Ichthyofaunal diversity and fishery status of Sutrapada Coast, Gujarat, India

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Abstract
Gujarat being a state having largest coastline and highest continental shelf in India represents diverse coastal habitats. Gujarat has vast potential of marine bioresources and offer considerable scope for marine fisheries. The ichthyofaunal diversity of Sutrapada, Gir Somnath district, Gujarat was investigated for a period of three years from June 2015 to June 2018 through the analysis of fish catch data of trawl fisheries and achieved of Fisheries Department, Central Institute of Fisheries Technology - Central Marine Fisheries Research Institute (CIFT-CMFRI), Marine Products Export Development Authority (MPEDA) and Commissioner Fisheries Office, Veraval. During this study period, 114 fish species belonging to 55 families and 93 genera were identified. The paper emphasizes the importance of further research on respective families for understanding of its distribution, ecology and conservation status.

Keywords: Diversity; Sutrapada; fish; species composition

1 | INTRODUCTION
Fishes are the largest group of vertebrates, which exhibit a remarkable diversity of morphological attributes and biological adaptations. Species identification is challenging for taxonomists (Zhang and Hanner 2011) when facing new biota. Globally, ichthyofaunal diversity comprises approximately half of the total members of the subphylum Vertebrata with 35588 valid fish species (Fricke et al. 2020). In India, ichthyofauna from the fresh and marine waters account for 9.7 percent of the global population, among which the marine fishes alone account for 7.4 percent (Eschmeyer and Fong 2014). Day (1899a, 1899b) reported 1418 species of fish belonging to 342 genera from British India whereas 2546 species of ichthyofauna from 969 genera, 254 families and 40 orders were described by Talwar (1991). Recent findings have increased number of valid fish species in India with an estimation of 3231 species of freshwater, brackish water and marine species (Gopi and Mishra 2015). Out of the total fish diversity, marine water supports 2443 species whereas freshwater supports 675 species (Gopi and Mishra 2015) and brackish water comprises approximately 113 species (Sarkar et al. 2012). Fishes are a major source of human diet (Sarwade and Khillare 2010; Galib et al. 2013) as well as of oil, fertilizer and feed for domestic animals.

The state of Gujarat coastline is about 20% of Indian coastline, 33% of the continental shelf area (164000 square km) and over 200000 square km of Exclusive Economic Zone (EEZ) and ranks first among India’s nine maritime states in marine fish production (Mohranraj et al. 2012). Fishes are the largest group of vertebrates, which exhibit a remarkable diversity of morphological attributes and biological adaptations. Species identification is challenging for taxonomists (Zhang and Hanner 2011) when facing new biota. Globally, ichthyofaunal diversity comprises approximately half of the total members of the subphylum Vertebrata with 35588 valid fish species (Fricke et al. 2020). In India, ichthyofauna from the fresh and marine waters account for 9.7 percent of the global population, among which the marine fishes alone account for 7.4 percent (Eschmeyer and Fong 2014). Day (1899a, 1899b) reported 1418 species of fish belonging to 342 genera from British India whereas 2546 species of ichthyofauna from 969 genera, 254 families and 40 orders were described by Talwar (1991). Recent findings have increased number of valid fish species in India with an estimation of 3231 species of freshwater, brackish water and marine species (Gopi and Mishra 2015). Out of the total fish diversity, marine water supports 2443 species whereas freshwater supports 675 species (Gopi and Mishra 2015) and brackish water comprises approximately 113 species (Sarkar et al. 2012). Fishes are a major source of human diet (Sarwade and Khillare 2010; Galib et al. 2013) as well as of oil, fertilizer and feed for domestic animals.

