Chapter 36 Indian Ocean

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1. Introduction

The Indian Ocean is the third largest ocean in the world, mostly surrounded by a rim of developing countries and island States, one of which is the fourth largest island in the world, Madagascar. The Indian Ocean is bound by Asia to the north, by Africa to the west, Australia to the east and Antarctica to the south. It has two major seas, the Red Sea between the Arabian Peninsula and Africa, and the Arabian Sea to the west of India, and the largest bay, the Bay of Bengal, to the east of India. Following the FAO statistical fishing areas, the Indian Ocean is divided into two major parts: the Western Indian Ocean (WIO) and Eastern Indian Ocean (EIO) (FAO, 1-2015).

In terms of the oceanographic physical environment of the Indian Ocean, the major epi()36(-1(p)l)([(g)2(lo)-2(b)-4(al h)6(e)-1(at)-4(,)1(s)2(ali)10(n)-4(it)-4.1(y)4.1(a)10(n)-4(d)-4( )1

Figure 1. Map to show the epipelagic water masses and current patterns in the Indian Ocean in relation to other global circulations in the world oceans (Source: Pierrot-Bults and Angel 2013)

It is noted that:

(a) From a wide geographical perspective, most of the major ocean area is under sampled with regard to both coastal and oceanic environments. The oceanic areas are particularly unsampled and therefore the biological diversity is still incompletely described for most ecosystems;
(b) In terms of human scientific capacity, there is an extreme lack of taxonomists and therefore most of the species are still undescribed or are si1(p)efonc wi/4(u-(c)4(o)-2 -1(g)2y)4

(b) Threatened megafauna species, particularly: marine mammals, marine reptiles and seabirds, focusing on describing the status and trends including their associated drivers and general abundances and what dominant taxa groups exist;

(c) Description of phytoplankton production, zooplankton and benthos structures focusing on their abundance and diversity, including the drivers of change and possible effects of climate change; identifying hot spots for primary production in both coastal and deepa seas over various time and geographical scales and major influences of seasonality.

Table 1: Types and area cover of marine ecosystems in the Indian Ocean (Source: Wafar et al., 2011)

3. Fish Biodiversity

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3.1 Marine Finfish

The contribution of coastal and marine capture fisheries (finfish, shellfish and molluscs) from the Indian Ocean (average of 11.01 million tons annually) to the global landings is third after the Pacific Ocean (average of 48.3 million tons annually) and the Atlantic Ocean (average of 11.03 million tons annually) based on the 2003, 2011 and 2012 FAO estimates (FAO, 2014). This chapter describes the coastal and marine fisheries finfish

the need for monitoring stock status and trends. In the EIO alone, this category "marine fishes nei" makes up about 42 per cent of the catches (FAO, 2014). A group of small pelagic fish categorized as "clupeoids nei" also support high landings, as do sharks, rays and skates in the EIO. The decline in fish catches in the EIO, especially within Australia's exclusive economic zone, can be partly explained by a reduction in effort and catches following structural adjustment to reduce overcapacity and a ministerial direction in 2005 aimed at ceasing overfishing and allowing overfished stocks to rebuild (FAO, 2014).

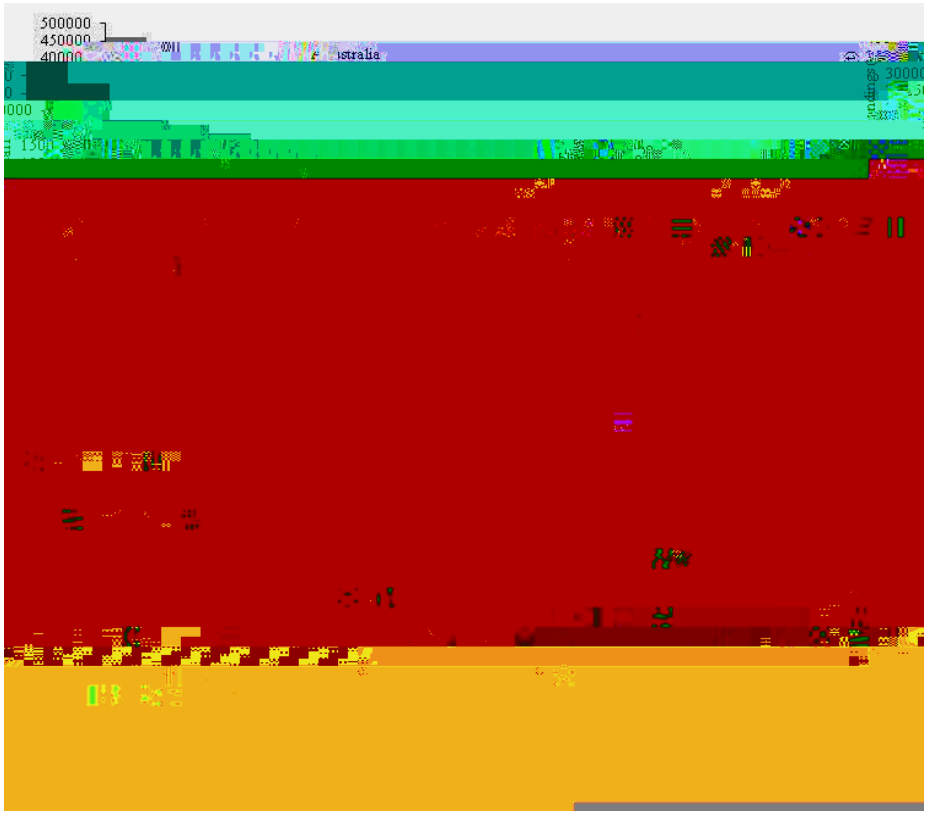

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Figure 4. Top twenty highest landed finfish species except tuna from the Eastern Indian Ocean based on total catches from 1950-2010 data in Australia and India (data source: Fishstat FAO Fishery and Aquaculture Global Statistics).

The WIO shows a similar scenario, in which the largest catches are made up of the category "marine fishes nei" followed by the small pelagic "Indian oil sardine", ponyfishes, and sharks, rays and skates. Total landings in the WIO reached a peak of 4.5 million tons in 2006, but then declined slightly, with 4.2 million tons in 2011 (FAO, 2014). A recent assessment has shown that the narrow-barred Spanish mackerel (Scomberomorus commerson) is overfished, and this species is among the most highly landed (FAO, 2014; Figure. 6) in the WIO. Long term catch data in the Indian Ocean, especially the WIO, are often not detailed enough for stock assessment and

species composition purposes, a situation aggravated by the lack of adequate resources to conduct scientific studies, monitoring and enforcement (McClanahan and Mangi, 2004). However, the Southwest Indian Ocean Fisheries Commission (SWIOFC) conducted stock assessments for 140 species in 2010 based on best available data and information

southern Kenya to northern Mozambique across to northeastern Madagascar and the Mascarene Islands and the Mozambique-South Africa border are areas with moderate to high fish diversity. The WIO fish fauna is one of the richest marine fish faunas in the world, with some 2,200 species or about 20 per cent of the world marine

(Figure 7). In this period, skipjacks, kawakawa and yellowfin tuna contributed the highest percent composition of 29 per cent, 24 per cent and 23 per cent respectively. The lowest percent composition was made up of albacore (0.4 per cent), like fishes nei (2 per cent), and bigeye tuna (4 per cent). The species frigate and bullet tunas, and southern bluefin tuna contributed intermediate percent composition of about 9 per cent each.

at large is declining spawning stock biomass and the possibility of recruitment overfishing.

3.3 Research gaps

There is a need to research the impacts of the target fish catches and fishing gear on non-target fish or bycatch, food chains cycles and overall on species biodiversity, especially focusing on various taxa over long-term periods in order to also account for climate change effects.

