Chapter. 03:

RESULTS & Discussion:

3.1 Ichthyofaunal Diversity

3.2 Fishery Aspects at Sutrapada Coast

3.2.1 Fishing operation

3.2.2 Crafts and Gears used at Sutrapada fish landing center

3.2.2.1 Gill-net use at Sutrapada Coast

3.2.2.2 Crafts used at Sutrapada Coast

3.2.3 Catch composition and Landings of the ichthyofauna at Sutrapada coast

3.3 Demographic Survey

3.3.1 Sex ratio and Age-group

3.3.2 Literacy rate

3.3.3 Government Assistance

3.3.4 Residential Status

3.3.5 Basic Needs and Household Facilities

3. RESULT AND DISCUSSION:

3.1 *Ichthyofaunal Diversity at Sutrapada:*

Among the eight maritime states of India, Gujarat state has the longest coastline of about 1,650 km length (about 22% of Indian coastline) having about 210 marine fishing villages and the almost same amount of fish landing centers on the western coast of India. According to habitat structure, Gujarat's coastline is characterized by 28% sandy beach, 21% rocky coast, 29% mud-flats and 22% marshy coast. Gujarat is famous for its coastal biodiversity, which has been the topic for several studies (Singh, 2002; Misra and Kundu, 2005; Venkataraman and Wafar, 2005; Dave, 2011). Gujarat is also having many ports fish landing centers. Many well-known marine institutions have their centers in Gujarat, including Central Marine Fisheries Research Institute (CMFRI), Marine Products Export Development Authority (MPEDA), Central Institute of Fisheries Technology (CIFT) and Gujarat Fisheries Department. Gujarat is surrounded by sea from two sides and has three different water bodies sharing the boundaries, the Arabian Sea, the Gulf of Khambhat, and the Gulf of Kachchh. The environment and biodiversity of these water bodies varies.

The rich marine biodiversity consisting Gujarat state is having about 306 reported Ichthyofaunal species (Joshi et al., 2017). In which, Gujarat fishery presently dominated by fishes like ribbonfishes (*Trchiurus lepturus*), Bombay duck (*Harpodon nehereus*), croakers, carangids, threadfin breams, lizardfishes, tuna (*Euthynnus affinis*, *Thunnus tonggol*, *Katsuwonus pelamis*, *Thunnus albacores* and *Sarda orientalis*), seerfish, pomfrets, catfish, flatfishes and non-penaeid prawns (Joshi et al., 2017).Sutrapada being a second largest and developing fish landing center of Gir-Somnath district. It holds the 1/3rd diversity of the total diversity recorded from Gujarat. It requires focus on the diversity of the capture fishes for the conservation and fisheries management point of view (Figure.9). Fish diversity data will emphasize the further studies on the other biological aspects. Fisheries data is also required for the proper management of the fish production and local fishermen.

Figure.9: Schematic Representation of Fishing and Fisheries Activities Carried out at Sutrapada Coast Gujarat, India.

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. During this study period, 114 fish species belonging to two classes, 18 orders(Figure. 11;

Table. 1), 55 families and 93 genera were identified (Table 1). The most dominant family found was Carangidae (n = 15), 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. Species of family Carangidae is highly commercially and also use as game fish exception with species (*Atropus atropos, Alepes kleinii, Scomberoides tol)* are of lesscommercial value. In the family Engraulidae, *Coilia mystus* is the subsistence fisheries where as others species are of commercial value, followed by family Nemipteridae (*Parascolopsis eriomma)* which is subsistence fisheries, from family Sciaenidae species like *Otolithoides biauritus* is a commercial whereas *Otolithes ruber* is minor commercial and *Roncador stearnsii* is for game fishing. The exception among them is the species, *Sardinella maderensis* in the family Clupeidae which is highly commercially exploited in Gujarat. Out of all 114 species 71 are under Least Concern (LC), 16 Not evaluated (NE), 15 Data Deficient (DD), 04 Vulnerable (VU), 04 Near Threatened (NT) and 02 Endangered (EN) categories as per IUCN category list (IUCN, 2021; Figure. 10).

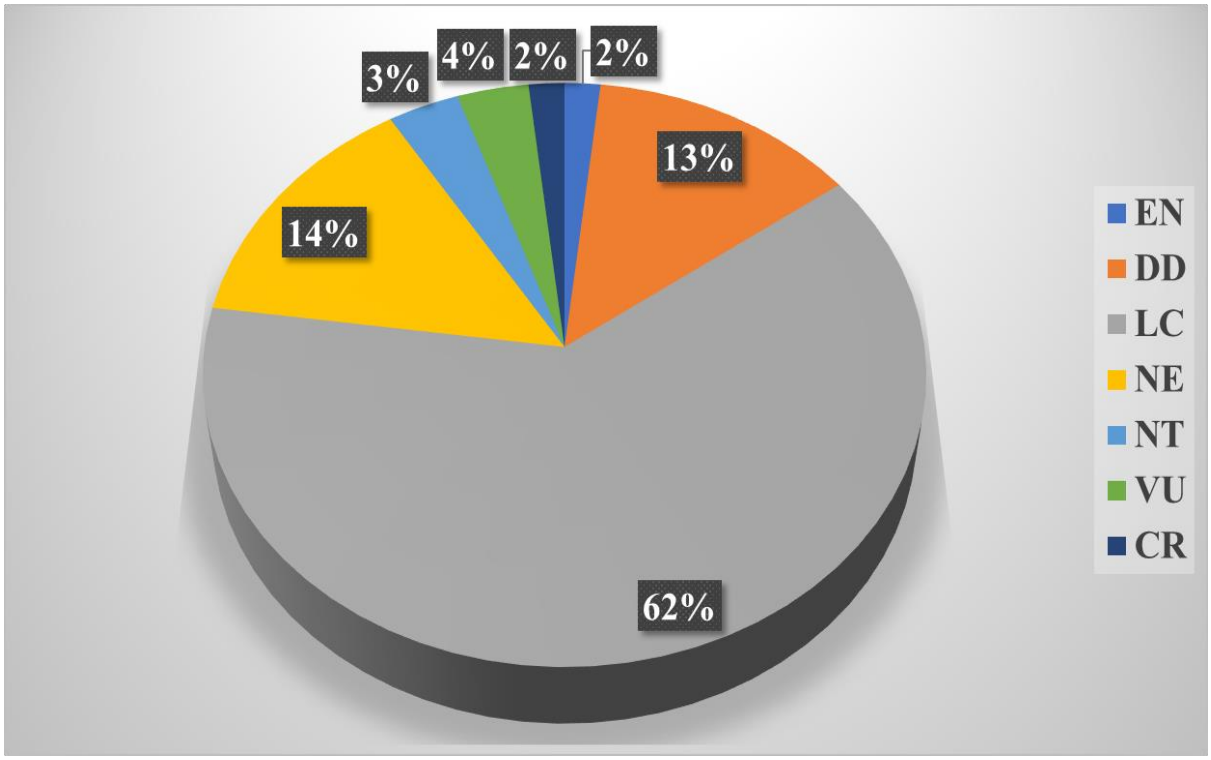

Figure.10: Fish Catch of Sutrapada related to IUCN Category.

