Distribution, Growth, Instability and Trend Analysis of Marine Fish Production in the Coastal States of India


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Abstract:
The fish production in India from inland and marine ecosystems is estimated as 10.07 million tonnes. Percentage contribution of marine fish production has shown declining trend from 44.08% (2005) to 34.66% (2015) whereas, the inland fish production indicated the increasing trend from 55.92% (2005) to 65.34% (2015). The Compound Growth Rate (CGR), Coppock’s instability of marine fish production for coastal states have been analysed in the present study. The states of Karnataka and Andhra Pradesh have shown high growth and high instability, while the state of Kerala indicated slow down growth and medium range of instability. The states of West Bengal, Maharashtra and Odisha are showing low growth and low instability, whereas, the state of Gujarat and Goa are at medium range of growth and instability. Tamil Nadu state is at the low growth and high instability. Predicted trends of marine fish production have also been analysed based on the data for the period 2005 to 2015.

Keywords: Ecosystems, Coastal States, Compound growth rate, Coppock’s instability, predicted trend

Introduction:
India has a coastline of 8118 kms and has the vast potential for fishery resources. Total fish production in India from Inland and marine ecosystem for the year 2014-15 was estimated as 10.07 million tonnes (CMFRI, 2016). Fisheries sector plays an important role in socio-economic development of the coastal population. The marine fish production is being affected by the several factors such as changes in marine environment, oceanographic changes, pollution and human intervention. With the advent of mechanization and development in the technology of fishing, the exploitation of fishery resources have increased and reached to its Threshold for some species. The distribution, abundance and availability of the resources and their landings are influenced, thereby, the fluctuations in the fish production have been observed. The studies on assessing the compound growth rates, instability in production required to be attempted to understand the status of fish production and fluctuations. Though, these aspects were dealt earlier by various researchers, but their works are limited to fish production pertaining to particular area/ region or exports and other products such as cotton and poultry. Among them, Fauzi and Anna (2010) on Java sea small scale fisheries in changing environment along Indonesia waters, Jeyanthi and Nikita (2012) on the growth and instability in Indian frozen scampi export, Ahmed and Joshi (2013) on analysis of instability and growth rate...

Marine fishery resources very often shows fluctuations in their landings which could be attributed to variations in fishing efforts, temporal fluctuations in environmental variables and natural prey-predator cycles (FAO, 2011). Mohanty (2013) points to the urgency of adopting sea-friendly fishery practices considering the global decline in the marine fisheries production. To understand the growth rates, instability indices of the marine fish production of the coastal states, this paper attempts to access the compound growth rate (CGR), trends in production. The compound growth rates of 9 coastal states of India and instability indices to measure the instability in fish production and predicted forecasting in fish production have been analysed.

Material and Methods:

The data for the study was collected from the Handbook of fisheries statistics, Ministry of Agriculture for the year 2005 to 2015 and the fishery profile of India (Anon, 2015). For each coastal state, fishery production data, the trend lines were drawn and trend lines are used according to the best fit for the data. The equation fitted to analyse the trend is semi-log exponential form i.e. \( Y = e^{A+Bt} \) where, \( Y \) represents production, \( t \) is time period in years, \( B \) = co-efficient, and \( A \) is intercept. Compound growth rate (r) was computed as \( r = (e^B-1) \times 100 \). In a logarithmic form, it can be read as \( r = (\text{antilog of (log 'b')-1}) \times 100 \). To understand the growth performance, year-wise fluctuation, an index of instability as suggested by Coppock (1962) was applied for the analysis. The instability was measured by fitting a long linearised exponential time trend using the equation \( CII = |\text{antiln}\sqrt{\ln V - 1}| \times 100 \),

\[
\text{Where, } \ln V = \frac{1}{(n-1)} \left[ \sum(lnY_{i+1} - lnY_i) - \frac{1}{(n-1)} \sum(lnY_{i+1} - lnY_0) \right]
\]

\[
\text{Where, } n \text{ is no. of years,} \\
\text{Y is value of marine fish production} \\
\text{t is the year.}
\]

Analysis of growth performance and instability applied by Jeyanthi and Nikita (2012), Krishnan et al. (1994), Larson et al. (2004), Piyanshi (2016) was followed in this undertaking. Predicted forecasting of fish production till the year 2017-18 has been attempted by using IBM SPSS statistics version 23 programme.

Results and discussion:

1. Trends of marine fish production in India:

The total marine production in India for the year 2014-15 was about 10.07 million tonnes. About 97% of the contribution comes from the 9 coastal states and the remaining 3% contributed by the 2 UTs and 2 Island groups.

