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Surge Pricing and Catch - Income Sustainability Paradox in Marine Fisheries in Maharashtra

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ABSTRACT

Demand for marine fish is a function of availability and practically enjoys inelastic demand in Mumbai. This paper examines the catch sustainability-income paradox that negates real income improvements of fishers in Maharashtra in the long run. The income scenario of the marine fishers in Maharashtra has not been too encouraging. Rise in prices have been inversely related to decline in landings in Maharashtra. The prices of premium species have surged manifold over the last 15 years. The threshold limits of select species or specie groups that have touched sustainability bounds and limits to which income of fishers can be increased, if at all, from this perspective has been examined. An analysis of income dynamics based on the Schaefer model or the "surplus production models" was estimated with data on aggregate fishing effort and the total production obtained from the stock. The overall growth of fish landings in Maharashtra has been declining by as much as (-) 15.48 per cent during 2000-2016, indicating a declining fishery in coastal Maharashtra. Given the scenario of overfishing, the increased income of the fishers may be attributed to the demand for fish. Ways to improve the income of the Maharashtra marine fishers is to regulate and implement the code of conduct for responsible fisheries strictly, enforce ban on purse seiners, strictly ban mechanised vessels in near shore waters, delicense vessels to achieve ideal fleet strength etc. Proactive forward looking policies that decry the demand for marine fishes below table size and a tax on landing of juvenile fishes would perhaps help contain the unsustainable fishing operations, ensuring sustained modal income for fishers.

Keywords: Catch sustainability, marine fish species, income dynamics, Maharashtra

JEL.: Q17, Q21, Q22,

I

INTRODUCTION

The Government of India looks to doubling farmers' income by 2022, the 75th year of India's Independence. *Pradhan Mantri Matsya Sampada Yojana, Krishi Sinchai Yojana'*, such as *Accelerated Irrigation Benefits Programme*, *Har Khet Ko Pani*, and *Per Drop, More Crop* are the programmes that have been developed to enable this doubling. One of the most consistent performers of the sub-sectors of the agricultural sector is fisheries. The current total fish production of 12.32 million metric tonnes constitutes about 6.3 per cent of the global fish production. The sector contributes to 1.1 per cent of the gross domestic product (GDP) and 5.15 per cent of the Indian agricultural GDP. The recently announced Prime Minister Matsya

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Sampada Yojana (PMMSY) is biggest shot in the arm for the fisheries sector which has catapulated its importance in the national scenario.

The performance of the marine fisheries sector in India has been declining. The percentage contribution of marine fisheries sector to total landing was 13.88 per cent in year 2000, 13.82 per cent in 2004, 11.05 per cent in 2008, 8 per cent in 2012 and in 2016. But for the diversification into aquaculture, the quantity of fish production in the country would have declined dramatically. On the contrary, active fishers in coastal villages in marine fisheries have been increasing over the years at a compound growth rate of 3.13 per cent almost in consonance with population growth of 3 per cent (Sathiadhas and Pratap, 2009). The income scenario of the marine fishers has not been too encouraging. At the sectoral level, incomes have been declining, but income distribution is skewed in favour of mechanised and motorised fishers (Sathiadhas *et al*., 2014). Again the bulk of the marine fishers are the artisanal fishers whose livelihood is threatened by depletion of resources as well as institutional weaknesses. Increased fish production alone does not ensure increased incomes. Increase in income to marine fishers is basically a function of weather risk, institutional support including insurance, market structure, conduct and performance as well as threshold of sustainability of fishery. But demand for marine fish is (now) a function of availability and practically enjoys inelastic demand (Robinson, 2011, Etzold and Christmas, 1986, Rosenthal, 1985) in Mumbai (Debnath, 2011).

In 2016, the share of Maharashtra in total fish landings in India was just 8 per cent with a coast line of 720 Kms (Table 1). Therefore, there is an urgent need to focus our attention on Maharashtra fisheries, fishers and their income levels. The Indian mackeral or *bangda* catch in Maharashtra has fallen by almost 63 per cent between 2010-11 and 2014-15 according to estimates of annual fish landings. The quantity of horse mackerel or *kharba bangda* has fallen by almost 83 per cent during the same period. While the traditional *bombil* or Bombay Duck has also taken a hit, registering a 19 per cent decline, the species that is abundant on the Maharashtra coast is the sardine or tarli. Overfishing can explain the decline of several species including Bombay Duck. The decline in mangrove cover has also impacted the breeding ground for fish including small shrimps, the red snapper and the perch. Red snapper catch has declined by 47 per cent in the five-year period, while that of small shrimps has dropped by almost 20 per cent. The landings for perch have fallen by 30 per cent in the same span of time. The overall trend in Maharashtra for the last several years has been a decline in fish stock and catch (CMFRI, 2016, Government of Maharashtra, 2017).

TABLE 1. SHARE OF MAHARASHTRA IN TOTAL FISH LANDINGS IN INDIA (2000-2016)

(*per cent*)

State/Year	2000	2004	2008	2012	2016
(1)	(2)	(3)	(4)	(5)	(6)
Maharashtra	13.88	13.82	11.05	8.00	8

Rise in prices have been inversely related to decline in landings in Maharashtra. The prices of premium species have shot up manifold over the last 15 years. Hilsa Ilisha for example recorded a 400 per cent hike in prices over the period 1997-98 to 2015-16, Pomfrets over 600 per cent and even, the mackeral over 800 per cent. In 2014, the valuation of marine fish landings from Maharashtra stood at INR 36,732 billion (USD 489 billion).[1] In 2015, it was INR 50,378.08 billion (USD 683 billion). As far as share of consumer rupee to the fisher is concerned, Oil sardine nets 57 per cent of the consumer rupee; Indian mackeral (59 per cent), Anchovies (62 per cent), Soles (57 per cent); Threadfinbreams (48 per cent); Carangids (71 per cent); Rays (67 per cent); Tunnies (52 per cent); Ribbonfish (56 per cent); Squids (59 per cent); Cuttle fish (52 per cent); Penaeid shrimps (69 per cent); Seer fish (76 per cent); Black pomfret (92 per cent) (CMFRI, 2017).

The major constraints, according to noted economists, for doubling of income are low Minimum Support Price (MSP), non-remunerative prices in the market, low share of farmers in the final price, poor penetration of crop insurance, high and increasing input cost, absence of market infrastructure and past record of modest growth compared to 12 per cent needed for doubling in nominal terms (20 to 30 per cent in real terms) (Satyasai and Bharti, 2016). While much of these arguments hold good for low incomes for fishers, these constraints are compounded by climate risk and institutional infirmities.

However, this paper is based on the argument that increased fish production alone does not ensure increased incomes. Increase in income to marine fishers is basically a function of weather risk, institutional support including insurance, market structure, conduct and performance as well as threshold of sustainability of fishery.[2] However the scope of this paper is limited to examining the threshold limits that select species or species groups have touched in terms of sustainability and limits to which income of fishers can be increased if at all, from this perspective. This paper thus addresses the issues of the current status of marine fishers' income at the sectoral level in the state of Maharashtra and examines the possibility of doubling the fishers' income. It also documents the leakages in the system that needs to be plugged in order to help fishers get a higher income.

II

DATA AND METHODOLOGY

An analysis of income dynamics must be based on time series data. Unfortunately, in India no such series is available on farmers' income, leave alone that of fishers. The National Accounts Statistics, published by the Central Statistical Organization (CSO) of the Ministry of Statistics and Programme Implementation of the Government of India, provides estimates of the gross as well as net domestic product from agriculture and allied activities and the value of output of various agricultural commodities, but not of the incomes from sources other than agriculture and allied activities. Occasionally, it also provides estimates of rural income (not farmers' income) and its components at all-India level (Birthal *et al*., 2017).

Surplus production models were introduced by Graham (1935), but they are often referred to as "Schaefer-models". The "surplus production models" can be estimated with data on aggregate fishing effort and the total production obtained from the stock. It does not require any details such as the growth and mortality parameters or the effect of the mesh size on the age of fish captured, etc. The objective of the application of "surplus production models" is to determine the optimum level of effort, i.e., the effort that produces the maximum yield that can be sustained without affecting the long-term productivity of the stock or the maximum sustainable yield (MSY). The theory behind the surplus production models has been reviewed by many authors, like Ricker (1975) and Gulland (1983).

Since holistic models are much simpler than analytical models, the data requirements are also less demanding. There is, for example, no need to determine cohorts and therefore no need for age determination. This is one of the main reasons for the relative popularity of surplus production models in the tropical fish stock assessment. Surplus production models can be applied when data are available on the yield (by species) and of the effort expended over a certain number of years. The fishing effort must have undergone substantial changes over the period covered (Sparre and Venema, 1998; McAllister *et al.,* 2001, Imanuel *et al*., 2017).

The maximum sustainable yield (MSY) can be estimated as follows;

$f(i)$ = effort in year i, $i = 1,2,...,n$

Y/f = yield (catch in weight) per unit of effort in year 'i'.
Y/f may be derived from the yield, Y(i), of year 'i' for the entire fishery and the corresponding effort, f(i), by

$$Y/f = Y(i)/f(i),\ i = 1,2,...,n \qquad ....(1)$$

The simplest way of expressing yield per unit of effort, Y/f, as a function of the effort, f, is the linear model suggested by Schaefer (1954):

$$Y(i)/f(i) = a + b*f(i) \text{ if } f(i) \leq -a/b \qquad ....(2)$$

Eq. 2 is called the "*Schaefer model*"
For Schaefer model, MSY and f_{MSY} is estimated as follows;

$$MSY = -\,a^2/(4b)$$

$$f_{MSY} = -\,a/(2b)$$

The slope, b, must be negative if the catch per unit of effort, Y/f, decreases for increasing effort, f. The intercept, a, is the Y/f value obtained just after the first boat fishes on the stock for the first time. The intercept therefore must be positive. Thus, -a/b is positive and Y/f is zero for f = -a/b. Since a negative value of catch per unit of effort Y/f is absurd, the model only applies to f-values lower than -a/b.

