Stock assessment of the Thinspine Sea Catfish *Plicofollis Tenuispinis* (Day, 1877) Landed along veraval Centre of Saurashstra, North Western Coast of India

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Abstract

Stock assessment Studies on Plicofollis tenuispinis (DAY, 1877) fishery landed along the Veraval Centre of Saurashstra, North Western Coast of, India were carried out from March 2016 to February 2017. This study suggested with major resource conservation strategies for the optimum sustainable judicious exploitation of the P.tenuispinis fishery stock exploited along the coast.

Introduction

Intensive fishing pressure due to utilization of efficiently advanced navigational aids, fish finding equipment's, crafts and gears are potential for Ghost fishing, Illigal unreported and unregulated (IUU) fishing, on fishery resources. Fishery resources are currently under threat of over exploitation in globally due to commercially important major fish stocks associated by-catch of untargeted species and other aquatic resources. Resulted in unrecoverable impact on the resources due to pollution of aquatic environment.

The estimated number of fishing vessels in the world nearly 4.6 million in 2016, out of this Asia contributes about 75% (3.5 million vessels) of the world fleet size. The world wide number of engine-powered vessels was estimated to be 61 percent (2.8 million) of all fishing vessels. The total global estimated fish production was 171 million tonnes, out of this Western Indian Ocean fishing region contributes 4931124 tin 2016, out of this a share that has increased significantly in recent decades over 151 million tones (88%) was utilized for direct human consumption. The major share of the 12 percent used for non-food uses (nearly 20 million tonnes) was reduced to fishmeal and fish oil. Live, fresh or chilled is often the most preferred and highly priced form of fish and indicates the major share of fish for direct human consumption (45%), followed by frozen (31%), an estimated loss or wastage between landing and consumption is about 27 percentage of landed fish in 2016 [1,2].

The fishery potential of 3.93 million tonnes in our Indian EEZ and provides narrow scope for further increase in production along 8,129km coast line. Over 14.5 million peoples for their livelihood currently depended on fisheries activities [3]. The state of Gujarat with a coastal line of 1,600km and continental shelf of 1,84,000km^2, currently predominant marine fish landing coastal state of the India. The present study carried out on stock assessment of the Thinspine Sea Catfish for devising Fisheries Management strategies for conservation of exploited Thinspine Sea Catfishes landed along Veraval Centre of Saurashstra, North Western Coast of, India.

Materials and methods

The materials required for conducting the experiment were the followings – i. *P. tenuispinis* landed at Veraval fish landing Centre. ii. Measuring tape, iii. Electronic balance (capacity = 10 kg, sensitivity = 50g), iv. Labels, v. A Computer with installed FiSAT-II software.

This study was carried out along the marine coastal waters at Veraval (21º35'N, 69º36'E), this landing centre is situated along the North west coast of Gujarat, India. Landings of the *P. tenuispinis* at Veraval were considerably higher quantity along fish landing sites of Gujarat.

Study duration: This Study were conducted for one year from March 2016 to February 2017 by excluding the month of July which is seasonal fishing ban at Veraval landing centre of maritime states of Gujarat.

Materials: following materials were utilized during current investigation of details on Reproductive biology of *P. tenuispinis* landed at Veravalcentre such as *P.tenuispinis*catch landed at Veraval fishing harbour (Nos. 25/week) specimens store jars, Measuring Scale/board, Electronic weighing balance (capacity = 5kg, sensitivity = 50g), Electronic balance (capacity = 200g, sensitivity = 10mg), Insulated box (5kg, capacity), Labels, Cloth for wiping out surface slime, wastes materials,

Specimen bottles, Forceps, Scissors, Formalin (4-5% cons), Compound microscope, Ocular and stage micrometer and Stereo zoom microscope, Verniercaliper. Computer with Installed FISAT-II software programme utilized for data analysis and end result in the Form of Figures.

Methodology: This study adopted the CMFRI, Multi stage stratified random sampling method was followed for estimating the monthly and annual catch of *P. tenuispinis* exploited by trawlers at Veraval landing centre. On a weekly basis the fishes stratified into multi stage size groups, 25 *P. tenuispinis* were collected randomly from different areas[4].

Observations Recorded: i. Total length (TL) of the fish (mm), ii. Total weight of the fish (g), iii. Length at first maturity (mm).

