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Agribusiness Opportunities of Ornamental Fisheries in North-Eastern Region of India

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Abstract

The North-Eastern region produces the bulk of India's ornamental fish exports but remains unattended for developing market opportunities. Several agribusiness opportunities can be explored through systematic collection and selling of native ornamental fish (wild catch) as well as rearing of exotic ornamental fish species (captive breeding) suitable in the region. In view of these, the present study has analysed the economic (social perspective) and financial (private perspective) viabilities of development of ornamental fisheries in the North-Eastern region. It has been concluded that the agribusiness opportunities can be realized at every stage, namely, production, marketing and conservation of ornamental fishes. The ornamental fish production in the NE region has been observed to be financially as well as economically viable and investment-friendly. With the initiatives by the government such as providing incentive to establish ornamental fish production unit, considerable private investment can be attracted to this industry, which would generate additional employment opportunities in this area. The concerted efforts of the government as well as key institutions can increase the ornamental fish production substantially in the region, which in turn, can gain a larger share in the world market. Public-private partnership can be encouraged through establishment of ornamental fish production units in different parts of the NE region to make the ornamental fishery sector more vibrant and remunerative.

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Introduction

India is the third largest producer of fish in the world and the fishery sector is a major foreign exchange earner, which accounted for US$ 1.64 billion during 2005-06. Besides providing affordable nutrition to the rural people, fish simultaneously guarantees the livelihood of around 11 million people of the country (Govt. of India, 2007). Ornamental fish is one of the important items among the various types of commercially important fishes marketed nationally and internationally. Ornamental fishes, popularly known as 'aquarium fish', or 'live jewel', are exported to 27 countries, which amounted to 2568 Mt (0.86 per cent of the total marine export) in terms of quantity and US$14 million (0.50 per cent of total marine export) in terms of value (MPEDA, 2007). Though in terms of percentage share to total quantity and value these figures are small, the growth potential of this sector is quite encouraging. During 2005-06, the export of aquarium fish recorded an increase of 14 per cent in quantity and 22 per cent in value, as compared to those in the preceding year. The entire supply of Indian ornamental fish is primarily dependent on wild catch (85 per cent) and a few artificially bred varieties (15 per cent) of exotic fish. Among the wild catch fishes exported from the country, West Bengal and the North-Eastern states are the major contributor (Mahapatra *et al*., 2006).

All the North-Eastern States, namely, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, are gifted with vast aquatic resources which are harbouring diverse ornamental fishes with immense commercial importance. Although North-Eastern states produce a bulk of the India's ornamental fish exports, the region still remains relatively untapped for the development of ornamental fisheries. Increasing agribusiness opportunities of these live fishes in the world market could be a matter of concern for the sustainability of this natural wealth in the long-run, since the supply is entirely dependent on wild catch. In spite of being a renewable resource, indiscriminate harvesting of ornamental fishes from the natural water bodies is likely to cause serious depletion of the stock, particularly of those species which are already under the threat of extinction or endangerment. The depletion of fish diversity will reduce opportunities in the aqua-business. Therefore, all stakeholders— collectors, exporters, importers, dealers and consumers— have their shared responsibility to make the ornamental fish industry environmentally sustainable. The users and beneficiaries of biodiversity businesses are increasingly becoming concerned and have started showing involvement in its management. Many experts have expressed their concern about the high market demand and pricing of these beautiful ornamental fishes. These species are being harvested at greater volumes and fetching higher rates, threatening the viability or

sustainability of this fishery across various parts of the world (Vagelli and Erdmann 2002; Cato and Brown 2003; Lunn and Moreau 2004). On the other hand over cautiousness and unnecessary enforcement of stringent rules and regulations to restrict the collection of ornamental fishes may inhibit the full utilization of business opportunities and will lead to natural wastage. In fact, the collection of ornamental fishes from the natural water bodies or captive breeding can be made sustainable and self-reliant for marketing by following sound ecological and economic principles. The sustainable management of the ornamental fisheries is possible through appropriate strategic planning. In addition, this will ensure and generate employment for a substantial section of labour force in the North-Eastern states. Enormous agribusiness opportunities can be explored in systematic collection and marketing of native ornamental fishes (wild catch) as well as rearing of exotic ornamental fish species (captive breeding) suitable in the region. Perhaps the opportunity of gainful employment underlines at all the levels of activities in the ornamental fish industry, viz. production, marketing and exports. Besides, the corporate sector must share the 'corporate social responsibility' through active participation in various conservation measures involved in the ornamental fisheries. Therefore, appropriate strategies are to be derived from relevant studies in the North-Eastern region so as to make the ornamental fish industry more vibrant, transparent and economically and financially viable. In view of these issues, the present study was undertaken to analyse the economic (social perspective) and financial (private perspective) viabilities of the development of ornamental fisheries in the North-Eastern region. The study would be helpful to policymakers in formulating appropriate policies and to commercial houses in exploring the agribusiness opportunities for ornamental fisheries in the region in a sustainable manner.

