Depleted and Collapsed Marine Fish Stocks along Southwest Coast of India – A Simple Criterion to Assess the Status

K.S. Mohamed[1]*, T.V. Sathianandan[1], P.U. Zacharia[2], P.K. Asokan[3], P.K. Krishnakumar[4], K.P. Abdurahiman[4], Veena Shettigar[5] and R.N. Durgekar[1]

[1] Central Marine Fisheries Research Institute
P.O. Box 1603, Cochin 682 018, Kerala, India

[2] Research Centre of CMFRI
South Beach Road, Tuticorin 628 001, Tamilnadu, India

[3] Research Centre of CMFRI
P.O. West Hill, Kozhikode 673 005, Kerala, India

[4] King Fahd University of Petroleum and Minerals
P.B. No.: 1454, Dhahran 31261, Saudi Arabia

[5] Regional Centre of CMFRI
Ocean View layout, Visakhapatnam 530 003, Andhra Pradesh, India

**E-mail: ksmohamed@vsnl.com*

Introduction

India's marine fishery has grown from a subsistence level to an industrial one. From a meagre 0.6 million tonnes in 1950s it has crossed 3.0 million tonnes in 2008. Kerala, and to a lesser extent, Karnataka have been the major contributors to the marine fish production of the country (having 12% of the total coastline and contributing 30-35% of the production). Mechanization of the fishing fleets has focussed increased effort on the fish stocks in the region (southwest coast), and consequently, many stocks are not as abundant as they were before. The intense exploitation of commercial marine species along these coasts has reportedly led to threats of species loss. So far no comprehensive study has been made to assess the health of Indian marine fish stocks with respect to depletion and collapse, and therefore, no restoration or stock rebuilding plans are available. Most of the world's most valuable fish stocks are either fully exploited or overexploited (FAO, 2007). The 25% of the stocks that remain underexploited tend to comprise of low-value species.

The identification of depleted and collapsed fish stocks in the light of loss of biodiversity has been engaging the attention of marine fishery scientists all over the world. A criterion reported by Worm *et al*. (2006) is: *depletion* (>50% decline over baseline abundance); *collapse* (>90% decline) and *extinction* (100% decline). Abundance data are difficult to come by for tropical fish stocks, and even assuming that catch is proportional to abundance, would be grievous using the above percentages, as half the fish stocks in Kerala and Karnataka would have to be considered in depleted status. It is quite clear that in the absence of abundance data (as is the case of most tropical fisheries) new criteria would have to be developed for classification of fish stocks. It can be seen that, most tropical fish stocks, even if forming only a small percentage of the maximum catch in the present period are able to sustain the fisheries, mainly due to the high recruit turnover even with low spawning stock biomass (Devaraj *et al*., 1994; Mohamed and Rao, 1997).

The present study therefore, is aimed at determining those fish stocks from the southwest coast of India which can be considered as depleted and collapsed using a fairly robust and simple methodology. The ranking of the catches of depleted and collapsed species was then examined to derive long-term trends and to arrive at restoration plans.

Materials and Methods

For the analysis, primary records containing species-wise and gear-wise catch and effort of marine fish landings of Kerala and Karnataka maintained by the Central Marine Fisheries Research Institute (CMFRI) in NMLRDC (National Marine Living Resources Data Centre) was the principal data source (period 1970-2005 for Kerala and 1971-2005 for Karnataka). These data were collected by trained enumerators, who could identify fished organisms to the species level in most cases. The CMFRI estimates marine fish catch and effort data from all along the Indian coast based on a stratified multi-stage random sampling design (Srinath *et al*., 2005). In this design, the stratification is over space and time.

A second dataset used was catch records from the Madras Presidency Fishery Bulletin containing species-wise catch records of key species from Malabar Coast (Shirali in present Udupi District of Karnataka to Chavakkad in Thrissur district of Kerala) for the period 1932 to 1950 (18 years with some years missing).