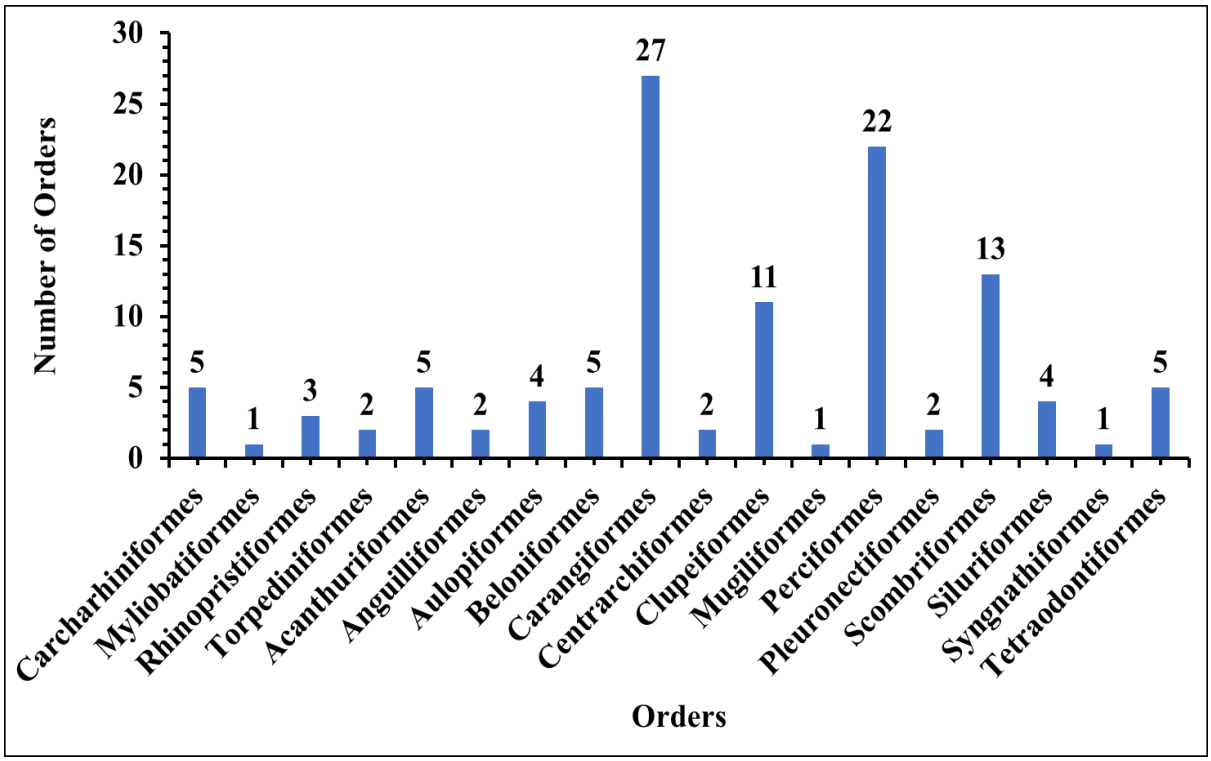

Figure.11: Order-wise Diversity of Ichthyofauna from Sutrapada Fish Landing Center, Gujarat

Solanki *et al.* (2020) carried out a study on commercially important of marine fin fish and shell fish along Okha (Dwarka district) fish landing center, Gujarat and reported 86 fin fishes belongs to 74 genera. Out of all the recorded species, Clupeids and Carangids were higher in numbers followed by Flounders, Shark, Lizard fishes, Croakers, Seer fishes, Pomfrets, Rays, Ribbon Fish, Thread Fins, Mackerels, Skates, Eels, Grunters & sweet lips, Reef cods, Cat fishes, Barracuda, Sole fishes, Flying fishes, Full beak and other fishes.

Another study was carried out by Joshi et al, (2018) from Veraval (Gir-Somnath district), reported 94 finfish and 26 shellfish species belonging to 62 families and 18 orders were identified from the Kharakuva Fish market of Veraval Taluka from Gir-Somanth district of Gujarat. There was total 52 families of finfish species were reported during the present study. Amongst them Carangidae contributes a greater number of finfish species (9 spp.), which was followed by Scombridae (7 spp.), Sciaenidae (6 spp.), Synodontidae (5 spp.), Clupeidae (4 spp.), Polynemidae, Carcharhinidae, Myliobatidae, Ariidae (3 spp. each), Stromateidae, Istiophoridae, Serranidae, Haemulidae, Sphyraenidae, Trichiuridae, Muraenesocidae, Hemiramphidae (2 spp.

each) and remaining 35 families reported one species each of observed fin fish diversity. The order wise observations of finfish represent Perciformes was the most abundant with 54.26%, which was further followed by Clupeiformes (8.51%), Carcharhiniformes (5.32%), Aulopiformes (5.32%), Pleuronectiformes (4.26%), Myliobatiformes (4.26%), Beloniformes (4.26%) and Tetraodontiformes (3.19%; Figure 2). The Kharakuvalocal fish market price study stated that the fish price varies between 20-1,500/-. The highest price fetched fishes in the market were Jew fish (Ghol), Silver pomfret, Chinese pomfret, Indian scad, Chinese herring, silver conger eel, Sharks, Ribbon fishes etc. The highly valued fishes mostly consumed fresh and remaining catch goes to the processing plants, from where after value addition and freezing those were exported to the other countries.

Katira and Kardani (2017), recorded ichthyofaunal diversity of Sikka coast represented total 112 species belonged to 12 orders, 50 different fish families and 84 genera. Order Perciformes represented highest number of families with 29 numbers of different families followed by Clupeiformes with 5 fish families; Pleuronectiformes with 3 families. Order Elopiformes, Siluriformes, Tetraodontiformes and Beloniformes contained 2 families of each. Order Carcharhiniformes, Myliobatiformes, Anguilliformes, Gonorhynchiformes and Scopaeniformes represented only one family of each. There was total 50 numbers of different families represented by 112 fish species from Sikka coast, Jamnagar. Family Carangidae contributed maximum with 11.6 percent of total ichthyofaunal biodiversity (13 species) followed by Clupeidae and Serranidae with 6.25 percent contribution of each (7 species); Haemulidae contributed 5 percent followed by Mugilidae, Sparidae and Tetraodontidae with 4 percent of each. Dasyatidae, Garreidae, Leiognathidae, Sciaenidae and Ariidae contributed 3 percent each and other families contribute 2 and 1 percent. Total 112 fish species recorded from Sikka coast belonged to 50 different families. Family Carangidae represented maximum 13 number of fish species followed by Serranidae and Clupeidae with 7 species of each; Haemulidae with 6 species; Sparidae and Mugilidae with 5 species of each; Tetraodontidae with 4 species; Ariidae, Sciaenidae, Dasyatidae, Garreidae and Leiognathidae with 3 species of each. Other families represented with 1 to 2 numbers of fish species.

Tank et al., (2019) reported the statistical information on the major fish landings at Veraval Coast, Gujarat. In 2010, major resources landed in the trawl net were Ribbon fish (19%),

threadfin bream (18%), white fish (7%), shrimp (6%), grouper (5%) and squid (5%). The catch of ribbon fish was declining from February to April which September onwards the catch of ribbon fish was increased. In 2011, major resources landed in the trawl net were ribbon fish (33%), threadfin bream (11%), squid (8%) and lizard fish (7%). There was declined in the catch during November may be due to cyclone. In 2012, major resources landed in the fishing gear were Ribbon fish (21%), threadfin bream (20%), squid (11%) and cuttlefish (10%). A catch was declined from February to May and stable in August and September. In January to May 2013, major resources landed in the trawl net were Ribbon fish (43%), threadfin bream (16%), squid (14%) and lizard fish (5%). During the study period ribbon fish dominated with 31% followed by thread fin bream (17%), squid (11%), lizard fish (6%) and cuttle fish (7%) (Figure 1). A highest total catch fluctuation was noted during 2010. A highest catch was recorded during November 2010 and lowest during February 2010.

Sidat et al., (2021) carried out a study at Jakhau and Mandvi Coast of Gulf of Kachchh, Gujarat. They reported a total of 96 fish species, belonging to 47 families from 20 orders, from both the Coast. Out of all the reported species, the class chondrichthyes represented 4.16% (4 species, 4 orders), while class Osteichthyes represented 95.83% (92 species, 16 orders).The order Eupercaria is most dominant with 18 species belonging to 8 families followed by Carangiformes (11 species, 2 families), Perciformes (10, 3), Scombriformes (9, 4), Clupeiformes (8, 4), Carangaria (7, 4), Pleuronectiformes (6, 4), Acanthuriformes (4, 4), Siluriformes (4, 1), Beloniformes (3, 2), Mugiliformes (3, 1), Aulopiformes (2, 1), Tetraodontiformes (2, 1), Centrarchiformes (2, 1), Torpediniformes, (2, 1), Carcharhiniformes (1, 1), Anguilliformes (1, 1), Myliobatiformes (1, 1), Rhinopristiformes (1, 1), and Mulliformes (1, 1) comprising of 95.83% of total fish diversity. Out of 47 families, Carangidae was dominant with 10 species followed by Sciaenidae (6 species), Serranidae (6), Ariidae (4), Clupeidae (4), Scombridae (4), Sparidae (4), Mugilidae (3), Platycephalidae (3), Sphyraenidae (3), Haemulidae (3). The families Belonidae, Cynoglossidae, Engraul idea, Paralichthyidae, Polynemidae, Stromateidae, Synodontidae, Terapontidae, Tetraodontidae, and Trichiuridae represented with 2 species each. The remaining 26 families represented with 1 species each. The total number of species reported from the Jakhau sampling site was 74, of which 4 species belong to Chondrichthyes and 70 species belong to Osteichthyes. Order Eupercaria was dominant in Jakhau with 10 species, followed by Scombriformes with 9 species, Carangiformes and Clupeiformes with 8 species. Similarly, the

number of species reported from the Mandvi sampling site was 77, of which 2 species belong to Chondrichthyes and 75 species belong to Osteichthyes. Order Eupercaria was dominant in the Mandvi sampling site with 16 species, followed by Carangiformes with 10 species. A total of 54 species were reported common from both the sampling sites. As per IUCN red list status 2021, 10 species were assessed as Not evaluated, 06 species as Data deficient, 68 species as Least concern, 05 species as near-threatened (*Scoliodon laticaudus, Harpadon nehereus, Diagramma pictum, Protonibea diacanthus, Thunnus albacares*), 04 species as Vulnerable (*Planiliza klunzingeri, Oreochromis mossambicus, Pampus argenteus, Cynoglossus macrostomus*), two species as endangered (*Maculabatis gerrardi, Eleutheronema tetradactylum*), and one species as critically endangered (*Rhynchobatus djiddensis*).