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Saurashtra Coast represents major portion of the Gujarat coastline, having 26 landing centers which is 78% of the total landings of the state (Balan et al. 1987). Saurashtra coastline – peninsula of Gujarat is having major fish landing centres such as Okha, Porbandar, Mangrol, Veraval, Sutrapada, Navabandar, Jafarabad etc. Gujarat is the leading state in marine fish production since 2012 (Frad, CMFRI 2018). In 2016, the total landing of the marine fishes was 0.77 metric tonnes, which constitutes around 21.32% to the total fish landings of India. In Gujarat state, Gir-Somnath district contributes maximum landings (0.34 lakh tonnes) which is approximately 44% of the total landings of Gujarat (Joshi et al. 2018). Sutrapada is the second major landing centre of the Gir-Somnath district, Gujarat. To date, there are no studies carried out on the diversity of the ichthyofauna from Sutrapada Coast but study of ichthyofauna and their status are essential for the sustainable management of the fishery (Galib 2015; Galib et al. 2009, 2016; Mohsin et al. 2009, 2013). In Sutrapada, the fishery constitutes primarily of pomfrets, seer fishes, croakers, hilsa and other clupeoids, catfish, ribbonfish, perches and silver bass. The aim of this study was to investigate the current ichthyofaunal diversity of Sutrapada. The study outcomes will be helpful in the management and conservation of the commercially and ecologically important fishes.

2 | METHODOLOGY

In Sutrapada village - bander, about 381 Out Boat Motors (OBM) gillnetters are being operated of which most are involved in fishing. These vessels are made up of Fibre Reinforced Plastics (FRP). In this study data were collected from 23 OBM gillnetters. Fishermen in the study area usually go for 3 to 5 days fishing trip but one day trip is also common. Multifilament and monofilament nylon nets operated by FRP canoes fitted with outboard machine were being used for fishing.

The fish specimens were collected with the help of professional fishermen from Sutrapada Coast (20°50’11.94”N, 70°28’52.48”E) from June 2015 to June 2019. The collection of the fishes was performed on a monthly basis during winter (November to February) and summer (March to June) seasons. In monsoon (July to October) season fishing activities are closed due to safety reasons thus, no collection was made during this period. After collection, on field photographs were taken and morphological characters were recorded. The meristic and morphometric characters of collected specimens were measured and used for identification of the species following standard process and literature (Day 1878; Jhingran 1983; Sarwade and Khillare 2010; Murugan and Namboothri 2012). Conservation categories of the fish species are based on Redlist database of International Union for Conservation of Nature and Natural Resources (IUCN 2021).

3 | RESULT AND DISCUSSION

The marine fishery recourses of Sutrapada consisted exclusively of capture fisheries. Many collected fishes are having economic importance and sold after collection in the local fish market (Sarwade and Khillare 2010). During this study period, 114 fish species belonging to two classes, 18 orders, 55 families and 93 genera were collected and identified (Table 1). The most dominant family found was Carangidae (n = 15 species) followed by Scombridae (n = 9), Sciaenidae (n = 6), Carcharhinidae (n = 4), Scombridae (n = 4), Ariidae (n = 4), Clupeidae (n = 3), Engraulidae (n = 3), Nemipteridae (n = 3) and rest families constituted of single or double species (Table 1).