Data on species wise landings were collected from CMFRI landing statistics over the period 1997-2016. Also the landing prices of major species at Mumbai for the same period of time from Department of Fisheries (DoF), Maharashtra. For easier handling of Species wise, data were divided into 4 major groups, i.e., demersal, pelagic, molluscs and crustaceans. The simple criterion proposed by Mohamed *et al.* (2010) was used to assess the present status of different resources by classifying them into five groups viz., abundant, less abundant, declining, depleted and collapsed (Table 2). The prices were also similarly grouped and deflated using fish price index of FAO (2001-02 base prices) (Tveteras *et al.*, 2012).

TABLE 2. CRITERIA USED FOR FISH STOCK CLASSIFICATION (MOHAMED *ET AL.*, 2010)

Stock classification (1)	Recent average catch in historical maximum (per cent) (2)
Abundant	> 70
Less abundant	50 – 69
Declining	11 – 49
Depleted	6 – 10
Collapsed	< 5

III

RESULTS AND DISCUSSION

In order to understand the relationship between the total fishing effort (AFH) and catch per unit effort (CPUE) in the overall perspective of the Maharashtra fisheries, data were collected from the Handbook of Fisheries Statistics (2016) for the period 2000 to 2016. The model given in equation 2 above was used to estimate the value of the parameters. The fitted model gave the result $y = 77.01 - 3.42*10^{-6}x$ with the correlation coefficient r = - 0.91. Based on the 'r' value, it can be said that there is a strong but negative correlation in Maharashtra fisheries, implying that CPUE and effort are negatively correlated.

The regression coefficient, $b = -3.42*10^{-6}$ explains that standard effort and CPUE are inversely related, when standard effort decreases, CPUE increases. The determination of the coefficient R^2 = 83.27 per cent implies 83.27 per cent of the variation in CPUE is explained by effort. The correlation coefficient (-) 0.91 implied that the correlation between CPUE and standard effort was quite strong (Figure 1). From the analysis, it was found that carrying capacity K = 8,65,917 tonnes yr^{-1} and MSY was 4,32,959 tonnes yr^{-1} (Figure 2). The maximum yield that can be caught from the Maharashtra coast is 4, 32,959 tonnes yr^{-1} and the optimum level of effort to achieve the MSY level is 1,12,43,517 hours yr^{-1}.

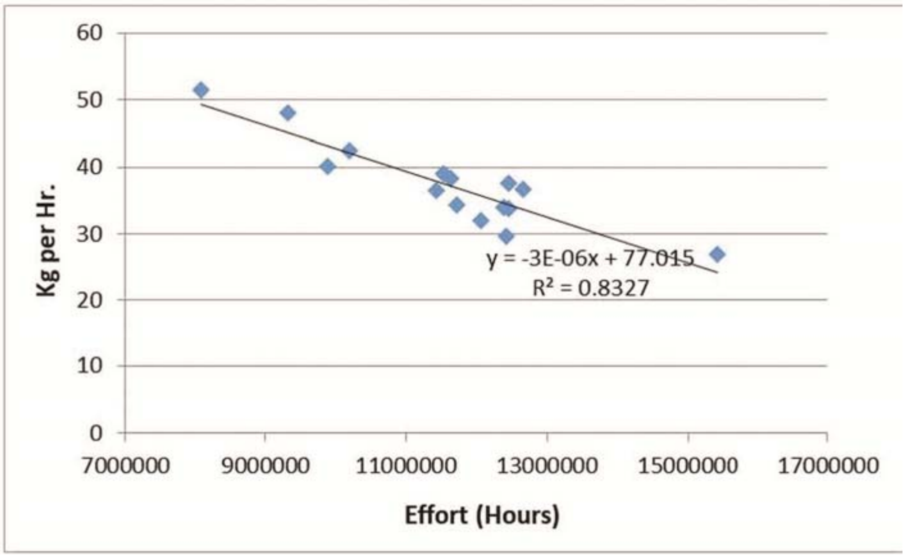

Figure 1. CPUE Schaefer of Maharashtra Marine Fish Landing.

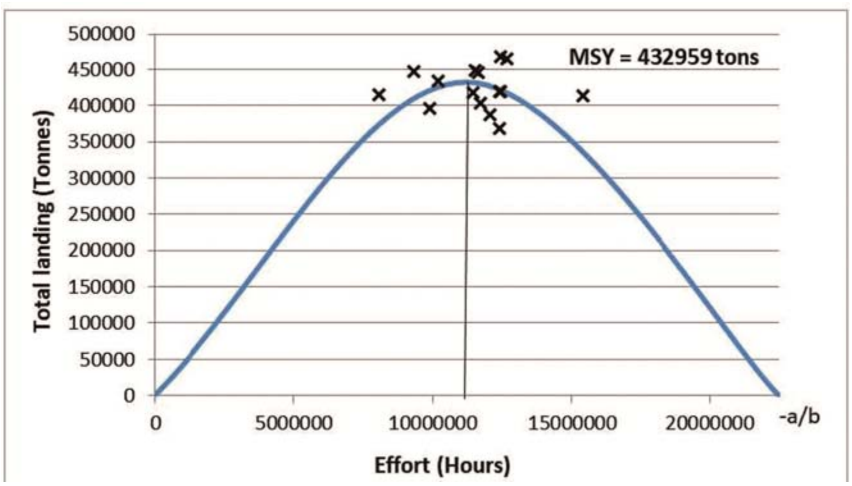

Figure 2. Schaefer Stock Equilibrium Curve (MSY) of Maharashtra Marine Fish Landing.

It can be seen from Figure 3 that landings of all species groups are relatively displaying similar performance. Though there is a marginal decline in the landings of the various species over 2000-2016, it may not yet be considered precarious.

The different resource groups were classified following Mohamed *et al*. (2010), it was found that only demersal fishers were 'abundant' and the other three groups were 'less abundant' viz. Pelagic, Crustaceans and Molluscs (Table 3). This classification based on resource group does not reflect the ground truth, when specie wise classification within each group is examined.

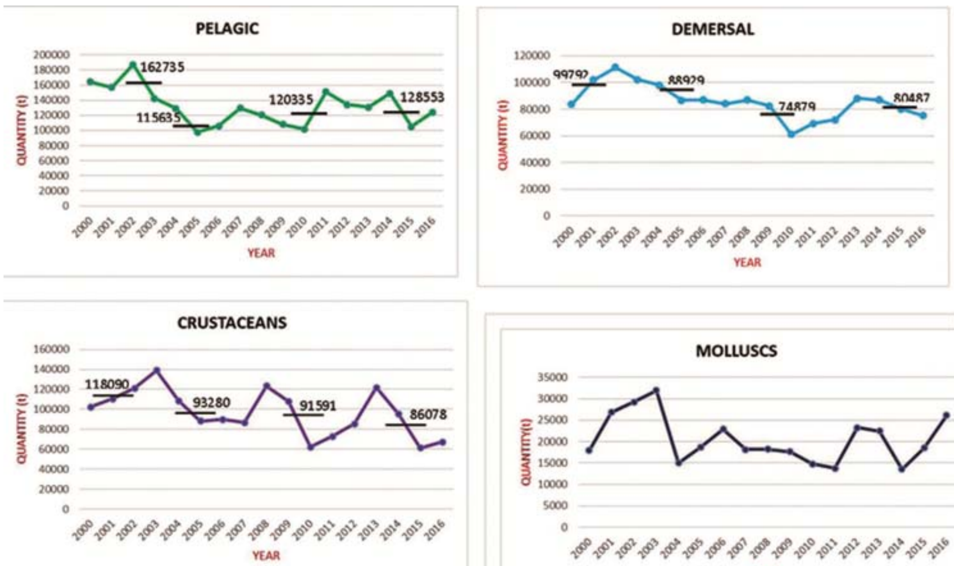

Figure 3. Trends in Landing of Marine Fishes in Maharashtra (2000-2016).

TABLE 3. CLASSIFICATION OF DIFFERENT RESOURCE GROUPS BASED ON LAST THREE YEARS (2014-16) AVERAGE LANDINGS

Group (1)	Av. landings 2014-16 (2)	Max. landings 2000-16 (3)	Year of Max. landing (4)	Per cent of total landings (5)	Status (6)
Pelagic	125966	187221	2002	67.28	Less abundant
Demersal	80797	111228	2002	72.64	Abundant
Crustaceans	74470	138756	2003	53.67	Less abundant
Molluscs	19399	31964	2003	60.69	Less abundant

Data source: CMFRI report.

Table 4 shows the status of different species within each group in Maharashtra. It can be seen that nearly 50 per cent of the species in the pelagic resource group in the Maharashtra were enjoying a healthy status. They were either abundant or less abundant. Of the balance 50 per cent, 42 per cent was in a declining status and only 8 per cent were depleted. Only the Clupieds was found to be in abundant status and species which were in less abundant status were Sardines, Anchovies, Bombayduck, Carangids, Mackerals, Barracudas, etc. Unfortunately most of the high value species like Seer fish, Tunnies, etc. were in declining status.

Though demersal resource group was enjoying a healthy status, species wise classification showed that only 63 per cent of the species were in healthy status and the remaining 37 per cent were in declining status. Species such as Catfishes, Perches, Goatfishes, Silver Promfret, Millets, etc. were in abundant and less abundant status while species such as Threadfins, Eels, Elasmobranchs, Black pomfrets, etc.

TABLE 4. CLASSIFICATION OF DIFFERENT RESOURCE GROUPS BASED ON LAST THREE YEARS (2014-16) AVERAGE LANDINGS

Group (1)	(2)	Av. landings 2014-16 (3)	Max. landings 2000-16 (4)	Year of Max. landing (5)	Per cent of total landings (6)	Status (7)
PELAGIC	Sardines	26771.2	46072	2011	58.1	Less Abundant
	Anchovies	11872.2	18530	2002	64.1	Less Abundant
	Clupeids	7339.3	9361	2014	78.4	Abundant
	Bombayduck	21398.9	33123	2014	64.6	Less Abundant
	Ribbon fishes	14608.2	67522	2002	21.6	Declining
	Carangids	12841.7	19279	2003	66.6	Less Abundant
	Silverbellies	262.6	3195	2004	8.2	Depleted
	Big-jawed jumper	1103.9	2589	2010	42.6	Declining
	Mackerels	19935.8	37313	2000	53.4	Less Abundant
	Seer fishes	6273.0	13256	2002	47.3	Declining
	Tunnies	4102.4	10766	2008	38.1	Declining
	Bill fishes	276.4	2023	2011	13.7	Declining
	Barracudas	1013.4	1862	2012	54.4	Less Abundant
	Unicorn cod	240.6	1017	2012	23.6	Declining
DEMERSAL	Elasmobranchs	4664.7	14384	2002	32.4	Declining
	Eels	1198.5	3491	2006	34.3	Declining
	Catfishes	10899.4	18422	2013	59.2	Less Abundant
	Perches	18814.9	36350	2003	51.8	Less Abundant
	Goatfishes	713.5	1022	2016	69.8	Abundant
	Threadfins	1168.9	2471	2006	47.3	Declining
	Croakers	28876.6	30783	2002	93.8	Abundant
	Soles	4884.0	6641	2014	73.5	Abundant
	Black pomfret	1546.7	3339	2003	46.3	Declining
	Silver pomfret	5437.4	8035	2014	67.7	Less Abundant
	Mullets	280.2	382	2016	73.4	Abundant
CRUSTACE	Penaeid prawns	33780.3	73196	2003	46.2	Declining
	Non-penaeid prawns	34416.5	86946	2013	39.6	Declining
	Lobsters	428.1	672	2007	63.7	Less Abundant
	Crabs	1425.7	1661	2003	85.8	Abundant
	Stomatopods	4265.2	10498	2000	40.6	Declining
MOLL USCS	Squids	13051.0	21684	2016	60.2	Less Abundant
	Cuttlefishes	5926.6	8785	2006	67.5	Less Abundant
	Octopus	266.4	922	2006	28.9	Declining

Data: CMFRI reports.

were in declining status. In crustaceans group, high value species such as Penaeid prawn, Non-penaeid prawns and Stomatopods were declining while lobsters and crabs were in healthy status. Cephalopods such as Squids and Cuttlefishes from the mollusc resources group were in healthy status while Octopus was declining.

Maharashtra witnessed lowest fish catch in 45 years in 2019, with a steep decline in all the fish species being caught. Fish catch from the western coast of India has declined (CMFRI, 2019). Climate scientists attribute this drop to the increasing pollution, global warming and a decrease in phytoplankton population. The total estimated fish landings (fish catch that arrives at the ports) in the state stood at 201,000 (2.01 lakh) tonnes in 2019 against 295,000 (2.95 lakh) tonnes in 2018, marking a 32 per cent decrease. Most of the fish catch came from Mumbai city district, followed by Raigad and Ratnagiri. Apart from the non-penaeid prawns, every other fish species showed decreased landings in comparison to 2018. The marine fisheries sector in Maharashtra is facing a crisis since the late 1990s. Mechanisation of the state's fishing fleets has resulted in increased effort on fish stocks and, subsequently many stocks had declined, leading to overfishing. The indicators of over-exploitation of state fish resources are primarily a decline in capture rates of prime quality fish, a change in the composition of catches and a shortening of the fishing season from 8-9 months earlier to less than six months later. As per the 2010 Marine Fisheries Census Report, the State had 17,362 fishing vessels, of which 75 per cent were mechanised. Trawler and purse-seine fishing fleets have developed overcapacity (twice the optimal) as a result they are fished out beyond the capacity of fish to reproduce and replace the exploited stocks. In addition to the intense fishing pressure and increased fishing efforts; juvenile fishing, industrial and domestic pollution in some pockets around coastal cities, destruction of habitats and reduction of mangrove vegetation, together with vagaries of climate change, have led to a decrease in catch and impacted recruitment patterns of commercially important fish resources, leading to a loss of fish stocks in the Maharashtra waters. The weather issues are also a consequence of climate change. The ocean surface warming in the Indian Ocean during the past century is up by 1.2 degrees Celsius, compared with a global surface warming of up to 0.8 degrees Celsius during the same period. Extreme weather patterns, extended rainy season and continuous large-volume exploitation of young fish/juveniles are the major reasons for low catch. These extreme weather events are the result of climate change and are likely to increase in the coming years (NABARD, 2018, CMFRI, 2019).

Figure 4 shows current prices of pelagic fishes have been rising steadily over the period 1997-98 to 2015-16. It has increased from INR 12,981.76 per tonne to INR 1, 13,516.64 per tonne (USD 176 per tonne to USD 1,539 per tonne). Within this group, the species that had contributed to this steep increase in prices was seer fishes, which increased from INR 43,887.20 per tonne to INR 3, 90,411.68 per tonne (USD 595 per tonne to USD 5,293 per tonne) over the same period of time indicating an 889 per cent increase in nominal prices.

As far as demersal fishes were concerned the rise in prices was disconcertingly steep over the same period of time. It had risen from INR 39,387.84 per tonne in 1997-98 to INR 2, 23,271.52 per tonne in (USD 534 to USD 3,027 per tonne (550 per cent)) in 2015-16. The major contributor to escalation of prices in this group is pomfrets whose prices rose from INR 1, 09,976.16 per tonne to INR 6,53,439.84 per tonne (USD 1,491 to USD 8,859 per tonne (600 per cent)) during the same period of time.

Similar to the other two groups, the prices of crustaceans have escalated manifold over the period 1997-98 to 2015-16. Crustaceans consist of penaeid prawns, non-penaeid prawns and lobsters. This group, as is well known, commands the highest prices in the export market. The prices of species within this group rose from INR 1,27,604.80 to INR 4,82,390.40 per tonne (USD 1,730 to USD 6,540 (400 per cent)) over 1997-87 to 2015-16. The major species that contributed to rise was lobsters which alone rose from INR 3, 21,446.08 to INR 1,11,73,669.12 per tonne (USD 4,358 to USD 15,912 (350 per cent)).

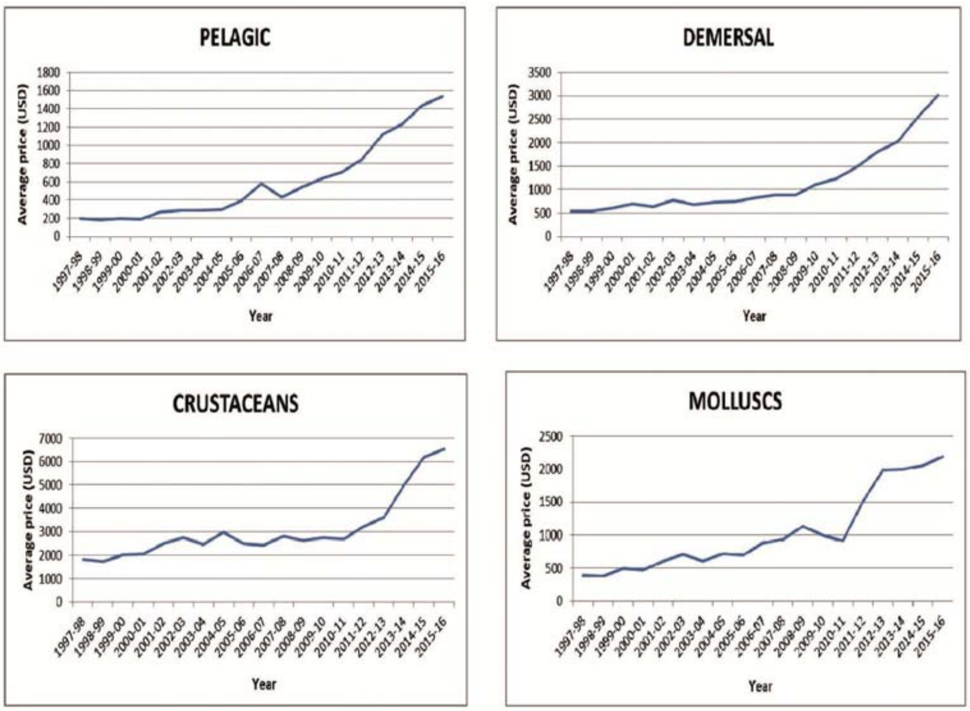

Figure 4. Trends in Current Prices of Marine Fishes (Boat Side) (1997-98 to 2015-2016).

It was only in the case of molluscs that the price rise was not steady. Molluscs are aquatic animals that are consumed locally. It is only of late that their consumption has become more widespread. The export market for molluscs has also only developed lately. This can be seen from the trend in rise in prices for molluscs during 1997-98 to 2015-16. Prices had increased from INR 28,176.32 to INR 1,61,239.36 (USD 382 per tonne to USD 2,186 (600 per cent)) during this period of time.

