there was a marked decline in CPUE of *R. djiddensis* in shark  
398 bather protection nets in KwaZulu-Natal during the period 1979–2017 (Nomfundo Nakabi, pers.  
399 comm., 17/04/2018). This decline is not considered to be a good indicator of population reduction as  
400 it may be explained, at least partially, by a shift in gear deployment whereby nets were gradually lifted  
401 off the substrate (which would reduce the capture of demersal species).

#### 402 **3.4.2.8 Australia**

403 The one region in which wedgefish and giant guitarfish populations may be in a better state than most  
404 of the rest of their range is Australia. Here, fishing effort is relatively low, the use of turtle exclusion



405 devices in trawl fisheries reduces the catch of large rays (Brewer et al. (2006) recorded a reduction of  
406 94%), and there are some controls on wedgfish catch and retention. Estimates of fishing mortality  
407 rates for wedgfish and giant guitarfish species in the Northern Prawn Fishery (the largest Australian  
408 fishery to interact these species) are well below those that would lead to significant population  
409 declines (Zhou & Griffiths, 2008).

### 410 **3.4.3 Eastern Atlantic and Mediterranean Sea**

411 Data on population status in the Eastern Atlantic Ocean and Mediterranean Sea is sparse, but there  
412 are several lines of evidence to support similar population reductions, as well as local extinctions. In  
413 the Mediterranean Sea, *G. cemiculus* was regarded as historically common within both northern (de  
414 Buen, 1935; Doderlein, 1884) and southern (Bradaï, Saidi, Enajjar, & Bouain, 2006; Quignard & Capapé,  
415 1971; Whitehead, Bauchot, Hureau, Nielsen, & Tortonese, 1984) areas. However, there are now  
416 contrasting situations between these two areas. The species has largely disappeared from the  
417 northern Mediterranean Sea and was not recorded in extensive trawl surveys under the  
418 Mediterranean International Trawl Surveys (MEDITS) program from 1994 to 2015 (Newell, 2016; Relini  
419 & Piccinetti, 1991), nor in trawl surveys in the Adriatic Sea between 1948 and 2005 (Ferretti, Osio,  
420 Jenkins, Rosenberg, & Lotze, 2013). In the southern Mediterranean Sea (including the Gulf of Gabés  
421 and areas of the eastern Mediterranean, which seem to be core parts of the species' distribution), the  
422 species is still present and, in some areas, still commonly caught (e.g. Echwikhi, Saidi, & Bradaï, 2014;  
423 Lteif, 2015; Newell, 2016; Soldo, Briand, & Rassoulzadegan, 2014).

424 In West Africa, trend data are lacking, but evidence points to severe declines of wedgfishes.  
425 *Rhynchobatus luebberti* is known to have disappeared from a significant part of West Africa  
426 (Mauritania to Sierra Leone but apparently with the exception of the Banc d'Arguin National Park;  
427 Diop & Dossa, 2011). However, the species is now sparsely reported in the Banc d'Arguin National Park  
428 with only two individuals recorded in the past decade during fish landing site monitoring (the most  
429 recent record being February 2019) (Sall Amadou, pers. comm., 14/02/19; Saïkou Oumar Kidé, pers.  
430 comm., 14/02/19). This species was moderately abundant across its former range in the 1960s but  
431 declined thereafter (Bernard Séret, pers. comm., 07/02/19); during Guinean trawl surveys in the  
432 1960s, catch rates were as high as 30–34 kg/hr (William, 1968). By contrast, recent fish market surveys  
433 across the region have either failed to locate it or found only low numbers of individuals. In The  
434 Gambia, annual surveys from 2010 to 2018 of landing sites that regularly land guitarfishes and other  
435 rays have not recorded the species (Moore et al., 2019). In one artisanal demersal gillnet fishery in  
436 Mayumba, Gabon (between 30 to 40 boats), surveys between February 2013 and October 2015  
437 identified 40 individuals, and surveys between May and October 2018 identified 5 individuals



438 (Godefroy de Bruyne, pers. comm., 14/09/18). Observers on board national trawlers off Gabon have  
439 not recorded the species in monitoring which commenced in 2015, despite many species of rays being  
440 recorded (Emmanuel Chartrain, pers. comm., 15/02/19). In Port Gentil, Gabon (around 400 boats),  
441 where rays are targeted, *R. luebberti* has not been seen during ongoing surveys that commenced in  
442 June 2017 (Godefroy de Bruyne, pers. comm., 14/09/18). A 2006 capture by a recreational fishing  
443 guide in Guinea-Bissau was reportedly described as 'very, very rare' (Moore, 2017). It was also recently  
444 confirmed from Sao Tomé Island through a photographic record (Reiner & Wirst, 2016).

### 445 **3.5 IUCN Red List categories**

446 All wedgefishes and giant guitarfishes were assessed as CR A2, with the exception of *R. palpebratus*  
447 which was assessed as NT (nearly meeting criterion A2). That is, 15 out of 16 species are inferred to  
448 have undergone a population reduction of >80% over the last three generations (30–45 years), where  
449 'the causes of reduction may not have ceased OR may not be understood OR may not be reversible'  
450 (IUCN, 2012). In this case, the causes are understood (over-exploitation in target and bycatch fisheries,  
451 driven by human consumption and trade in meat and fins), they are theoretically reversible (through  
452 the implementation of management measures; see Discussion), but they have not ceased (largely  
453 unregulated exploitation continues with fishing effort increasing). These population reductions are  
454 based on 'an index of abundance appropriate to the taxon' (IUCN, 2012), i.e. the declines in landings  
455 and catch rates presented above, and 'actual or potential levels of exploitation' (IUCN, 2012), i.e. high  
456 levels of exploitation in target and bycatch fisheries. Red List categories and criteria along with a brief  
457 assessment justification for wedgefishes are provided in Table 4 and for giant guitarfishes in Table 5.

458 Parts of Australasia and South Africa stand apart as the clear exceptions to the widespread intense  
459 fisheries elsewhere. Four species (*R. ancylostoma*, *R. australiae*, *R. palpebratus*, and *G. typus*) occur in  
460 tropical and warm-temperate waters of Australia where fishing pressure is relatively low and fisheries  
461 management measures are in place. For widely-distributed species (*R. ancylostoma*, *R. australiae*, and  
462 *G. typus*) this proportion of the species' range is not considered to be large enough relative to the  
463 global range to lower the global CR assessment status. The bulk of the currently recognised  
464 distribution of *R. palpebratus* is within Australian waters, influencing its more favourable global status  
465 of NT, compared to the other species. It should be noted however, that the full distribution of this  
466 species is not well understood, and the disjunct records (Australia/New Guinea, Thai Andaman Sea,  
467 and Taiwan; Compagno & Last, 2008; Ebert et al., 2013; Last et al., 2016c) suggests that it is/was more  
468 widely ranging throughout Southeast Asia and Australasia, or that there is an unresolved taxonomic  
469 issue. Fishing pressure is high where *R. palpebratus* occurs outside of Australia and based on the  
470 landings and catch rate data presented above, it is inferred that the species has undergone a >80%

471 population reduction over the last three generations (45 years) in the Asian part of its range. There is  
472 little contemporary information on the species outside of Australia, and it has not been recorded in  
473 recent landing site surveys on the Andaman coast of Thailand (Shin Arunrugstichai, pers. comm.,  
474 16/01/19). If the species was in fact wider-ranging throughout the Indo-Malay Archipelago/Southeast  
475 Asia, as its disjunct distribution suggests, it would likely have undergone a population reduction over  
476 the last three generations high enough to qualify it for a threatened category (possibly as high as CR,  
477 the status of all other wedgefishes).

