OFFSHORE FISHERIES OF THE SOUTHWEST INDIAN OCEAN:

their status and the impact on vulnerable species







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Rudy van der Elst and Bernadine Everett (editors)

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12. VULNERABLE TELEOST FISHES

A review of fisheries' impacts on threatened species in the Southwest Indian Ocean

Rudy van der Elst[1]

Abstract

The West Indian Ocean (WIO) is rich in fish diversity with some 2,200 species, equal to about 14% of the global total of marine fish species, grouped into 270 families representing 83% of all the fish families known. High levels of endemism at 13%, coupled with vulnerable features such as slow growth, limited distribution and declining populations place a number of species at risk. While traditional fish stock assessments deal with harvested fish stocks, it is often the less common but vulnerable species that require special attention. The identification of such species at risk is not straightforward and can best be done by interrogating several sources of information. The IUCN red data for marine fishes lists 1,058 marine fish species of concern in the WIO. Of these, 232 are elasmobranchs and 824 teleost fishes. Amongst the latter are 97 families dominated by coral reef species, including the larger Serranidae and Labridae. Combining the IUCN categories *critical, endangered* and *vulnerable* into a "threatened" category, supplemented with information from Cites as well as vulnerable species identified in WIOFish, results in a list of 12 species explicitly of concern to SWIOFP fisheries. The inadequate level of protection afforded by countries to some of these species raises concern about their future viability. Line and gillnet fisheries are especially implicated and in several cases the targeting of spawning aggregations and remote spawning refugia increases concern. It is recommended that a regional SWIO list of threatened marine fish species is compiled and adopted as a basis for collective action.

Biodiversity of teleost fishes in WIO

The Indo-West Pacific region has the greatest diversity of fishes of all the oceans' eight biogeographic regions. Embedded in this is the West Indian Ocean (WIO) with some 2,200 species, about 14 % of the global total of marine fishes (Smith and Heemstra 1986; Nelson 2006). The fish species found in the WIO can be grouped into 270 families, representing some 83% of all the fish families known. This richness is due to the large variety of habitats and oceanographic conditions of the region (van der Elst *et al.* 2005; UNEP 2009). On a national scale, the diversity of fishes is also considerable. For example, Tanzania's national marine fish species list may reach 1,000 species (Benbow 1976), that of the Seychelles over 1,000 species and, at a smaller scale, 552 species of fish for the Grand Reef at Toliara alone in south-west Madagascar (Gaudian *et al.* 2003). Mozambique has about two thousand species of marine fish with at least 307 species of linefish, La Réunion boasts 885 species (Letouneur *et al.* 2004) while the South African list is also around 2,500, including West Coast species. Many of these species are transboundary and shared between the SWIOFP countries. The West Indian Ocean marine fish assemblage includes many remarkable and iconic fishes, ranging from the world's "oldest" fish the coelacanth *Latimeria chalumnae* to the world's largest, the whale shark *Rhincodon typus*. The origin of the region's ichthyofauna is diverse, with about ½ considered to be Indo-Pacific (Smith & Heemstra 1986), about 13% endemic to the WIO and the rest made up of species that are global or original migrants from different regions as shown in Table 1.

Table 1. Origin of fish species found in the West Indian Ocean region. After Smith & Heemstra 1986.

Origin	*Percent*
Indo-Pacific	50
Atlantic	3-4
Southern ocean	<1
Global deep sea	29
Cosmopolitan	4
Endemic	13

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The distribution of this diversity of fishes in the WIO is not necessarily uniform. There are regions of higher diversity, such as the East African coast, Madagascar and India and also regions of relatively low diversity, such as the Arabian Gulf, with its shallow seas, high salinity and temperature fluctuation from 10ºC to 35ºC (Cohen 1973; Randall 1995). Significantly, there are also regions of high endemism. The Red Sea and Arabian Gulf, with their restricted opening and relative isolation from other seas have levels of endemism around 15%. Endemic species have also been recorded from several islands, especially belonging to the butterfly-, damsel and angelfish families (McAllistar *et al*. 1994). A surprisingly high level of endemism is also found off southern Mozambique and South Africa, with 227 endemic species (13% of its marine ichthyofauna) (Smith & Heemstra 1986). This endemism is largely attributable to five main families as reflected in Table 2.