<table>
<thead>
<tr>
<th>Class/Order/Family</th>
<th>Species</th>
<th>English name</th>
<th>Status</th>
</tr>
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<tbody>
<tr>
<td>Class: Elasmobranchii&lt;br&gt;Order: Carcharhiniformes</td>
<td>Carcharhinus limbatus (Müller &amp; Henle, 1839)</td>
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<td><strong>Torpedo sinuspersici</strong> Olfers, 1831</td>
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<td><strong>Chaetodon collare</strong> Bloch, 1787</td>
<td>Redtail butterflyfish</td>
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<td><strong>Pomacanthus annularis</strong> (Bloch, 1871)</td>
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<td><strong>Platx teira</strong> (Forsskål, 1775)</td>
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<td><strong>Decapterus macrosoma</strong> Bleeker 1851</td>
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<td><strong>Megalaspis cordyla</strong> (Linnaeus 1758)</td>
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<td><strong>Scomberoides commersonnianus</strong> Lacepède, 1801</td>
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<td><strong>Carax sexfasciatus</strong> Quoy &amp; Gaimard 1825</td>
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<td><strong>Echeneis naucrates</strong> Linnaeus, 1758</td>
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<td>Blotched croaker</td>
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<td><em>Otolithes cuvier</em> Trewavas 1974</td>
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<td><em>Johnius dussumieri</em> (Cuvier 1830)</td>
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<td><em>Otolithes ruber</em> (Bloch &amp; Schneider 1801)</td>
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<td><em>Protonibea diacanthus</em> (Lacepède 1802)</td>
<td>Blackspotted croaker/Ghol</td>
<td>LC</td>
</tr>
<tr>
<td>Scorpaenidae</td>
<td><em>Pterois miles</em> (Bennett, 1828)</td>
<td>Devil firefish</td>
<td>LC</td>
</tr>
<tr>
<td>Order: Pleuronectiformes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paralichthyidae</td>
<td><em>Pseudohombus arsius</em> (Hamilton 1822)</td>
<td>Large toothed flounder</td>
<td>LC</td>
</tr>
<tr>
<td>Psettodidae</td>
<td><em>Psettodes erumei</em> (Bloch &amp; Schneider 1801)</td>
<td>Indian halibut</td>
<td>DD</td>
</tr>
<tr>
<td>Order: Scombriformes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scombridae</td>
<td><em>Auxis rochei</em> (Risso, 1810)</td>
<td>Bullet tuna</td>
<td>LC</td>
</tr>
<tr>
<td></td>
<td><em>Euthynnus affinis</em> (Cantor 1849)</td>
<td>Little tuna</td>
<td>LC</td>
</tr>
<tr>
<td></td>
<td><em>Auxis thazard</em> (Lacepède 1800)</td>
<td>Frigate tuna</td>
<td>LC</td>
</tr>
<tr>
<td></td>
<td><em>Rastrelliger kanagura</em> (Cuvier 1816)</td>
<td>Indian mackerel</td>
<td>DD</td>
</tr>
<tr>
<td></td>
<td><em>Katsuwonus pelamis</em> (Linnaeus 1758)</td>
<td>Skipjack tuna</td>
<td>LC</td>
</tr>
<tr>
<td></td>
<td><em>Thunnus albacares</em> (Bonnaterre 1788)</td>
<td>Yellow fin tuna</td>
<td>NT</td>
</tr>
<tr>
<td></td>
<td><em>Thunnus tonggol</em> (Bleeker 1851)</td>
<td>Longtail tuna</td>
<td>DD</td>
</tr>
</tbody>
</table>
TABLE 1 Continued.

