

Species specific fishery assessment for Croakers of the northeastern Arabian Sea

Sustainable marine fisheries resource harvest and management depend heavily on the sound scientific investigation of the stock status of the resources on a periodic basis. In the Indian context, given the sheer diversity of fishery resources tapped with numerous craft gear combinations, the task of evaluating the individual management units (or stock) is intrinsically challenging. The complexity increases manifold when several similar looking species of a fishery group are landed together, posing difficulties in enumerating species wise abundance data from the field observations. Croakers with a high α -diversity and overlapping distribution form a significant component of the high value marine fish landings in India. Around a dozen species on the north-west coast of India are contributing significantly to the commercial landings. Since these individual species vary considerably in their life history traits, abundances and distribution pattern, species specific assessment of the resource status is desirable. The trawl fishery of the region has experienced significant 'technology creep' in terms of gear modification as well as species targeted, especially during the last one and half decade. Hence, the species-specific information gaps needed to be identified and addressed scientifically with advisories for sustainable management of croaker fishery.

¹Rahangdale, S., Zacharia, P. U., Kumar, R. and Vase, V., 2022. Evaluating the stock status of 10 croaker species landed along the north-eastern Arabian Sea using the length-based Bayesian biomass approach. *Frontiers in Marine Science*, 9: 952759. doi: 10.3389/fmars.2022.952795.

The wide continental shelf along the northwest coast is especially abundant with croaker resources and accounts for more than half of the total croaker landings along the entire Indian coast. The several species of croakers landed along the coast can be classified into two broad biological groups, namely larger sciaenids ($L_{max} > 100$ cm) and smaller sciaenids ($L_{max} < 100$ cm). The coast has a long history of commercial exploitation of the croaker resources, primarily through the operation of bottom trawls. Recognizing the importance of sustainable management of croakers in the region, a number of species-specific population dynamics and stock assessments were conducted between 1990 and 2000, particularly along the Mumbai coast. Most of the






assessed stocks of lesser sciaenids during 1990-2000 were fully exploited or overexploited, warranting a reduction in fishing pressure. Since then, however, there has been a lack of species-specific stock assessments for the group, resulting in a gap in the scientific advisories needed for sustainable management.





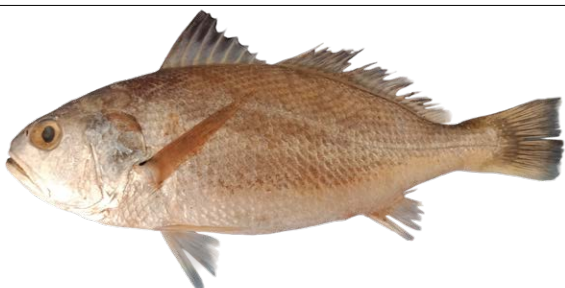
The recent catch trends in croaker catches of Gujarat showed a declining trend, especially in the last decade (2012-19) despite the increase in hours spent for fishing by trawlers (a major means to harvest croakers). The observation on time series catch and effort for croakers hinted at possible depletion in resource abundance along the coast. However, a parallel development in the trawling sector

with increasing use of pelagic or column trawling could result in a drastic reduction in effective fishing pressure on conventional demersal resources, such as croakers. The changing fisheries dynamics in the region necessitate a reassessment of the croaker fishery in the region.

To understand the implications of such dynamics, specific species stock assessment of lesser sciaenids landed along the Gujarat coast was taken up. As species-wise time series catch and effort data was not available, a length-based, species specific approach to stock assessment was adopted over catch based methods like CMSY and BSM (Froese *et al.*, 2017) in the study. The other factors, like seasonal fishery of some of the species, significant

Table 1. Details of stock status, life history traits, economic importance and management measures of the lesser sciaenid species landed along the Gujarat coast.

Species	Current stock status (Previous status)	Life history characteristics	Any other comments/(management advised, economic importance and any other unique traits)
 <i>P. semiluctuosa</i>	UE (NE)	$L_{\infty} = 46.4$ $M/K = 1.52$	Prefer shallow depth (< 30 m), used in fish meal, can be utilized for salt drying as landed in good quality, reduce landings of small sized specimens
 <i>A. alcocki</i>	UE (NE)	$L_{\infty} = 37.2$ $M/K = 1.76$	Deep water species, used in fish meal, poor quality at landings, can be used in salted form if landed fresh
 <i>O. ruber</i>	FE (NE)	$L_{\infty} = 51.2$ $M/K = 1.61$	Most preferred species among lesser sciaenids, surimi from smaller specimens, exported as silver croaker (whole frozen), maintain current level of fishing pressure
 <i>O. cuvieri</i>	FE (OE)	$L_{\infty} = 40.4$ $M/K = 1.52$	Domestic trade in salted form, surimi from smaller specimens, exported as silver croaker (whole frozen), maintain current level of fishing pressure
 <i>J. belangerii</i>	FE (NE)	$L_{\infty} = 28.4$ $M/K = 1.61$	Fish powder & surimi production, maintain current level of fishing pressure

Species	Current stock status (Previous status)	Life history characteristics	Any other comments/(management advised, economic importance and any other unique traits)
 <i>J. macrorhynchus</i>	FE (FE)	$L_{\infty} = 30.1$ $M/K = 1.42$	Fish powder & surimi production, exported as yellow croaker (whole frozen), maintain current level of fishing pressure
 <i>J. glaucus</i>	OE (OE)	$L_{\infty} = 34.2$ $M/K = 1.58$	Fish powder & surimi production, domestic trade in salted form, exported as yellow croaker (whole frozen), reduction in the fishing pressure recommended
 <i>J. dussumieri</i>	FE (OE)	$L_{\infty} = 27.6$ $M/K = 1.90$	Fish powder & surimi production, maintain current level of fishing pressure
 <i>J. borneensis</i>	FE (FE)	$L_{\infty} = 33.4$ $M/K = 1.57$	Fish powder & surimi production, domestic trade in salted form, exported as yellow croaker (whole frozen), maintain current level of fishing pressure
 <i>P. anea</i>	FE (FE)	$L_{\infty} = 28.0$ $M/K = 1.57$	surimi production, domestic trade in salted form, maintain current level of fishing pressure

UE: Under-exploited, FE: Fully exploited, OE: Over-exploited, NE: Not evaluated

evolution in the trawl fishery (rendering effort data in present form erroneous) and prevalence of COVID-19 during the study period (affecting the conventional month wise data collection) further led to the adoption of Length-Based Bayesian Biomass (LBB) estimation approach (Froese *et al.*, 2018). The length frequency (LF) data was collected over the period 2020-21 from the commercial trawlers only as trawl type selection was assumed in the model. The growth trajectory of the species was assumed following von Bertalanffy's growth curve and ten species of lesser sciaenids namely *Atrobucca alcocki* Talwar, 1980, *Otolithes cuvieri* Trewaves, 1974, *Otolithes ruber* (Bloch & Schneider, 1801), *Pennahia anea* (Bloch, 1793), *Paranibea semiluctuosa* (Cuvier, 1830), *Johnius dussumieri* (Cuvier, 1830), *Johnius belangerii* (Cuvier, 1830), *Johnius macrorhynchus* (Lal Mohan, 1976), *Johnius glaucus* (Day, 1876) and *Johnius borneensis* (Bleeker, 1851) having a significant share in commercial catches were assessed in the study. The B/B_0 , B/B_{MSY} , F/F_{MSY} , L_{mean}/L_{opt} , L_c/L_{opt} , and L_{95th}/L_{inf} were the outputs of the LBB of which, the B/B_{MSY} , F/F_{MSY} were used to group the resource in different status categories following Palomares *et al.* (2018).

Out of total 10 evaluated croaker stocks, four falls in the green quadrant of the conventional Kobe plot, one in yellow and three in the red quadrant. However, as per the classification of Palomares *et al.* (2018), only *J. glaucus* (red square) falls in the category of being overfished and hence the adoption of management strategies that ensure improvement in stock status is essential for the species. Five species classified as fully exploited requires close monitoring

and periodic assessment. Two species namely, *A. alcocki* and *P. semiluctuosa* were found under exploited.

Four species *viz.* *A. alcocki*, *P. semiluctuosa*, *J. belangerii* and *O. ruber* have been assessed for the first time from the region. Former two species were found underutilized as they are not the preferred species for direct human consumption because of their soft texture and black-tinged body. However, in recent times, they are landed in significant amount and consumed as raw materials in fish meal plants. The other two species form seasonal fishery in the region and are preferred species for human consumption, especially *O. ruber* which commands a good price in local markets. Despite the long existence of these resources in commercial fishery, they were not assessed earlier from the region. The current stock status of these two stocks is fully exploited.

Six species which have been earlier assessed from the region (1990-2000) were reassessed to visualize any change in the status during the last two decades. Four species: *J. borneensis*, *P. anea*, *J. macrorhynchus* and *J. glaucus* were found to retain their previously assessed status. However, two stocks, *J. dussumieri* and *O. cuvieri* have registered improvement in the stock status (Table 1). The improving stock status of the resources reflects a reduction in fishing pressure on this resource, which can be explained by the diversification of the major proportion of trawl effort towards pelagic and column trawling.

Length-based indicators like L_{mean}/L_{opt} and L_{95th}/L_{inf} , estimated by LBB, highlights the truncated length structure if present. The ideal value of these indicators is unity and value

lower than 0.90 (threshold value) shows truncated length structure, an unhealthy sign for the fishery. The higher incidence of sub-optimal size individuals was only observed for *P. semiluctuosa*. The sufficient number of larger individuals in the population is known to provide resilience to the fishery, a lack of which is evident in *O. cuvieri*, *O. ruber* and *J. belangerii*.

Conclusion

Most of the resources were found either fully exploited or under exploited, which is a good sign for the croaker fishery of the region. However, for most of the resources estimated stock indices were close to the centroid of the Kobe plot and hence a higher level of volatility with regard to stock status. Hence, close monitoring and periodic assessments for these resources should be in place. None of the resource showed further depletion from the previous assessment done almost two decades ago, despite an increase in fishing intensity. Rather, two stocks showed improvement in the status, which can be attributed to the release in effective fishing pressure due to diversification of trawl effort. Hence the need for periodic species specific stock assessment approach in the context of highly dynamic fisheries like the above mentioned croaker fishery, is highlighted.

References

- Froese, R., *et al.* 2017. *Fish. Fish.* 18(3): 506-526. doi: 10.1111/faf.12190.
- Froese, R., *et al.* 2018. *ICES J. Mar. Sci.* 75(6): 2004-2015. doi: 10.1093/icesjms/tsy078.
- Palomares *et al.* 2018. A preliminary global assessment of the status of exploited marine fish and invertebrate population. The University of British Columbia.