Methodology

Data Sources

Both primary as well as secondary data were used for the present study. Primary data were collected through various socio-economic surveys conducted by Division of Fisheries, ICAR Research Complex for NEH Region, covering all the 8 North-Eastern states. The primary survey was conducted during the period 2001-02 to 2003-04 under the project entitled "*Evaluation of Ornamental Fishery Potential in NEH Region – Its Farming and Export Feasibility*" and during 2003-04 to 2005-06 under the project entitled "*Strategy and Approach for Comprehensive Development of Fisheries Involving Community-based Programmes with*

Special Reference to NE Region". Primary survey was also conducted at various markets of ornamental fishes in Kolkata and in the North-Eastern states. Discussions were held with the fish farmers, collectors, traders, local hobby shop owners, exporters, and fishery scientists and experts working in the region. Data about economics of native (*Rasbora, Danio, Colisa* and *Puntius* spp) and exotic (gold, platy and angel) ornamental fish production were obtained from the experiments conducted during 2004-05 and 2005-06 in the Division of Fisheries, ICAR Research Complex, Umiam. Detailed information on consumer preference as well as availability of indigenous ornamental fishes was collected through discussions with collectors, local hobby shop owners, exporters and survey of 'Hatibagan Haat', Kolkata, which is the most important market for ornamental fish trade relevant to the region. Relevant secondary data were collected from FAO database on ornamental live fish; MPEDA publication and various research bulletins published by the ICAR Research Complex, Umiam; Assam Agricultural University; and Central Inland Fisheries Research Institute, Barrackpore, Kolkata.

Analytical Tools

Farm budgeting analysis has been employed for analysing the data. Financial (from the private investors point of view) as well as economic (from society's point of view) analyses of ornamental fishery units were carried out by employing discounted cash flow methods such as internal rate of return (IRR), benefit cost ratio (BCR) and net present value (NPV) to examine the long-term profitability of establishment. Also, undiscounted method such as payback period was calculated to judge the feasibility of investment on ornamental fisheries in the region. Annual costs and returns and requirement of initial investment were observed to be similar under exotic and native ornamental fisheries in the study area. Various assumptions on technical parameters were considered for these analyses after reviewing the relevant literature and discussions with the fishery experts. The economic life of fish-farm was considered to be 10 years to have a more realistic estimation. A 14 per cent discount rate was considered, which is the maximum interest rate charged by the bankers for agricultural loan in the study area. As the time value of money is not possible to measure exactly, borrowing interest rate charged by the bankers was taken as a proxy for the discount rate.

Considering the issue of sustainable management of ornamental fisheries, the financial analysis was extended further with a few more assumptions to carry out the economic viability of the indigenous ornamental fishes. Economic analysis examined the feasibility of establishment of ornamental

fisheries from the social perspectives. The assumptions under economic analysis were: (i) 40 per cent of the total production of fish fry would be released to natural water bodies so as to maintain the natural population; (ii) 40 per cent of the released fish fry would survive under natural condition; (iii) possible rate of catch of these fishes was assumed to be 60 per cent out of the survived fishes and this catch might occur at any stage of their life from any water resource by the fishermen; and (iv) the fish would be released at the fry stage in which the survival rate of fishes was high as compared to that at spawn stage. These assumptions were made in consultations with fishery scientists and fish farmers.

Results and Discussion

Current Status of Ornamental Fish Diversity and Water Resources for Aquaculture in NE Region

North-Eastern states are endowed with vast aquatic resources with great diversity of ornamental fishes. The ornamental fishes are diversified over 37 families, 114 genera and 10 orders. Out of the total 274 fish species reported from this region, around 250 species (91 per cent) possess ornamental value (Table 1). The major species having a large number of ornamental fishes belong to the Order Cypriniformes, followed by Siluriformes and Perciformes. The native ornamental fishes can be classified on the basis of

Table 1. Ornamental fish diversity in the North-Eastern Region (reported up to 2006)

Sl No.	Order	No. of families	No. of genus	No. of species	Share of fish species having ornamental value (%)
1	Anguilliformes	3	3	3	100
2	Clupeiformes	2	6	7	43
3	Cypriniformes	4	47	148	93
4	Cyprinodontiformes	1	1	1	100
5	Osteoglossiformes	1	2	2	100
6	Perciformes	12	17	33	94
7	Siluriformes	11	34	76	89
8	Synbranchiformes	1	2	2	100
9	Syngnathiformes	1	1	1	100
10	Tetraodontiformes	1	1	1	100
Total	10	37	114	274	91 (250)