India is one of the largest fish producing nations in the World (Parmar et al. 2015). India possesses a total of 2492 marine fish species (7.4%) of total world marine fish resources reported by CMFRI (Gopalakrishnan 2017). The highest number of marine species diversity was reported from Andaman and Nicobar Island. A study reported 1,121 species from the east coast and 1,071 species from the west coast of India (Sluka 2013). The present study records 114 species which shares 4.57% of the total diversity found in India. This represents the importance of Sutrapada fish landing center in diversity as well as fisheries point of view.

Table 1- Fish species collected from Sutrapada Landing Center (SLC). A 1 in the records column indicates this species recorded as present in India by the Fish base database (www.fishbase.org). The IUCN status is given as LC= Least Concern, NT = Near Threatened, VU= Vulnerable, EN= Endangered, DD= Data Deficient, and NE= Not Evaluated; OPI = Other Parts of India

Class/ Order/ Family	Species	English Name	IUCN status
Class: Elasmobranchii			
Order: Carcharhiniformes			
Carcharhinidae Jordan & Evermann 1896 (requiem sharks)	*Carcharhinus limbatus* (Müller & Henle, 1839)	Blacktip shark	VU
	Scoliodon laticaudus Müller & Henle 1838	Spade nose shark	NT
	Carcharhinus dussumieri (Müller & Henle 1839)	White cheek shark	EN
	Carcharhinus sorrah (Müller & Henle 1839)	Spot-tail shark	NT
Triakidae Gray 1851 (houndsharks)	*Mustelus mosis* Hemprich & Ehrenberg, 1899	Arabian smooth-hound	DD
Order: Myliobatiformes			
Dasyatidae Jordan & Gilbert 1879 (stingrays)	*Maculabatis gerrardi* (Gray, 1851)	Sharp nose stingray	VU
Order: Rhinopristiformes			
Rhinidae Müller & Henle 1841 (bowmouth guitarfishes / wedgefishes)	*Rhynchobatus djiddensis* (Forsskål 1775)	Giant guitarfish	CR
Rhinobatidae Bonaparte	*Rhinobatos punctifer* Compagno &	Spotted	NT

1835 (guitarfishes)	Randall, 1987	guitarfish	
Glaucostegidae Last, Séret & Naylor 2016 (giant guitarfishes)	*Glaucostegus granulatus* (Cuvier 1829)	Granulated/ Sharp nose guitarfish	CR
Order: Torpediniformes			
Torpedinidae Henle 1834 (electric rays / torpedo rays)	*Torpedo fuscomaculata* Peters, 1855	Black-spotted torpedo	DD
	Torpedo sinuspersici Olfers, 1831	Variable torpedo ray	DD
Class: Actinopteri			
Order: Acanthuriformes			
Acanthuridae Bonaparte 1835 (surgeonfishes and unicornfishes)	*Acanthurus mata* (Cuvier, 1829)	Elongate surgeonfish	NE
	Zebrasoma desjardinii (Bennett, 1836)	Indian sail-fin surgeonfish	LC
Chaetodontidae Rafinesque 1815 (butterflyfishes)	*Chaetodon collare* Bloch, 1787	Redtail butterflyfish	LC
Pomacanthidae Jordan & Evermann 1898 (angelfishes)	*Pomacanthus annularis* (Bloch, 1787)	Bluering angelfish	LC
Ephippidae Bleeker 1859 (spadefishes and batfishes)	*Platax teira* (Forsskål, 1775)	Longfin batfish	NE
Order: Anguilliformes			
Muraenesocidae Kaup 1859 (pike conger eels)	*Congresox talabonoides* (Bleeker 18 53)	Indian pike conger	NE
	Muraenesox cinereus (Forsskål 1775)	Daggertooth pike conger	LC
Order: Aulopiformes			

Synodontidae Gill 1861 (lizardfishes)	*Saurida tumbil* (Bloch, 1795)	Greater lizardfish	LC
	Saurida longimanus Norman 1939	Longfin lizardfish	LC
	Trachinocephalus myops (Forster, 1801)	Snakefish/ Bluntnose lizard fish	LC
	Harpadon nehereus (Hamilton 1822)	Bombay-duck	NT
Order: Beloniformes			
Belonidae Bonaparte 1835 (needlefishes)	*Tylosurus crocodilus* (Péron & Lesueur 1821)	Hound needlefish	LC
	Strongylura strongyle (van Hasselt 1823)	Spot tail needlefish	LC
Exocoetidae Risso 1827 (flyingfishes)	*Parexocoetus brachypterus* (Richardson 1846)	Sailfin flying fish	DD
	Hirundichthys coromandelensis (Hornell 1923)	Coromandel flying fish	LC
Hemiramphidae Gill 1859 (halfbeaks)	*Hemiramphus far* (Forsskål 1775)	Black-barred halfbeak	NE
Order: Carangiformes			
Carangidae Rafinesque 1815 (jacks, amberjacks, pompanos)	*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 &	Rainbow runner	LC

	Gaimard, 1825)		
	Parastromateus niger (Bloch, 1795)	Black pomfret	LC
	Scomberoides tol (Cuvier, 1832)	Needle scaled queenfish	LC
	Scomberoides commersonnianus Lacepède, 1801	Talang queenfish	LC
	Alepes djedaba (Forsskål 1775)	Shrimp scad	LC
	Caranx sexfasciatus Quoy & Gaimar d 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 Rafinesque 1815 (barracudas)	*Sphyraena jello* Cuvier 1829	Pick handle barracuda	LC
	Sphyraena putnamae Jordan & Seale 1905	Sawtooth barracuda	DD
Polynemidae Rafinesque 1815 (threadfins or tassel-fishes)	*Eleutheronema tetradactylum* (Shaw 1804)	four finger threadfin	EN
	Leptomelanosoma indicum (Shaw 1804)	Indian threadfin	LC
Istiophoridae Rafinesque 1815 (billfishes and marlins)	*Istiompax indica* (Cuvier 1832)	Black marlin	DD
	Istiophorus platypterus (Shaw 1792)	Indo-Pacific sailfish	LC
Coryphaenidae Rafinesque 1815 (dolphins or dolphinfishes)	*Coryphaena hippurus* Linnaeus, 1758	Common dolphinfish	LC

Echeneidae Rafinesque 1810 (remoras and sharksuckers)	*Echeneis naucrates* Linnaeus, 1758	Live shark sucker	LC
Menidae Fitzinger 1873 (moonfishes)	*Mene maculata* (Bloch & Schneider, 1801)	Moonfish	NE
Polynemidae Rafinesque 1815 (threadfins or tassel-fishes)	*Leptomelanosoma indicum* (Shaw, 1804)	Indian threadfin	NE
Rachycentridae Gill 1896 (cobias)	*Rachycentron canadum* (Linnaeus, 1766)	Cobia	LC
Xiphiidae Rafinesque 1815 (swordfishes)	*Xiphias gladius* Linnaeus 1758	Swordfish	LC
Order: Centrarchiformes			
Kyphosidae Jordan 1887 (sea chubs)	*Kyphosus vaigiensis* (Quoy & Gaimard, 1825)	Brassy chub	LC
Terapontidae Richardson 1842 (grunters or tigerfishes)	*Terapon jarbua* (Forsskål, 1775)	Jarbua terapon	LC
Order: Clupeiformes			
Clupeidae Cuvier 1816 (herrings, shads, sardines and allies)	*Sardinella gibbosa* (Bleeker, 1849)	Gold stripe sardinella	LC
	Sardinella longiceps Valenciennes, 1847	Indian oil sardine	LC
	Tenualosa ilisha (Hamilton 1822)	Hilsa shad	LC
Chirocentridae Bleeker 1849 (wolf herrings)	*Chirocentrus nudus* Swainson 1839	Whitefin wolf-herring	LC
	Chirocentrus dorab (Forsskål 1775)	Dorab wolf-herring	LC
Dussumieriidae Gill 1861	*Dussumieria acuta* Valenciennes,	Rainbow	LC

