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Original Article

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

Santosh Kumar Singh[1] • Kangkan Jyoti Sarma[2] • Dhaval M. Bhatt[1] • Pradeep C. Mankodi[1]

[1] *Division of Marine and Freshwater Biology, Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara – 390020, India*
[2] *Division of Fish and Fishery Biology, Department of Zoology, School of Biological Sciences, University of Science & Technology Meghalaya, Ri-Bhoi, Meghalaya-793101, India*

Correspondence
Santosh Kumar Singh; Division of Marine and Freshwater Biology, Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara – 390020, India
santosh123.14689@gmail.com

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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 achieves 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 (Mohanraj *et al.* 2009). 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 2 – 3 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), Synodontidae (*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 1 Fish species collected from Sutrapada Coast. Status of the species is based on IUCN (2021). EN, Endangered; DD, Data Deficient; LC, Least Concern; NE, Not Evaluated; NT, Near Threatened; VU, Vulnerable.

Class/ Order/ Family	Species	English name	Status
Class: Elasmobranchii			
Order: Carcharhiniformes			
Carcharhinidae	*Carcharhinus limbatus* (Müller & Henle, 1839)	Blacktip shark	VU
	Scoliodon laticaudus Müller & Henle 1838	Spadenose shark	NT
	Carcharhinus dussumieri (Müller & Henle 1839)	Whitecheek shark	EN
	Carcharhinus sorrah (Müller & Henle 1839)	Spot-tail shark	NT
Triakidae	*Mustelus mosis* Hemprich & Ehrenberg, 1899	Arabian smooth-hound	DD
Order: Myliobatiformes			
Dasyatidae	*Maculabatis gerrardi* (Gray, 1851)	Sharpnose stingray	VU
Order: Rhinopristiformes			
Rhinidae	*Rhynchobatus djiddensis* (Forsskål 1775)	Giant guitarfish	CR
Rhinobatidae	*Rhinobatos punctifer* Compagno & Randall, 1987	Spotted guitarfish	NT
Glaucostegidae	*Glaucostegus granulatus* (Cuvier 1829)	Granulated guitarfish	CR

TABLE 1 Continued.

Class/ Order/ Family	Species	English name	Status
Order: Torpediniformes			
Torpedinidae	*Torpedo fuscomaculata* Peters, 1855	Black-spotted torpedo	DD
	Torpedo sinuspersici Olfers, 1831	Variable torpedo ray	DD
Class: Actinopterigii			
Order: Acanthuriformes			
Acanthuridae	*Acanthurus mata* (Cuvier, 1829)	Elongate surgeonfish	NE
	Zebrasoma desjardinii (Bennett, 1836)	Indian sail-fin surgeonfish	LC
Chaetodontidae	*Chaetodon collare* Bloch, 1787	Redtail butterflyfish	LC
Pomacanthidae	*Pomacanthus annularis* (Bloch, 1787)	Bluering angelfish	LC
Ephippidae	*Platax teira* (Forsskål, 1775)	Longfin batfish	NE
Order: Anguilliformes			
Muraenesocidae	*Congresox talabonoides* (Bleeker 1853)	Indian pike conger	NE
	Muraenesox cinereus (Forsskål 1775)	Daggertooth pike conger	LC
Order: Aulopiformes			
Synodontidae	*Saurida tumbil* (Bloch, 1795)	Greater lizardfish	LC
	Saurida longimanus Norman 1939	Longfin lizardfish	LC
	Trachinocephalus myops (Forster, 1801)	Snakefish lizard fish	LC
	Harpadon nehereus (Hamilton 1822)	Bombay-duck	NT
Order: Beloniformes			
Belonidae	*Tylosurus crocodilus* (Péron & Lesueur 1821)	Hound needlefish	LC
	Strongylura strongyle (van Hasselt 1823)	Spottail needlefish	LC
Exocoetidae	*Parexocoetus brachypterus* (Richardson 1846)	Sailfin flyingfish	DD
	Hirundichthys coromandelensis (Hornell 1923)	Coromandel flyingfish	LC
Hemiramphidae	*Hemiramphus far* (Forsskål 1775)	Black-barred halfbeak	NE
Order: Carangiformes			
Carangidae	*Atropus atropos* (Bloch & Schneider, 1801)	Cleftbelly trevally	LC
	Decapterus russelli (Rüppell, 1830)	Indian scad	LC
	Decapterus macrosoma Bleeker 1851	Shortfin scad	LC
	Megalaspis cordyla (Linnaeus 1758)	Torpedo scad	LC
	Alectis indica (Rüppell, 1830)	Indian threadfish	LC
	Alepes kleinii (Bloch, 1793)	Razorbelly scad	LC
	Elagatis bipinnulata (Quoy & Gaimard, 1825)	Rainbow runner	LC
	Parastromateus niger (Bloch, 1795)	Black pomfret	LC
	Scomberoides tol (Cuvier, 1832)	Needlescaled queenfish	LC
	Scomberoides commersonnianus Lacepède, 1801	Talang queenfish	LC
	Alepes djedaba (Forsskål 1775)	Shrimp scad	LC
	Caranx sexfasciatus Quoy & Gaimard 1825	Bigeye trevally	LC
	Carangoides malabaricus (Bloch & Schneider 1801)	Malabar trevally	LC
	Carangoides coeruleopinnatus (Rüppell 1830)	Coastal trevally	LC
	Atule mate (Cuvier 1833)	Yellowtail scad	LC
Sphyraenidae	*Sphyraena jello* Cuvier 1829	Pickhandle barracuda	LC
	Sphyraena putnamae Jordan & Seale 1905	Sawtooth barracuda	DD
Polynemidae	*Eleutheronema tetradactylum* (Shaw 1804)	Fourfinger threadfin	EN
	Leptomelanosoma indicum (Shaw 1804)	Indian threadfin	LC
Istiophoridae	*Istiompax indica* (Cuvier 1832)	Black marlin	DD
	Istiophorus platypterus (Shaw 1792)	Indo-Pacific sailfish	LC
Coryphaenidae	*Coryphaena hippurus* Linnaeus, 1758	Common dolphinfish	LC
Echeneidae	*Echeneis naucrates* Linnaeus, 1758	Live sharksucker	LC
Menidae	*Mene maculata* (Bloch & Schneider, 1801)	Moonfish	NE
Polynemidae	*Leptomelanosoma indicum* (Shaw, 1804)	Indian threadfin	NE
Rachycentridae	*Rachycentron canadum* (Linnaeus, 1766)	Cobia	LC
Xiphiidae	*Xiphias gladius* Linnaeus 1758	Swordfish	LC