Statistical Analysis: Probability of Capture[5]: The length or age denoted as L_c or t_c is the length or age at 50% of the capture and become at vulnerable to exploitation in gear. It is one of the important parameter for the estimation of yield per recruit for Beverton and Holt's[6], dynamic pool model. It is required to find out various probabilities of capture at 50% of the fish entering the gear for selection ogive method.

Maximum Sustainable Yield (MSY): The conservation of exploited fishery resources are necessary to maintain within maximum sustainable yield. Total stock denoted as 'P' and biomass denoted as 'B' were estimated from the ratios Y/U and Y/F respectively; where, Y is the annual average yield in tonnes. The Maximum sustainable yield of for exploited fish stocks was calculated by the equation given by Gulland[7]:

$$MSY = Z \times 0.5 \times B;$$

Where: MSY= Maximum Sustainable Yield, Z = total mortality, B = biomass. Y/R = The relative yield per recruit and B/R= biomass per recruit at different levels of fishing mortality was estimated using FiSAT, Gayanilo *et al*[8].

Length based Thompson and Bell Model[9]: Thompson and Bell length based cohort analysis is commonly used forward version which combines with mixed features of Beverton and Holt's[10] relative yield per Recruitment (Y'/R) model and Virtual population Analysis (VPA) by Pauly[11-13]. The analysis required inputs as fishing mortality by length group, length at maturity, number of fishes in smallest length group, natural mortality same as from the length cohort analysis and cost of fish species/kg at different length groups. It provides output as yields, biomass and spawning stock biomass and Revenue against range of f-factors. It is used predict catches and stock sizes under the assumption on future exploitation levels and mesh sizes.

Figure-1: View of Banned fishing vessels at Veraval fishing harbour during fishing ban season (June 10 to August 15).

Results and discussion

Seasonal Abundance: Fishery of Thin spine sea catfish were landed throughout the year of study except during the month of July due to most of the fishermen's effectively implementing the fishing ban at Veraval center. Normally trawl net dominated catch landing with mean 81% except during the month of June in which gill net predominately contributed with 86%. The Maximum and lowest contribution of trawl net and gill net was 97 % and 2.6% noticed during the month of February 2017. Maximum and lowest gill net and trawl net contributed during month of June was 86.7% and 13.3% respectively. The highest catch per unit effort (CPUE) were estimated as 2.63kg/hour February followed by 2.25 in June and 2.05kg/h. Lowest CPUE was noticed during the month of May followed by December and August were 0.76, 0.86 and 0.9kg/h respectively. These study also noticed that currently there was no species specific

landing of *P. tenuispinis* was existing and its catch contribution were significantly higher among composite marine catfish landings at Veraval. This Fishery catch landed at Veraval was very poor in quality during many observations in throughout the year of study, which fetches low market demand while for larger matured individuals of *P. tenuispinis* were fetching elated demand with higher market price of more than 100 rupees per kilogram at Veraval. Major *P. Tenuispinis* landed were transported from Veraval to different parts of the India in form of frozen, dried, value added products, for the fishmeal plants, its air bladder fetches very higher demand due to its interior quality for the preparation of Isinglass.

The comparative landings of marine catfishes (t) of Gujarat with India were show in Table-1.