4. Plankton Diversity

The contribution of the Indian Ocean plankton data into the World Ocean Database (WOD) is still very minimal. Similarly, except for India and South Africa and to some extent Indonesia and Pakistan, very little research is undertaken by the countries of the Indian Ocean region. The national contribution of plankton data in the WOD09 by the countries bordering the Indian Ocean is less than 1.5 per cent Likewise, among the

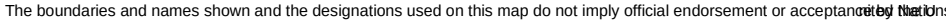

Figure 8. Boundaries for the 12 major oceanographic basins (Source: Gregg et al., 2003).

Figure 9. Differences between SeaWiFS (1997-2002) and CZCS (1979-1986) in the 12 major oceanographic basins. Differences are expressed as SeaWiFS - CZCS. Top left: Annual primary production

studies will remain fragmented and consequently the data and information will be difficult to use for comparative studies, or to provide baselines for documenting trends.

relationships into focus through ecosystem approach rather than dealing with single factors in isolation.

5.1 Research Gaps

- There is a lack of, or there are relatively few

- There is a need for monitoring marine litter disturbance of benthic habitats, especially intertidal zones due to dumpings of solid wastes.
- There is a need for undertaking long-term regional assessments of root causes or causal chain analyses of habitat loss and degradation to combat loss of biodiversity.

6. Megafauna

The megafauna, namely marine mammals (cetaceans and the sirenians), seabirds, and reptiles (sea turtles and sea snakes) may be described characteristically as large species with low fecundity and productivity, slow growth, and late age at maturity. Such biological characteristics have important implications for their sustainability in fisheries, especially as bycatch because they can sustain only very low rates of mortality. Moreover, they typically depend on a healthy, stable environment and generally have limited capacity to sustain and recover from depleted populations, such as result from heavy fishing pressure.

The megafauna in marine ecosystems play a significant role in the structure and functions of the ecosystems and in the economic sectors, especially in tourism. The representative groups in consideration are as follows: (a) marine mammals, (b) marine reptiles, and (c) seabirds. These groups have characteristic species whose lives are interconnected with maritime zones, coastal and shelf waters and deep sea oceanic habitats as grazers or primary consumers and predators or secondary consumers in the ecological food chain cycles. In these predator-prey relationships these megafauna groups play an important ecological role in regulation of marine biodiversity, species

6.4 Research Gaps on Sea Turtles

> There is a need to undertake research on bycatch intensity by taxa and gear ty
effective conservation management;

> Methods of assessment of bycatch should be standardized so that the dat
information can be comparable using GIS and reduce high variances espec
regional levels;

> There is a need for long-term multidisciplinary research study to understand t life
histories and ecology of the various species of turtles in the various regions, ho
they relate to seasonality and climate change;

> There is a need to deploy observers in industrial fishing vessels to collect all the es
information for management of bycatch;

> Nesting and feeding grounds at national and regional levels need to be mapped;

> The genetic connectivity of the various taxa groups needs to be known in order to
understand the nature of regional connectivity of the sea turtles.

6.5 Seabirds

Seabirds are characterized by their nature and behaviour to live partly in a terrestrial environment and partly in marine littoral, pelagic and oceanic habitats. Essentially they exploit the terrestrial environment for reproduction strategies and the benthic coastal marine and pelagic oceanic environment for foraging or feeding, playing the role of a fisher l

Antarctic and temperate regions that come wintering in the tropics, after travelling tens of thousands kilometres. Chapter 38 discusses the major global threats to seabirds, including bycatch mortality in fisheries, habitat degradation and loss, exploitation of their food supply, bioaccumulation of pollutants and toxins, and sea-level rise. Because the seabirds use the Indian Ocean for only part of their annual cycle, it is very difficult to distinguish the impacts of pressures in the Indian Ocean from other pressures on the same populations. Combined with the few targeted studies of seabirds in the Indian Ocean, particularly offshore, it is hard to evaluate status and trends of most

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