TABLE 1 Continued.

Class/ Order/ Family	Species	English name	Status
Order: Centrarchiformes			
Kyphosidae	*Kyphosus vaigiensis* (Quoy & Gaimard, 1825)	Brassy chub	LC
Terapontidae	*Terapon jarbua* (Forsskål, 1775)	Jarbua terapon	LC
Order: Clupeiformes			
Clupeidae	*Sardinella gibbosa* (Bleeker, 1849)	Goldstripe sardinella	LC
	Sardinella longiceps Valenciennes, 1847	Indian oil sardine	LC
	Tenualosa ilisha (Hamilton 1822)	Hilsa shad	LC
Chirocentridae	*Chirocentrus nudus* Swainson 1839	Whitefin wolf-herring	LC
	Chirocentrus dorab (Forsskål 1775)	Dorab wolf-herring	LC
Dussumieriidae	*Dussumieria acuta* Valenciennes, 1847	Rainbow sardine	LC
Engraulidae	*Thryssa setirostris* (Broussonet, 1782)	Longjaw thryssa	LC
	Thryssa dussumieri (Valenciennes, 1848)	Dussumier's thryssa	LC
	Thryssa malabarica (Bloch, 1795)	Malabar thryssa	DD
Pristigasteridae	*Ilisha megaloptera* (Swainson 1839)	Bigeye ilisha	LC
	Opisthopterus tardoore (Cuvier 1829)	Tardoore	LC
Order: Mugiliformes			
Mugilidae	*Mugil cephalus* Linnaeus, 1758	Grey mullet	LC
Order: Perciformes			
Haemulidae	*Pomadasys maculatus* (Bloch, 1793)	Saddle grunt	LC
	Pomadasys argenteus (Forsskål 1775)	Silver grunt	LC
Priacanthidae	*Priacanthus hamrur* (Forsskål, 1775)	Moontail bullseye	LC
Serranidae	*Cephalopholis sonnerati* (Valenciennes, 1828)	Tomato hind	LC
	Epinephelus diacanthus (Valenciennes, 1828)	Spinycheek grouper	LC
Sillaginidae	*Sillago sihama* (Forsskål, 1775)	Silver sillago	LC
Lethrinidae	*Lethrinus ornatus Valenciennes 1830*	Ornate emperor	LC
	Lethrinus nebulosus (Forsskål, 1775)	Spangled emperor	LC
Lutjanidae	*Lutjanus johnii* (Bloch, 1792)	John's snapper	LC
Sparidae	*Argyrops spinifer* (Forsskål, 1775)	King soldier bream	LC
Uranoscopidae	*Uranoscopus archionema* Regan, 1921	–	NE
Nemipteridae	*Nemipterus japonicus* (Bloch, 1791)	Japanese threadfin bream	NE
	Scolopsis vosmeri (Bloch, 1792)	Whitecheek monocle bream	NE
	Parascolopsis eriomma (Jordan & Richardson, 1909)	Swallowtail dwarf monocle bream	NE
Platycephalidae	*Platycephalus indicus* (Linnaeus, 1758)	Bartail flathead	DD
Sciaenidae	*Otolithoides biauritus* (Cantor, 1849)	Bronze croaker	NE
	Nibea maculata (Bloch & Schneider 1801)	Blotched croaker	NE
	Otolithes cuvieri Trewavas 1974	Lesser tigertooth croaker	LC
	Johnius dussumieri (Cuvier 1830)	Sin croaker/ Bearded croaker	LC
	Otolithes ruber (Bloch & Schneider 1801)	Tiger toothed croaker	LC
	Protonibea diacanthus (Lacepède 1802)	Blackspotted croaker/Ghol	LC
Scorpaenidae	*Pterois miles* (Bennett, 1828)	Devil firefish	LC
Order: Pleuronectiformes			
Paralichthyidae	*Pseudorhombus arsius* (Hamilton 1822)	Largetooth flounder	LC
Psettodidae	*Psettodes erumei* (Bloch & Schneider 1801)	Indian halibut	DD
Order: Scombriformes			
Scombridae	*Auxis rochei* (Risso, 1810)	Bullet tuna	LC
	Euthynnus affinis (Cantor 1849)	Little tuna	LC
	Auxis thazard (Lacepède 1800)	Frigate tuna	LC
	Rastrelliger kanagurta (Cuvier 1816)	Indian mackerel	DD
	Katsuwonus pelamis (Linnaeus 1758)	Skipjack tuna	LC
	Thunnus albacares (Bonnaterre 1788)	Yellow fin tuna	NT
	Thunnus tonggol (Bleeker 1851)	Longtail tuna	DD