478 Generally, there are few catch and trend data for elasmobranchs in the Eastern Atlantic and there  
479 was no population trend information available for the three species found there: *R. luebberti*, *R.*  
480 *mauritaniensis*, and *G. cemiculus*. Nevertheless, inference can be drawn from general regional  
481 fisheries trends. Fishing effort and the number of fishers has increased in recent decades across West  
482 Africa, with demand for shark and ray product increasing over the same period due to the shark fin  
483 trade (Diop & Dossa, 2011). For example, large regional fishing nations including Mauritania and  
484 Senegal have seen significant increases in fishing effort since the second half of the 20th Century, with  
485 considerable artisanal and industrial fishing fleets operating in waters off West Africa (ANSD, 2016;  
486 Belhabib et al., 2012; FAO, 2008; ONS, 2017). The severe population reductions inferred for Indo-West  
487 Pacific wedgefishes and giant guitarfishes from several datasets could likely be considered  
488 representative of the situation in the Eastern Atlantic. Indeed, heavy exploitation has led to the  
489 depletion of *R. luebberti* and the possible disappearance of *R. mauritaniensis*.

### 490 **3.6 Possible extinction of two wedgefish species**

491 The most at-risk species are those with very-restricted ranges: *R. cooki* of the Indo-Malay Archipelago  
492 and *R. mauritaniensis* of Mauritania, both of which may be very close to extinction, even before they  
493 were taxonomically described in 2016 (Last et al., 2016a; Séret & Naylor, 2016). The full distribution  
494 of *R. cooki* is unclear as it has only been collected from fish landing sites in Singapore and Jakarta  
495 (Indonesia), and these landings come from fisheries that operate widely across the Indo-Malay  
496 Archipelago (Last et al., 2016a). There has only been a single record of this species since 1996 (an  
497 individual observed at a Singapore fish market in early 2019; Naomi Clark-Shen and Kathy Xu, pers.  
498 comm., 26/05/2019). The limited number of records in a heavily fished and scientifically well-surveyed  
499 area raises serious concerns for the species. Further surveys are required to understand its  
500 contemporary occurrence and status, and ongoing monitoring of fish markets should pay special  
501 attention to wedgefish landings while making an effort to determine from fishers where the species  
502 was caught, and therefore its natural range.

503 *Rhynchorhina mauritaniensis* is known only from one location, the Banc d'Arguin National Park,  
504 Mauritania. The Indigenous Imraguen population of the local area were traditionally subsistence  
505 fishers until a shift to commercial shark fishing from the mid-1980s (see Belhabib et al., 2012; Diop &  
506 Dossa, 2011). This shift, along with increasing artisanal and industrial fishing effort in Mauritanian  
507 waters possibly depleted the population even before it was formally described by Séret & Naylor  
508 (2016). This species is known to occur in an area where targeting of sharks has been prohibited since  
509 2003 (Diop & Dossa, 2011) and only Indigenous fishers are permitted to fish using traditional methods  
510 (the Banc d'Arguin National Park). However, the artisanal fishing effort in the National Park, combined  
511 with illegal fishing effort is considerable (Belhabib et al., 2012), and *R. mauritaniensis* is known to be  
512 landed locally. Individuals have been observed with their fins removed when landed, and the fins sold  
513 to local fin dealers (Séret & Naylor, 2016). This species is not likely to have any refuge from fishing  
514 within its very restricted range given the combined effort from subsistence, artisanal, and illegal  
515 fishing coupled with the high value of its fins. The species' extent of occurrence is estimated to be  
516 <5,000 km<sup>2</sup>, which combined with its presence in only one location, and an inferred continuing decline  
517 in the number of mature individuals due to this ongoing fishing pressure, meets EN under criterion B  
518 (as EN B1ab(v)) (IUCN, 2012). However, a lack of records, high actual levels of exploitation, and a broad  
519 understanding of declines of similar species in the Indo-West Pacific, as well as the locally-occurring  
520 *R. luebberti*, also lead us to infer that *R. mauritaniensis* has undergone a >80% population reduction  
521 over the last three generations (45 years) and is assessed as CR A2d.

522 The poorly-known *R. immaculatus* is also considered to be at elevated risk. It is another species known  
523 only from fishing landing sites, in this case, in northern Taiwan (Last et al., 2013). The lack of records  
524 suggests a very limited distribution which raises serious concerns for its ability to sustain historic and  
525 current levels of fishing pressure. Taiwan is a major fishing nation with a long history of exploitation  
526 of coastal resources, which were considered to be overfished by the 1950s (and which led to the  
527 development of Taiwan's distant water fleet) (Kuo & Booth, 2011). Taiwan ranks among the top 20  
528 shark fishing nations globally (Lack & Sant, 2011) and is a major global shark fin trading nation (Clarke  
529 et al., 2006; Dulvy et al., 2014). Furthermore, there is an extensive illegal, unreported, and unregulated  
530 (IUU) fishing issue in Taiwan (Kuo & Booth, 2011).

### 531 **3.7 Red List Index**

532 The global RLI for wedgefishes and giant guitarfishes starts relatively high in 1980 at 0.7, declining  
533 steadily to 0.43 in 2005 and further to 0.24 in the current assessment (2020) (Figure 3a). The global  
534 index is driven mainly by the greater diversity of the Indo-West Pacific, which has a similar RLI in 1980  
535 of 0.63. In the Eastern Atlantic however, a steep decline in RLI occurs between 1980 to 2005, from 1

536 to 0.4, compared to the Indo-West Pacific, which declines from 0.63 to 0.43 over the same time period  
537 (Figure 3a). This difference in decline rates is likely due to the later development of wedgfish and  
538 giant guitarfish fisheries and fin trade in the Eastern Atlantic. By 1980, it is inferred that 11 species  
539 were already likely to be threatened (i.e. Red List category of CR, EN, or VU); all these species occur in  
540 the Indo-West Pacific, where there has been an early development of fisheries and trade, particularly  
541 in Asia with its proximity to Hong Kong as the major shark fin trade centre. For example, *R.*  
542 *immaculatus* (Indo-West Pacific), is inferred as already CR by 1980 due to the early development of  
543 intensive fisheries in Taiwan and proximity to Hong Kong. By contrast, all three species found in the  
544 Eastern Atlantic were LC in 1980 (thus resulting in RLI of 1 for the region; Figure 3a). By 2005, it was  
545 inferred that at a global level, one species was CR, 13 were EN, one was VU, and one was NT. By the  
546 current assessment (2020), the RLI has declined to 0.25 and 0.2 for the Indo-West Pacific, and the  
547 Eastern Atlantic, respectively (Figure 3a).

548 The trends in wedgfish and giant guitarfish fisheries and fin trade described above are reflected in  
549 the geographic regions that display the sharpest declines in Red List Index between the different  
550 assessment years (Figure 3b and c). Declines in RLI between 1980 and 2005 are concentrated in West  
551 African and Mediterranean Sea nations (Figure 3b), shifting to East African nations between 2005 and  
552 2020 (Figure 3c). Declines are less severe in the Indo-West Pacific since most species are already likely  
553 threatened by 1980 (Figure 3b and c). Species' ranges in the Eastern Atlantic and the Indo-West Pacific  
554 overlap with the EEZ of forty-one and forty-six nations, respectively (Figure 3d, Table 6). The top ten  
555 percent of nations in the Eastern Atlantic responsible for the conservation of species in this region are  
556 Mauritania, Guinea, Guinea-Bissau, and Nigeria (collectively representing 57% of all national  
557 responsibility for the region); in the Indo-West Pacific, these nations are Indonesia, India, Australia,  
558 Taiwan, and Malaysia (representing 55% of all responsibility for the region; Figure 3d, Table 6).

#### 559 **4 DISCUSSION**

560 This study brings together several lines of evidence to show severe population reductions in  
561 wedgfishes and giant guitarfishes globally, resulting in 15 of 16 species (94%) facing an 'extremely  
562 high risk of extinction', i.e. assessed as Critically Endangered on the IUCN Red List. That makes these  
563 the most imperilled marine fish families globally, overtaking the sawfishes which are comprised of  
564 three CR and 2 EN species (IUCN, 2019). The demand for shark and ray products, including the high-  
565 value 'white' fins of wedgfishes and giant guitarfishes will continue to drive and incentivise targeting  
566 and retention, and urgent action is required to prevent extinctions. Next, the following topics are  
567 considered: (1) data quality and knowledge gap issues in assessing extinction risk in wedgfishes and  
568 giant guitarfishes; (2) the intersection between species richness and threat; (3) the current shortfall in

569 conservation and management; (4) Australia as a refuge for a quarter of the fauna; and, (5) measures  
570 that are needed to prevent extinction.

#### 571 **4.1 Data quality and knowledge gaps**

572 Most of the available data upon which these assessments were based were catch landings under  
573 broad aggregate categories such as ‘giant guitarfish’, ‘rhinobatid’, and ‘whitespotted wedgefishes’.  
574 These non-species-specific groupings limit the possibility of analysing population trends for individual  
575 species but are useful to infer trends based on overlapping habitat and depth ranges across species,  
576 and likely similar catchability in extensive coastal and shelf fisheries in tropical and warm temperate  
577 Indo-West Pacific and Eastern Atlantic waters.

578 Although landings data are not a direct measure of abundance, these can be used to infer population  
579 reduction where landings have decreased while fishing effort has remained stable or increased, hence  
580 approximating a decline in CPUE. In nearly all cases used here to assess population status, there was  
581 no reason to suspect that overall effort had decreased (although directed fishing effort may have  
582 shifted in response to resource collapse/depletion; e.g. the Aru Islands gillnet fishery in Indonesia). In  
583 fact, fishing effort and power is continuing to increase globally as the coastal human population  
584 continues to grow and fishing technology and market access improves. Some of the highest increases  
585 in fishing effort and power occur in the Asian region (Anticamara, Watson, Gelchu, & Pauly, 2011;  
586 Watson et al., 2013), which is a centre of wedgefish and giant guitarfish diversity. Hence, declining  
587 catches are inferred to likely indicate reductions in abundance.

588 All of the wedgefishes and giant guitarfishes were assessed using the IUCN Red List ‘Population size  
589 reduction’ A criterion (IUCN, 2012; IUCN, 2019; Mace et al., 2008). The IUCN Red List Criteria were  
590 designed to allow a range of data quality to be used, allowing taxa to be assessed in the absence of  
591 complete, high-quality datasets (IUCN Standards and Petitions Subcommittee, 2017). Moving from the  
592 highest to the lowest levels of acceptable data quality, IUCN accepts information that is ‘observed’  
593 (e.g. population decline based on well-documented observations of all known individuals in the  
594 population); ‘estimated’ (e.g. population decline based on repeated surveys that involve statistical  
595 assumptions); ‘projected’ (e.g. a future population decline model based on past repeated surveys and  
596 threats that are unlikely to stop); ‘inferred’ (e.g. a population decline based on trade or fisheries  
597 landings data), or ‘suspected’ (e.g. information based on circumstantial evidence). For the  
598 wedgefishes and giant guitarfishes, population reductions were ‘inferred’. Of the available  
599 contemporary datasets, only the catch rate data of myliobatoid rays from Maharashtra, India (Raje &  
600 Zacharia 2009) could be used to ‘estimate’ a population reduction (86–95% over three generations).

601 However, when applied to the assessment of wedgfish and giant guitarfish extinction risk, the data  
602 quality was low since population reductions were inferred from another demersal ray lineage  
603 (Myliobatiformes). Because the datasets used from Iran, Pakistan, and Indonesia (DGCF, 2015; 2017;  
604 FAO, 2018a; M.A. Gore, unpubl. data) consisted of landings only, these could only be used to ‘infer’  
605 population reduction.

606 Inferring population reductions from broad landings data of aggregate species categories highlighted  
607 the data deficiency around these species, not only in catch and trade data, but also in basic habitat  
608 and life history parameters. For example, amongst the wedgfishes, depth ranges are completely  
609 unknown for three species, annual fecundity is unknown across the family (and litter size is known  
610 from only four species), and generation length had to be inferred from giant guitarfishes. Across both  
611 families, age and growth studies are restricted to only two published works (Enajjar et al., 2012; White  
612 et al., 2014), with no accurate data for wedgfishes given that White et al. (2014) analysed mixed  
613 species samples.

#### 614 **4.2 The intersection between species richness and threat**

615 Species richness is highest in areas of significant fishing effort, and these hotspots of overlap between  
616 diversity and pressure may be priorities for management. The Indo-West Pacific (13 species) is the  
617 centre of diversity for wedgfishes and giant guitarfishes, with low diversity in the Eastern Atlantic  
618 (three species), and no species in the Western Atlantic or Eastern Pacific. The Northern Indian Ocean,  
619 particularly the Arabian/Persian Gulf to India, and the Indo-Malay Archipelago are areas of special  
620 concern. These regions include several countries that rank among the top 20 shark fishing nations  
621 globally, specifically Indonesia, India, Pakistan, Malaysia, Thailand, Sri Lanka, and Iran (Lack & Sant,  
622 2011) and are under high levels of coastal fishing effort (Stewart et al., 2010). Unsurprisingly, there  
623 have been steep declines in shark and ray landings over the past decade in this region likely due to the  
624 collapse of chondrichthyan stocks (Davidson, Krawchuk, & Dulvy, 2016) It is informative to consider  
625 the sheer number of fishing vessels in operation in these regions, for example (1) all Indian states have  
626 high numbers of fishing vessels (e.g. as reported in 2010: Maharashtra, 5,613 trawlers; Kerala, 3,678  
627 trawlers, Tamil Nadu, 5,767 trawlers; total trawlers in India: 35,228) and a high number of gillnetters  
628 (total of 20,257 as reported in 2010), (2) Oman with 19,000 artisanal boats, (3) Pakistan with 2,000  
629 trawlers, (4) Sri Lanka with 24,600 gillnet vessels operating in 2004; and, (5) Indonesia with ~600,000  
630 fishing vessels in marine waters (CMFRI, 2010; Dissanayake, 2005; Jabado et al., 2017; KKP, 2016). The  
631 intensity of fishing pressure on the coastal and shelf waters leaves little refuge for wedgfishes and  
632 giant guitarfishes.