Although abundance data is not available in the present study, it was assumed that catch is proportional to abundance, and the historical maximum catch during the 34/35 year period was taken as the baseline catch. This assumption reiterates that abundance would be close to the figure for maximum catch. For comparison, the recent average catch during 2003-05 (3 years) was compared to that of the baseline catch in percentage. Species identified as occurring rarely were not taken in this study and only those species occurring in more than 30 out of 35 years (i.e., forming a fishery) of the study period was selected. Deciding a cut-off percentage, though arbitrary, is necessary to classify the stocks. The decision on the cut-off percentage was based on the range of percentages seen and *a-priory* knowledge of the stock catch and abundance. Stocks were classified (Table 1) as abundant (recent average catches > 70% of the historical maximum); less abundant (50-69%); declining (11-49%); depleted (6-10%) and collapsed (< 5%).

Table 1: Criteria used for fish stock classification

Stock Classification	Recent average catch in historical maximum (%)
Abundant	> 70
Less abundant	50-69
Declining	11-49
Depleted	6-10
Collapsed	< 5

Once the depleted and collapsed species were identified, their ranking in the catches were examined for two species during the 1934-35 year period by using NMLRDC dataset and the Madras Presidency Fishery Bulletin dataset. Ranks provide a succinct assessment of the estimated viability (probability of persistence) of occurrences of a given species. They provide an estimation of the likelihood that, if current conditions prevail, a species occurrence will persist for a period of time. Hammerson *et al.* (2008) reported that elaborate or highly specific quantitative criteria are not required in order to rank species occurrences usefully for conservation purposes. In the present context a very simplified approach of quantitative ranking according to magnitude of catch was taken. Catch data are known to vary greatly with surveyor, methods, season, or other factors, and so the resulting data may not accurately reflect abundance, but is the closest estimate one can get under the given conditions.

Results and Discussion

Results showed that more than 57% of the fished taxa, both in Kerala and Karnataka, were species which occurred only between 1-10 times during the 1934-35 year period. The rarity of a species could be assessed by their frequency of occurrence during the period. Nearly 32% in Kerala and 22% in Karnataka were species that occurred only once during the 1934-35 year period. These were not taken for further analysis.

Catch data of a total of 19 species in Kerala and 22 species in Karnataka were analysed (Table 2 and 3). Nearly 37% of the species considered in Kerala were in healthy status (abundant or less abundant) and 47% were in declining status. In Kerala, the whitefish, *Lactarius lactarius* and the silver pomfret, *Pampus argenteus* were identified as depleted stocks as their recent average catch levels were between 10 and 6% of the historical maximum and *Arius* sp. was identified as a collapsed stock as its recent average catch level was only 0.7% (below 5%) of the long-term maximum catch (Table 2).

Table 2: Recent average catch during 2003-2005 of different species as percentage of the historical maximum catch (baseline catch) during 1970-2002 in Kerala

Species/ Stock	Historical maximum catch (t)	Recent 3-year average catch (t)	% of maximum catch	Stock status
Scomberomorus commerson	8126	8167	100.50	Abundant
Sardinella longiceps	241411	235958	97.74	Abundant
Saurida sp.	14126	10841	76.75	Abundant
Cynoglossus sp.	27301	18759	68.71	Less abundant
Auxis spp.	9601	5670	59.05	Less abundant
Nemipterus sp.	55078	31396	57.00	Less abundant
Sphyraena sp.	9781	4335	44.32	Declining
Trichiurus sp.	31775	13242	41.67	Declining
Euthynnus affinis	25082	10053	40.08	Declining
Stolephorus sp.	55042	21217	38.55	Declining
Rastrelliger kanagurta	128411	46512	36.22	Declining
Chirocentrus dorab	1685	587	34.84	Declining
Hemiramphus sp.	3574	1152	32.22	Declining
Leiognathus sp.	18392	5014	27.26	Declining
Carcharhinus sp.	10338	2447	23.67	Declining
Lactarius lactarius	6663	481	7.22	Depleted
Pampus argenteus	2305	122	5.31	Depleted
Arius sp.	33526	234	0.70	Collapsed