Brindle bass, *Epinephelus lanceolatus.* Photo: Dennis King

Table 2. Main groups of endemic fishes found off SE Africa.

Family	*Common name*	*No. of species*
Clinidae	Klipfishes	38
Gobidae	Gobies	28
Sparidae	Seabreams	25
Scylliorhinidae	Catsharks	11
Batrachoideidae	Toadfishes	7

The reason for this high level of endemism in South Africa can be attributed to the unique environment of the southern tip of continental Africa. This is the only coastal region in the West Indian Ocean that has a temperate climate with distinctly different environmental conditions in association with the Agulhas large marine ecosystem (Beckley *et al.* 2002.) Some of the endemics in the West Indian Ocean may be glacial relics, meaning that they were once more widespread during the Pleistocene (Randall 1995). In some cases, upwelling systems may have contributed to their isolation, such as off South Africa, Oman and Somalia. There is also evidence of disjunct distribution of fishes, such as the croaker, *Argyrosomus hololepidotus* (Griffiths & Heemstra 1995). Surveys have suggested anti-tropical distribution of several inshore species that have been found off Puntland in Somalia and KwaZulu-Natal in South Africa, but not in between these latitudes. Examples of this are the elf *Pomatomus saltatrix,* the blacktail *Diplodus sargus,* the Cape fur seal *Arctocephalus pusillus* and the Natal rock lobster *Panulirus homarus*. (Mann & Fielding 2000.)

Despite the extensive fish collections made, and the major studies undertaken in the West Indian Ocean over the years, the ichthyofauna remains poorly understood. Very few countries of the region have national collections, most specimens are housed in northern hemisphere museums and the institutional support for ichthyology and taxonomy has declined. Hence the precise numbers of species found in the region and the levels of endemism will continue to vary as new species are added, synonyms recognised and errors corrected. For example, the notable ichthyologist Jack Randall added 52 new species based on collections he made during several surveys in the seas off Oman (Randall 1995). Most of the large and comprehensive ichthyofauna surveys were published before the 1960s and the more recent studies have been focussed on individual families or specific sites, such as those in Mozambique (Gell & Whittington 2002) and Kenya (Mwatha *et al.* 1998; McClanahan *et al.* 1996). There are, however, two notable exceptions, namely the five-volume FAO species' guide to the West Indian Ocean (Fischer and Bianchi 1984) and the comprehensive Smith's Sea Fishes, edited by Smith and Heemstra (1986). A further major contribution is imminent when "Fishes of the West Indian Ocean" is published by Heemstra and Heemstra.

Species under threat

Fishes of the WIO region are variably at risk. These risks may be attributed to various causes, including ecosystem and/or habitat destruction, climate change and of course as a result of fishing. In the case of fisheries, the risks imposed can be either as a result of directly targeting, incidental by-catch or impact on the species' environment. Whatever the case, some species are more vulnerable than others and these require identification and protection. The identification of such species at risk can be done on the basis of several different criteria. Included are issues such as declining populations, limited distributions, endemism, slow turn-over life cycles, reduced distribution range, high mortality rates, etc. While traditional fish stock assessments should be able to deal with harvested fish stocks, it is often the less common but vulnerable species that require special attention. There are several approaches, including the IUCN Red List system as well as national conservation programmes.