633 While fishing pressure is the primary threat driving population reduction of wedgefishes and giant  
634 guitarfishes, these effects are compounded by habitat loss and degradation. The shallow, inshore soft-  
635 bottom habitat preferred by the species is threatened by habitat loss and environmental degradation  
636 (Jabado et al., 2017; Moore, 2017; Moore, McCarthy, Carvalho, & Peirce, 2012; Stobutzki et al., 2006;  
637 White & Sommerville, 2010). In the Arabian Sea and adjacent waters, dredging and coastal land  
638 reclamation has increased in recent years and has resulted in almost total loss of mangroves in some  
639 areas, such as Bahrain (Jabado et al., 2017; Sheppard et al., 2010), while Southeast Asia has seen an  
640 estimated 30% reduction in mangrove area since 1980 (FAO, 2007; Polidoro et al., 2010). Combined  
641 with targeted and bycatch fishing, the cumulative impacts of habitat loss and degradation will hinder  
642 recovery.

### 643 **4.3 Current shortfall in conservation and management**

644 There are minimal international and national management measures in place for wedgefishes and  
645 giant guitarfishes, and these are not at the scale currently required to curtail the severe extinction risk  
646 of these species. Regarding international agreements, *R. australiae* was listed on Appendix II of the  
647 Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 2017 which aims to  
648 provide a framework for the coordination of measures adopted by Range States to improve the  
649 conservation of the species. However, listing is not the same as implementation; a recent review of  
650 implementation of CMS listings revealed serious deficiencies in implementation across Range States  
651 (Lawson & Fordham, 2018). The CMS Memorandum of Understanding on the Conservation of  
652 Migratory Sharks also lists *R. australiae*, *R. djiddensis*, and *R. laevis* on Annex 1 (since December 2018).  
653 Annex 1 lists species that have an unfavourable conservation status and would significantly benefit  
654 from collaborative international conservation action. *Glaucostegus cemiculus* is listed on Annex II of  
655 the Specially Protected Areas and Biological Diversity Protocol for the Mediterranean under the  
656 Barcelona Convention, and cannot be retained on board, trans-shipped, landed, transferred, stored,  
657 sold, displayed or offered for sale, and must be released unharmed and alive (to the extent possible).  
658 European Union (EU) vessels are prohibited from fishing for guitarfishes in EU waters of several  
659 International Council for the Exploration of the Sea (ICES) sub-areas.

660 At the national or subnational level, there are very limited species-specific conservation or  
661 management measures in place. Some localised protections, trawl bans, finning bans, as well as  
662 general fisheries management and marine protected areas likely benefit these species, although in  
663 many areas, effective enforcement is an ongoing issue. Of 87 countries whose waters are home to one  
664 or more species of wedgefish or giant guitarfish, only eight have specific national or subnational level  
665 protections in place: (1) Guinea, where *R. luebberti* is protected (specified within the annual national



666 fisheries management plan rather than the Fisheries Code); (2) South Africa, where *R. djiddensis* is  
667 protected; (3) Israel, where all sharks and rays are protected; (4) the United Arab Emirates (UAE),  
668 where all wedgefishes and guitarfishes are protected; (5) Kuwait, where all rays are protected; (6)  
669 Pakistan, where all guitarfishes and wedgefishes are protected in Balochistan province, and where  
670 juvenile guitarfishes and wedgefishes (less than 30 cm) are protected in Sindh province (note that this  
671 size limit is below the known size-at-birth of all wedgefishes and most giant guitarfishes; Tables 1 &  
672 2); (7) India, where '*R. djiddensis*' is protected; and, (8) Bangladesh, where '*R. djiddensis*' and *G.*  
673 *granulatus* are protected. However, *R. djiddensis* does not occur in India or Bangladesh (Last et al.,  
674 2016c), and the species present there, *R. australiae* and *R. laevis*, are currently not listed on national  
675 legislation. Collectively, these countries represent only 19% of all conservation responsibility in the  
676 Indo-West Pacific and just 8% in the Eastern Atlantic (Israel and Guinea only).

677 The UAE, Qatar, and Oman have banned trawling in their waters, Malaysia has banned trawling in  
678 inshore waters, and other countries have seasonal trawl closures that may benefit species. Finning  
679 (i.e. removing fins and discarding the body at sea) has been banned in several range states including  
680 some West African countries, UAE, Oman, Iran, Israel, and Australia. This may have reduced the  
681 retention of animals solely for their fins, but fins are still traded when whole animals are landed.  
682 Furthermore, unreported finning of sharks and 'guitar sharks' has been reported in the Mauritania  
683 industrial shrimp fishery (Goudswaard & Meissa, 2006) and no doubt occurs more widely.

#### 684 **4.4 Lifeboat Australia**

685 Across the global range of wedgefishes and giant guitarfishes, Australia offers some refuge for the four  
686 species occurring there (*R. ancylostoma*, *R. australiae*, *R. palpebratus*, and *G. typus*), particularly as  
687 Australia has the third highest conservation responsibility for all species occurring in the Indo-West  
688 Pacific. Fishing pressure is considerably lower in the tropical and subtropical waters of the northern  
689 half of the Australian continent than most places in the Indo-West Pacific, although the degree of  
690 connectivity with Indonesia and elsewhere is unknown. If animals regularly move into Indonesian  
691 waters, they would face significantly higher levels of fishing pressure. There are no target fisheries for  
692 these species in Australia, although they are taken as bycatch in numerous non-target fisheries (e.g.  
693 Stobutzki, Miller, Heales, & Brewer, 2002; White, Heupel, Simpfendorfer, & Tobin, 2013). The  
694 introduction of turtle exclusion devices in northern and eastern Australian prawn trawl fisheries is  
695 likely to have significantly reduced the mortality of these species in trawl fishing gear (Brewer et al.,  
696 2006). Furthermore, in the state of Queensland there is a trip limit of five wedgefishes in commercial  
697 net fisheries (DAFF, 2009) and in all jurisdictions, there are prohibitions on retention of any shark  
698 product in several fisheries. General recreational shark and ray possession limits are also in place.