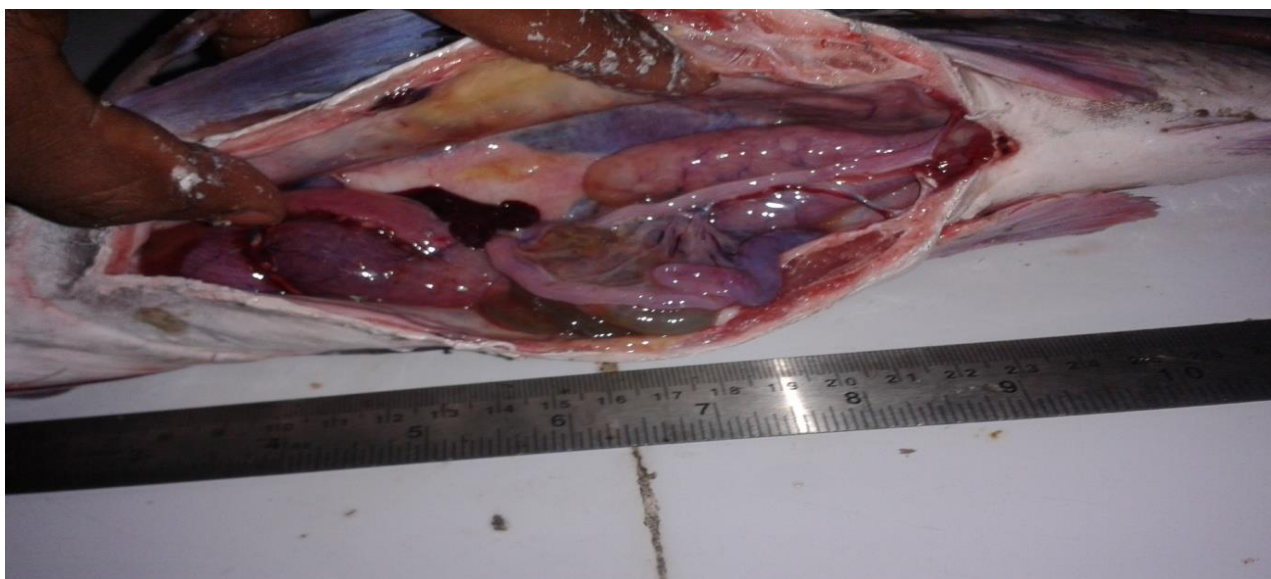**Figure-2:** Drift gill net mesh size measuring with scale.

Figure-3: View of Stomach, Gonads and Recording of biological population parameters.

Table-1: Comparative landings of marine catfishes (t) of Gujarat with the India[14].

Year	Gujarat Marine catfish (t)	India catfish landing (t)	% of Gujarat in India	India total landings	Marine Catfish % in Indian
2015	39845	83354	47.80	3404771	2.45
2014	33190	68675	48.33	3592853	1.91
2013	36152	89141	40.56	3781868	2.36
2012	46851	88524	52.92	3937752	2.24
2011	40364	92678	43.55	3820207	2.42
2010	32875	85670	38.37	3346687	2.55
2009	42703	107593	39.68	3204522	3.35
2008	36623	92401	39.63	3210530	2.87
2007	25696	65049	39.50	1862335	3.49
2006	20870	56540	36.91	2710988	2.08

Note: Landings in tones.

Table-2: Exploited Length groups range of the *P. tenuispinis* by trawl net and gill net.

Size of the fish Sample (numbers/Month)	Month of the collection	Length group (cm)
125	March 2016	22to52
102	April, 2016	24to48
102	May,2016	20to50
100	June,2016	24to48
106	August,2016	20 to 42
100	September,2016	18 to 50
100	October,2016	18 to 46
100	November,2016	24 to 52
102	December,2016	22 to 64
100	January, 2017	18 to 52
100	February,2017	20 to 54
1137	Total (year)	18 to 64

Note: Length in centimeter (cm), sample size in numbers.

Stock assessment of *P. tenuispinis* landed at Veraval: Probability of Capture: The probability of capture at which length 50% *P. tenuispinis* using trawl net type selection was estimated during the analysis of current observation using FiSAT software were 27.48cm. (274mm). as shown in Figure-4 probability of Capture on Y-axis and Length classes on X-axis.

Virtual population analysis (VPA) *P. tenuispinis* stock landed at Veraval: The Virtual population analysis (VPA; Fig 4.14) of *P. tenuispinis* stock representing that the predominant mortality size of the stock were below the 170mm (17cm) was due to the causes of natural mortality. This fish stock enter vulnerable stage to the gear when that this *P. tenuispinis* stock

reaches more than 170mm size then the gradually increasing the fishing mortality and exceeds the natural mortality. The highest fishing mortality of *P. tenuispinis* stock at Veraval estimated by VPA was 1.42 at Veraval during current study, which is at 350mm (35cm) length class. The mean fishing mortality (F) calculated was about 0.66. The maximum steady state biomass was 870.74 tonnes at which fishing mortality and length 1.06 and 290mm respectively.

Estimation of Maximum Sustainable Yield (MSY) using Gulland[7]: Present study estimated total biomass of *P. tenuispinis* landed at Veraval were about 5052.422t, total mortality was 1.77 and Estimated MSY were 4471.394 t.