<table>
<thead>
<tr>
<th>Class/Order/Family</th>
<th>Species</th>
<th>English name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scombridae</td>
<td>Thunnus obesus (Lowe 1839)</td>
<td>Bigeye tuna</td>
<td>VU</td>
</tr>
<tr>
<td></td>
<td>Scomberomorus guttatus (Bloch &amp; Schneider 1801)</td>
<td>Indo-Pacific king mackerel</td>
<td>DD</td>
</tr>
<tr>
<td>Stromateidae</td>
<td>Pampus argenteus (Euphrasen, 1788)</td>
<td>Silver pomfret</td>
<td>VU</td>
</tr>
<tr>
<td></td>
<td>Pampus chinesis (Euphrasen 1788)</td>
<td>Chinese silver pomfret</td>
<td>DD</td>
</tr>
<tr>
<td>Trichiuridae</td>
<td>Trichiurus lepturus Linnaeus, 1758</td>
<td>Largehead hairtail fish</td>
<td>LC</td>
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<tr>
<td></td>
<td>Lepturacanthus savala (Cuvier 1829)</td>
<td>Savalai hairtail/Ribbon fish</td>
<td>DD</td>
</tr>
<tr>
<td>Order: Siluriformes</td>
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<tr>
<td>Ariidae</td>
<td>Picofo lis layardi (Günther, 1866)</td>
<td>Thinspine sea catfish</td>
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<tr>
<td></td>
<td>Picofo lis dussumieri (Valenciennes 1840)</td>
<td>Blacktip sea catfish</td>
<td>NE</td>
</tr>
<tr>
<td></td>
<td>Osteoneogeneous militaris (Linnaeus 1758)</td>
<td>Soldier catfish</td>
<td>DD</td>
</tr>
<tr>
<td></td>
<td>Netum a thalassina (Rüppell 1837)</td>
<td>Giant catfish</td>
<td>LC</td>
</tr>
<tr>
<td>Order: Syngnathiformes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mullidae</td>
<td>Upeneus molucensis (Bleeker, 1855)</td>
<td>Goldband goatfish</td>
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</tr>
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<td>Order: Tetraodontiformes</td>
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</tr>
<tr>
<td>Balistidae</td>
<td>Odun us niger (Rüppell, 1836)</td>
<td>Red-toothed triggerfish</td>
<td>NE</td>
</tr>
<tr>
<td></td>
<td>Abalistes stellaris (Bloch &amp; Schneider 1801)</td>
<td>Starry triggerfish</td>
<td>LC</td>
</tr>
<tr>
<td>Tetraodontidae</td>
<td>Takifugu oblongus (Bloch, 1786)</td>
<td>Lattice blasasop</td>
<td>LC</td>
</tr>
<tr>
<td>Triacanthidae</td>
<td>Triacanthus biaculeatus (Bloch, 1786)</td>
<td>Short-nosed tripodfish</td>
<td>NE</td>
</tr>
<tr>
<td></td>
<td>Pseudo triacanthus strigilifer (Cantor 1849)</td>
<td>Long-spined tripodfish</td>
<td>LC</td>
</tr>
</tbody>
</table>

Species of family Carangidae are of high commercial importance and also used as game fishes except Atropus atropos, Alepes kleinii and Scomberoides tol which are of less commercial importance. In the family Engraulidae, Colia mystus forms the subsistence fisheries whereas others species are of commercial value. Parascapta perima of Nemipteridae also forms subsistence fisheries. Within Scaenaedidae family, Otolithoides biauritus was of high commercial importance whereas Otolithes ruber was of minor commercial value; Roncador stearnsi was primarily used for game fishing. Sardinella maderensis of Clupeidae was highly exploited species in Gujarat. Out of all 114 species majority 71 were belonging to Least Concern (LC) category followed by Not evaluated (NE, n = 16), Data Deficient (DD, n = 15), Vulnerable (VU, n = 4), Near Threatened (NT, n = 4) and Endangered (EN, n = 2) categories (IUCN 2021). A total of 86 species were reported in a study on commercially important of marine finfish and shellfish of Okha, Dwarka district of Gujarat (Solanki et al. 2020). In another study (Joshi et al. 2018) 94 species were reported in Veraval of Gir-Somnath district. However, both studies have reported less number of species than the present study.

4 | CONCLUSIONS
The coast of Sutrapada supports rich ichthyofauna. This study confirmed presence of more species than other parts of Gujarat. Fishes are important, both commercially and ecologically, and therefore, the diversity of fishes needs to be conserved, valued and managed properly. The present study emphasizes on the proper management of the fishery and conservation aspects of the fishes at Sutrapada Coast.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHORS’ CONTRIBUTION
SKS primary survey, collection of specimens and identification. KJS review of the manuscript and helped with the identification. DMB specimens collection, photography and manuscript preparation. PCM research supervision and review of the manuscript.

DATA AVAILABILITY STATEMENT
The data supporting the findings of this study are available within the article [and/or] its supplementary materials.

REFERENCES
Day F (1878) The Fishes of India: being a natural history of fishes known to inhabit the seas and fresh waters of India, Burma and Ceylon. William Dawson and Sons Ltd., London. 778 pp.