(round herrings)	1847	sardine	
Engraulidae Gill 1861 (anchovies)	*Thryssa setirostris* (Broussonet, 1782)	Long jaw thryssa	LC
	Thryssa dussumieri (Valenciennes, 1848)	Dussumier's thryssa	LC
	Thryssa malabarica (Bloch, 1795)	Malabar thryssa	DD
Pristigasteridae Bleeker 1872 (longfin herrings)	*Ilisha megaloptera* (Swainson 1839)	Bigeye ilisha	LC
	Opisthopterus tardoore (Cuvier 1829)	Tardoore	LC
Order: Mugiliformes			
Mugilidae Jarocki 1822 (mullets)	*Mugil cephalus* Linnaeus, 1758	Grey mullet	LC
Order: Perciformes			
Haemulidae Gill 1885 (grunts)	*Pomadasys maculatus* (Bloch, 1793)	Saddle grunt	LC
	Pomadasys argenteus (Forsskål 1775)	Silver grunt	LC
Priacanthidae Günther 1859 (bigeyes)	*Priacanthus hamrur* (Forsskål, 1775)	Moon tail bullseye	LC
Serranidae Swainson 1839 (sea basses and groupers)	*Cephalopholis sonnerati* (Valenciennes, 1828)	Tomato hind	LC
	Epinephelus diacanthus (Valenciennes, 1828)	Spiny cheek grouper	LC
Sillaginidae Richardson 1846 (sillagos)	*Sillago sihama* (Forsskål, 1775)	Silver sillago	LC
Lethrinidae Bonaparte 1831 (emperor snappers)	*Lethrinus ornatus Valenciennes 1830*	Ornate emperor	LC
	Lethrinus nebulosus (Forsskål, 1775)	Spangled emperor	LC
Lutjanidae Gill 1861	*Lutjanus johnii* (Bloch, 1792)	John's snapper	LC

(snappers)			
Sparidae Rafinesque 1818 (porgys and seabreams)	*Argyrops spinifer* (Forsskål, 1775)	King soldier bream	LC
Uranoscopidae Bonaparte 1831 (stargazers)	*Uranoscopus archionema* Regan, 1921		NE
Nemipteridae Regan 1913 (threadfin breams and spinycheeks)	*Nemipterus japonicus* (Bloch, 1791)	Japanese threadfin bream	NE
	Scolopsis vosmeri (Bloch, 1792)	White cheek monocle bream	NE
	Parascolopsis eriomma (Jordan & Richardson, 1909)	Swallowtail dwarf monocle bream	NE
Platycephalidae Swainson 1839 (flatheads)	*Platycephalus indicus* (Linnaeus, 1758)	Bar tail flathead	DD
Sciaenidae Cuvier 1829 (croakers and drums)	*Otolithoides biauritus* (Cantor, 1849)	Bronze croaker	NE
	Nibea maculata (Bloch & Schneider 1801)	Blotched croaker	NE
	Otolithes cuvieri Trewavas 1974	Lesser tiger tooth 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 Risso 1827 (scorpionfishes and allies)	*Pterois miles* (Bennett, 1828)	Devil firefish	LC
Order: Pleuronectiformes			
Paralichthyidae Regan	*Pseudorhombus arsius* (Hamilton 18	large tooth	LC

1910 (sand flounders)	22)	flounder	
Psettodidae Regan 1910 (spiny turbots)	*Psettodes erumei* (Bloch & Schneider 1801)	Indian halibut	DD
Order: Scombriformes			
Scombridae Rafinesque 1815 (mackerels, tunas and bonitos)	*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
	Thunnus obesus (Lowe 1839)	Bigeye tuna	VU
	Scomberomorus guttatus (Bloch & S chneider 1801)	Indo-Pacific king mackerel	DD
Stromateidae Rafinesque 1810 (butterfishes)	*Pampus argenteus* (Euphrasen, 1788)	Silver pomfret	VU
	Pampus chinensis (Euphrasen 1788)	Chinese silver pomfret	DD
Trichiuridae Rafinesque 1810 (cutlassfishes)	*Trichiurus lepturus* Linnaeus, 1758	Large head hairtail/ Large-headed ribbon fish	LC
	Lepturacanthus savala (Cuvier 1829)	Savalai hairtail/Ribbon fish	DD
Order: Siluriformes			
Ariidae Bleeker 1858 (sea	*Plicofollis layardi* (Günther, 1866)	Thinspine sea	NE

catfishes)		catfish	
	Plicofollis dussumieri (Valenciennes 1840)	Blacktip sea catfish	NE
	Osteogeneiosus militaris (Linnaeus 1 758)	Soldier catfish	DD
	Netuma thalassina (Rüppell 1837)	Giant catfish	LC
Order: Syngnathiformes			
Mullidae Rafinesque 1815 (goatfishes)	*Upeneus moluccensis* (Bleeker, 1855)	Gold band goatfish	LC
Order: Tetraodontiformes			
Balistidae Rafinesque 1810 (triggerfishes)	*Odonus niger* (Rüppell, 1836)	Red-toothed triggerfish	NE
	Abalistes stellaris (Bloch & Schneider 1801)	Starry triggerfish	LC
Tetraodontidae Bonaparte 1831 (puffers)	*Takifugu oblongus* (Bloch, 1786)	Lattice blaasop	LC
Triacanthidae Bleeker 1859 (triplespines)	*Triacanthus biaculeatus* (Bloch, 1786)	Short-nosed tripod fish	NE
	Pseudotriacanthus strigilifer (Cantor 1849)	Long-spined tripod fish	LC

3.2 *Fishery Aspects at Sutrapada Coast:*

Success of any fisheries depends on several aspects related to this activity and center. Sutrapada is one of the fast-developing Fisheries center in Gujarat and play a significant role as is very close to most important fisheries center – Veraval. The fisheries center is having various basic and ancillary components.

3.2.1 *Fishing operation:*

The regular interactions were carried out with the local fishermen to gather the information regarding the fishing activities, fishing trips, fishing time, post fishing activities (Figure.13).Fisherman from Sutrapada go for intraday as well as multiday fishing for 2 to 10 days covering areas like Mumbai, Dwarka, Porbandar, Diu etc. depending on days. For same day fishing they depart from their base at morning or noon and travels 5-6 hours to reach the fishing ground. Gillnet is operated at night preferably during dark nights or after the moon has set. The net is released into the water and kept drifted with the current till the operation of net is completed. The time taken for haul varies depending on the fish catch. Usually, the haul made per trip was 4-5. Generally, 5-6 hours were taken for one haul. Nets are usually operated at 20-45 m depth. Fishing operations were confined to the surface and mid-depth zones at the fishing grounds. The fisherman gets back to the coast to unload the catch in the morning as well as afternoon hours. Generally, the manpower required was 8 per unit.

The map of Preferential Fishing Zones by Fishermen projects the potential Fishing Zones covered and continuously visited by the fishermen of Sutrapada (Figure. 12). The area covered is based on few important aspects like, available fishing crafts and men power, type of gears they operate, varieties of fishes etc. It was observed that fishing is mostly carried out up to 50 meters bottom depths due to either indigenous crafts or motorized crafts are operated with comparatively less men power. Occasionally the fishermen do visit long distances for a week duration on board trawlers.