Estimation of the Management reference points using Thompson and Bell model[9] for the *P. tenuispinis* stock landed at Veraval: The current study for the stock assessment

of *P. tenuispinis* was estimated management reference points for the purpose of *P. tenuispinis* fishery exploitation and predicted limits for the establishment of appropriate management regulatory limit for the further sustainable harvesting measures and economically best possible catch limits for these. Thin spine sea catfish stock were suggested for the fishery management of P. tenuispinis at Veraval. The estimated maximum biomass, spawning stock biomass (SSB), Maximum sustainable yield (MSY) and Maximum Economic yield was during the present study was 34301.9 tonnes, 29801.3 t, 4766.7 t and 252952010.1 rupees, respectively at various levels of the f-factor. The MEY and MSY were estimated during this year for these Thinspine Sea catfish catch at Veraval was about 25.29 corers and 4766.7 t, which at f- factor at 0.6 and 0.8, respectively. Results of the study were presented in the Table-4 and Figure-4.15 and 4.16 on results of Thompson and Bell model.
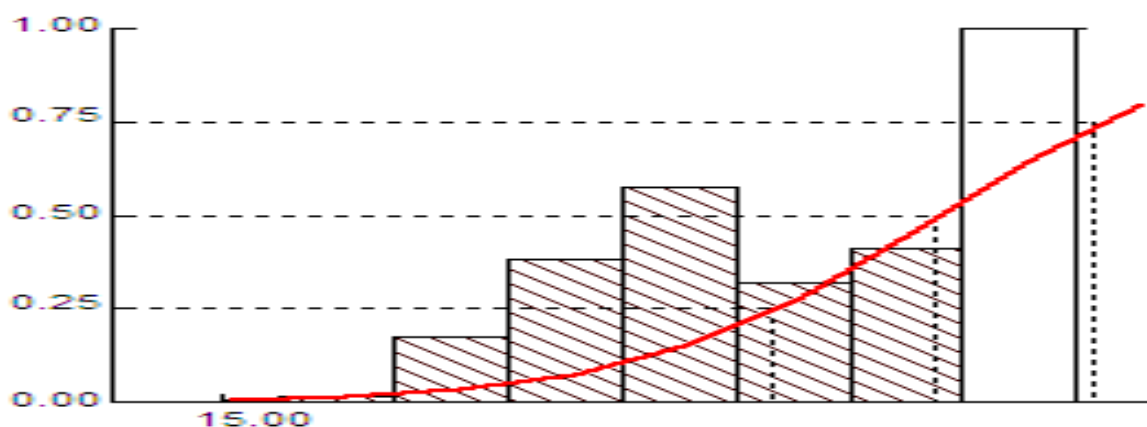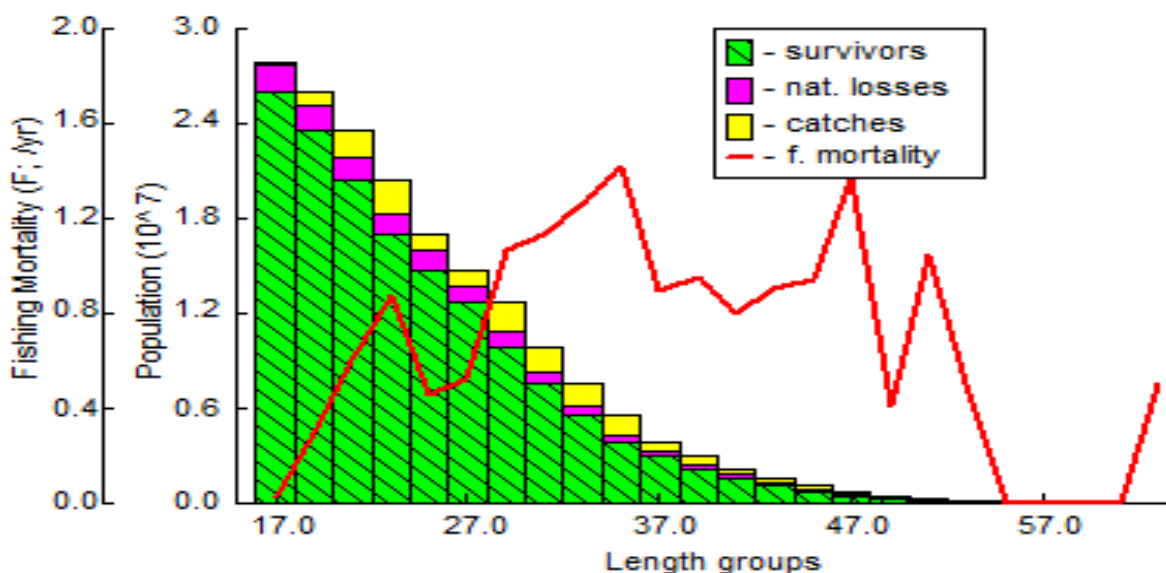