Note: Figures within the parentheses indicate total number of fish species possessing ornamental value

their diversified character, such as beautiful colour (e.g., *Pseudecheneis sulcatus, Tetradon cutcutia*), stripes & banding pattern (e.g., *Botia rostrata, Brachydanio rerio*), chamelionic habit (e.g., *Badis badis, Puntius shalynius*), jumping behaviour (e.g., *Esomus danricus, Chela laubuca*), charming predatory habit (e.g.,*Channa orientalis, Glossogobius giuris*), calm behaviour (e.g., *Ctenops nobilis, Nandus nandus*), transparent body (e.g., *Chanda mama, Pseudambassis baculis*), small size (e.g., *Danio dangila, Brachydanio rerio*), hardiness (*Anabas testudineus*) and suckers (e.g.,*Garra gotyla gotyla, Garra mcllendi*). Some larger food fishes like *Neolissocheilus hexagonolepis, Labeo gonius, Channa maurulius* and *Rita rita* are also treated as ornamental fishes in their juvenile stage and are termed as non-classified ornamental fishes.

The North-Eastern region of the country has major rivers like the Brahmaputra and the Barak with their countless tributaries. The region accounted for 11 per cent of country's total (195210 km) rivers and canal water resources and 8 per cent of other water resources for aquaculture, which include reservoirs, tanks, lakes, floodplain lakes and derelict water and brackish water (Table 2). Meghalaya possesses the maximum length of rivers and canal water resource (5600 km) among the North-Eastern states, followed by Assam (4820 km), Manipur (3360 km), Arunachal Pradesh (2000 km), Nagaland (1600 km), Mizoram (1395 km), Tripura (1200 km) and Sikkim (900 km). However, in terms of 'other' water resources for aquaculture, Arunachal Pradesh ranks first with an area of 3.18 lakh ha, followed by Assam (1.35 lakh ha), Nagaland (0.65 lakh ha) and other states with less than 0.5 lakh ha area. These water bodies harbour diversified native ornamental fishes with large economic importance under natural condition.

The distribution of the important native ornamental fish species (trade name) has been reported in Table 2. It is estimated that nearly 200 species of ornamental fishes are exported from India, out of which 85 per cent are from the North-Eastern states (Nair, 2004). The market opportunities for the local ornamental fish species are rising gradually in both domestic and international markets. The native ornamental fish species have been further classified into four groups, depending on the consumer preference and their availability in the natural water bodies (Appendix I). Details of these classifications along with the trade name, price in Rs and US$ have also been reported in this Appendix. The price of native ornamental fishes varied from Rs 3 to Rs 50 per piece across the domestic market. The Freight on Board (FOB) price offered by the exporters for native ornamental fishes was observed to be varying from US$ 0.06 to as high as US$ 4.825 per piece. Most of the native ornamental fish species from the North-Eastern

Table 2. Distribution of water resources for aquaculture and important ornamental fish species available in North-Eastern states

States	Major rivers	Important species (Trade name)	Length of rivers and canals (km)	Other water resources (lakh ha)
Arunachal Pradesh	Kameng, Subansiri, Siang, Lohit, Tirap and their tributaries	Leopard loach, Shovel mouth catfish, Goliath hill trout, Rani loach, Peacock snakehead	2000	3.18
Assam	Brahmaputra, Barak and their tributaries	Violet, snakehead, Peacock snakehead, Nobel gourami	4820	1.35
Manipur	Imphal, Thobal, Nambul and their tributaries	Blyth's loach, Shovel mouth catfish, Goliath hill trout, Rani loach	3360	0.10
Meghalaya	Umiam, Kopili, Myntang, Jingiram, Simsang, Kynshi, and their tributaries	Shaylini barb, Moustached danio, Devil catfish, Violate snakehead, Blue channa	5600	0.10
Mizoram	Tlawng, Sonai, Kolodyne, Karnaphuli, Serhii, Teirei, Tut, Tuirial, Tuiruang, and their tributaries	Shovel mouth catfish, Rani loach, Moustached danio, Clown catfish, Stone fish	1395	0.02
Nagaland	Dhansiri, Doyang, Dikhu, Jhanji and their tributaries	Leopard loach, Rani loach, Moustached danio, Clown catfish, Stone fish	1600	0.67
Sikkim	Teesta and Rangit along with their tributaries like Ramman, Reshi, and Ranichu	Nobel gourami, Goliath hill trout, Devil catfish	900	0.03
Tripura	Dhalai, Khowai, Burigang, Gumti, and their tributaries	Leopard loach, Shovel mouth catfish, Goliath hill trout, Rani loach	1200	0.18

Source: Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture (2003-04). Other water resources include reservoirs, tanks, canals, lakes, floodplain lakes and derelict water and brackish water.