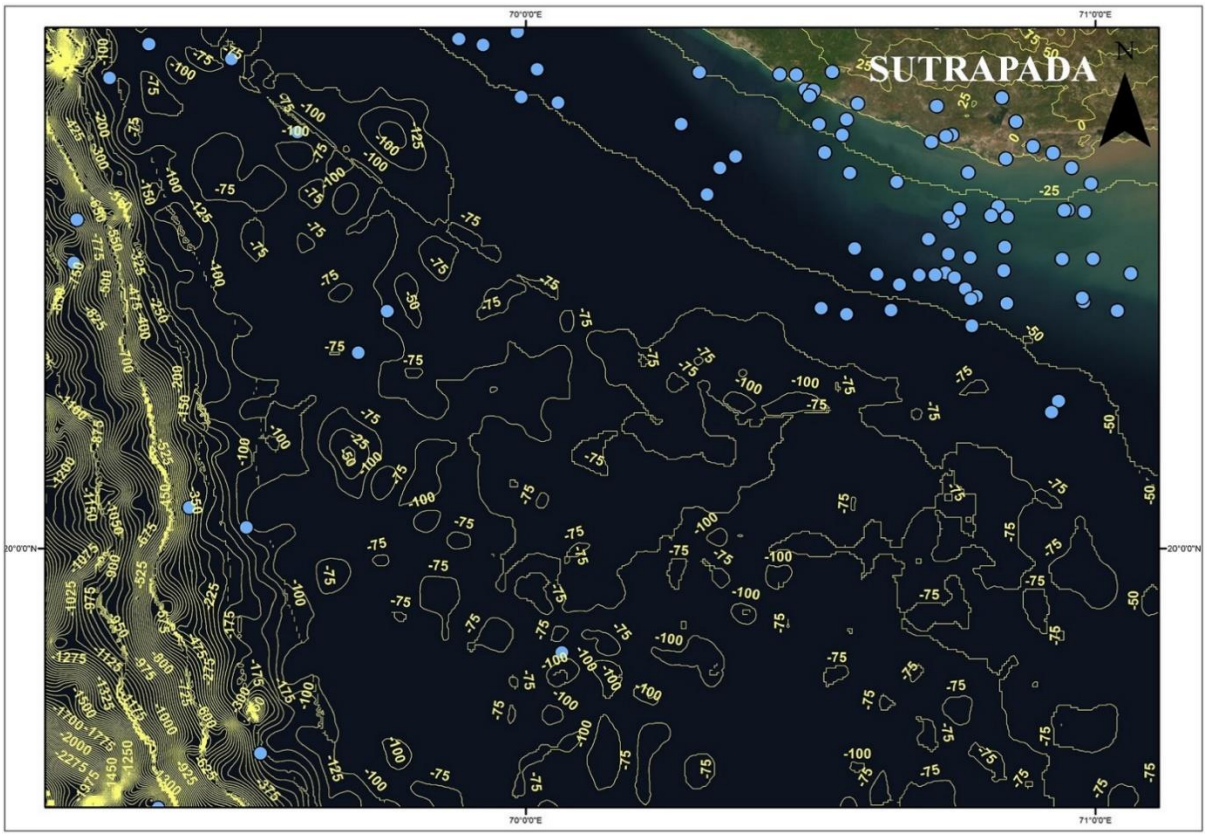

Figure.12: Map of Preferential Fishing Zones by Fishermen of Sutrapada.

Figure.13: Interactions with Local Fishermen to know about Fisheries Scenario in Sutrapada.

3.2.2 *Crafts and Gears used at Sutrapada fish landing center:*

3.2.2.1*Gill-net use at Sutrapada Coast:*

During the study tenure, regular field visits were carried out to check the post fishing activities by the local fishermen. In the non-fishing season (July – August) fishermen perform the gill-netting activities (Figure.14), repairing of boats and equipment used in fishing activities such as batteries and motors.

Gill net is a traditional gear commonly operated along maritime states of India. Many workers have made an attempt to know the profitability of gillnetters operating along the Indian coast (Silas *et al*.,1984; Datta *et al*., 1989; Sehara and Karbhari, 1989a; Sehara and Karbhari, 1989b; Annamalai and Kandoran, 1990; Panikkar *et al*., 1990; Rao and Pandey, 1990; Sathiadhas and Benjamin, 1990; Chayya *et al*., 1991; Sathiadhas *et al*., 1991; Sehra and Karbhari, 1991; Datta and Dan, 1992; Anomaly and Kandoran, 1993; Iyer, 1993; Panikkar *et al*., 1993; Sathiadhas *et*

al., 1993; Joshi, 1996; Doss *et al*., 1997; Luther *et al*., 1997; Sathiadhas, 1997; Rao and Raju, 1998; Sehra, 1998; Shiyani, 2000; Dave, 2004; Markad, 2004).

The gillnets were fabricated by local net braiders in a shed near the landing center or by woman at home. The fabricated nets were as per the individual requirements of fisherman and local practices. Mainly six different types of gillnets were in practice along Sutrapada coast. The nets are locally known as *chokla, patira, jada jaal,pakha jaal,ghaghra, maoul na jaal, point na jaal etc.* Mesh size, length of net and depth of net may vary according to the type of gillnet (Table 2). Fisherman decided upon the type of gillnets based on availability of catch. Generally, they carried more than 90 net and made long chain and joining one after the other based on the condition.

3.2.2.2*Crafts used at Sutrapada Coast:*

The Outboard machine (OBM) gillnetters operated off Sutrapada village were fiber reinforced plastic (FRP) coated. There were about 381 OBM gillnetters in Sutrapada and most of them were active in fishing. These OBM gillnetters were fitted with 2 cylinders, 8 horse power (HP) engine, which operated with kerosene. Table shows the vessel and engine specifications for OBM gillnetters operating from Sutrapada fishing village. The length of OBM gillnetters varied from 9.6 to 11.4 m and their breadth varied from 1.21 to 1.80 m. The tonnage of these gillnetters ranged from 1.58 to 1.6 t. They used to have one fish hold in the boats. The OBM gillnetters belong to the local fisherman (Figure. 15).

In the state of Gujarat, there are about 9,003 OBM gillnetters in operation in out of these 4,294 OBM gillnetters are active in Junagadh district. Among these, total 1,144 OBM gillnetters are in active fishing in Veraval.

Table 2. Specification of Gill net operated by Non-Mechanized and Mechanized boats at Sutrapada Coast

Types of net	Mesh size (mm)	Length of net (m)	Height of net (m)	Total No. of net	Species caught
Chokla	66-81	60	5	80-100	Chinese herring, croakers, mackerel, shark, Bombay duck, big eye ilisha etc.
Patira	43-53	55	4	80-90	Chinese herring, croakers, pomfret, ribbon fish etc.
Jada Jaal	177-190	70	7	70-85	Shark, Jew fish, tunas, croakers, seer fish etc.
Pakha Jaal	195-203	75	8	70-80	Tunas, seer fish. croakers, Jew fish etc.
Ghaghra	254-266	75	18	70-75	Bronze croaker, Jew fish, Indian thread fin, tuna etc.
Maoul na jaal	152-165	70	6	100-120	Tunas, seer fish, mackerel etc.

Figure.14: Visit to the Fish Landing Center of the Sutrapada Coast during offseason to observe net-making activities by Fishermen

Figure. 15: Crafts used at Sutrapada Coast: (a) Fiber Reinforced Plastic (FRP) boat with OBM (b) trawlers with IBM (c) Canoe boats

3.2.3 Catch composition and Landings of the ichthyofauna at Sutrapada coast:

During the study period of 2014-2017 along with the diversity study, catch composition and fish catch in kg data were also obtained from local fishermen as well as Department of Fisheries, Sutrapada. Regular monthly field visits were carried out at the landing center when fishermen returning from the long duration fishing. At the time, fish species were observed from the landings of the particular boat. It was observed that each month, a particular boat catches 25 to 30 species in long duration fishing activity. Their preservation techniques were also studied. In which, large fishes were placed at the bottom especially bony fishes and elasmobranchs were placed at the top. In the fish hold on board, regularly reshuffling of this catch in the hold is done and fresh salt as well as ice is sprinkled. It was observed that in 2014-15, the catch of all the species were higher while in 2015-16 and 2016-17 the catch was equal and gradually decreased compare to previous year except ribbon fishes and mackerels. In 2014-15, black pomfret, sharks, cat-fishes and leather jackets were higher in catch.The gillnets fishery off sutrapada coastr was supported by White pomfret (vichuda), Black pomfret (halva), Hilsa (Palva, Chakshi), Shark (Magra) Ray, Cat fish (Khaga-khaga), Leather Jacket (Sag-Aal), Seer fish (Chhapari, Surmai), Ribbon fish (Patti, Baga), Silver bar (Dal), Perches (Kothi), Small Sciendies (Dhoma), Tuna (Setava, Gedara), Carangies/ Mackrel(Bangdi), Sole fish (Jibh), Other clupids (Palvi, Kati) (Figure. 16).