699 Lastly, Australia has a system of marine protected areas stretching across the distribution of  
700 wedgefishes and *G. typus*, and although these are multi-use parks, they include areas with limitations  
701 on fishing activities. Collectively, this management seascape may offer these species a ‘lifeboat’, a  
702 term first used by Fordham et al. (2018) in the context of Australia and sawfishes.

#### 703 **4.5 Preventing extinction**

704 The application of IUCN Red List Categories and Criteria to wedgefishes and giant guitarfishes has  
705 shown that without immediate action, there is an extremely high likelihood of global extinction for  
706 most species. Declines in Red List Indices are severe at global, regional, and national levels, with a  
707 relatively small number of countries responsible for the majority of conservation of these species.  
708 Accurate extinction risk assessments are essential to inform policy and decision making, and to  
709 improve conservation efforts and sustainable management of shark-like rays. It is therefore necessary  
710 to continue to refine future assessments by resolving taxonomic issues, improving our understanding  
711 of species distributions and life histories, and monitoring threats.

712 Taxonomic resolution combined with accurate species-specific identification would greatly enhance  
713 gathering life history and habitat data, and lead to improved fisheries monitoring data recording.  
714 However, accurate identification is wanting, particularly in the ‘whitespotted wedgefish’ species-  
715 complex. While *R. ancylostoma* and *R. mauritaniensis* are distinctive, the eight *Rhynchobatus* species  
716 are morphologically similar externally, and are usually separated, if at all, by the patterning of spots  
717 around a black pectoral marking. The problem with separating these species based on spot patterns  
718 is that these may change with growth and natural variations between animals. Further compounding  
719 the matter is the poor original descriptions for many of these species; two *Rhynchobatus* species (*R.*  
720 *djiddensis*, *R. laevis*) were described over 215 years ago, and two others (*R. luebberti*, *R. australiae*)  
721 were described 114 and 80 years ago, respectively. In the past 11 years four new species (*R. cooki*, *R.*  
722 *immaculatus*, *R. palpebratus*, *R. springeri*) have been described, but most were based on smaller  
723 juvenile specimens, without consideration of ontogenetic changes in spot patterning. The giant  
724 guitarfishes are even more problematic since all were described more than 175 years ago, with their  
725 descriptions being poor. A taxonomic revision of both families is needed with corresponding field  
726 identification guides to improve specific-species data collection.

727 International trade in highly prized and valuable fins is a major driver of over-exploitation in  
728 wedgefishes and giant guitarfishes (Dent & Clarke, 2015; Hau et al., 2018; Jabado, 2018; 2019; Moore,  
729 2017; Suzuki, 2002) and hence, trade regulation is an important part of the solution to reduce  
730 incentives to serially deplete populations of these species. Two species of wedgefish (*R. australiae* and

731 *R. djiddensis*) and two species of giant guitarfish (*G. cemiculus* and *G. granulatus*) have been proposed  
732 for listing under Appendix II of the Convention on the International Trade in Endangered Species, with  
733 all other members of both families to be listed under the 'look alike' criterion. An Appendix II listing  
734 enables international trade to be controlled through export permits issued by Parties where 'the  
735 specimen was legally obtained and if the export will not be detrimental to the survival of the species'  
736 (CITES, 2019). There are currently 183 Parties to CITES so this instrument has broad global reach  
737 (CITES, 2019), yet implementation and enforcement are ongoing issues.

738 A logical first step to guide and prioritise actions for these species is a global conservation planning  
739 exercise. A global sawfish strategy was instrumental in catalysing research and monitoring for  
740 sawfishes (Fordham et al., 2018; Harrison & Dulvy, 2014), although much work remains to be done to  
741 secure those species. To conserve wedgefish and giant guitarfish populations and to permit recovery,  
742 a suite of national, regional, and international measures will be required which will need to include  
743 species protection, spatial management, bycatch mitigation, and harvest and international trade  
744 management measures. Effective enforcement of measures will require ongoing training and capacity-  
745 building (including improving species identification; Jabado, 2019). Catch monitoring, especially in  
746 artisanal fisheries, is needed to help understand local population trends and inform management. The  
747 dire situation of two wedgefish species, *R. cooki* and *R. mauritaniensis*, outlined here highlights the  
748 urgency of global concerted action.

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**TABLE 1** Distribution and life history of wedgefishes (Rhinidae). Life history data from Last & Stevens (2009); Last et al. (2016c); van der Elst (1993); White & Dharmadi (2007).

Species	Distribution	Depth range (m)	Maximum size (cm TL)	Size-at-maturity (cm TL)	Size-at-birth (cm TL)	Litter Size	Generation Length (years)
Bowmouth Guitarfish <i>Rhina ancylostoma</i> Bloch & Schneider, 1801	Indo-West Pacific	Inshore–70	270	♀ ~180 ♂ 150–175	46–48	2–11	15
Bottlenose Wedgefish <i>Rhynchobatus australiae</i> Whitley, 1939	Indo-West Pacific	Inshore–60	~300	♀ ~155 ♂ 110–130	46–50	7–19 (mean 14)	15
Clown Wedgefish <i>Rhynchobatus cooki</i> Last, Kyne & Compagno, 2016	Southeast Asia	n/a	81	♀ n/a ♂ <70	n/a	n/a	10
Whitespotted Wedgefish <i>Rhynchobatus djiddensis</i> (Forsskål, 1775)	Western Indian	Inshore–70	310	♀ n/a ♂ ~150	60	4	15
Taiwanese Wedgefish <i>Rhynchobatus immaculatus</i> Last, Ho & Chen, 2013	Taiwan	n/a	>99†	♀ n/a ♂ n/a	n/a	n/a	10
Smoothnose Wedgefish <i>Rhynchobatus laevis</i> (Bloch & Schneider, 1801)	Indo-West Pacific	Inshore–60	>200	♀ n/a ♂ ~130	n/a	n/a	15
African Wedgefish <i>Rhynchobatus luebberti</i> Ehrenbaum, 1915	Eastern Atlantic	Inshore–35	~300	♀ n/a ♂ n/a	79–85	2–5	15
Eyebrow Wedgefish <i>Rhynchobatus palpebratus</i> Compagno & Last, 2008	Indo-West Pacific	5–61	262	♀ n/a ♂ 103	46–50	n/a	15
Broadnose Wedgefish <i>Rhynchobatus springeri</i> Compagno & Last, 2010	Southeast Asia	16–40	213	♀ n/a ♂ ~115	n/a	n/a	15
False Shark Ray <i>Rhynchorhina mauritaniensis</i> Séret & Naylor, 2016	Mauritania	n/a	275	♀ n/a ♂ n/a	n/a	n/a	15

TL, total length; n/a, not available; †Immature male, maximum size suspected to be ~150 cm TL.

**TABLE 2** Distribution and life history of giant guitarfishes (Glaucostegidae). Life history data from Capapé & Zaouali (1994); Enajjar et al. (2012); Gohar & Mazhar (1964); Last et al. (2016c); Moore et al. (2012); Moore & Peirce (2013); Muhammad Moazzam Khan, pers. comm., 07/02/2019; Prasad (1951); Seck et al. (2004).

Species	Distribution	Depth range (m)	Maximum Size (cm TL)	Size-at-maturity (cm TL)	Size-at-birth (cm TL)	Litter Size	Generation Length (yrs)
Blackchin Guitarfish <i>Glaucostegus cemiculus</i> (Geoffroy St Hilaire, 1817)	Eastern Atlantic & Mediterranean Sea	Inshore–80	265	♀ 163 (Senegal) ♀ 110–138 (Tunisia) ♂ 155 (Senegal) ♂ 100–112 (Tunisia)	~34	16–24 (Senegal) 5–12 (Tunisia)	15
Sharpnose Guitarfish <i>Glaucostegus granulatus</i> (Cuvier, 1829)	Northern Indian	Inshore–120	229	♀ n/a ♂ n/a	~39	6–18	15
Halavi Guitarfish <i>Glaucostegus halavi</i> (Forsskål, 1775)	Northern Indian	Inshore–100	187	♀ ~83 ♂ ~83	~29	up to 10	10
Widenose Guitarfish <i>Glaucostegus obtusus</i> (Müller & Henle, 1841)	Indo-West Pacific	Inshore–60	93	♀ n/a ♂ ~48	n/a	4–10	10
Clubnose Guitarfish <i>Glaucostegus thouin</i> (Anonymous, 1798)	Indo-West Pacific	Inshore–60	~300	♀ n/a ♂ n/a	n/a	n/a	15
Giant Guitarfish <i>Glaucostegus typus</i> (Bennett, 1830)	Indo-West Pacific	Inshore–100	270	♀ 150–180 ♂ 150–180	38–40	n/a	15

TL, total length; n/a, not available

**TABLE 3** Overall decline, annual proportional change, proportion remaining, and proportional decline over three generation lengths for landings and catch rate datasets. Proportional decline is provided for small (<200 cm TL) and large (≥200 cm TL) wedgefish and giant guitarfish species by applying a 3 generation length of 30 and 45 years, respectively.

Location	Iran		Sindh, Pakistan		Balochistan, Pakistan		Maharashtra, India		Indonesia	
Data type	Landings (t)		Landings (t)		Landings (t)		Catch rate (kg/hr)		Landings (t)	
Data category	'giant guitarfish'		'rhinobatid'		'rhinobatid'		'myliobatoid rays'		'whitespotted wedgefishes'	
Data period (x years)	1997–2016		1999–2011		1994–2011		1990–2004		2005–2015	
Data source	FAO (2018a)		M.A. Gore, unpubl. data		M.A. Gore, unpubl. data		Raje & Zacharia (2009)		DGCF (2015; 2017)	
Proportional decline over x years	0.665		0.720		0.806		0.631		0.876	
Annual proportional change	0.947		0.907		0.913		0.936		0.827	
3 generation lengths (3GL)	30 yrs	45 yrs	30 yrs	45 yrs	30 yrs	45 yrs	30 yrs	45 yrs	30 yrs	45 yrs
Proportion remaining	0.194	0.086	0.053	0.012	0.065	0.016	0.136	0.050	0.003	0.0002
Proportional decline over 3GL	0.806	0.914	0.947	0.988	0.935	0.984	0.864	0.950	0.997	0.9998



**TABLE 4** Summary of IUCN Red List (RL) Categories and Criteria for wedgefishes (Rhinidae).

Species	RL Category & Criteria	Justification
<i>Rhina ancylostoma</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across most of range; some refuge in Australia but not considered a large enough proportion of range to lower assessment
<i>Rhynchobatus australiae</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across most of range; some refuge in Australia but not considered a large enough proportion of range to lower assessment
<i>Rhynchobatus cooki</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across range; only a single record since 1996 in well surveyed and heavily fished areas
<i>Rhynchobatus djiddensis</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across most of range; some refuge in South Africa but not considered a large enough proportion of range to lower assessment
<i>Rhynchobatus immaculatus</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; limited distribution in heavily fished area; no refuge
<i>Rhynchobatus laevis</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across most of range; no refuge
<i>Rhynchobatus luebberti</i>	CR A2d	Once common and now only sporadically recorded; localised extinction; high levels of exploitation across range; no refuge
<i>Rhynchobatus palpebratus</i>	NT A2bd	Assuming disjunct range of Australia/PNG, Thailand & Taiwan (as opposed to wider Australasian/Southeast Asian range): high levels of exploitation in Thailand & Taiwan, refuge in northern Australia (significant proportion of range)
<i>Rhynchobatus springeri</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across range; no refuge
<i>Rhynchorhina mauritaniensis</i>	CR A2d	High levels of exploitation across range; absence of records; no refuge

CR, Critically Endangered; NT, Near Threatened.

**TABLE 5** Summary of IUCN Red List (RL) Categories and Criteria for giant guitarfishes (Glaucostegidae).

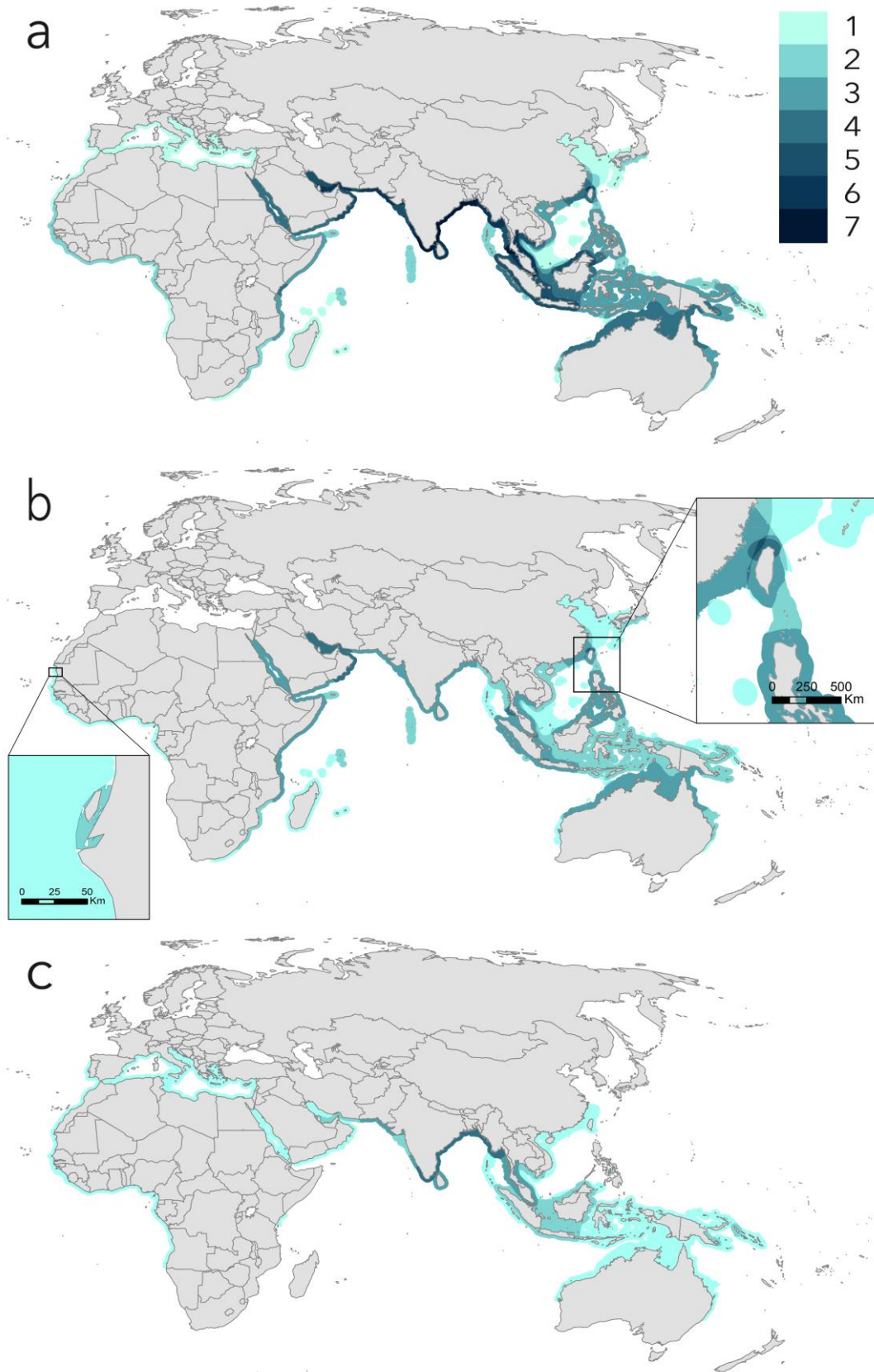
Species	RL Category & Criteria	Justification
<i>Glaucostegus cemiculus</i>	CR A2d	Localised extinctions in northern Mediterranean; high levels of exploitation across West Africa; no refuge
<i>Glaucostegus granulatus</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across most of range; no refuge
<i>Glaucostegus halavi</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across most of range
<i>Glaucostegus obtusus</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across range; no refuge
<i>Glaucostegus thouin</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across range; rarity; no refuge
<i>Glaucostegus typus</i>	CR A2bd	Indo-West Pacific population reductions in rhinopristsoids; high levels of exploitation across most of range; some refuge in Australia but not considered a large enough proportion of range to lower assessment

CR, Critically Endangered.

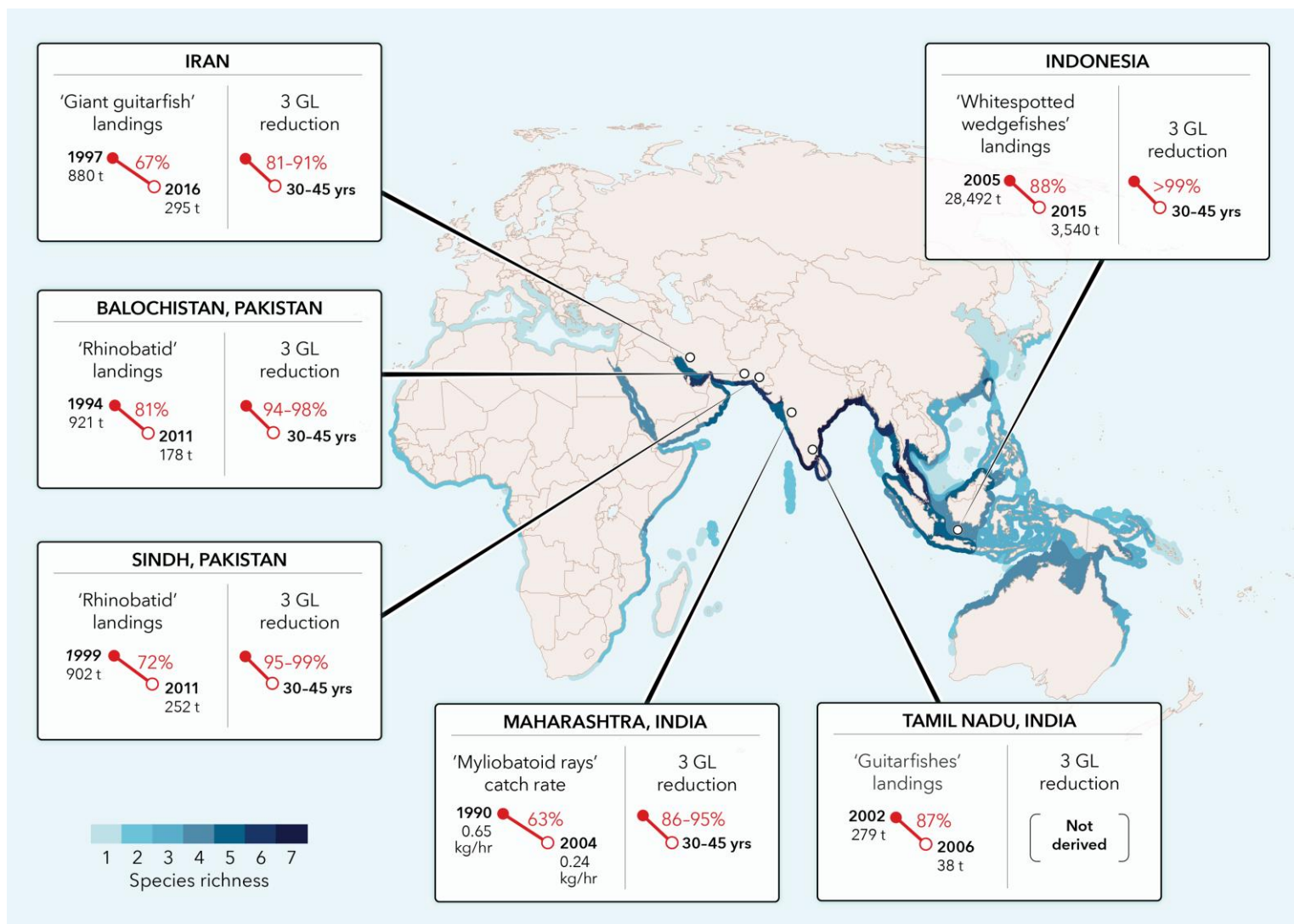
**TABLE 6** National conservation responsibilities (NCR) for all wedgefish and giant guitarfish species across 87 countries. Conservation responsibility (calculated as the sum of threat scores for each species weighted by the proportion of species range contained within each country's EEZ; see methods) is determined separately and normalised to range from 0 to 1 for comparability between the two distinct regions, the Eastern Atlantic Ocean and Mediterranean Sea region, and Indo-West Pacific Ocean region.

Eastern Atlantic and Mediterranean Sea		Indo-West Pacific	
Country	NCR	Country	NCR
Mauritania	1	Indonesia	1
Guinea	0.209	India	0.487
Guinea-Bissau	0.172	Australia	0.322
Nigeria	0.149	Taiwan, Province of China	0.242
Gabon	0.112	Malaysia	0.221
Sierra Leone	0.108	Thailand	0.202
Egypt	0.101	Myanmar	0.177
Senegal	0.086	Islamic Republic of Iran	0.166
Italy	0.067	China	0.155
Tunisia	0.066	Saudi Arabia	0.136
Ghana	0.063	United Arab Emirates	0.122
Western Sahara	0.062	Eritrea	0.086
Cameroon	0.050	Pakistan	0.082
Angola	0.048	Vietnam	0.080
Libya	0.044	Oman	0.073
Greece	0.041	Bangladesh	0.069
Liberia	0.040	Qatar	0.068
Morocco	0.036	Philippines	0.064
Croatia	0.031	Yemen	0.056
Côte d'Ivoire	0.030	Mozambique	0.048
Equatorial Guinea	0.028	Egypt	0.040
Spain	0.027	Sri Lanka	0.037
Gambia	0.023	Papua New Guinea	0.030
Turkey	0.019	Somalia	0.022
Congo	0.016	Cambodia	0.022
Portugal	0.015	Kuwait	0.020
Benin	0.009	Sudan	0.018
France	0.008	Japan	0.016
Algeria	0.007	Bahrain	0.015
The Democratic Republic of the Congo	0.007	United Republic of Tanzania	0.011
Togo	0.005	South Africa	0.009
Israel	0.004	Kenya	0.007
Albania	0.004	Republic of Korea	0.007

Cyprus	0.002	Madagascar	0.006
Montenegro	0.002	Seychelles	0.004
Lebanon	0.001	Brunei Darussalam	0.003
Syrian Arab Republic	0.001	Maldives	0.002
Malta	0.001	Singapore	0.002
Slovenia	<0.001	Israel	0.002
Bosnia and Herzegovina	<0.001	Democratic People's Republic of Korea	0.002
Monaco	0	Djibouti	0.001
		Solomon Islands	0.001
		Iraq	0.001
		Timor-Leste	<0.001
		Mauritius	<0.001
		Réunion	0

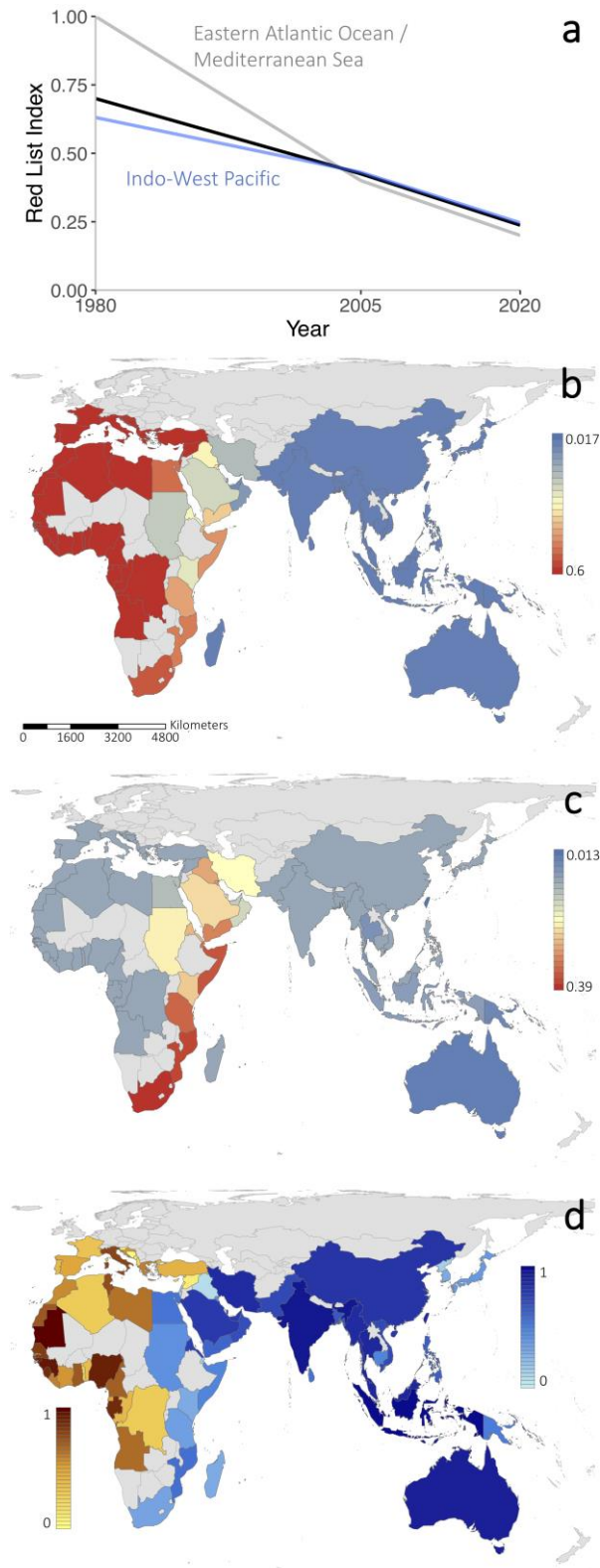


**FIGURE 1** Wedgefish and giant guitarfish species richness: (a) Global species richness of wedgefishes and giant guitarfishes combined (n = 16 species); (b) Global species richness of wedgefishes (n = 10 species); (c) Global species richness of giant guitarfishes (n = 6 species).



**FIGURE 2** Summary of landings and catch rate data used to infer population reductions in wedgefishes and giant guitarfishes overlaid on the map of global species richness of wedgefishes and giant guitarfishes combined (Figure 1A). Data sources are provided in Table 3. GL, generation length.





**FIGURE 3** Red List Indices for wedgefishes and giant guitarfishes. (a) Global Red List Index (RLI; black line) decomposed for the two main oceanic regions, Indo-West Pacific Ocean (blue line), and the Eastern Atlantic Ocean and Mediterranean Sea (gray line); decline in country-weighted RLI from (b) 1980 to 2005, and (c) 2005 to 2020; and, (d) National conservation responsibilities for all wedgefish and giant guitarfish species across the two main regions, Indo-West Pacific Ocean (blues) and the Eastern Atlantic Ocean and Mediterranean Sea (yellows).



**APPENDIX I** Individual species range maps for wedgefishes (a–j) and giant guitarfishes (k–p): (a) *Rhina ancylostoma*; (b) *Rhynchobatus australiae*; (c) *Rhynchobatus cooki*; (d) *Rhynchobatus djiddensis*; (e) *Rhynchobatus immaculatus*; (f) *Rhynchobatus laevis*; (g) *Rhynchobatus luebberti*; (h) *Rhynchobatus palpebratus*; (i) *Rhynchobatus springeri*; (j) *Rhynchorhina mauritaniensis*; (k) *Glaucostegus cemiculus*; (l) *Glaucostegus granulatus*; (m) *Glaucostegus halavi*; (n) *Glaucostegus obtusus*; (o) *Glaucostegus thouin*; (p) *Glaucostegus typus*.

