Resource distribution, growth and strategies for enhancing fish production in north-eastern states of India

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ABSTRACT

Contribution of the eight north-eastern states of India towards national fish production is only 5.9% despite the vast resources available in the region. There is a clear disparity in the total fish production *vis-a-vis* the potential in these states of India. This paper estimates the growth and instability of fish production in the north-eastern states of India relating the performance to the resource availability in the region and suggests strategies for enhanced fish production. Compound growth rates and Coppock's instability index were used to determine the growth and performance of fish production in these states. Assam emerged as the state producing the maximum quantity of fish among the eight north-eastern states during the period 1999-2010. The share of Tripura was 16% and only 13% of the total fish production was contributed by the other six states. In terms of productivity, Manipur followed by Tripura and Mizoram head the table. There is considerable scope for improving the performance of fisheries sector in the north-eastern states of India by adoption of appropriate technologies and up-scalable models.

Keywords: ARIMA, Fisheries, Growth trend analysis, North-east India

Introduction

The total fish production in India for the year 2012 was 8.67 million t (DAHDF, 2013). This comprised contributions from both the inland and the marine fisheries sector. There are perceptible areas where inland fish production especially freshwater aquaculture has made significant impact. The north-eastern (NE) region of India comprises many important fishery resources in the country and in fact, ranks 6th among the top 25 biodiversity hotspots in the world (Kottelat and Whitten, 1996; Gurumayum and Choudhury, 2009). The fisheries sector in the NE region of India holds an important position in the socio-economic and cultural context of the people in the region. However, the contribution of the NE region to the fisheries sector inspite of the presence of the vast fisheries resources in the region is only nearly 5.9% (DAHDF, 2013). A cursory examination of the data on fish production at the national level clearly indicates a disparity in the total fish production *vis-a-vis* the potential of the same in a given area. This paper attempts to assess (i) the relative fisheries resource distribution and (ii) growth and instability of fish production in NE states of India; as well as (iii) to develop strategies for enhanced fish production in the NE region of India.

Materials and methods

Fish production statistics of North-eastern Development Finance Corporation Ltd. were used for the study. Trend lines were used for analysing the observed fish production in all the states of North-east India. The different trend lines used in this study are based on the criteria of the best fit for the data.

Compound growth rate (CGR) was estimated with the standard Cobb-Douglas type function $Y = AX_I^{bi-1}$ and $r = \text{antilog} (\beta-1) \times 100$.

Coppock's instability index (CII) was used to measure the instability in fish production in each of the NE states and also for the NE region as a whole (Coppock, 1962). This was measured by fitting a log-linearised exponential time trend using the formula: $|\text{anti } \text{In}\sqrt{\text{In } V} - 1| \times 100$, where, $\text{In} V = \frac{1}{n-1}\left[\sum (\text{In } Y_{t+1} - \text{In } Y_t)\right] - \frac{1}{n-1}\left[\sum (\text{In } Y_{t+1} - \text{In } Y_t)\right]$

Growth performance and instability studies have also been used by Jeyanthi and Nikita (2012) to analyse

the CGR, market concentration and instability indices of Indian scampi export and by Krishnan *et al.* (1994) to capture the trends in the growth of marine products exports in the context of newly introduced liberalisation policies in the country. Studies in analysing the CGR and instability indices in the scenario of Indian agriculture across spatial and temporal scales have been reported by Larson *et al.* (2004); Prajneshu and Chandran (2005); Chand and Raju (2008 a,b) as well as Reddy (2009) and the same in the milk production sector in Gujarat by Shah and Dave (2010).

Forecasting fish production till the year 2015 was done using SPSS (Version 16) through Time Series Expert Modeler with ARIMA, Simple, Holt and Brown models and Microsoft Excel (2007) program.

Results and discussion

Resource availability

North-eastern states of India abound with pristine water bodies whose potential for fish production has been barely tapped. The potential of fish production in NE states of India is estimated to be 4.88 lakh t. A total of 5.63 lakh ha of water spread area is available for fish production in the eight NE states of India excluding the riverine resources (Table 1). This comprises 0.33 lakh ha of reservoir water spread area, 3.71 lakh ha of water spread in tanks and ponds and 1.59 lakh ha of flood plains and derelict water bodies. Arunachal Pradesh alone has 3.18 lakh ha of water spread area followed by Assam with 1.35 lakh ha. The riverine resources alone comprises 20,875 km of water resources (Table 2). Meghalaya has 5600 km of rivers followed by Assam (4820 km) and Manipur (3360 km).