IUCN RED LIST SYSTEM

One system that encapsulates vulnerability is the IUCN Red List. Although the Red List system was initially developed for terrestrial use as an indication of the risk of extinction of individual species, it has progressively been improved and expanded since Version 1 in 1991, to Version 3.1 released in 2001. The suite of criteria used to evaluate species includes: population size, maturity levels, reductions and continued declines in abundance, extreme fluctuations, severely fragmented populations, range and area of occupancy, location in relationship to risk and quantitative assessments. Evaluations are conducted by a network of species specialists who assess the status of species based on the best expertise and information available. The data that supports the IUCN Red List system is the IUCN Species Programme, a centralized database and species information service which is publicly available via a searchable database. The records of all plants and animals listed in the Red List Categories are accessible, including marine fishes. Marine fishes present specific challenges for the Red List system as marine fishes invariably "have a much larger population size and a greater (potential) dispersal capability provided by the presence in many of pelagic larval life history phases" than terrestrial animals (Sadovy *et al*. 2013). This suggests that extinction is extremely remote. In the case of marine fishes there are specialist groups dealing with families of fishes, including Serranidae, Labridae and Sparidae. This process is guided by a set of rules that assist in defining the level of risk. Notwithstanding, the system does provide a useful framework for assessing threats and thus Red List categories should be considered as "flags of threat" which are an index of endangerment rather than an absolute risk of extinction of a particular species (Issac & Mace 1998; Mace *et al*. 2008). Indeed, no marine fishes have been listed as extinct in the wild. More details of the Red List criteria can be obtained from the IUCN website. Accordingly, the following categories are identified (Table 3). Based on the IUCN red data listing for marine fishes there are presently a total of 1058 marine fish species listed in the Red List for the WIO. Of these, 232 are Chondrichthyes, 2 are hagfishes and 824 are teleost fishes. Amongst the latter are 97 families dominated by coral reef species as shown in Figure 1 (see next page).

Included in this list is a total of 17 (3.4%) listed as "threatened" comprising either Critical= 2; Endangered=3 or Vulnerable=12. Of these, six are shallow water and not threatened directly by industrial/commercial fisheries, while the remaining 11 are variably taken in fisheries in the SWIOFP region, mostly by line. In contrast, there are 57 species of elasmobranch listed (24% of total) as "threatened" comprising Critical=8; Endangered=8 and Vulnerable=41. This higher proportion signifies the higher levels of risk associated with elasmobranchs as well as the greater effort and progress made by the respective specialist group. One further species that is red-flagged listed as Critical is the coelacanth *Latimeria chalumnae*, belonging to the class Sarcopterygii.

Table 3. Red List categories as defined by IUCN.

Extinct in the wild	EW	A taxon is Extinct in the Wild.
Critically Endangered	CR	A taxon is Critically Endangered when the best available evidence indicates that it is considered to be facing an extremely high risk of extinction in the wild.
Endangered	EN	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.
Vulnerable	VU	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.
Near Threatened	NT	A taxon is Near Threatened if it does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern	LC	A taxon is Least Concern if it does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient	DD	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.
Not Evaluated	NE	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

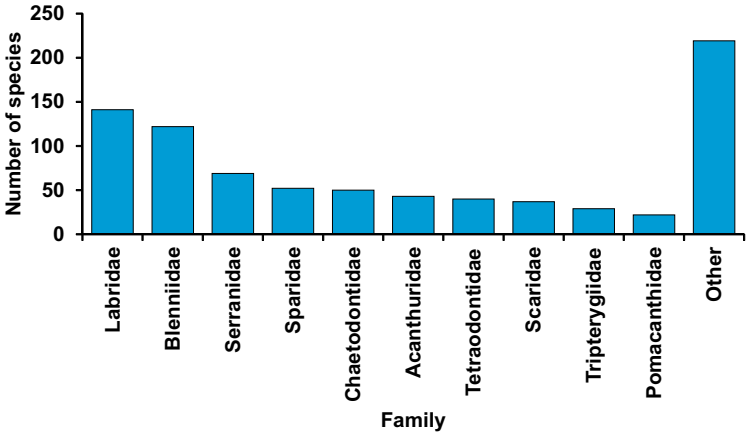

Figure 1. Distribution of the number of species red-flagged for the main WIO teleost fish families (IUCN).

Latimeria chalumnae	Coelacanth	CR
Thunnus maccoyii	Southern bluefin tuna	CR
Argyrosomus hololepidotus	Madagascar kob/croaker	EN
Cheilinus undulatus	Humphead wrasse	EN
Epinephelus marginatus	Dusky grouper	EN
Bolbometopon muricatum	Bumphead parrotfish	VU
Epinephelus albomarginatus	Captain fine	VU
Epinephelus gabriellae	Gabriella's grouper	VU
Epinephelus lanceolatus	Brindle bass	VU
Plectropomus areolatus	Spotted coral trout	VU
Plectropomus laevis	Black-saddled coral grouper	VU
Thunnus obesus	Big eye tuna	VU

Table 4. The twelve non-elasmobranch WIO species that have been red-flagged as "threatened".