Figure-4: Probability of Length at 50% Capture (Lc50); (Note: figure generated by FISAT-II Software programme).

a=0.012; b=2.958; M=0.54; L in f = 66.5cm K= 0.35
Figure-5: Virtual population analysis of *P. tenuispinis* (Note: figure geanrated by FISAT-II Software programme).

Table-4: Results of management reference points using Thompson and Bell model[9] for the *P.tenuispinis.*

Factor-f	Yield(t)	Biomass(t)	Value(Rupees)	SSB(t)
0.0	0.0	34301.9	0.0	29801.3
0.2	2908.4	21475.8	181513797.3	17345.3
0.4	4166.7	14243.3	242263027.2	10441.3
0.6	4649.2	9998.9	252952010.1	6489.2
0.8	4766.7	7406.1	243689109.5	4157.1
1.0	4716.9	5755.3	227464430.2	2739.3
1.2	4595.6	4659.2	209801973.7	1851.9
1.4	4448.9	3900.4	192926066.2	1280.6
1.6	4298.8	3354.0	177610067.2	902.8
1.8	4154.8	2946.0	164006870.4	647.0
2.0	4021.0	2631.4	152021631.8	469.9
2.2	3898.2	2381.9	141476363.3	345.0
2.4	3786.1	2179.4	132179808.3	255.6
2.6	3684.0	2011.6	123954657.5	190.6
2.8	3590.9	1870.2	116646038.1	143.0
3.0	3505.7	1749.3	110122202.0	107.7
Maximum	4766.7	34301.9	252952010.1	29801.3

Note: f-factor = fishing mortality factor, SSB= spawning stock biomass, t= tonnes, value in rupees.
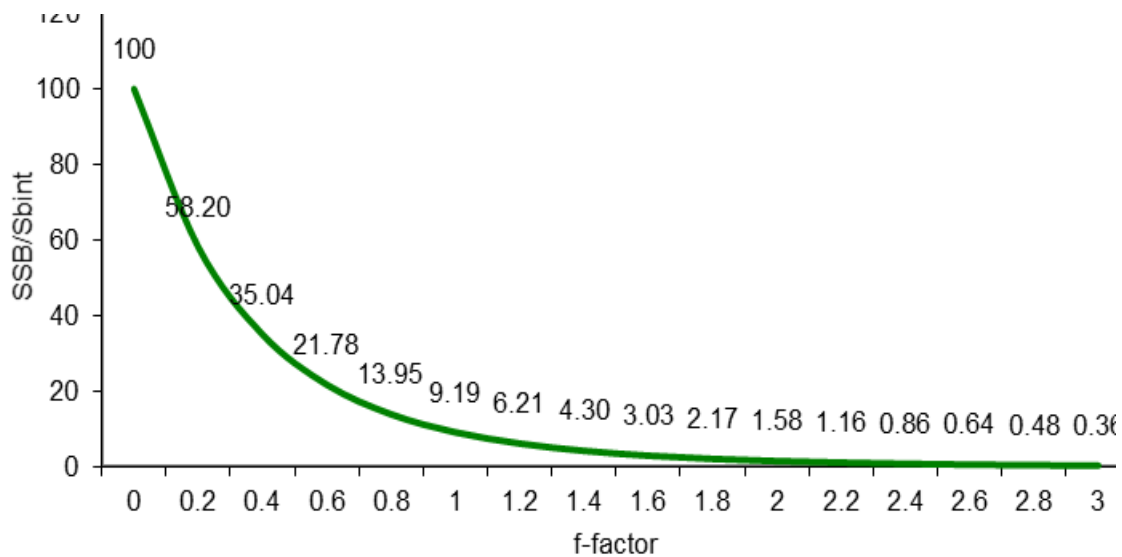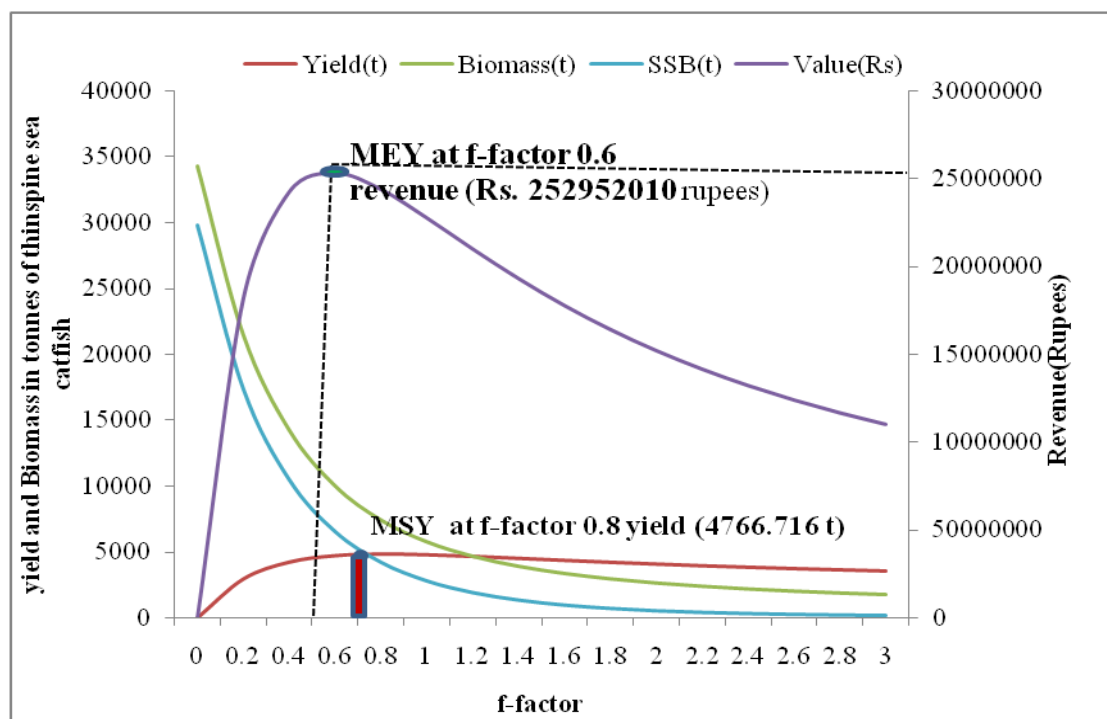

Spawning stock Biomass
Figure-6: Relative yield percentage of *P tenuispinis* at different levels of f- factor.

Note: ⬭ = point denoting Maximum economic yield (MEY) revenue in rupees,
🟥 = points indicating Maximum sustainable yield (MSY) in tonnes
Figure-7: Estimated management reference points for the *P tenuispinis* stock landed at Veraval.

Earlier studies on cat fishes were carried out in various localities on *P.tenuispinis,* Dan[15]; Dan and Mojumder[16]; Das *et al*[17]; Sahar *et al*[18]; Hashemi*et al*[19]. On *Tachysurus dussumieri* Menon *et al*[20]. While on the stock and exploitation of two major species *Tachysurus thalassinus* and *T. tenuispinis*, Menon *et al*[21]. On the Stock assessment of soldier catfish *Osteogeneiosusmilitaris,* Deepak Gulati *et al*[22]. *Arius caelatus* and *Arius thalassinus,* Sawant and Raje[23]. Estimates of age, growth and mortality of spotted catfish, *Arius maculates* were studied by Wu-Shan Chu *et al*[24].