The NE states contributed 3.14 lakh t of fish during the period 2010-2011 (Table 3). This signifies a substantial increase in fish production in the region by as much as 1 lakh t over a period of 10 years (Fig. 1). It can be seen from Table 3 that the total fish production was only 2.2 lakh t in the region during 1999-2000. The extent

Table 2. Riverine resources of the NE states of India

State	Rivers and canals (km)
Arunachal Pradesh	2000
Assam	4820
Manipur	3360
Meghalaya	5600
Mizoram	1395
Nagaland	1600
Sikkim	900
Tripura	1200

Source: NEDFI Databank, 2013

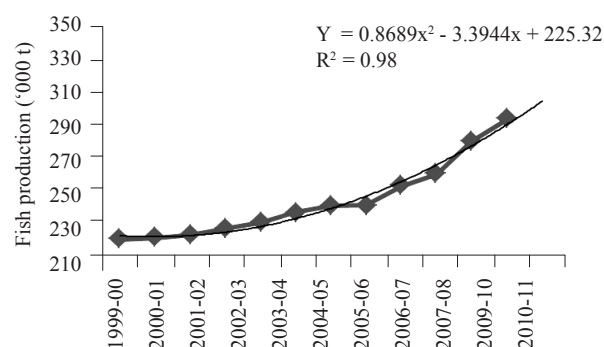$Y = 0.8689x^2 - 3.3944x + 225.32$
$R^2 = 0.98$

Fig. 1. Trend in fish production in NE region of India

of disparity in the performance of fish production across the eight states is evident from the fact that 72% of the total fish production in 2010-11 was from Assam, while Tripura contributed 16% and the other six states together contributed 13%.

Table 4 gives the trend in fish productivity in the eight NE states of India during 1999-2010. The data excludes the output from riverine systems. It can be seen that productivity is maximum for Manipur with an output of 17.80 t per ha of water spread area (WSA), followed by Tripura with 17.21 t and Mizoram with 16.37 t.

One of the major issues in analysing data for fish production in NE states of India is the fact that there appears to be substantial discrepancies and inconsistencies in the available data.

Table 1. Fishery resources of the NE states of India excluding the riverine resources

State	Reservoirs (lakh ha)	Tanks and ponds (lakh ha)	Flood plain lakes and derelict water bodies (lakh ha)	Total water bodies (lakh ha)
Arunachal Pradesh	0.00	2.76	0.42	3.18
Assam	0.02	0.23	1.10	1.35
Manipur	0.01	0.05	0.04	0.10
Meghalaya	0.08	0.02	0.00	0.10
Mizoram	0.00	0.02	0.00	0.02
Nagaland	0.17	0.50	0.00	0.67
Sikkim	0.00	0.00	0.03	0.03
Tripura	0.05	0.13	0.00	0.18

Source: NEDFI Databank, 2013

Table 3. Fish production ('000 t) in the NE states of India

State	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Arunachal Pradesh	2.40	2.50	2.60	2.60	2.65	2.70	2.75	2.77	2.83	2.88	2.65	3.04
Assam	159.77	158.62	161.45	165.52	181.00	186.31	188.00	181.48	190.32	200.15	218.82	227.24
Manipur	15.51	16.05	16.45	16.60	17.60	17.80	18.22	18.61	18.60	18.80	19.20	20.20
Meghalaya	4.68	6.18	4.97	5.37	5.15	5.64	4.12	5.49	4.00	3.96	4.21	4.56
Mizoram	2.89	2.86	3.15	3.25	3.38	3.68	3.75	3.76	3.76	2.89	3.04	2.90
Nagaland	5.00	5.50	5.20	5.50	5.56	4.90	5.50	5.80	5.80	6.18	6.36	6.59
Sikkim	0.14	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.18	0.17	0.17	0.18
Tripura	29.34	29.42	29.45	29.52	17.98	19.84	23.87	28.63	36.25	36.00	42.27	49.23
Total	219.73	221.27	223.41	228.50	233.46	241.01	246.36	246.69	261.74	271.03	296.72	313.93