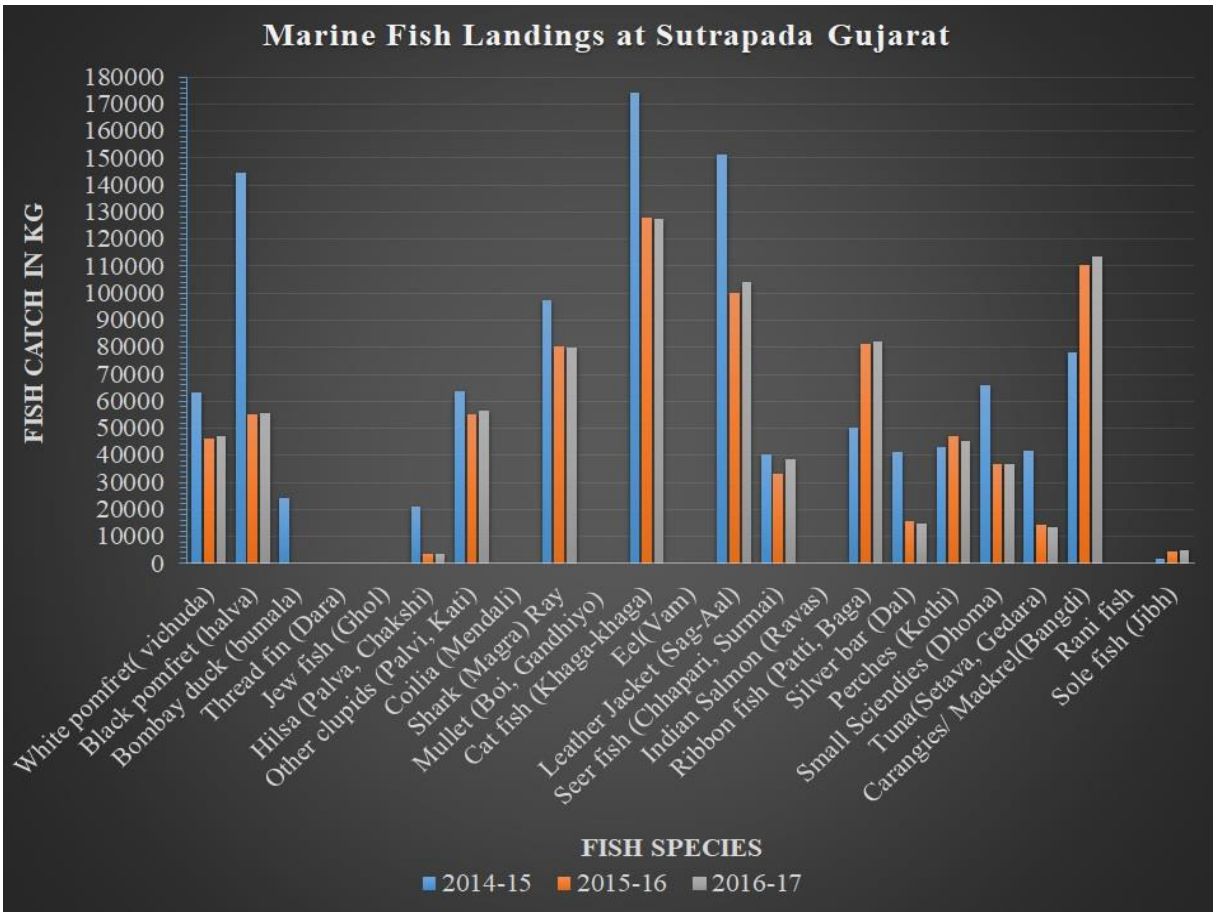

Figure.16: Ichthyofaunal catch (in Kg) at Sutrapada Fish Landing center during 2014-2017.

3.3 *Demographic Survey:*

The fisheries activity solely depends on either fishermen community working by birth or skilled workers and entrepreneurs. Demographic survey to understand the status and the needs of such fishermen community is very much essential. Here we have collected data through physical survey and meetings with fishermen community of Sutrapada fishing village (Figure. 17).

3.3.1 *Sex ratio and Age-group:*

The random samplings of fishermen were carried out to check the sex-ratio and age-group involved in the fishing activities at Sutrapada Coast, Gujarat. The findings of the survey resulted that the sex ratio of local fisherman involved in fishing activity of Males was higher than Females, having 57 males and 29 females. The sex ratio of fisherman is 66.27 % of the total

population is whereas 33.72% are female in Sutrapada bunder (Figure. 18). The fishing activity is mostly done by all age groups. The larger age groups individual involved in fishing activity was between 31-40 years, gradually declining till 71-80yrs. In the survey of 86 fisherman the Sutrapada fishing dominance of age group 31 to 40 as around 32% fisherman are involved in fishing followed by 41-50 age group having 31% of fisherman than to 51-60 age group around 23% whereas in age group of 61-70 there is just 6.9% of fisherman as well as in age group of 21-30 there are just 4.6% of fisherman but only 1.2% of fisherman are involved in the age slab of 71-80 (Figure.19).

3.3.2 *Literacy rate:*

The literacy rate of the local fisherman was higher for below 10^{th} class. The more number individuals prefer to directly get involved in fishing activity than acquiring knowledge about it. Literacy rate should be increased through the proper awareness and management. This will helpful in acquiring the proper knowledge of fishing and conservation of the biodiversity. From the random sampling during the survey of literacy rate, it was observed that the literacy rate 69.76 % of the fisherman is having education up to class 10 or below and around 30.23 % of the population is only class 10 pass whereas there are no fisherman having education above class 12 (Figure.20).

3.3.3 *Government Assistance:*

Government assistance is the remuneration provided by the government to the local fishermen in case of any causalities, damage to the crafts and gears etc. Almost, all the fishermen received the government assistance after the application (Figure.21). The 72.09% of fisherman are getting the government assistance whereas 27.90% are not receiving any grant from government.

3.3.4 *Residential Status:*

The residential status of the fisherman staying in the vicinity was higher. Majorly the fishermen were having their own house and a fewer number of individuals stayed as tenant. There were some fishermen who were migratory and have moved there for some time during the fishing period (Figure.22). The residential status of the fisherman is around 62.79% of fisherman of

Sutrapada is having their own house and around 37.20% of fisherman are on rent whereas 1% are only migrant fisherman in the village as per survey report.

3.3.5 *Basic Needs and Household Facilities*:

The Basic needs included the internet facility which was necessary for the signaling processes for fishing activity being neglected. The other basic needs including water connection and electricity connection was better but the sewage connection was quite poor and requires to be considered by the government for maintenance (Figure.23). The basic facilities available to the fisherman like electricity connection to the house of 100 % of fisherman, water connection to 98.83% whereas sewage connection is just 8.1% to the fisherman and only 2.32% of the fisherman are using Internet rest are not having the facilities of the internet connection. Household facilities include basic electronic gadgets such as television, fan, radio, refrigerator, mobile (android/basic). Fan was the common gadget which was owned by all the fishermen followed by television. Very few fishermen own the refrigerator and mobile (Figure. 24). The household survey interpretation tells that 76.74 are having Television, 2.32 % are having refrigerator, 100% are having the facilities of fan, only 17% fisherman population is using radio, 2.32% are using android phone whereas 8.13% are using basic phone but rest of the population are not having this type of facilities. So, economic standard is of average type of these fishermen.

Figure.17: Demographic Survey of the Fishermen of Sutrapada during offseason.

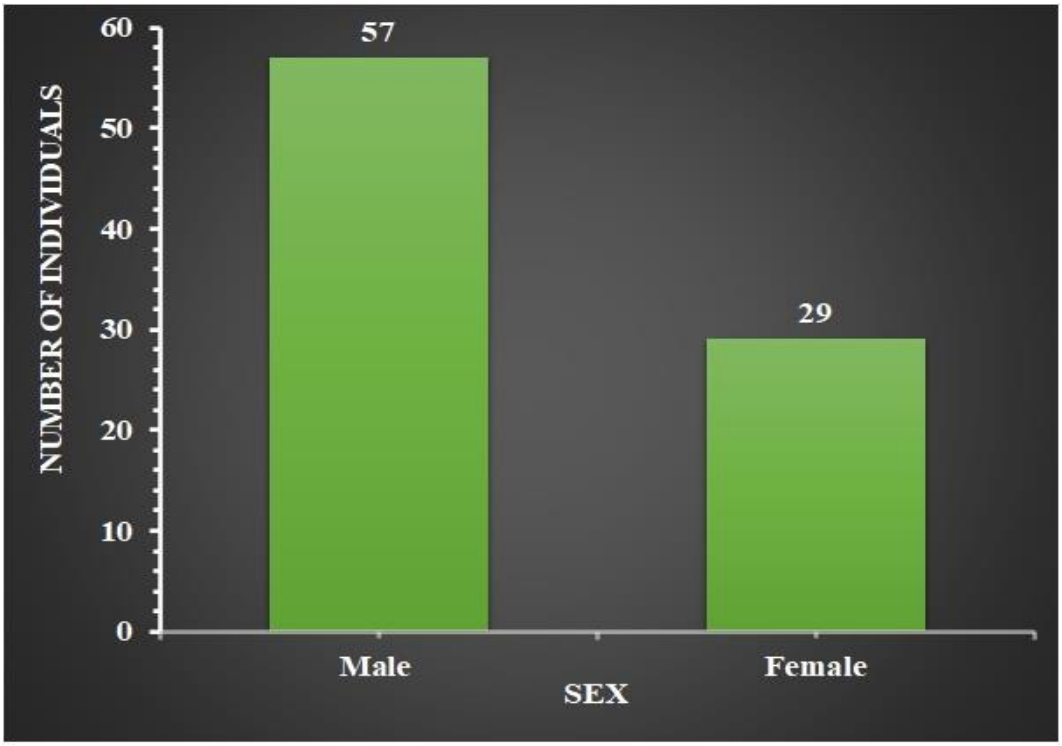

Figure.18: Sex-ratio in the Fishermen Community Present at Sutrapada, Gujarat, India

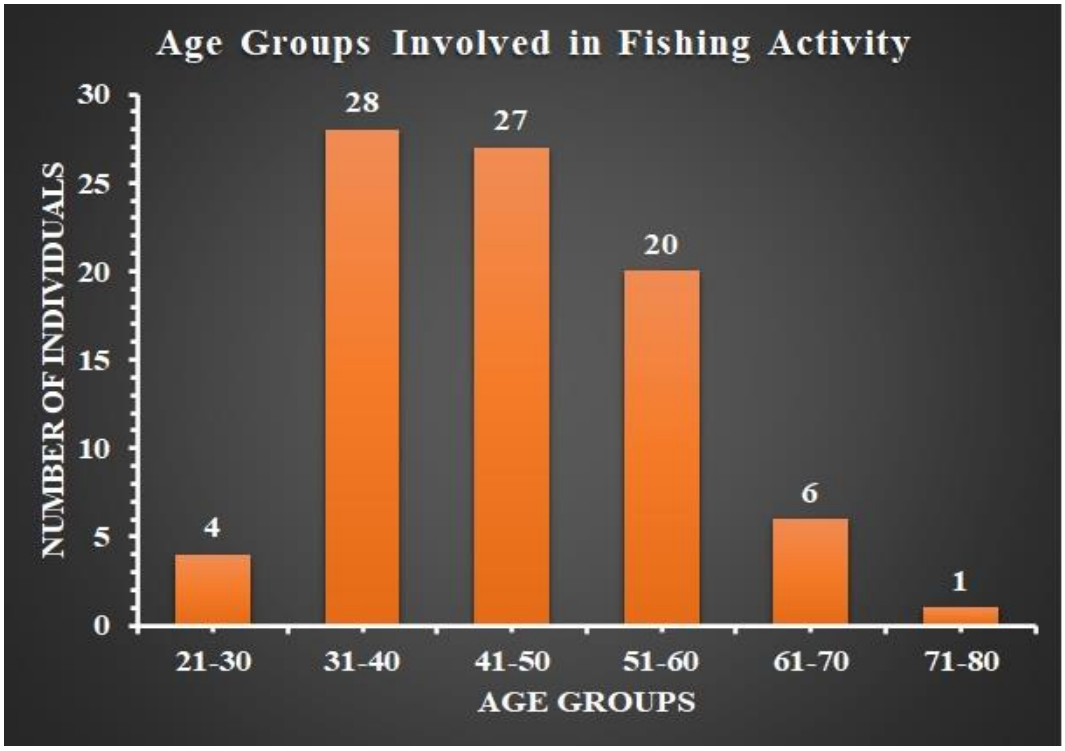

Figure.19: Age-group in the Fishermen Community Present at Sutrapada, Gujarat, India

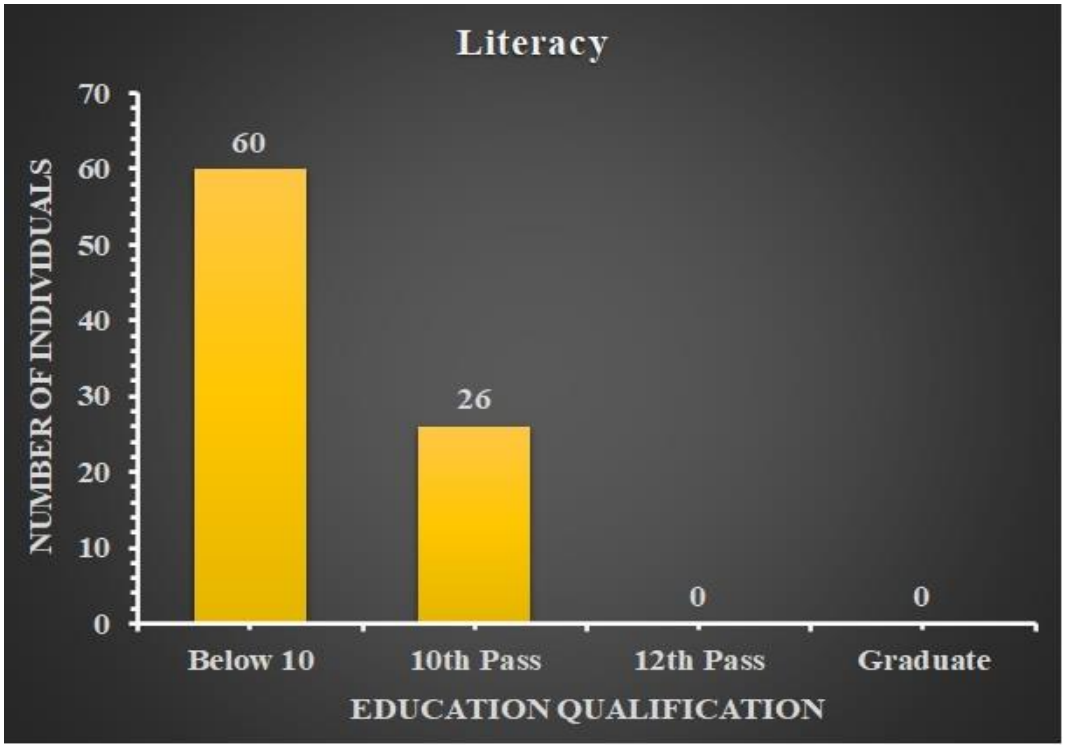

Figure.20: Literacy Rate in the Fishermen Community at Sutrapada Coast, Gujarat.

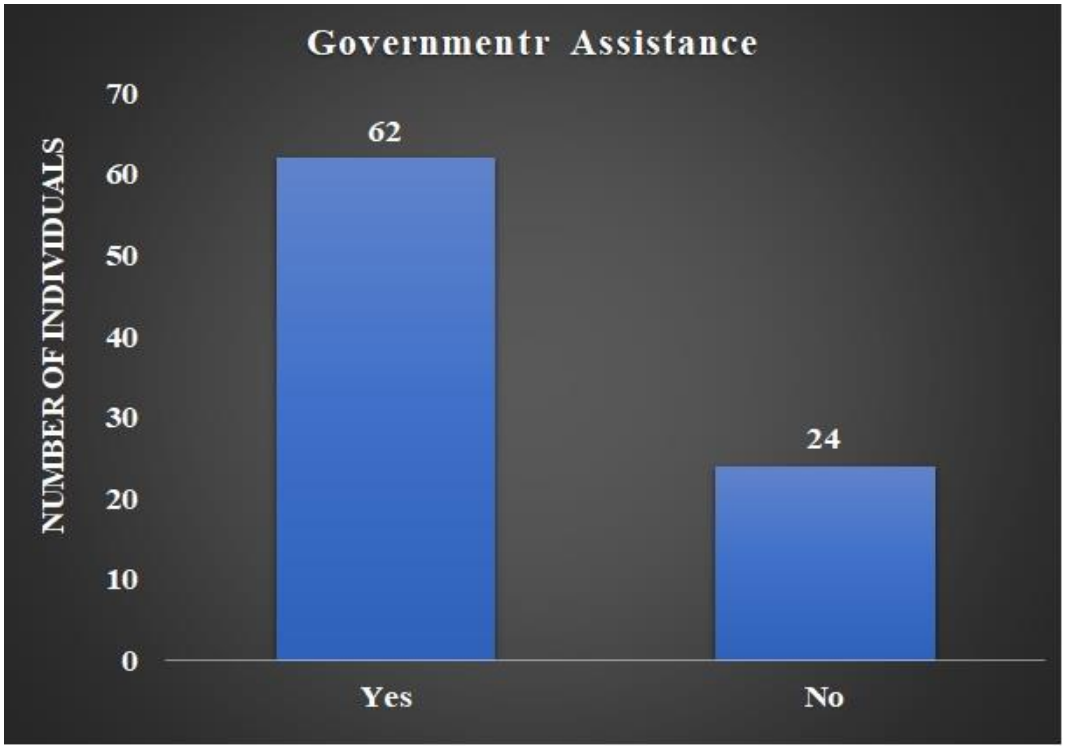

Figure. 21: Government Assistant provided to the Fishermen at Sutrapada Coast, Gujarat.

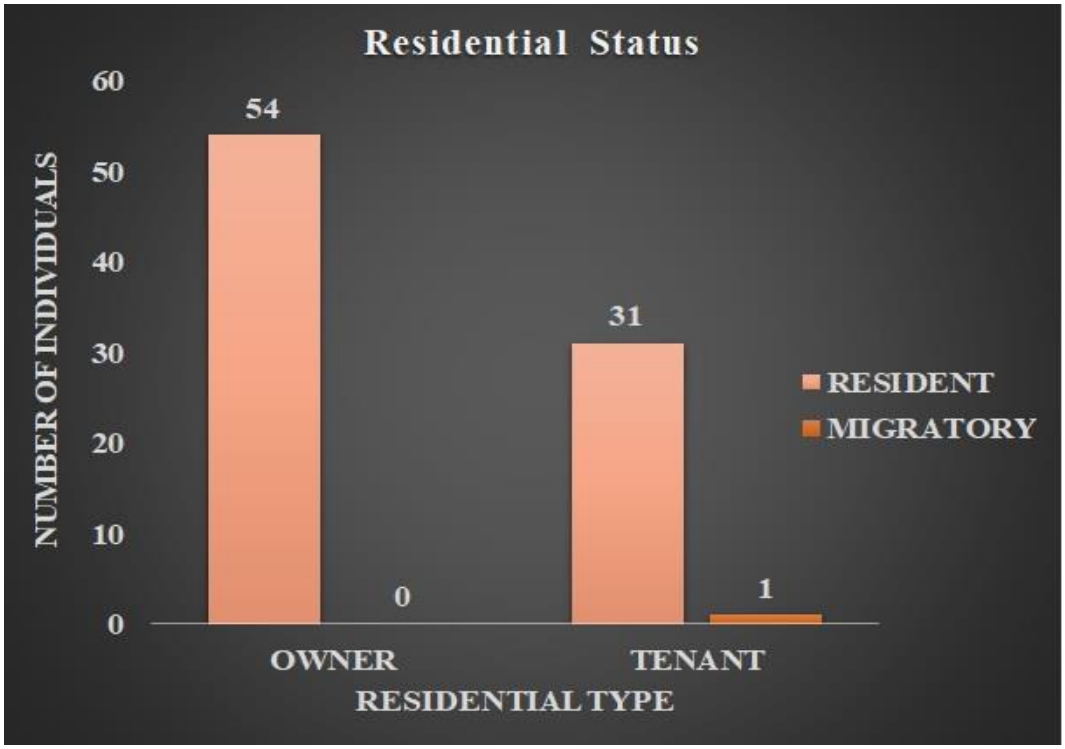

Figure.22: Residential Status of Fishermen at Sutrapada Coast, Gujarat.

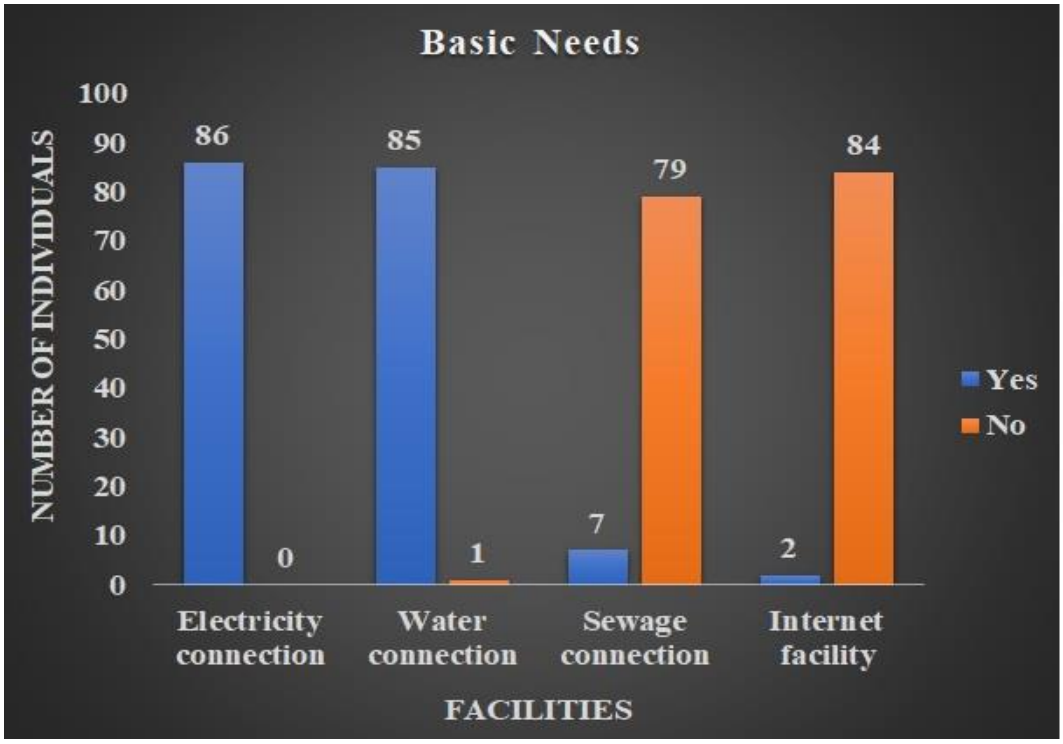

Figure.23: Basic Needs facilitated to the Fishermen at Sutrapada Coast, Gujarat

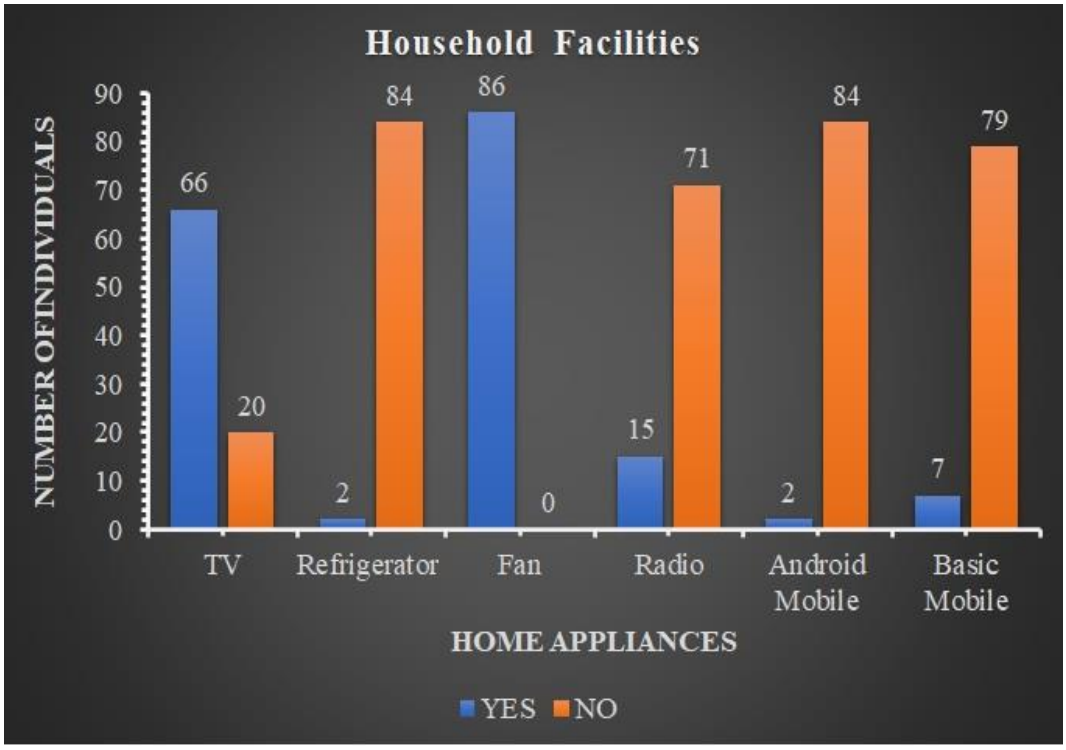

Figure.24: Household Facilities owned by the Fishermen at Sutrapada Coast, Gujarat.