It can be seen from Figure 5, that the real prices of fish groups have been increasing overtime indicating that the landings have been fetching higher prices. In relative value terms, the real prices of crustaceans have increased from a low of INR 1, 95,021.44 to INR 4,62,475.20 per tonne (USD 2,644 to more than USD 6,270 per tonne) over the period 2003-2016, indicating a 237 per cent increase in real prices over an 14-year period. Crustaceans, primarily shrimps, are an export species and obviously this has contributed to rise in value realisation from the exports of these species. The prices of demersal group and pelagic group and molluscs have also been rising significantly overtime indicating rising income of the fishers as the prices considered here are landing centre prices (*a la*, farm gate prices).

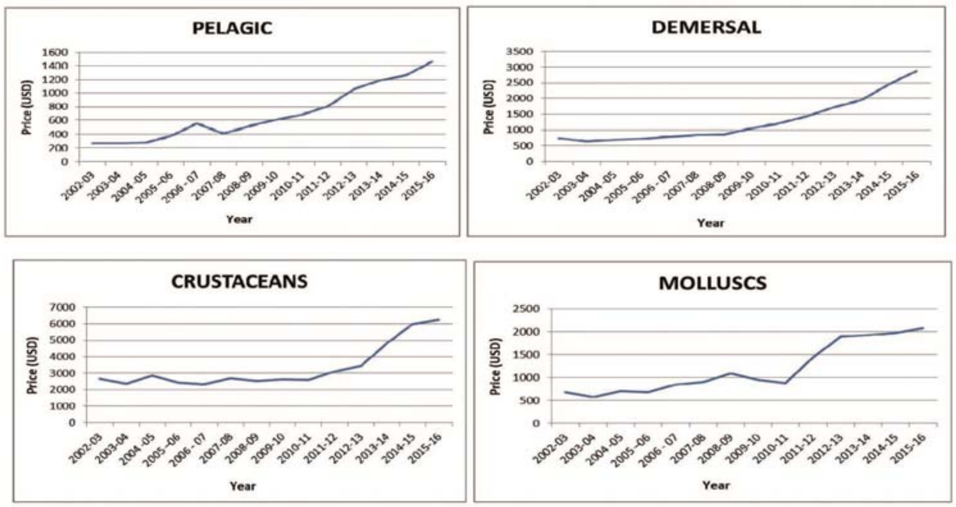

Figure 5. Trends in Real Prices of Fish Groups (2003-2016).

It can be seen from Table 5 that the overall growth of fish landings in Maharashtra has been declining by as much as (-) 15.48 per cent during 2000-2016, indicating a declining fishery in coastal Maharashtra. The year on year growth of different groups also shows a declining trend in most years, except that of molluscs, which shows great potential in overall growth. Growth rates of crustaceans (includes shrimp, that have maximum export market) have been declining dangerously by as much as (-) 30.27 per cent. Pelagic fishery is declining by (-) 19.64 per cent and demersal by (-) 4.30 per cent.

TABLE 5. COMPOUND GROWTH RATES OF MARINE FISH LANDINGS IN MAHARASHTRA (2000-2016)

Year (1)	Pelagic (2)	Demersal (3)	Crustaceans (4)	Molluscs (5)	Total (6)
2000	-4.49	22.00	7.69	49.30	7.53
2001	19.34	9.01	9.71	9.19	13.31
2002	-23.84	-8.04	14.70	9.20	-7.37
2003	-9.288	-4.18	-21.87	-53.16	-15.61
2004	-24.41	-11.49	-18.65	25.23	-16.90
2005	8.20	0.18	1.87	22.16	4.80
2006	22.54	-3.23	-3.46	-20.78	4.31
2007	-7.19	3.27	42.26	0.49	9.46
2008	-10.18	-5.12	-12.58	-3.24	-9.41
2009	-5.78	-25.93	-42.22	-16.10	-24.06
2010	48.43	13.65	16.93	-7.06	27.98
2011	-11.21	3.87	17.18	69.13	2.53
2012	-2.61	22.28	42.41	-3.63	15.21
2013	13.91	-1.19	-21.69	-39.45	-4.98
2014	-29.43	-7.79	-35.80	36.37	-23.14
2015	18.04	-6.27	9.71	41.06	10.36
2016	-19.64	-4.30	-30.27	54.82	-15.48

Fishers' Income

Figure 6 gives the trend in gross income of fishers in different fish resource group based on landing centre prices (CMFRI, 2016). The gross incomes are the product of landings multiplied by its landing centre price. The gross incomes of fishers in different fish resource group have been increasing overtime indicating that the fishers have been earning higher incomes. The trend in gross income from pelagic fishes has risen from INR 2.36 billion to INR 14.09 billion (USD 32 million to USD 191 million) during the period 2000 to 2016. As far as demersal fishes were concerned the gross incomes were also increasing over time. Similar to the other two groups, the gross income from crustaceans has fallen during the period 2007 and 2010, though it is increasing overtime. This is mainly due to decrease in fish catch during the period. The gross income of the fishers from the mollusc resources groups was also increasing overtime. Thus the current real income of fishers is strictly a function of quantity landed and increasing real prices without consideration of sustainability of the stock.