TABLE 1 Continued.

Class/ Order/ Family	Species	English name	Status
Scombridae	*Thunnus obesus* (Lowe 1839)	Bigeye tuna	VU
	Scomberomorus guttatus (Bloch & Schneider 1801)	Indo-Pacific king mackerel	DD
Stromateidae	*Pampus argenteus* (Euphrasen, 1788)	Silver pomfret	VU
	Pampus chinensis (Euphrasen 1788)	Chinese silver pomfret	DD
Trichiuridae	*Trichiurus lepturus* Linnaeus, 1758	Largehead hairtail fish	LC
	Lepturacanthus savala (Cuvier 1829)	Savalai hairtail/Ribbon fish	DD
Order: Siluriformes			
Ariidae	*Plicofollis layardi* (Günther, 1866)	Thinspine sea catfish	NE
	Plicofollis dussumieri (Valenciennes 1840)	Blacktip sea catfish	NE
	Osteogeneiosus militaris (Linnaeus 1758)	Soldier catfish	DD
	Netuma thalassina (Rüppell 1837)	Giant catfish	LC
Order: Syngnathiformes			
Mullidae	*Upeneus moluccensis* (Bleeker, 1855)	Goldband goatfish	LC
Order: Tetraodontiformes			
Balistidae	*Odonus niger* (Rüppell, 1836)	Red-toothed triggerfish	NE
	Abalistes stellaris (Bloch & Schneider 1801)	Starry triggerfish	LC
Tetraodontidae	*Takifugu oblongus* (Bloch, 1786)	Lattice blaasop	LC
Triacanthidae	*Triacanthus biaculeatus* (Bloch, 1786)	Short-nosed tripodfish	NE
	Pseudotriacanthus strigilifer (Cantor 1849)	Long-spined tripodfish	LC

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, *Coilia mystus* forms the subsistence fisheries whereas others species are of commercial value. *Parascolopsis eriomma* of Nemipteridae also forms subsistence fisheries. Within Sciaenidae family, *Otolithoides biauritus* was of high commercial importance whereas *Otolithes ruber* was of minor commercial value; *Roncador stearnsii* 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.

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SK Singh https://orcid.org/0000-0002-4861-4242
KJ Sarma http://orcid.org/0000-0002-5073-2539
DM Bhatt https://orcid.org/0000-0003-2737-7951
PC Mankodi https://orcid.org/0000-0002-8454-1984