Source: NEDFI Databank, 2013

Table 4. Productivity trends in fish production in NE India (1999-2010)

State	(WSA*) (lakh ha)	Productivity (t ha^{-1} WSA)
Arunachal Pradesh	3.18	0.084
Assam	1.35	13.69
Manipur	0.10	17.80
Meghalaya	0.10	4.86
Mizoram	0.02	16.37
Nagaland	0.67	0.84
Sikkim	0.03	0.51
Tripura	0.18	17.21

*WSA: Water spread area

resources with golden mahseer (*Tor putitora)* as the state fish. It can be observed (Fig. 2a) that the power function gave the best fit to the data of fish production in Arunachal Pradesh. This function described 78% of the variation in fish production over time. Fish production in Arunachal Pradesh showed consistent improvement over the period from 1995 to 2011. Using the forecasting feature in SPSS (Version 16), it can be seen that fish production in Arunachal Pradesh is likely to grow from the current production of 3.03 thousand t registering a modest growth rate of 310 t over the period of next four years in absolute terms (Fig. 4a).
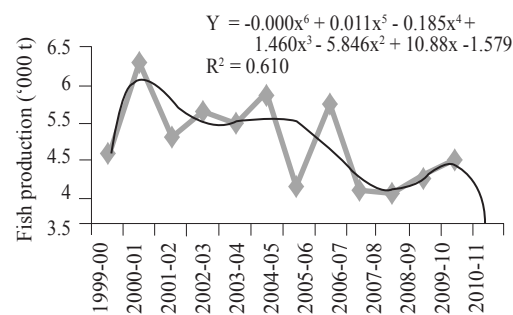

(a)

$Y = 2.3781x\ 0.0745$
$R^2 = 0.7869$

(b)

$Y = 0.354x^2 + 1.266x + 157.4$
$R^2 = 0.931$

(c)

$Y = -0.0072x^2 + 0.477x + 15.09$
$R^2 = 0.9706$

(d)

$Y = -0.000x^6 + 0.011x^5 - 0.185x^4 + 1.460x^3 - 5.846x^2 + 10.88x - 1.579$
$R^2 = 0.610$
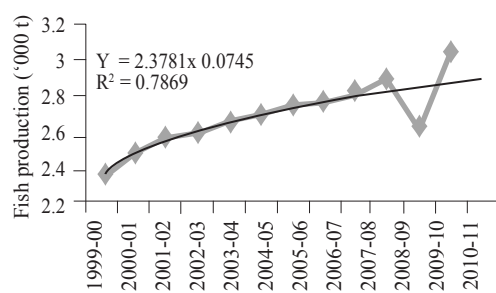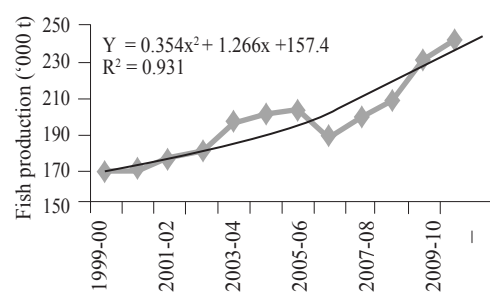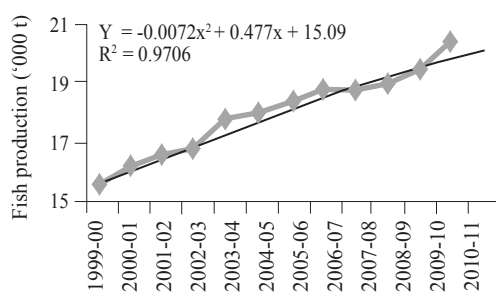
Fig. 2. Trends in fish production in different states of the North-eastern region of India. (a) Arunachal Pradesh, (b) Assam, (c) Manipur, (d) Meghalaya

Arunachal Pradesh is characterised by a hilly terrain with lakes in the middle and higher belts and beels in the lower belts. Aquatic resources are spread over an area of 7,000 ha which comprise 30 - 40% of cold water aquatic