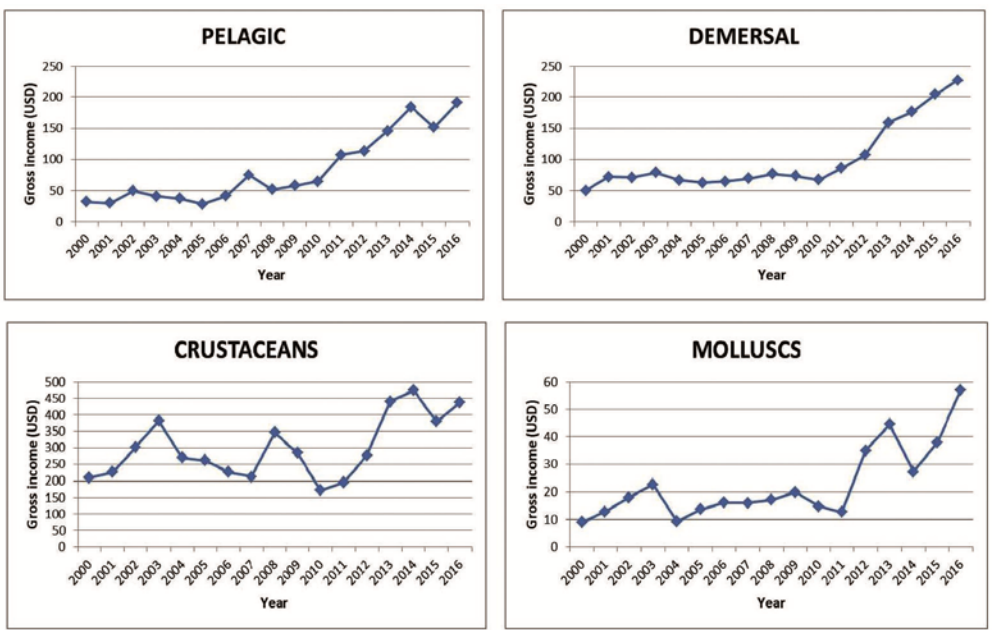

Figure 6. Trends in Gross Income of Fishers from Different Fish Groups (2000-2016).

Catch Sustainability – Income Paradox

It has been seen that (Figure 2) the MSY for Maharashtra fisheries is 4.33 lakh tonnes. The current level of fish production from Maharashtra waters is to the tune of

4.6 lakh tonnes. Therefore, there is approximately overfishing to the extent of 30,000 tonnes. It can be seen that the income of the fishers has been increasing overtime across the different fish resource groups. Given the scenario of overfishing, the increased income of the fishers may be attributed to the demand for fish. It is obvious that the income of the fishers could rise in spite of fishing beyond the MSY limits of Maharashtra fishery as long as the demand for fish exists. This is the typical situation of the tragedy of the commons wherein a common property resource without institutional governance could get fully exploited and goes beyond recovery (Delgado *et al*., 2003).

Under such circumstances the only way to improve the income of the Maharashtra marine fishers is to regulate and implement the code of conduct for responsible fisheries (FAO, 1995) strictly, enforce ban on purse seiners (Chatterjee, 2017), strictly ban mechanised vessels in near shore waters, delicense vessels to achieve ideal felt strength, streamline the functioning of fish landing auction centres, ensure availability of short term credit to fishers for operational expenses, improve fisheries co-operatives by making them independent of political interferences, introduce alternate livelihood options closely related to the fisheries avocation, protect and develop mangrove areas, actively promote voluntary agencies engaged in eliminating social evils like drinking in fisher villages and promotion of education among fishers and fisher families.

Though the objective of the government of India for doubling farmers (fishers) income is noble, there is no one shot solution to double fishers' income. It is only with the concerted effort of the concerned institutions that the negative externalities in price realisation can be eliminated to achieve the full income potential of marine fishers in Maharashtra.

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NOTES

1) 1 USD = INR 73.76 on September 28, 2020.

2) 69 per cent of the 68 fish species studied were found to be vulnerable to climatic changes in Maharashtra. They include Bombay duck, tuna, sharks, various shrimp, pomfret, and catfish, among others. Even though the west coast also has high fishing pressure but it is richer in fish so it is a bit less vulnerable. Overfishing plays a major role in the vulnerability of 16 species. Overfishing leads to increased sensitivity to climatic fluctuations. Vulnerability hinges on the ability of a species to adapt to climatic change. Their spawning patterns, geographic location and the availability of prey would eventually determine their numbers. Species most under pressure include Bombay duck on the western coast, hilsa in the east and the oil sardines found off Tamil Nadu (CMFRI).

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