Table 5. Distribution and level of protection of species relevant to SWIOFP that are IUCN red-flagged or listed under national regulation. F= fully protected; P=partial, N= no protection, ?=uncertain. Blue indicates presence. *= source of listing.

		Red	*Cites*	*Nat*[2]	*RSA*	*MOZ*	*TANZ*	*KEN*	*SEY*	*FRN/ EPRS*	*MAU*	*MAD*	*COM*	*SOM*
Coelacanth	*Latimeria chalumnae*	*	*	*	F	F	F	F				N	F	
Southern bluefin tuna	*Thunnus maccoyii*	*			?							N		
Madagascar kob	*Argyrosomus hololepidotus*	*										?		
Humphead wrasse	*Cheilinus undulatus*	*	*	*		N	N	N	N	P	N	N	N	
Dusky grouper	*Epinephelus marginatus*	*			P	N					O			
Bumphead parrotfish	*Bolbometopon muricatum*	*				N	N	N	N	P	N	N	N	N
Captain fine grouper	*Epinephelus albomarginatus*	*		*	P	?								
Gabriella's grouper	*Epinephelus gabriellae*	*												N
Brindle bass	*Epinephelus lanceolatus*	*		*	F	F	N	N	N	P	N	N	N	N
Spotted coral trout	*Plectropomus areolatus*	*								P		N		N
Black-saddled grouper	*Plectropomus laevis*	*				N	N	N	N	P	N	N	N	
Big eye tuna	*Thunnus obesus*	*			N	N	N	N	N	N	N	N	N	N
Natal wrasse	*Anchichoerops natalensis*			*	F	N								
Potato bass	*Epinephelus tukula*			*	F	F	N	N	N	N	N	N	N	N
Seventyfour	*Polysteganus undulosus*			*	F	F								

2. Information contributed by Component 5 national focal points.

CITES: CONVENTION IN TRADE OF ENDANGERED SPECIES

This convention is designed to monitor and manage the trade in endangered species. Species are allocated to lists based on their threatened status. Appendix I lists those that are severely under threat and may not be traded whereas Appendix II limits and controls trade for the listed species. While a number of marine fish species are listed, only two are relevant to SWIOFP: *Cheilinus undulatus* (Appendix II) and *Latimeria chalumnae* (Appendix I).

NATIONAL SPECIES CONSERVATION LISTS

In addition to the *red-flagged* species, individual SWIOFP countries have also identified species in their ichthyofauna that require special protection. While some of these species are endemic and may apply to one country only, others are transboundary and shared by more than one country. An amalgamated list of such specially protected species is given in Table 5, thus a reflection of fish species considered to be threatened and in need of special protection. In some cases species are partially protected by marine protected areas while in others they are fully protected and may not be landed at all. The table reflects that aside from the coelacanth there is considerable room for improved regional collaboration in the protection of red-flagged non-elasmobranch fishes. In most cases the red-flagged species are not even listed in national management regulations.

Fisheries that harvest listed species

There are a number of fisheries that may target some of the red-flagged species. In many cases this is an incidental catch but in some cases the red-flagged species represent a specific target. Potentially, several sources of information could indicate whether such red-flagged species are taken and at risk in the WIO. These range from formal international databases to scientific studies.

FAO RECORDS

Each year countries of the WIO submit their catch statistics to the FAO in Rome. These records are assembled into a database which provides insight into the region's fisheries landings by species, group, country and region. Several of the red-flagged species are taken in large numbers and hence reflected in the FAO fisheries landings data for the WIO (area 51).

The fact that no more vulnerable species are reported to the FAO data does not mean that *red-flagged* species are not caught. For example, several species of *Epinephelus* are *red-flagged*, but these have not been identified to species level and are reported as Serranidae or *Epinephelus* spp, the latter accounting for about 35,500 mt in the WIO in 2012. The

Table 6. Landings of red-flagged species declared to FAO in 2009 comparing WIO to global.

Species	Capture per region (t)		Reporting nations (WIO)
	Global	WIO = Area 51	
Argyrosomus hololepidotus	18,055	14	South Africa
Argyrosomus regius	7,284	0	n/a
Argyrozona argyrozona	371	0	n/a
Bolbometopon muricatum	150	150	Saudi Arabia
Cephalopholis hemistiktos	250	250	Saudi Arabia
Cheilinus undulatus	984	0	n/a
Epinephelus coioides	8,152	8,152	Iran, UAE
Epinephelus fuscoguttatus	50	50	Saudi Arabia
Epinephelus marginatus	1,157	0	n/a
Epinephelus polylepis	470	470	Bahrain, Saudi Arabia
Lophius vomerinus	6,786	0	n/a
Makaira nigricans	38,446	6,896	16 nations
Petrus rupestris	2	0	n/a
Plectropomus areolatus	410	410	Saudi Arabia
Plectropomus leopardus	20,699	0	n/a
Plectropomus pessuliferus	340	340	Saudi Arabia
Thunnus alalunga	256,082	15,355	21 nations
Thunnus albacares	1,352,204	295,405	28 nations
Thunnus maccoyii	9,243	1,251	6 nations
Thunnus obesus	450,546	71,573	23 nations

reporting of *A. hololepidotus* is a specific issue of confusion. *A. hololepidotus* is endemic to the southeast coast of Madagascar (Griffiths & Heemstra 1995) and known to be severely restricted and declining. Those listed as *A. hololepidotus* from elsewhere are either *A. japonicus* or other *Argyrosomus* species.

Blacksaddle grouper, *Plectropomus laevis*. Photo: Dennis King

WIOFISH DATABASE

WIOFish was first conceived in 2000 as part of an IUCN initiative under the Jakarta Mandate of the CBD. It was noted that despite the importance of the WIO as a region of great marine biodiversity and as an essential source of food security for millions of people, very few of the region's fisheries had been formally identified and described, especially the small-scale fisheries. In response it was decided to identify and document all fisheries of the region focussing on small-scale and artisanal fisheries. WIOFish has evolved into a viable information system with the following primary objectives:

- to identify and describe each unique fishery type found in the WIO coastal regions and to capture such information into a freely accessible database of annotated fishery profiles for all fisheries of the region;
- to annually update this information and to facilitate public web-based access to the data through an interactive web-based system that allows for comprehensive access and a wide range of reporting routines;
- to report annually on the "status" of the fisheries, including risk profiles and management needs, via a semi-quantitative scoring system;
- to foster development of small-scale fisheries co-management systems through the sharing of information and access to common information sources;
- to use WIOFish as a mechanism to maintain a permanent regional partnership between national fishery nodes in the main WIO countries.

WIOFish is a partner programme involving most of the SWIOFP member states. While the WIOFish database is not a statistical fisheries database, it is a repository for as much descriptive information as possible about each fishery that is currently operating or has operated in the western Indian Ocean. This includes information related to threatened species. By 2012, a total of 260 fisheries had been documented reflecting fisheries in Comoros, Seychelles, Kenya, Tanzania, Mozambique, South Africa, Mauritius and Madagascar. Analysis of the WIOFish database indicates that 108 species considered as domestically threatened were taken in 40 different fisheries. These included elasmobranchs (16), sea turtles (5), marine mammals (6), sea cucumber (13), molluscs (19), prawn (8), lobster (5), corals (2), crab (1) and 33 species of teleost fish, inclusive of the coelacanth. These species are thus in addition to the Red List *flagged* species as reflected in Table 7.

Table 7: Species listed as threatened by WIOFish countries in addition to those red-flagged by IUCN.