In the case of Assam, the trend in fish production was amenable to the polynomial trend line of degree 2 which explained as much as 93% of the variation in fish production with respect to time (Fig. 2b). The forecasted

Fig. 4. Predicted fish production of (a) Arunachal Pradesh, (b) Assam, (c) Manipur, (d) Meghalaya

modestus). Mizoram aims to achieve self-sufficiency in fish production by the end of the 12th five year plan. The variation in the data is quite obvious and the polynomial curve of degree 2 explained 71% of the variation in fish production of Mizoram (Fig. 3a). As in the case of Meghalaya, the forecasted fish production of Mizoram is expected to increase by only 510 t over the period 2010-11 to 2015-16 (Fig. 5a).

With the present utilisation of fishery resources at 4.5% of the 30,000 ha of the lentic resources, performance of Nagaland in fish production varied from 4,900 t in 2004-05 to 6,580 t in 2010-11 (Fig. 3b). The state fish is chocolate mahseer (*Neolissochilus hexagonolepis*). Fish production trend in Nagaland has been captured by the polynomial trend line of degree 2 which explained as much as 82% of the variation of fish production in the state over the period of time. In comparison to Meghalaya and Mizoram, the forecasted fish production of Nagaland appears to be on a better footing and is expected to record an additional 500 t over the period from 2010-11 to 2015-16 (Fig. 5b).

Fish production of Sikkim shows inconsistency and could be attributed to erroneous recording of data. Fish production in Sikkim ranged from 140 to 180 t only between the periods 1999 to 2011 (Fig. 3c). Though the absolute increase in fish production in Sikkim was marginal, it is surprising that the exponential function has given the best fit to the data, explaining as much as 78% of the variation in fish production with respect to time.

Data inconsistency being so obvious in the case of fish production in Sikkim, the forecasted fish production is only as reliable as the base data. Fish production in Sikkim is expected to increase from 180 t in 2010-11 to 200 t in 2015-16 (Fig. 5c).

Tripura is a high achiever among the eight NE states of India. This is more so when compared to the resource availability in the state. Fish production in Tripura varied from 1798 t in 2003-04 to 4923 t in 2010-11 (Fig. 3d). This high performing state has overcome certain inconsistencies in data in the initial years used for this analysis; but perusal of recorded data after 2003-04 showed a significant increasing trend. These inconsistencies of the initial years appear to have played a major role and a polynomial trend line of degree 2 gave the best fit to fish production in Tripura and explained 86% of the total variation in fish production in Tripura for the period considered. It may be noted that the data would be showing an exponential trend line if the trend line were fitted to the data for the period 2003-04 to 2010-11. The predicted fish production in Tripura also showed a substantial increase in absolute terms over the period 2010-11 to 2015-16 (Fig. 5d). Fish production in Tripura could rise as much as 2,683 t during this period of time.

The total fish production in NE states of India varied from 219,000 t in 1999 to 313,000 t in 2010-11. This performance of fish production in NE India has been aptly captured by the polynomial trend line of degree 2 which has explained 98% of the variation in fish production
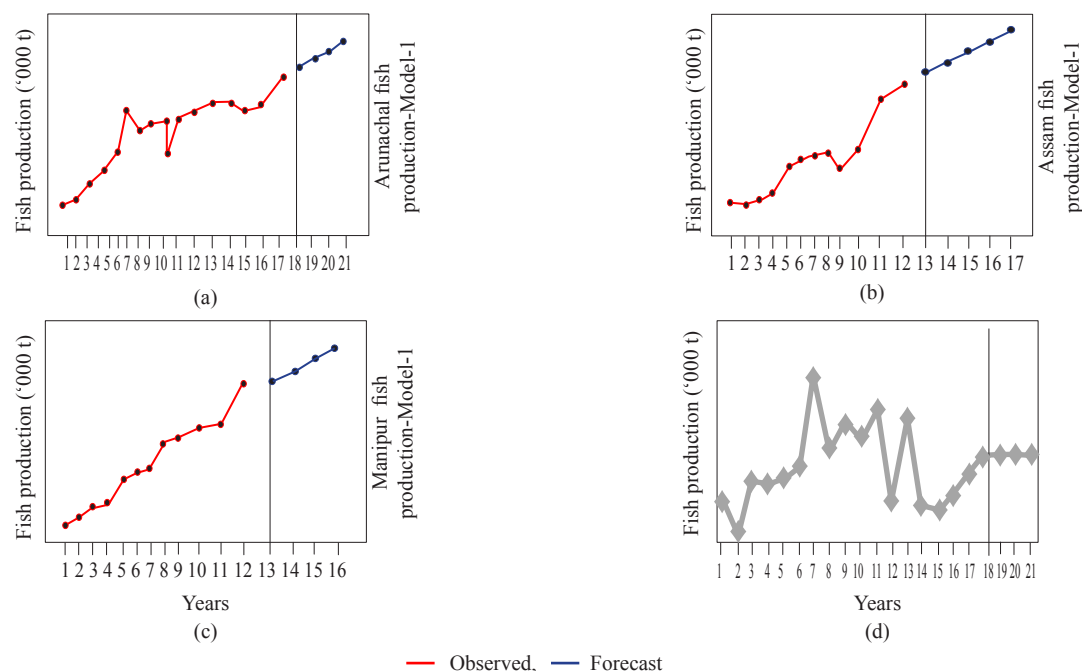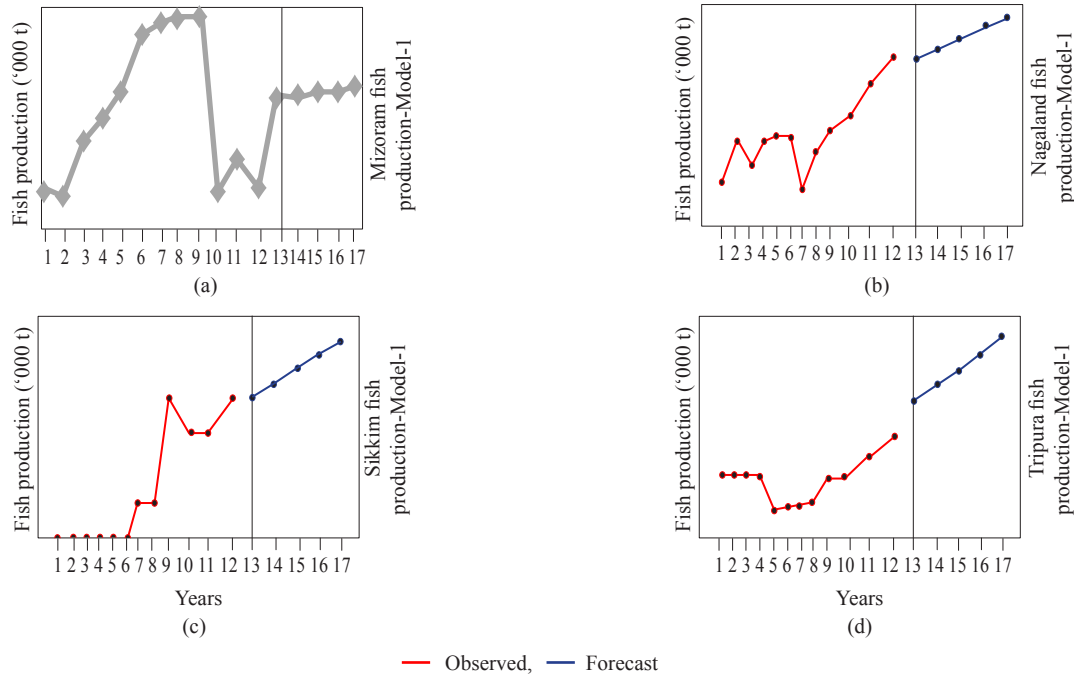
Fig. 5. Predicted fish production of (a) Mizoram, (b) Nagaland, (c) Sikkim and (d) Tripura

with respect to time (Fig.1). It is expected to increase to 406,000 t in the year 2015, indicating an absolute increase in fish production by as much as 92,000 t (Fig. 6).

Several things need to be kept in mind before taking a final stand on the trends in fish production in NE states of India. The forecasted fish production in the NE states of India relies on expectations *vis-a-vis* the potentiality of the resources that are available in the region. Furthermore, there is much to be desired in respect of the standardisation of methodology as well as organised compilation, tabulation and publication of fisheries statistics.

Fig.7 shows that the CGR and CII of the different NE states of India. The state of Tripura lies in the zone of high growth and high instability in contrast to the state of Mizoram which lies in the zone of low growth and low instability. However, a low instability index does not indicate a desirable situation with respect to the performance in fish
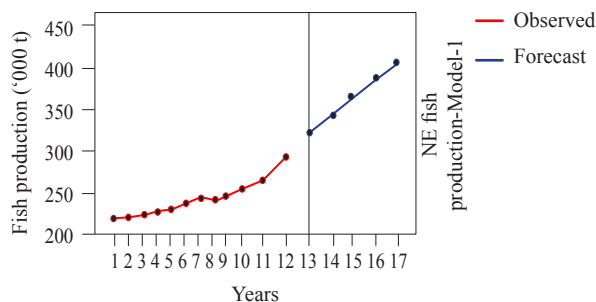
production as in the case of Mizoram which showed meager growth in terms of fish production in spite of being relatively stable with low CII in comparison to the other states. This is clearly observed in the case of Tripura, which registered the highest growth in fish production despite having high instability index. The states of Arunachal Pradesh, Assam, Sikkim, Manipur and Nagaland were found to be in the medium range of growth-instability and Meghalaya lay close to Mizoram in terms of growth *vs* instability.

Even though there are vast fishery resources across the whole NE region of India, the opportunities to harness and utilise these resources are still untapped in many of

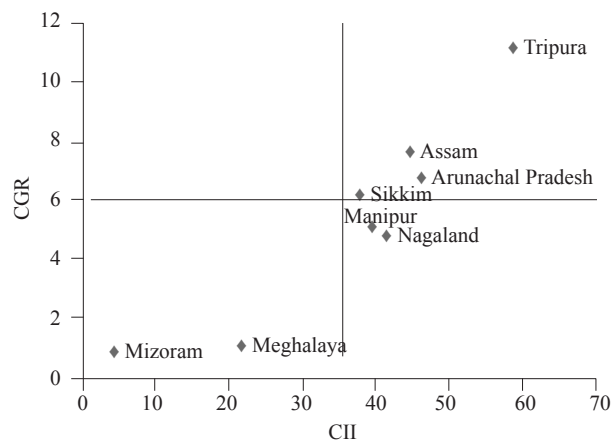Fig. 6. Predicted fish production in the NE region of India

Fig. 7. Compound growth rate (CGR) *vs* Coppock's instability index (CII) of fisheries of the NE States of India

the states (Sarkar and Ponniah, 2006). It is again a matter of fact that sustainable utilisation of these resources requires that the constraints crippling the NE region including inadequacies in infrastructure, communications, technology and transportation need to be sorted out. This would enhance and strengthen the institutional functioning and networking in fisheries. Further, there is a need to attract private investments in the fisheries sector in the region for sustainable utilisation of resources, replenishment of stocks wherever overexploited, proper functioning of the present hatcheries and stopping destructive fishing methods such as dynamite poisoning (Gurumayum and Choudhury, 2009). This is very important for ensuring the sustainability of fisheries through appropriate policies which would otherwise result in instability owing to inconsistent growth oriented policies (Fauzi and Anna, 2012). Strengthening of the required database and resource mapping through GIS and remote sensing to carry out suitable research and development activities in the NE fisheries sector are the important issues that need to be addressed at present as the information available is limited only to the potential of the North-east with respect to cultivable, sport and ornamental fishes (Sarkar and Ponniah, 2006). Since the NE region of India is home to different tribes in the region, the socio-economically disadvantaged tribal people can greatly benefit from the subsidised schemes of the Department of Animal Husbandry Dairying and Fisheries (DAHDF), New Delhi for development of freshwater aquaculture.

The NE region of India shares its borders with international boundaries with the countries Bangladesh, Bhutan, China, Myanmar, and Nepal. This can be used to the advantage of boosting foreign trade with fish and fishery products from the region. Since majority of the population in the NE region are fish eaters, there is an urgent need for the entire region to be self-sufficient in fish production.

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