region were highly preferred by the hobbyists across the globe (e.g., *Anabas testudineus, Botia Dario,* etc.). Prices were found high for species due to less-abundant species and vice versa. However, prices of ornamental fishes varied widely due to steep competition among the suppliers and quality of the fish. Many of the highly preferred native ornamental fish species (e.g., *Balitora brucei, Botia berdmorei,* etc.) are becoming less abundant in the natural condition because of their over-exploitation or degradation of water bodies and need urgent attention for their sustainable utilization. Interestingly, due to lack of steady supply of common ornamental fishes, many new species (e.g., *Ailia coila, Anguilla bengalensis,* etc.) were emerging as ornamental fishes and the trade opportunities in these species were expanding, which was an added advantage to sustaining the agribusiness opportunity of this industry. This category of potential ornamental fishes is a ready reference for an entrepreneur to explore the entrepreneurial opportunities.

Economics of Exotic Ornamental Fish Production

From the view point of exploring the agribusiness opportunities in ornamental fisheries, the rearing of exotic ornamental fishes is likely to fetch higher and steady returns than collection of fishes from wild catch due to their better quality and lower risk of mortality during transportation. Also, raising and supplying of exotic ornamental fishes under captive breeding would reduce the pressure on volume of wild catch and therefore, would complement the conservation efforts of native ornamental fish species. It has been estimated that a sum of Rs 1,31,500 was required as capital cost to establish an ornamental fish-rearing unit, which is sufficient for rearing multiple ornamental fish species (Table 3). This estimation has been made considering three popular exotic ornamental fishes, namely gold fish (*Carassius auratus*), platy fish (*Xiphophorus maculates*) and angel fish (*Pterophyllum scalare*). The major cost component in initial investment is establishment of basic infrastructure like cemented tank, shed house, balance, water analysis kit, electric pump, air pump, oxygen cylinder, glass aquaria, overhead tank, etc. (Table 3).

The annual costs and returns of the three selected ornamental fishes (gold, angel and platy) revealed it to be a highly profitable business, the average net return per year being Rs 61633 and combined profitability being Rs 86500 per year. Rearing of gold fish was observed to be most rewarding with an annual net return of Rs 76500, followed by angel fish (Rs 54950) and platy fish (Rs 53450). The major variable cost components were cost of labour, feed, purchase of chemicals, medicines, polythene bags, and charges for electricity and maintenance, cost of brood fish (parent stock) and miscellaneous cost. These three exotic fish species are very compatible

Table 3. Details of initial investment required for establishment of exotic ornamental fish-rearing unit (2006-07 prices in Meghalaya)

Particulars	Quantity	Rate (Rs)	Cost (Rs)
Rental value of land	100 sq m	20	2000
Cost of shed house	800 sq m	300 per sq m	24000
Overhead tank	1(6000 L capacity)	6000	6000
Cement tank	12	4000 per cistern	48000
Glass aquaria	5	1400 per unit	7000
Air pumps	12	250 per piece	3000
Electric pumps	1 (2 HP)	7000	7000
Oxygen cylinder with key, spanner, pressure gauge, etc.	1 set	7500	7500
Balance and water analysis kit	1 set	18000	18000
Net, buckets and plastic trays	20 each	Varying	4000
Glassware, water heater	10 each	Varying	5000
Total cost			131500

Table 4. Annual costs and returns of exotic ornamental fish production (2006-07 prices in Meghalaya)

(in Rs per year)

S. No.	Particulars	Gold fish	Angel fish	Platy fish	Average	Combined
A. Costs						
1	Cost of brood fish (Rs 500 / pair)	2500	5000	5000	4167	12500
2	Feed	10000	10000	9000	9667	29000
3	Chemicals, medicine, polythene bags	3000	2000	2000	2333	7000
4	Electricity and maintenance	3000	4800	4800	4200	12600
5	Labour charges (Rs 50 / manday)	18000	18250	18250	18167	54500
6	Miscellaneous expenditure	1000	1000	1500	1167	3500
	Total cost	37500	41050	40550	39700	119100
B. Returns						
1	Sale of fish	111600	98000	96000	103333	205600
C. Net returns		**76500**	**54950**	**53450**	**61633**	**86500**

and can be grown either in separate tanks or as composite fish culture. Since the feeding habit of these species is quite similar, the magnitudes of various cost components are almost similar. But, the breeding process was strikingly different among these fish species; for example, platy delivered

babies directly in contrast to laying of eggs by other two fish species. Accordingly, proper care (time of feeding) had to be ensured. It is important to mention here that the market price of the ornamental fishes varies widely in the export market, depending on unpredictable supply-demand situation. Moreover, production of ornamental fishes requires sound knowledge about the breeding process, feeding habit and rearing technique. Lack of knowledge and experience may cause severe losses due to high mortality of these fishes. It is always advisable to undergo training on ornamental fish farming before establishing a unit.

Financial Viability of Ornamental Fish Farm Unit

Based on the estimated annual costs and returns, all the financial viability criteria (IRR, NPV and BCR) were found favourable for investment on ornamental fish farming (Table 5). The investment on individual fish species was observed to be quite favourable and encouraging. The payback period was calculated to be 1.72 years under gold fish unit, followed by angel fish (2.39 years) and platy fish (2.46 years). The NPV was estimated to be highest (Rs 172884) under gold fish unit, followed by angel fish (Rs 76483) and platy fish (Rs 70413). Similarly, IRR and BC ratio were calculated to be higher under gold fish (42 per cent and 1.52, respectively) than angel (27 per cent and 1.22, respectively) and platy fish (26 per cent and 1.20, respectively). The analysis indicated that establishment of such fishery unit was not only financially viable but a highly attractive proposition also for entrepreneurial development.

This economic analysis was carried out considering the same basic assumptions as followed under financial analysis and a social discount rate was assumed to be 10 per cent (14 per cent under financial analysis) because society is expected to discount the future value of money at a lower rate as compared to the prevailing rate of interest, which is generally taken as the

Table 5. Financial viability of establishment of ornamental fish rearing

S. No.	Investment criteria	Gold fish	Angel fish	Platy fish	Average	Combined
1	Payback period (years)	1.72	2.39	2.46	2.13	1.52
2	Net present value (NPV, in Rs)	172884	76483	70413	106593	319897
3	Internal rate of return (IRR, in %)	42	27	26	32	32
4	Benefit cost ratio (BCR)	1.52	1.22	1.20	1.31	1.31

discount rate under financial analysis. Some assumptions were also made in consultation with fishery scientists and fish farmers, as reported in the methodology section. Under this analysis, four native ornamental fish species were considered, namely *Danio, Rasbora,, Puntius,* and *Colisa*. Initial investment and annual costs and returns were the same as reported under the financial analysis of exotic ornamental fishes. The investment requirement calculated for four fishery units was Rs 684000 as initial investment and Rs 158800 as annual variable cost, assuming that these fish species would be raised separately (Table 6). However, they can be raised as composite culture also, which would reduce the total investment cost substantially but separation of these species is essential while marketing of fishes.

Net return from these units has been estimated to be Rs 356400 per annum assuming the price as Rs 2 and Rs 3 per piece for farm-raised fish fry and wild catch, respectively. The values of IRR, BCR and NPV have indicated that this investment was favourable in the region. In fact, the

Table 6. Economic viability of investment on establishment of indigenous ornamental fish production units

S. No.	Particulars	Unit	Value
1	Fixed cost (for 4 units @ Rs 131500/unit)	Rs	684000
2	Annual variable cost (for 4 units @ Rs 39700/unit)	Rs	158800
3	Estimated annual production of fish (No. of fry)	No.	400000
4	Release to natural water bodies (40% of production)	No.	160000
5	Survival in natural water bodies (40 % of release)	No.	64000
6	Estimated catch from natural water bodies (60 % of survived)	No.	38400
7	Return from sale of farm raised fry (@ Rs 2/piece)	Rs	400000
8	Estimated return from sale of fry from wild catch (Rs 3/piece)	Rs	115200
9	Gross return including catch	Rs	515200
10	Net return (Gross return – Annual variable cost)	Rs	356400
11	**Economic viability (when wild catch included)**		
	Net present value (NPV)	Rs	1243378
	Internal rate of return (IRR)	Per cent	51
	Benefit-cost ratio (BCR)	Ratio	1.87
12	**Economic viability (when wild catch not included)**		
	Net present value (NPV)	Rs	640979
	Internal rate of return (IRR)	Per cent	32
	Benefit-cost ratio (BCR)	Ratio	1.26

Note: Suggested fish species include *Danio, Rasbora, Puntius* and *Colisa*, social discount rate was considered as 10 per cent and economic life as 10 years.

investment was observed to be economically viable even under the situation when the estimated return from wild catch was not included in the analysis. The NPV was estimated to be Rs 1243378 when the return from wild catch was included; and Rs 640979 when wild catch was not included. Similarly, IRR and BCR were estimated to be higher (51 per cent and 1.87, respectively) with the inclusion of wild catch than that without inclusion (32 per cent and 1.26, respectively). However, this economic analysis can be considered as indicative and not exhaustive because very few assumptions were employed under this analysis. More detailed and improved Social Cost Benefit Analysis (SCBA) needs to be carried out considering more assumptions. Biological parameters such as the existing stock density, spawning habit, breeding season, number of eggs/babies per spawning and rate of catch are to be included in the economic analysis model. Besides, more number of social and environmental parameters and the existing socio-economic conditions of the local farmers should be incorporated in the analysis. But definitely, the government should provide incentive on raising and river ranching of ornamental fish species, which are critically endangered, or near extinct following the proposed model. Establishment of such units in different parts of the North-Eastern states through public-private partnership mode would ensure better business opportunities in the ornamental fish industry. Such initiatives would facilitate societal gain for the region.

Marketing of Ornamental Fish in North–Eastern Region – Status and Prospects

Despite having tremendous growth potential, the ornamental fish sector in the North-Eastern states remains untapped mainly due to lack of systematic marketing, poor infrastructure (essential for transportation of vulnerable live fishes) and lack of access to market information. It was also learnt that some deliberate and biased practices were being followed by traders, such as accepting fish from selected fish farmers or collectors only. The marketing system was highly unorganized and no direct export was being done. Only a few traders collect the native ornamental fishes through local collectors and supply them to different exporters based in Kolkata, Howrah, Mumbai, Chennai, Trivandrum and Cochin. The most prevailing marketing channel of ornamental fish marketing was: collectors – unregistered small traders – wholesalers – exporters at various ports. Estimation showed that exporter enjoyed the lion's share of profit (45 per cent), followed by wholesaler (30 per cent), unorganized trader (20 per cent), and a meager share of 5 per cent was realized by the collectors (Mahapatra *et al.*, 2006). This pattern of profit-sharing indicated that the benefit of this industry was distributed unequally, depriving the farmers or collectors heavily. This could be improved

by providing pertinent training to the interested farmers on captive breeding and rearing of ornamental fishes and providing incentives and assistance to them to create basic infrastructure for a fishery unit. Since the water resources of the North-Eastern states are endowed with diverse ornamental fishes with high market value, the potential of this industry is very high. However, training on breeding of native and exotic ornamental fishes must be given to the farmers to make this business ecologically and economically sustainable in the long-run.

Conservation Status of Native Ornamental Fish in North-Eastern Region

Indiscriminate collection of native ornamental fishes would lead to extinction of many fishes and thereby, industry would loose the business opportunities. Therefore, while collecting the native ornamental fish species, knowledge about their conservation status is essential. Based on this information, suitable strategies are to be adopted for the collection of fish species. The effective conservation action would help in their sustainable management. In view of this, all the ornamental fish species (250) reported from the North-Eastern region have been categorized according to their conservation status, following the international norm (IUCN) of classification (Table 7), as Critically endangered (CR), Endangered (EN), Vulnerable (VU), Lower risk - near threatened (LR-nt), Lower risk - least concerned (LR-lc) and Data deficient (DD). Besides, a number of ornamental fish species that were not evaluated (NE) so far, have also been reported. It has been observed that most of the high-priced ornamental fish species (e.g. Violet snakehead, Peacock snakehead, Nobel gourami) were becoming vulnerable due to various reasons, including degradation of water bodies, pollution, poisoning and over-fishing of broods and juveniles. Their population was abundant in natural habitats, even one or two decades ago. But, in recent years, some of the species have become rare and most of them have become threatened. Ornamental fishes, caught from the rivers and other natural open water bodies are declining at an alarming rate. Conservation status of the native ornamental fishes has shown that out of the 250 species, 10 are Critically Endangered (e.g. *Ompok bimaculatus, Schistura singhi*), 28 are Endangered (e.g. *Aborichthys elongates, Anguilla bengalensis, Chaca chaca*), 50 are Vulnerable (e.g. *Anabas testudineus, Barilius barila, Danio naganensis*), 45 are Lower risk - near threatened (e.g. *Acanthocobitis botia, Brachydanio rerio*), 8 are Lower risk - least concerned (e.g. *Amblypharyngodon mola, Chela laubuca*), 3 are Data deficient (e.g. *Acanthocobitis zonalternans, Aplocheilus panchax*) and 106 species (42 per cent) have not been evaluated so far.

Table 7. Conservation status of native ornamental fish species of North-Eastern states

(number of species)

Criteria/ Conservation status	AR	AS	MN	ML	MZ	NL	SK	TR	NE
Critically endangered (CR)	3 (2.9)	4 (3.5)	3 (3.2)	1 (1.0)	0 (0.0)	3 (6.7)	0 (0.0)	2 (2.4)	10 (6.9)
Endangered (EN)	19 (18.1)	21 (18.6)	12 (12.9)	20 (19.8)	1 (3.8)	5 (11.1)	4 (21.1)	12 (14.6)	28 (19.4)
Vulnerable (VU)	35 (33.3)	36 (31.9)	32 (34.4)	35 (34.7)	8 (30.8)	22 (48.9)	10 (52.6)	21 (25.6)	50 (34.7)
Lower risk- near threatened (LR-nt)	41 (39.0)	42 (37.2)	37 (39.8)	39 (38.6)	16 (61.5)	11 (24.4)	5 (26.3)	39 (47.6)	45 (31.3)
Lower risk- least concerned (LR-lc)	6 (5.7)	8 (7.1)	7 (7.5)	5 (5.0)	0 (0.0)	2 (4.4)	0 (0.0)	7 (8.5)	8 (5.6)
Data deficient (DD)	1 (1.0)	2 (1.8)	2 (2.2)	1 (1.0)	1 (3.8)	2 (4.4)	0 (0.0)	1 (1.2)	3 (2.1)
Total evaluated	105 (100)	113 (100)	93 (100)	101 (100)	26 (100)	45 (100)	19 (100)	82 (100)	144 (100)
Not evaluated (NE)	60	74	46	54	20	26	10	41	106
Total	165	187	139	155	46	71	29	123	250

Notes: 1. Figures within the parentheses indicate per cent to respective totals
2. AR, AS, MN, ML, MZ, NL, SK, TR, & NE stand for Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and North-Eastern states, respectively.
3. Criteria/conservation status are based on IUCN.
4. Total in column under NE may not tally with the sum of species under various states because one species in a state under one criteria, say Vulnerable under AR may not necessarily be vulnerable under other states (say, AS), and vice versa.

Sincere efforts are needed for the sustainable management of ornamental fisheries in which both public and private sectors have to share greater responsibilities. All stakeholders involved in ornamental fish industry – fish farmers, collectors, traders, exporters and consumers — have to play an active role in the management of these fisheries. Some of the important steps involved are: (i) legal banning on the indiscriminate catch of brood and juveniles fishes; (ii) provision should be made to sell the endangered fish species which are farm-raised only and separate tag can be maintained for these farm-raised species for ready reference to consumers; (iii) export should be allowed based on the conservation status of gene pool of the

indigenous ornamental fishes; (iv) captive breeding and farming should be encouraged for sustaining supply of indigenous ornamental fishes while reducing the pressure on volume of wild catch; (v) identification and protection of natural breeding grounds of native ornamental fish; (vi) ensuring less disturbance to fishes during monsoon season to facilitate the natural spawning process; (vii) creation of mass awareness among the fish farmers and local people regarding the value of ornamental fish species, their conservation status and providing technological back-up for their raising and handling; (viii) prevention and control of aquatic pollution, protection of wetland from conversion, prevention and control of rivers from siltation through appropriate soil conservation measures, and (ix) biology of fish especially feeding and breeding biology including behaviour should be studied thoroughly for appropriate utilization. Various conservation activities are to be evolved including encouraging the private sectors to take active participation by mobilizing financial resources or creating awareness on ornamental fisheries as a part of their 'corporate social responsibility'. Private investment in this industry would be helpful to reduce the market risks and may be considered as a win-win situation for the corporate sector.

Conclusions

Indian ornamental fish industry is heavily dependent on the supply of native ornamental fishes from the North-Eastern states. The agribusiness opportunities of these live fishes have been recognized by the producers, collectors and traders. Since, almost the entire volume of ornamental fishes is collected from the natural aquatic resources of the North-Eastern region, there is a big sustainability threat to these resources. This calls for an urgent attention on formulating sound ecological and economic strategies. It has been stressed in this article that agribusiness opportunities in ornamental fish farming can be realized at every stage, viz. production, marketing and conservation of ornamental fishes. The ornamental fish production in the North-Eastern region has been observed to be financially as well as economically viable and investment friendly. With some initiatives by the government like providing incentive to establish ornamental fish production unit, considerable private investment can be attracted to this industry, which would generate additional employment opportunities. With the concerted efforts of all stakeholders, the ornamental fisheries can be developed substantially in the region, which in turn, will gain a larger share in the world market. Public-private partnership can be encouraged through establishment of ornamental fish production units in different parts of the region to make this sector more vibrant and remunerative.

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Appendix I

Classification of ornamental fish based on consumers' preference and extent of availability in natural water bodies

High consumer preference + Abundance	High Consumer preference + Low abundance	High Consumer preference + Very low abundance	Newly emerged (potential) species
Anabas testudineus (Climbing perch, 8, 0.15)	*Acanthocobitis botia* (Leopard loach, 25, 0.19)	*Balitora brucei* (Balitora loach, 25, na)	*Pseudechenies sulcatus* (Sulcatus catfish)
Aplocheilus panchax (Red/Blue panchax, 4, 0.02)	*Aorichthys aor* (Shovel mouth catfish, 30, 2)	*Botia berdmorei* (Blyth's loach, 50, na)	*Ailia coila* (Gangetic ailia, 11, na)
Botia dario (Rani loach, 20, na)	*Badis badis badis* (Dwarf chameleon fish, 6, 0.20)	*Botia rostrata* (Reticulated banded loach, 25, 0.50)	*Amblypharyngodon mola* (Brass fish, na, na)
Channa gachua (Asiatic snakehead, 5, 1.10)	*Badis badis burmanicus* (Red chameleon fish, 9, 0.71)	*Chaca chaca* (Devil catfish, 12, 1.15)	*Anguilla bengalensis* (Indian long fin eel, 13, na)
Channa punctatus (Checkered snakehead, 8, 0.75)	*Barilius bola* (Goliath hill trout, 25, 2)	*Chandramara chandramara* (Golden headstrander catfish, 15, 0.35)	*Aorichthys seenghala* (Giant river catfish, 30, na)
Channa striatus (Striped snakehead, 5, 1.25)	*Barilius shacra* (Striped hill trout, 18, 0.27)	*Channa barca* (Violet snakehead, 50, 2.30)	*Bagarius bagarius* (Painted giant catfish, na, na)
Danio regina (Focoler's danio, na, na)	*Channa marulius* (Peacock snakehead, 12, 4.85)	*Channa stewartii* (Goerette snakehead, 16, 3.07)	*Chanda nama* (Indian glass fish, 3, na)
Glossogobius giuris (Sleeper goby, 5, 0.20)	*Danio aequipinnatus* (Giant danio, 5, na	*Conta conta* (Thread tail catfish, na, 0.9)	*Chitala chitala* (Humb back knife fish, 40, na)
Lepidocephalus guntea (Panther loach, 8, 0.15)	*Danio dangila* (Moustached danio, 7, 0.75)	*Ctenops nobilis* (Nobel gourami, 30, na)	*Eutropiichthys vacha* (Batchua vacha, na, 0.80)
Mystus vittatus (Pyjama stripped catfish, 5, 0.22)	*Gagata cenia* (Clown catfish, na, 0.56)	*Danio devario* (Silver danio, 6, 0.26)	*Labeo calbasu* (Black shark, 4, na)

Contd.

Appendix I — *Contd*

Pseudambassis ranga (Indian glass fish, 3, 0.60)	*Macrognathus pancalus* (Striped spiny green eel, 8, 1.10)	*Garra gotyla gotyla* (Stone fish, 12, 0.35)	*Neolissocheilus hexastichus*
Puntius ticto (Fire-fin barb, 5, 0.20)	*Mastocembelus armatus* (Tire-track eel, 10, 0.50)	*Glyptothorax cavia* (Banded torrent catfish, 10, 0.18)	*Olyra longicaudata* (Long fighting catfish, na, na)
Chanda nama (Indian glass fish, 3, na)	*Mystus tengara* (Guinea catfish, na, 0.23)	*Hara hara* (Butterfly catfish, na, 0.41)	*Ompok bimaculatus* (Butter catfish, na, na)
Channa punctatus (Checkered snakehead, 8, 0.75)	*Nandus nandus* (Leaf fish, 15, 0.75)	*Hara jerdoni* (Dwarf anchor catfish, 10, 0.18)	*Ompok pabda* (Gulper catfish, na, na)
Colisa fasciatus (Giant gourami, 4, na)	*Pangasius pangasius* (Indian tiger shark, 40, na)	*Laguvia ribeiroi* (Ribero's catfish, na., 1.00)	*Ompok pabda* (Gulper catfish, na, na)
Colisa labiosus (Thick lipped gouramy, 4, na)	*Psilorhynchus balitora* (Banded torrent, 35, na)	*Laguvia shawi* (Cheetah catfish, na, 0.70)	*Osteobrama belangeri*
Colisa lalia (Dwarf gourami, 6, na)	*Puntius conchonius* (Indian rosy barb, 5, 0.18)	*Puntius gelius* (Golden barb, 8, 0.13)	*Somileptes gongota* (Jaguar loach, 35, 0.80)
Colisa sota (Honey gourami, 6, na)	*Puntius terio* (Terry barb, 6, 0.20)	*Rita rita* (White catfish, 35, 0.22)	*Tor putitora* (Yellow-finned mahseer, na, na)
Esomus danricus (Indian flying barb, 3, na)	*Rasbora rasbora* (Yellow-tail black tip, 6, 0.40)	*Schistura denisoni dayi* (Ring loach, 15, 0.25)	*Tor tor* (Red finned mahseer, na, na)
Xenentodon cancila (Silver needle fish, 6, na)	*Schistura sikmaiensis* (Orange loach, 24, na)	*Schistura scaturigina* (Victory loach, 12, 0.25)	*Wallago attu* (Fresh water shark, 18, na)

Source: Authors' compilation, Ghosh *et al*.; 2003, Mahapatra *et al*.; 2005 and MPEDA

Note: Figures within the parentheses indicate Trade name, domestic price (Rs/piece) and export price (US $/piece)

Domestic market price obtained through survey on different hobby shops, Hatibagan Haat for ornamental fish market, Kolkata, farmers and traders.