The present study findings were suggested for the fisheries management purpose with few problems and recommended management strategies after few more similar studies at landing centre such as i. As the breeding season of *P. tenuispinis* were noticed that is extended from March to June, currently followed seasonal ban (June to August) at Veraval were does not preventing the harvesting of spawners from their overexploitation. It suggested to enforce regulatory measures during the right season of closure or restrict the catching of *P. tenuispinis* at Veraval during its single extended peak breeding season from the March to June. ii. It is observed that there is a size specific demanding of the consumers for the matured individuals of these fishery due to its taste larger edible ripe eggs contains within the ovary or bucco-oral cavity of fishes, recommended to imposing the excess fine than the value of the catch in demanded market for reducing the irresponsibility of fishermen and complete seasonal banning or restricting of

catching of wild brooders of *P. tenuispinis* during breeding season of March to June. iii. Lessen the current level exploitation efforts by reducing the size of the fishing fleet. iv. Decreasing chances of excess quantity of landings, following the allowable catch limits. v. Reduce the size of the massive harvesting advanced gears and restrict the entry of crafts, equipment's, other accessories and specifically irresponsibleexploitation of fishery catch. vi. Cease should be impose on the process of harvesting which causes bottom habitat destruction, gear causing ghost fishing, heavy pollution at feeding and breeding grounds of these species. vii. The fishery landings of *P. tenuispinis* advisable to be monitored during the random sampling among the mixed fishery, viii. It is recommended to be with equality in enforcing proper evidence while recording the activity involving towards violence, before Strictly cease the vessels for the short time as long time ban on a vessel may effects the specific boat dependent fishermen livelihoods of crew workers up to one or two months is optimum time suggested for the re-entry of ceased vessels for fishing to ensure their responsible to create awareness and alerts among the individuals of boat owners, for others to alerts as stock conservation measures. ix. During the banning any alternative employment opportunities as net mending, boat repairs, coastal aquaculture, seaweed farming, marine aquaculture practices as cage culture, similar activities need to be trained in prior to the seasonal closure for the welfare of fishermen and daily working laboursin the fisheries dependent occupation and practically feasible new best management

strategies need to be implemented after careful prior trialsin suitable situations for their livelihood development should be suggestible. x. Fishermen and handling workers are more commonly involve in the harvesting of catfishes, they are commonly inflicted with the sharp pectoral and dorsal spines of catfishes which cause very painful, excess bleeding, swelling of inflicted part, headache, fever among the individuals affected with the catfish spines, as preventive measures suggested here as given – a. Avoid negligence and be careful in see and handle during harvesting of catfishes and their handling until their spines completely removed from catfishes body parts in processing. b. Commonly inflicted place on handling workers as reported during direct interactions during the current study were lower edge tip of the feet's, whole bare hands fingers, sometimes other body of the fishermen when they are unconsciously fall down. As preventive measures handling workers suggested to work in night in the presence of light, wear strong preventive handling gloves both in hands and feet's. All the vessels involving in the catfish harvesting should carry with first aid kits on vessels, medicines and other necessary accessories of requirements for the short time pain relief from inflicted spines to the individuals on the vessels.

There should be with preplanned after proper assessment for enforcing best management strategies and to regulate the overexploitation of the *P. tenuispinis* stock, as the existing conditions of the fishery catch is more than that of maximum sustainable yield as estimated from the present stock assessment study on *P. tenuispinis*.

It isnecessary to recommended a regulatory measures for optimizing stakeholders participation in resource use in a responsible, policies for the exploitation of marine catfish fisheries resources at Veraval and enforcing them in action as early as possible. It is suggestible to adequate assessment studies for practicing the fisheries co-management during the implementation policies with the resource users as ecosystem based fisheries management. By incorporating all positive and negative side effects into concerns during the policy implementation after few proper impact assessment studies. The awarenessprogrammes on conservative practices to alert them on time regarding depletedstock, in order get Stakeholders willingness to participate in conservation programme which Suggested to be in resource users or Public Participatory mode.

Conclusion

The current carried out investigations ensuring that the fishery catch of *P. tenuispinis*was occurred with minor variations in the quantity landed during throughout the year of study except during the month of July in which complete fishing ban. The exploitation ratio (E) of the species was 0.69, pointing that the current existing rate of exploitation of the *P. tenuispinis* in the Veraval Centre, was exceeded the Maximum sustainable yield levels. The length at capture (28.48mm) were smaller than that of length at 50% maturity (35cm), indicating catch landed were

immature individuals of the stock, for eumetric fishing, it is recommended to increase the minimum mesh size of trawl net and drift gill net. Since the present excessive fishing efforts were reduced the initial and spawning stock biomass was significantly dragging towards less economic returns from the exploitation.

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