Table 3: Recent average catch during 2003-2005 of different species as percentage of the historical maximum catch (baseline catch) during 1970-2002 in Karnataka

Species/ Stock	Historical maximum catch (t)	Recent 3-year average catch (t)	% of maximum catch	Stock status
Sepia sp.	4619	5958	128.99	Abundant
Trichiurus sp.	11906	10882	91.40	Abundant
Nemipterus sp.	24933	18321	73.48	Abundant
Uroteuthis duvauceli	8220	5859	71.28	Abundant
Sardinella longiceps	65614	44236	67.42	Less abundant
Hemiramphus sp.	349	220	63.04	Less abundant
Sphyraena sp.	2002	1228	61.34	Less abundant
Caranx sp.	29668	14081	47.46	Declining
Leiognathus sp.	11563	4735	40.95	Declining
Cynoglossus sp.	18153	7163	39.46	Declining
Mugil cephalus	295	84	28.33	Declining
Oratosquilla nepa	45159	12631	27.97	Declining
Lactarius lactarius	2930	756	25.80	Declining
Chirocentrus sp.	784	177	22.58	Declining
Rastrelliger kanagurta	101790	20000	19.65	Declining
Carcharhinus sp.	4711	775	16.45	Declining
Stolephorus sp.	18718	2766	14.78	Declining
Pampus argenteus	1077	126	11.70	Declining
Metapenaeus dobsoni	27633	2862	10.36	Declining
Metapenaeus monoceros	15793	1235	7.82	Depleted
Arius sp.	10253	293	2.86	Collapsed
Upeneus sp.	936	0	0.00	Collapsed

In Karnataka, 32% of the stocks studied were in healthy status and 55% were in declining status (Table 3). The brown shrimp *Metapenaeus monoceros* was identified as a depleted stock. The Kiddi shrimp *Metapenaeus dobsoni* and *Pampus argenteus* were also close to this status (10.36 and 11.7% respectively). The catfish *Arius* sp., whose recent average catch was only 2.86% of the maximum, was classified as a collapsed stock. In the case of the goat fish *Upeneus* sp., the recent average catch was nil, pointing to an almost extinct status. However, considering that this species is still being caught from Kerala waters, it was classified as a collapsed stock.

The catfishes were classified as a collapsed fish stock in both Kerala and Karnataka. This large teleostean fish is exceptionally slow-growing and has low fecundity (Devaraj and Vivekanandan, 1999). To compensate for low fecundity, the male catfishes incubate the eggs in their mouth (mouth brooder). However, when schools of catfishes were caught by purse seines and ring seines, the males spit out the large eggs in order

to save them, but, because of the small mesh size of the seines, they were also caught. Silas *et al*. (1980) estimated the total number of eggs destroyed by Mangalore purse seiners in one month as 25 million. Raje and Vivekanandan (2008) also reported that males are more vulnerable to fishing resulting in disproportionate sex ratios in the population. Although catfishes have been exploited for ages from the southwest coast of India, it is most likely that the advent of large scale exploitation of eggs by seines has driven the stock to a collapsed status. In the past (during the nineteen thirties and forties), catfish was one of the major species caught along Malabar Coast (Fig. 1). In species ranking it occupied ranks in the first 10 in the 1930s and 1940s (number one ranked fish in 1937), but showed a trend of decreasing ranking towards 1950s. After the start of seining of fish and eggs, the ranking has slipped to below 100 in Kerala and near 100 in Karnataka (Fig. 2). The Government of Karnataka was repeatedly advised (1989-92) by CMFRI regarding the negative impact of purse seining of catfish stocks particularly with regard to recruitment overfishing (Menon, 2003).

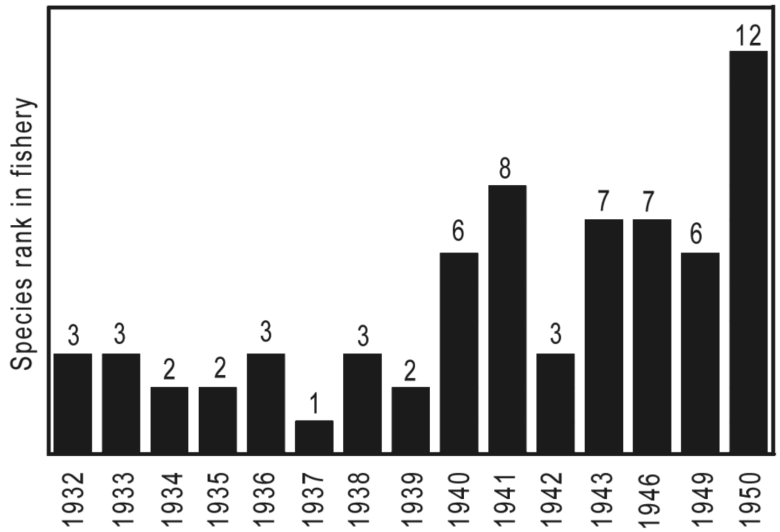

Fig. 1. Rank of catfish in the fishery of Malabar during 1932-1950

The silver pomfret stock was depleted in Kerala and close to depletion in Karnataka. A fish which is in high demand locally and internationally, its relative abundance in the southwest coast ecosystem has never been as high as seen along the northwest coast of India. Primarily a zooplankton feeder (Abdurahiman *et al*., 2006) not facing any limitation for food, it has probably reached the current status due to excessive fishing

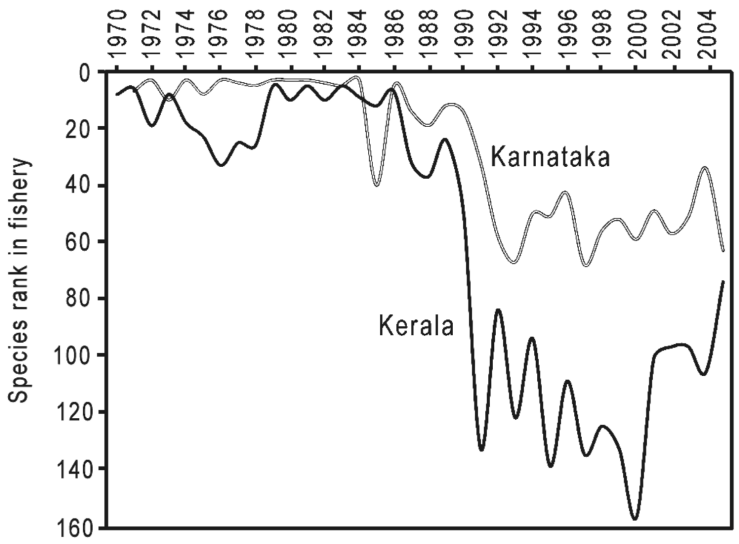

Fig. 2. Rank of catfish in the fishery of Kerala and Karnataka during 1970-2005

pressure and use of small (below legal limits) codend mesh in trawls. Another demersal fish in a similar situation is the whitefish *L. lactarius*. Its stock status is depleted in Kerala and declining in Karnataka. The whitefish is a carnivorous and highly fecund fish (Vivekanandan *et al*., 2003b). These authors report that the proportion of juveniles in the catch at Mangalore is as high as 23% and that the mean length of the fish has declined from 150 to 138 mm within a span of 6 years. Again, excessive trawl effort and use of small meshed trawls are probable reasons for its depleted and declining status. The species rank in the fishery has gone down steeply in Kerala, while it is fluctuating in Karnataka (Fig. 3).

In Karnataka the brown shrimp is depleted and the Kiddi shrimp is close to this status. Both these shrimps are a major component of the trawl fisheries of the state, and the decline in catches in recent times is disconcerting. While the latter is a target of the single day fleet (SDF) of trawlers, the former was the mainstay of the multi-day fleet (MDF) trawlers (Zacharia *et al*., 1996). It is quite clear that there has been excessive fishing pressure combined with excessive capture of juveniles (growth overfishing) which has resulted in this status.

The status of goatfish is enigmatic. A small-sized low value fish, dominant along the southeast coast, its catch from southwest coast amounts to only 23% of the all India catch. Mostly exploited by trawlers,

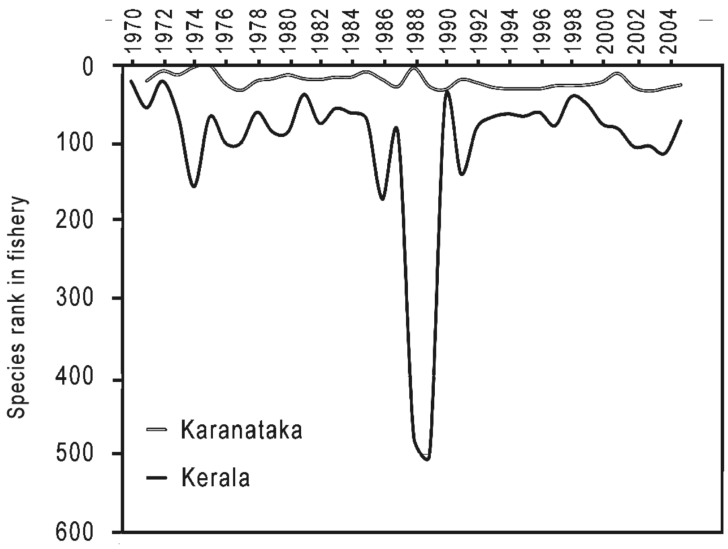

Fig. 3. Rank of whitefish *Lactarius lactarius* in the fishery of Kerala and Karnataka during 1970-2005

it is reported that juveniles form as much as 60% of the catch in some centres (Vivekanandan *et al*., 2003a). Here again, excessive trawl effort and use of small meshed cod-ends would have contributed to the collapsed status in Karnataka. Goatfishes are a highly resilient group with low vulnerability (Froese and Pauly, 2004), and therefore, its status may need reassessment, particularly because such a situation is not prevalent in Kerala.

It appears that for most small tropical short-lived species short-term fluctuations are not very significant, even if it is caused by excessive fishing pressure. With slackening of fishing pressure, optimum environmental conditions and lack of predatory pressure the situation is reversed very soon naturally. This fact has also been highlighted recently by Worm *et al.* (2006) when they stated after a global study that enhanced recovery is possible in areas with high diversity because fishers can switch more readily among target species, potentially providing overfished taxa with a chance to recover. The same reasoning may not hold good for relatively large tropical species such as the catfish (or also sharks), whose rankings have slipped from the first 5 to 160 in recent years particularly in Kerala.

The depleted and declining stocks (particularly those close to the threshold of depleted status) needs to be carefully monitored and its

conservation and rebuilding plans need to be made. The majority of the depleted and collapsed stocks are those species which are mainly caught in trawls. As a first step for rebuilding stocks, trawl effort has to be reduced in both Kerala and Karnataka. Strict implementation of the legal cod-end mesh sizes in trawls would particularly help in preventing growth overfishing and restoration of stocks. It is expected that small and short-lived species could recover fast. However in the case of large and long-lived species such as the catfish, it is nearly 20 years since the species has become depleted and collapsed. The catfish stocks appear to be improving in recent years (Fig. 2) with ranks climbing from 160 to 70, and care must be taken that recruitment overfishing is not allowed to happen again by restricting its capture during the breeding period by seiners.

We would like to place on record our sincere thanks to the Indian Council of Agricultural Research for granting us funding to execute a project on impact of fishing on biodiversity. We are also thankful to the Director, CMFRI for facilities and encouragement. We are grateful to all staff at Mangalore Research Centre of CMFRI and the Molluscan Fisheries Division, CMFRI, Cochin.

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