Scientific Name	*English Name*	*Fishery Name*	*Area*
Acanthopagrus berda	Goldsilk seabream, Picnic seabream	Hook & line, shore, estuarine (rec)	South Africa
Atractoscion aequidens	Geelbek croaker	Hook & line, vessel, commercial	South Africa
Cephalopholis argus	Peacock hind	Diving, speargun, fish	Kenya
Cephalopholis boenak	Brownbarred rockcod	Diving, speargun, fish	Kenya
Cephalopholis leopardus	Leopard rockcod	Diving, speargun, fish	Kenya
Cephalopholis miniata	Coral hind	Diving, speargun, fish	Kenya
Cephalopholis sonnerati	Tomato hind	Diving, speargun, fish	Kenya
Cephalopholis taeniops	Bluespotted seabass	Diving, speargun, fish	Kenya
Cephalopholis urodeta	Duskyfin rockcod	Diving, speargun, fish	Kenya
Cetoscarus bicolor	Bicolour parrotfish	Diving, speargun, fish	Comoros
Chrysoblephus anglicus	Englishman seabream	Hook & line, small boat & motor, charter/party; Hook & line, vessel, commercial	South Africa
Ctenochaetus striatus	Striated surgeonfish	Diving, speargun, fish	Comoros
Epinephelus caeruleopunctatus	Whitespotted rockcod	Diving, speargun, fish	Kenya
Epinephelus coioides	Orange-spotted grouper	Diving, speargun, fish	Kenya
Epinephelus fasciatus	Blacktip grouper	Diving, speargun, fish	Kenya
Epinephelus fuscoguttatus	Blotchy rockcod	Diving, speargun, fish	Kenya
Epinephelus longispinis	Streakyspot rockcod	Diving, speargun, fish	Kenya
Epinephelus malabaricus	Malabar grouper	Diving, speargun, fish	Kenya
Epinephelus merra	Honeycomb grouper	Diving, speargun, fish	Kenya
Latimeria chalumnae	Coelacanth	Hook & line, handline, fish; Small nets, gill nets, sharks & rays	Comoros; Madagascar
Lichia amia	Leerfish	Hook & line, paddleski, fish	South Africa
Mulloidichthys flavolineatus	Yellowstripe goatfish	Other, dynamite, fish	Comoros
Parupeneus indicus	Indian goatfish	Other, dynamite, fish	Comoros
Pomadasys commersonnii	Smallspotted grunter	Hook & line, shore, estuarine (sub); Traps, staked, fish	South Africa
Pomatomus saltatrix	Bluefish	Small nets, cast net, fish/prawns	South Africa
Pterocaesio tile	Dark-banded fusilier	Other, dynamite, fish	Comoros
Rhabdosargus sarba	Goldlined seabream	Hook & line, shore, estuarine (sub); Traps, staked, fish	South Africa
Scarus ghobban	Yellowscale parrotfish	Diving, speargun, fish	Comoros
Scomberomorus commerson	Narrow-barred Spanish mackerel	Small nets, gill nets, sharks & rays	Madagascar
Siganus argenteus	Streamlined spinefoot	Small nets, gillnets & cast nets, fish & shrimps	Madagascar
Siganus stellatus	Brown-spotted spinefoot	Diving, speargun, fish	Comoros
Thunnus obesus	Bigeye tuna	Industrial nets, purse seine, tuna; Small nets, gill nets, sharks & rays	Madagascar
Umbrina ronchus	Slender baardman	Diving, speargun/no SCUBA, fish	South Africa

Specific fisheries' interactions

Certain fisheries are more prone to harvesting r*ed-flagged* species. Some are discussed.

TROPICAL ARTISANAL AND SEMI-INDUSTRIAL LINEFISHING

Linefishing in association with reefs often targets Serranidae and Labridae. This can include the capture of *red-flagged* species, especially *E. tukula, E. lanceolatus, E. albomarginatus, P. laevis, P. areolatus, C. undulatus* and *B. muricatum* as well as *L. chalumae*. These are all slow growing and *k*-selected species, rendering them vulnerable so that they seldom occur on reefs that are or have been intensely fished (Sadovy *et al*. 2013). However, on the more remote reefs these species may still be prevalent. For example, remote and inaccessible hotspots such as Bassas da India and other atolls and islands are refugia for such species. Occasional visits by fishers lead to the capture of such species (Figures), as shown in the images taken of a commercial linefish catch at Bassas da India some years ago (van der Elst *et al.* 2009). This presents a problem as such refugia may well represent an important source of spawning stock. Similarly, most of these *red-flagged* reef species were also recorded on Geyser Reef by Chabenet *et al.* (1996). Smith & Smith (1963) also reported the presence and capture of these species at several locations in the Seychelles while Polunin (1987) refers to a similar fish assemblage at Aldabra, especially *C. undulatus*. Visual observations by the author at Aldabra revealed a considerable number of *B. muricatum* (> 50) in the main Aldabra channel in 1995.

In some line fisheries that operate in deeper water, the capture of coelacanths has been reported. This is especially true of areas around volcanic islands with steep slopes and narrow shelf regions so that the fisheries operate in deep water.

Figure 2: Two vulnerable serranids *(P. laevis & P. areolatus)* taken by fishers at Bassas da India.

The best example is that of the Comoros where coelacanths are not infrequently caught. Coelacanths have also been reported from Mozambique and Kenya caught by trawler. In the late 1990s and early 2000s there was a sudden increase in coelacanth catches with reports from Tanzania, Zanzibar and Madagascar. In most of these cases the specimens were caught using hook and line, except for Tanzania where deep set gillnets were used (Ngatunga 2003; Nikaido 2011).

Figure 3: Coelacanths caught in Tanzania. (Photo: TAFIRI)

GILL NETTING

There are at least 15 different gill net fisheries in the WIO reported in WIOFish (WIOFish 2012). Many of these have the potential to capture *red-flagged* species. Most notable is the Seychelles gillnet fishery for humphead parrotfish *B. muricatum*. This is a local artisanal fishery without any obvious restrictions. The catch is sold fresh or frozen as a popular local food, although this fishery conflicts with diving tourists. Fishers involved are subsidised to the extent that they have fuel subsidies and social security benefits. Few of the other gill net fisheries report detailed catch information although a synopsis of these fisheries gives useful insight, as tabulated opposite (Table 8).

Table 8. List of WIO gill net fisheries with those that reported capture of red-flagged species to the WIOfish data.

Country	*Fishery*	*Critical*	*Vulnerable*	*Near threatened*
Comoros	Small nets, gill nets bottom, fish			
	Small nets, gill nets surface, fish			
	Small nets, gillnets – surrounding, fish			
Kenya	Small nets, bottom gill net, sharks/rays/fish			
	Small nets, gillnets, crustaceans			
	Small nets, surface gill net, sharks/rays/fish			*Thunnus albacares*
Madagascar	Small nets, gill nets, sharks & rays	*Latimeria chalumnae*	*Thunnus obesus*	*Epinephelus malabaricus, Thunnus alalunga, Thunnus albacares*
	Small nets, gillnets & cast nets, fish & shrimps			
	Small nets, gillnets surface, fish			
Mauritius	Small nets, gill net, Fish			
Mozambique	Small nets, bottom gillnet, artisanal			
	Small nets, gillnet, shrimp			
	Small nets, gillnet, small pelagic			
Seychelles	Small nets, bottom gill net, slipper lobster			
	Small nets, gill net, humphead parrot fish (Filanbaz)		*Bolbometopon muricatum*	
	Small nets, gill nets, sharks			
	Small nets, pelagic gill net, mackerel			
South Africa	Small nets, surface gill net, sharks			
Tanzania	Small and large mesh nets, bottom gill net			*Thunnus albacares*
	Small nets, surface (drift) gill net, pelagics			*Thunnus albacares*
	Small nets, surrounding net (Zuwio)			

SPORT AND TOURIST FISHERIES

Sport fishing and tourism are important economic drivers in the WIO region. While many sport fishers and tourist operators are increasingly adopting conservation approaches in their angling, there is a new trend towards accessing the more exotic and remote species. In some cases this leads to the targeting of *red-flagged* species and accessing remote biodiversity hotspots. Specific examples include fishing trips to Bassas da India, a French atoll located in the mid-Mozambique Channels. A web search lists a great many ventures to fish at this site and promotes the capture of *red-flagged* species. Similar ventures to the Seychelles' remote outer islands such as Farquahar and Mauritius' remote St Brandon are increasingly popular. In some cases these trips are reported on in fishing magazines, further promoting the catching of *red-flagged* fish, including *C. undulatus*, *B. muricatum, E. lanceolatus and E. tukula.* While in some cases the catch is released, this is not always true and threatened species may be taken without any management controls or reporting. These isolated hotpots are considered to be refugia of such *red-flagged* species and are thus especially important for their future survival (van der Elst & Chater 2009). Notwithstanding their remoteness, it is incumbent on the authorities to manage and protect these sites as envisaged under the French "Isles Eparses" programme.

AQUARIUM AND ORNAMENTAL SPECIMEN COLLECTIONS

There is a variable level of live fish collecting in the WIO for aquariums, both for private collectors as well as for public aquaria. While such fisheries and their associated trade can be quite lucrative, in most cases they are poorly controlled and monitored. Where records are kept, these pertain mostly to trade statistics referring to "mixed" species. However, it is clear that coral reef fishes predominate in these fisheries. Although industrial fisheries in the SWIO region do not target such species, the suggestion that aquarium collecting may represent an alternative livelihood to offset depleted industrial fisheries needs to be made with caution. In some cases specimens are taken as bycatch in trawl fisheries that have ornamental value. Examples include the puffers such as *Diodon hysterix* which are dried and inflated, at times made into lamp shades. Without a scientific basis such resources should not be targeted and developed as alternative sources of income. Public aquaria also make collections in the WIO region. Although the quantities may appear modest, rare species are more in demand. For example the pursuit of endangered sawfish (*Pristis* sp) should be prohibited. It is recommended that the Pan African Association of Zoos, Aquaria and Botanical Gardens (PAAZAB) be encouraged to take a lead in this regard.

Individual species profiled

While exploitation of marine species is known to be the dominant factor in causing declines in populations (Dulvy *et al*. 2003), certain life history traits can exacerbate species' vulnerability. Larger species that mature late and produce fewer offspring are more susceptible to population decline than species with high fecundity (Sadovy *et al*. 2013). Table 7 provides a synopsis of the main reference points that contribute to the species' vulnerability.

Relevance to SWIOFP

Clearly there are vulnerable and endangered species implicated in a number of SWIO fisheries. In some cases these represent a serious threat – such as the targeting of iconic species in remote locations where they may represent a remnant spawning stock. In most cases the capture of red-flagged species is not seen as a matter of concern by management agencies, except perhaps the coelacanth. Similarly, the capture of elasmobranchs is not generally viewed in the light of their red-flagged status. It is thus proposed that, under the joint auspices of the Nairobi Convention and the SWIOFC, a list of species is drawn up which reflects a collated red-flagged species list for the WIO and which countries are encouraged to report on capture and be managed accordingly.

Table 9: Key life history parameters for some species of concern including red-flagged species (primarily sourced from www.fishbase.org).

Name	Distribution	Habitat	Fisheries Impact	IUCN listing	Cites listing	L mat (cm)	L max (cm)	Mean pop doubling time in yrs	Vulnerability index
Latimeria chalumnae	IP	Deep reef ledges	Artisanal fisheries	CR	I	150	170-183	> 14	86/100
Cheilinus undulatus	IP	Reef associated	Live food & aquarium	EN A2bd+3bd	II	52?	229	4.5 - 14	74/100
Epinephelus marginatus	Atlantic; SWIO& Med	Reef associated	Linefish	EN A2d	n/a	47	150	4.5-14	72/100
Epinephelus tukula	IP	Reef associated	Linefish	LC	n/a	99	200	>14	71/100
Epinephelus lanceolatus	IP	Reefs & brackish lagoons	Linefish, aquarium	VU A2d	n/a	129	270	>14	74/100
Epinephelus albomarginatus	SWIO	Reef associated	Linefish	VU A2d	n/a	Unknown	100	4.5-14	50/100
Epinephelus areolatus	IP	Sea grass; reefs	Linefish Aquaculture	LC	n/a	23	47	1.4 - 4.4	36/100
Epinephelus gabriellae	NWIO	Rocky bottom	Artisanal	VU Blab(v)	n/a	Unknown	70	1.4 - 4.4	26/100
Plectropomus laevis	IP	Reef associated	Linefish	VU A2d+4d	n/a	60	125	>14	55/100
Polysteganus undulosus	SWIO	Reef associated	Linefish	n/a	n/a	33	100	1.4 - 4.4	45/100
Anchichoerops natalensis	SWIO	Reef edges	Linefish	LC	n/a	Unknown	75	4.5 - 14	45/100
Bolbometopon muricatum	IP	Reefs & lagoons	Linefish & aquarium	VU A2d	n/a	Unknown	130	4.5 - 14	67/100
Thunnus obesus	Pantropical	Oceanic	Industrial fisheries	VU A2bd	n/a	100-125	250	4.5 - 14	56/100
Thunnus maccoyii	Global	Oceanic	Industrial fisheries	CR A2bd	n/a	120-130	245	4.5 - 14	67/100
Argyrosomus hololepidotus	Endemic to Madagascar	Estuarine & offshore	Diverse fisheries	EN B1ab+2ab	n/a	Unknown	200	>14	77/100

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