As per the table 1, comparison of total marine fish production of 9 coastal states indicated that, the state of Gujarat has always at its peak from 585 metric tonnes (2005) to 698 MT (2015) followed by Andhra Pradesh (475 MT), Kerala (473 MT), Tamil Nadu (457 MT), Maharashtra (423 MT), West Bengal (178 MT), Odisha (133 MT) and Goa (117 MT).
Table 1. Marine fish production (in ‘000 tonnes) in coastal states during 2004-05 to 2014-15

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>210.7</td>
<td>218.8</td>
<td>240.2</td>
<td>254.8</td>
<td>291.1</td>
<td>293.1</td>
<td>288.6</td>
<td>433.2</td>
<td>414.3</td>
<td>438.2</td>
<td>475.4</td>
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<tr>
<td>Goa</td>
<td>94.81</td>
<td>100.9</td>
<td>98.97</td>
<td>32.26</td>
<td>83.14</td>
<td>81.93</td>
<td>89.96</td>
<td>86.21</td>
<td>73.71</td>
<td>109.5</td>
<td>114.5</td>
</tr>
<tr>
<td>Gujarat</td>
<td>584.7</td>
<td>663.8</td>
<td>670.5</td>
<td>644.5</td>
<td>623.0</td>
<td>678.4</td>
<td>688.9</td>
<td>692.4</td>
<td>693.5</td>
<td>695.5</td>
<td>698.4</td>
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<tr>
<td>Karnataka</td>
<td>171.2</td>
<td>176.9</td>
<td>168.5</td>
<td>175.5</td>
<td>218.1</td>
<td>248.7</td>
<td>340.5</td>
<td>347.3</td>
<td>357.3</td>
<td>389.8</td>
<td></td>
</tr>
<tr>
<td>Kerala</td>
<td>601.8</td>
<td>558.9</td>
<td>598.0</td>
<td>586.2</td>
<td>583.1</td>
<td>570.0</td>
<td>560.4</td>
<td>553.1</td>
<td>530.6</td>
<td>522.3</td>
<td>472.7</td>
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<tr>
<td>Maharashtra</td>
<td>417.7</td>
<td>445.3</td>
<td>464.0</td>
<td>419.8</td>
<td>395.9</td>
<td>415.7</td>
<td>446.7</td>
<td>433.6</td>
<td>448.9</td>
<td>467.4</td>
<td>423.7</td>
</tr>
<tr>
<td>Odisha</td>
<td>121.9</td>
<td>122.2</td>
<td>128.1</td>
<td>130.7</td>
<td>135.4</td>
<td>129.3</td>
<td>133.4</td>
<td>114.3</td>
<td>118.3</td>
<td>120.0</td>
<td>133.2</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>307.6</td>
<td>307.9</td>
<td>387.2</td>
<td>393.2</td>
<td>365.2</td>
<td>401.1</td>
<td>404.6</td>
<td>426.7</td>
<td>428.4</td>
<td>432.2</td>
<td>457.4</td>
</tr>
<tr>
<td>West Bengal</td>
<td>179.5</td>
<td>160.0</td>
<td>178.1</td>
<td>182.7</td>
<td>189.2</td>
<td>179.0</td>
<td>197.1</td>
<td>182.0</td>
<td>152.3</td>
<td>188.2</td>
<td>178.8</td>
</tr>
<tr>
<td>INDIA</td>
<td>2690.3</td>
<td>2755.0</td>
<td>2933.2</td>
<td>2820.1</td>
<td>2884.9</td>
<td>3006.0</td>
<td>3150.0</td>
<td>3269.0</td>
<td>3217.0</td>
<td>3331.0</td>
<td>3344.0</td>
</tr>
</tbody>
</table>

(Source: Handbook on Fisheries Statistics, 2014)

2. State-wise marine fish production trends along the East coast:

The fish production data of Andhra Pradesh fitted in the exponential function as it gave the best fit. The variations in fish production observed to have been 93% over a period of time (Fig. 1). The consistent improvement of marine fish production has been observed during the period 2005-15. The power function gave the best fit to the marine fish production data of the Tamil Nadu state and observed variations are at 87%. The fish production data of Odisha and West Bengal was fitted in the polynomial function of degree 6 and observed 81% and 40% of the variation in the fish production respectively.

3. State-wise marine fish production trend along the West coast:
The logarithmic trend line gave the best fit trend line for the marine fish production for the state of Gujarat and the observed value of variation was 67% whereas, the polynomial trend line degree 2 gave the best fit for Karnataka, Kerala, Maharashtra and Goa and the observed variation values were 91%, 89%, 70% and 64% respectively (fig. 2).

\[
y = 0.0019x^6 + 0.0653x^5 - 0.8066x^4 + 4.3016x^3 + 9.7589x^2 + 10.652x + 117.31
\]
\[R^2 = 0.8112\]

\[
y = 0.0035x^6 + 0.1055x^5 - 1.0738x^4 + 3.3499x^3 + 6.8541x^2 - 43.195x + 212.09
\]
\[R^2 = 0.3993\]
4. Compound Growth Rates (CGR) and Instability Indices:

As indicated in the fig. 3, the Compound Growth Rate (CGR) and the Coppock’s Instability Index (CII) of the 9 coastal states, the states of Karnataka and Andhra Pradesh have shown high growth and high instability, indicating the highest CGR value of 10.41 and 31.27 CII value for Karnataka and 8.98 CGR value 31.07 CII value for Andhra Pradesh. The state of Kerala has shown negative growth (-1.00) and medium range of instability (15.88). The states of West Bengal, Maharashtra and Odisha are showing low growth and low instability the CGR and CII values obtained for West Bengal was 0.10 and 1.82 and of Maharashtra was 0.30 and 3.65. In the state of Odisha, the compound growth rate neither increased nor decreased and instability found to be at 9.33. Though the state of Gujarat has longest coastline (1600 kms) and wider continental shelf and of Goa having the smallest coastline (104 kms) the CGR values for both the states were at medium range of growth and instability. The Tamil Nadu state is at the low growth and high instability. The CII values obtained for all the nine coastal states are in the range of 1.82-31.27 (Table 2).

\[
y = -1.5749x^2 + 9.0511x + 576.1 \\
R^2 = 0.8869
\]

In comparison to the analysis of Lingamurthy (2015) on growth rates of marine fish production of coastal states during 1978-2011 for India, the present analysis of the year 2005-2015 have shown increased growth rates for Andhra Pradesh, Goa, Gujarat, Karnataka, Tamil Nadu. Whereas, Maharashtra and West Bengal has indicated almost similar growth rates while Odisha has shown less growth rate.

<table>
<thead>
<tr>
<th>Coastal States</th>
<th>CGR over last 11 years (%)</th>
<th>CII over last 11 years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>8.98</td>
<td>31.07</td>
</tr>
<tr>
<td>Goa</td>
<td>2.22</td>
<td>13.94</td>
</tr>
<tr>
<td>Gujarat</td>
<td>1.21</td>
<td>13.48</td>
</tr>
<tr>
<td>Karnataka</td>
<td>10.41</td>
<td>31.27</td>
</tr>
<tr>
<td>Kerala</td>
<td>-1.00</td>
<td>15.88</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>0.30</td>
<td>3.65</td>
</tr>
<tr>
<td>Odisha</td>
<td>0.02</td>
<td>9.33</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>3.56</td>
<td>20.79</td>
</tr>
<tr>
<td>West Bengal</td>
<td>0.10</td>
<td>1.82</td>
</tr>
</tbody>
</table>
5. Probable trends of marine fish production in coastal states:

The present marine fish production in the state of Gujarat is 698 MT (2015). As per the fig.4, the Gujarat has shown the predicted trend in growth till the year 2017-18 was 733MT indicated the increase of fish production of about 35 MT. While, the state of Karnataka is indicating the increase of 66 MT by the year 2017-18 when compared to the present production of 445MT. The trend in growth rate in respect of Goa is 88 MT for the year 2017-18 showing decreasing trend when compared to 2014-15 (115 MT). The present fish production in Andhra Pradesh is 475 MT (2014-15) and the predicted trends in growth observed as 546 MT which is indicating 24 MT increase by the year 2017-18. The present trend of fish production in respect of Odisha is 133MT and the predicted trend value showing the decreasing trend by 7% during 2017-18. The trends in growth during 2014-15 in respect of Tamil Nadu were 457 MT an increase of 9% probable growth is predicted by 2017-18. The marine fish production observed for all the states together to be on the higher side for the year 2017-18 as per the present analysis. The nine coastal states contributed 3.34 million tonnes of marine fish production during the year 2014-15 forming 75.54% of the Potential Yield (Anon, 2011) and the predicted trend of marine fish production for the year 2017-18 is 3.59 million tonnes forming 81.41% of the PY showing the increasing trend by 6% in the marine fish production (Fig. 4 a & b).
The state of West Bengal indicated the decreased trend in fish production by 10 MT (2017-18). The present trend in the marine fish production in 9 coastal states observed that though the slight increase in overall fish production but, predicted trend of marine fish production showing increasing trend for certain states and decreasing trend for very few states. Proper planning and implementation of policies envisaged for the exploitation of marine fishery resources is required to be addressed so as to maintain the sustainability.

Conclusion:

It is evident from the present study, the CGR, CII and predicted trend values obtained, indicated further growth in marine fish production in some states whereas a few states are showing decreasing trends. The nine coastal states contributed 3.34 million tonnes of marine fish production during the year 2014-15 forming 75.54% of the Potential Yield and the predicted trend of marine fish production for the year 2017-18 is 3.59 million tonnes forming 81.41% of the PY showing the increasing trend by 6% in the marine fish production. This study provides the understanding of marine fishery resources trends of nine coastal states so that appropriate strategies for development, conservation management could be adopted. In order to develop and maintain the sustainability of the marine fish production, there is a need to provide awareness to the fishermen who are actively involved in fishing to go for modern fishing techniques such as tuna long lining, bottom set vertical long lining to harvest the oceanic resources as well as the resources available in coral and rocky areas and also mid water trawling to exploit the pelagic resources. Proper Marine Fishing
Regulation Act (MFRA) envisaged for the respective states if strictly followed, the states showing the decreasing trends could also be brought to the sustainable level. The researchers who are involved in the assessing the pollution and oceanographic impacts would be very much needed to understand the fluctuations in the fish production. There is scope for increased production and judicious exploitation by adopting appropriate technologies and proper implementation of marine fishing policies.

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Reference: