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Ichthyofaunal Diversity, Socio-Economic Status of Fisher Community, Gears Used and Techniques of Fish Catch in the Beels of Hajo, Kamrup District, Assam

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ABSTRACT

Hajo revenue circle (26°5' N Latitude and 91°32' E Longitude) of Kamrup district, Assam, abounds in large number of beels. These beels have long been known for their very high fish production. Fishing is the only source of income for 25% of population residing in the villages surrounding the beels. The Garjan beel has 33 component beels. Various aspects of fish and fisheries and the fishing community dependant on it were investigated in detail over a period of four years (2003-2007). Rapid shrinking of beel areas, loss of beels due to siltation, heavy weed infestation and over-exploitation during breeding season were found to be some of the causes for depletion of indigenous fish fauna. The paper documents the ichthyofaunal diversity, use of different gears and two new innovative techniques for capturing different size groups of fishes and records the socio-economic status of the fisher community.

Key Words: Garjan Beel, Fish Fauna, Depletion, Exploitation, Livelihood Pattern,

INTRODUCTION

Beels in northeastern region of India are highly productive ecosystems. Since times immemorial, capture fisheries from these beels have been the major source of income for the neighbouring population. Knowledge of fish and fisheries has passed down many generations and large numbers of devices have been designed to cater the needs of capturing different fish species in different seasons and for different migratory behaviour of fishes.

Fish genetic resources of the northeastern region are unique in being a mixture of Indo-Gangetic plains, Burmese and South Chinese forms (Sinha 1994). Various workers reported 187 species of fishes from the water bodies of Assam (Sen 1985, Nath et al. 1997, Sen et al. 1984, Kar et al. 2007). Through an extensive work, 367 species were reported (Nautiyal 2005) from the highlands of Himalaya (India, Nepal and Bhutan), Central India and the Western Ghats. The threat categories of fishes were re-evaluated in Nepal (Jha et al 2006).

In recent past, fish and fishery resources of Assam have been investigated by Mahanta et al. (1998), Lalmohan (2000) and Sarma et al. (2004) whereas some endemic species were reported from Assam and neighbouring northeastern states (Sen 1985, Ponniah et al 2000, Sen 2003). The potentials, ecology and management, traditional fishing and socio-economic status of some beels of Assam were studied by Dutta et al. (1987), Jhingran et al. (1987), Bhagowati et al. (1987) and Goswami et al. (1994). The fish diversity and conservation aspects of the beels and various types of fishing gears and devices have also been studied (Sinha 2002, Kar et al. 2006, Goswami et al. 2006)..

Local inhabitants have known the ecology and behaviour of different species of fishes over decades. Accordingly various devices for capturing fishes have

evolved. These devices vary from place to place depending upon the species of fish. While recording fishing practices, we could record two new innovative techniques for capturing fishes. This communication reports on the diversity of fish, causes of the depletion of fish catch, fishing gears, fishing techniques and socio- economic study of the fisher community in and around the Garjan beel ecosystem.

STUDY AREA

Garjan beel is a riverine wetland under Hajo revenue circle (26°5' N Latitude and 91°32' E Longitude, 681.2 sq. km, population 198,150) of Kamrup district of Assam. It encompasses 33 component beels with an area of about 678 hectares (Figure 1). The beel is bounded by villages Akadi and Hainadi in the north, Hatiputhi beel in the east, No. (1) and No. (3) Bagta and Satdala in the south and Hidiajani and Bamunbodi in the west. The major inlet called Baralia river originates from the mighty river Brahmaputra. Lakhaitara, another inlet is not directly joined to but it has about a half km long channel to the beel area. Out of 33 beels, full water level is maintained in 20 beels throughout the year. Water depth ranges from 1.5 to 4.5 m during floods. Four beels namely, Jarakh, Kwori, Bhoilla and Noilla, are interconnected by a cannel called Marrow jan.

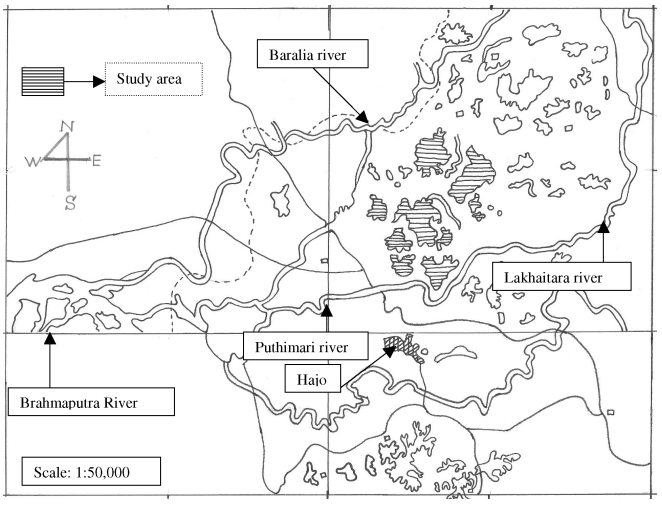

Figure 1. Map of Hajo Revenue Circle showing various beels

METHODOLOGY

Data on fish diversity was collected over four years (June 2003 to May 2007). Fish catch was recorded at monthly intervals, species were identified and their conservation status was noted (CAMP 1998). Species were identified with the help of existing literature (Talwar and Jhingran 1991, Jayaram 1998) and the nomenclature followed the fishbase data (http//www.fishbase.org). Water samples were analysed for temperature, pH, dissolved oxygen (DO), free carbon dioxide (FCO_2), total alkalinity (TA), conductivity, total hardness (TH), phosphate, nitrate and total dissolved solid (TDS) over two years (2005-2006) following the methods of APHA (2000). Atomic absorption spectrometric analysis of water was made at the Sophisticated Analytical Instrumentation facility of the North Eastern Hill University, Shillong . Daily arrival of fish was recorded at the landing sites. Annual fish production data was procured from daily catch record (2003-2006) at all the landing sites of beel while the trend and index of production were constructed by the 12-month moving average method (Pillai 1991).For socio-economic survey, a total of 800 families dependent on the beels for livelihood were interviewed and the questionnaire data was analysed. Resident dfoshes were collected by periodic netting. Gears were photographed while in use in the field.

OBSERVATIONS

Ichthyofaunal Diversity

Seventy-two species of fish belonging to 24 families and 9 orders were recorded from the study area (Table 1). Of these, five species are endangered (EN), 11 species are vulnerable (VU), 29 species are at a lower risk near threatened (LRnt), 7 species are at lower risk least concern (LRlc), one is data deficient (DD) and 19 species are not evaluated (NE) in the workshop (CAMP 1998). One species, *Puntius ornatus* is a new record from the Brahmaputra drainage basin in Assam (Bordoloi and Baishya 2006). Of these fish species, 47.7% are riverine fishes whereas the rest occur in lentic habitats. Of the recorded species, 54 species are Eastern Himalayan in distribution (Nautiyal 2005).

Fish Yield

The data on fish yield from the four major landing sites

Table 1. Systematic list of fishes of Garjan beel

Taxa	IUCN status
Order: - Osteoglossiformes (CAMP, 1997)	
Family: - Notopteridae	
1. *Chitala chitala* (Hamilton, 1822)	EN
2. *Notopterus notopterus* (Pallas, 1769)	LRnt
Order: - Clupeiformes	
Family: - Clupeidae	
3. *Gudusia chapra* (Hamilton, 1822)	LRlc
Order: - Cypriniformes	
Family: - Cyprinidae	
4. *Hypophthalmichthys molitrix* (Valenciennes, 1844)	NE
5 *Salmostoma bacaila* (Hamilton, 1822)	LRlc
6. *Salmostoma phulo* (Hamilton, 1822)	NE
7 . *Aspidoparia morar* (Hamilton, 1822)	LRnt
8. *Aspidoparia jaya* (Hamilton, 1822)	VU
9. *Chela laubuca* (Hamilton, 1822)	LRlc
10. *Esomus danricus* (Hamilton, 1822	LRnt
11. *Devario devario* (Hamilton, 1822)	LRlc
12. *Danio rerio* (Hamilton, 1822)	NE
13. *Rasbora daniconius* (Hamilton,1813)	LRnt
14. *Amblypharyngodon mola* (Hamilton, 1822)	LRlc
15. *Ctenopharyngodon idellus* (Valenciennes, 1844)	NE
16. *Cyprinus carpio communis* Linnaeus, 1758	NE
17. *Osteobrama cotio cotio* (Hamilton, 1822)	LRnt
18. *Puntius sarana* (Hamilton, 1822)	VU
19. *Puntius ticto* (Hamilton, 1822)	LRnt
20. *Puntius terio* (Hamilton, 1822)	LRnt
21 *Puntius phutunio* (Hamilton, 1822)	LRlc
22 *Puntius chola* (Hamilton, 1822)	VU
23 *Puntius sophore* (Hamilton, 1822)	LRnt
24. *Puntius ornatus* (Vishwanath-Laisram, 2004)	NE
25. *Cirrhinus mrigala* (Hamilton, 1822)	LRnt
26. *Catla catla* (Hamilton, 1822)	VU
27. *Labeo gonius* (Hamilton, 1822)	LRnt
28. *Labeo rohita* (Hamilton, 1822)	LRnt
29. *Labeo calbasu* (Hamilton, 1822)	LRnt
30. *Labeo bata* (Hamilton, 1822)	LRnt
Family: - Balitoridae	
31. *Acanthocobitis botia* (Hamilton, 1822)	LRnt
Family: - Cobitidae	
32. *Botia Dario* (Hamilton, 1822)	NE
33. *Somileptus gongota* (Hamilton, 1822)	LRnt
34. *Lepidocephalichthys guntea* (Hamilton, 1822)	NE
35. *Lepidocephalichthys annandalei* Chaudhuri, 1912	LRnt
36. *Lepidocephalus caudofurcatus* Tilak & Hussain	VU
Order: Siluriformes	
Family: Bagridae.	
37. *Sperata aor* (Hamilton, 1822)	NE
38. *Mystus bleekeri* (Day, 1822)	VU
39. *Mystus vittatus* (Bloch, 1794)	VU
40. *Mystus tengara* (Hamilton, 1822)	NE
41. *Mystus cavasius* (Hamilton, 1822)	LRnt
Family: Siluridae	
42. *Ompok pabda* (Hamilton, 1822)	EN
43. *Wallago attu* (Bloch & Schneider, 1801)	LRnt
Family: Schilbeidae	
44. Neotropius atherinoides (Bloch, 1794)	EN
Family: Sisoridae	
45. *Gagata cenia* (Hamilton, 1822)	NE
46. *Pseudolaguvia ribeiroi* (Hora, 1921)	LRnt
47. *Glyptothorax cavia* (Hamilton, 1822)	EN
Family: - Clariidae	
48. *Clarias batrachus* (Linnaeus, 1758)	VU
Family: - Heteropneustidae	
49. *Heteropneustes fossilis* (Bloch, 1794)	VU
Family: - Chacidae	
50. *Chaca chaca* (Hamilton, 1822)	EN
Order: Beloniformes	
Family: Belonidae	
51. *Xenentodon cancila* (Hamilton, 1822)	LRnt
Order: - Cyprinidontiformes	
Family: - Aplocheilidae	
52. *Aplocheilus panchax* (Hamilton, 1822)	DD
Order: - Synbranchiformes	
Family: - Synbranchidae	
53. *Monopterus cuchia* (Hamilton, 1822)	LRnt
Family: Mastacembelidae	
54. *Macrognathus pancalus* (Hamilton, 1822)	LRnt
55. *Macrognathus aral* (Bloch & Schneider, 1801)	LRnt
56. *Mastacembelus armatus* (Lacepede, 1800)	NE
Order: - Perciformes	
Family: - Ambassidae	
57. *Chanda nama* (Hamilton, 1822)	NE
58. *Parambassis ranga* (Hamilton, 1822)	NE
59. *Parambassis lala* (Hamilton, 1822)	NE

Family: - Nandidae	
60. *Badis badis* (Hamilton, 1822)	NE
61. *Nandus nandus* (Hamilton, 1822)	LRnt
Family: - Cichlidae	
62. *Oreochromis mossambicus* (Peters, 1852)	NE
Family: - Gobiidae	
63. *Glossogobius giuris* (Hamilton, 1822)	LRnt
Family: - Anabantiidae	
64. *Anabas testudineus* (Bloch, 1792)	VU
Family: - Belontidae	
65. *Colisa fasciata* (Bloch & Schneider, 1801)	LRnt
66. *Colisa lalia* (Hamilton, 1822)	NE
67. *Colisa sota* (Hamilton, 1822)	NE
Family: - Channiedae	
68. *Channa striatus* (Bloch, 1793)	LRlc
69. *Channa punctatus* (Bloch, 1793)	LRnt
70. *Channa marulius* (Hamilton, 1822)	LRnt
71. *Channa orientalis* (Bloch & Schneider, 1801)	VU
Order: Tetraodontiformes	
Family: Tetraodontidae	
72. *Tetraodon cutcutia* (Hamilton, 1822)	LRnt

(Table 2) during 2003-2006 show a declining trend. The data are affected by the climate and hydrological variation. During 2003, the total annual fish catch from 5 landing sites was 233.41 Mg. In 2004, it was 218.64 Mg but one landing site was lost in 2004 due to siltation as the year experienced unprecedented flood. Later, the fish catch declined to 111 Mg in 2005 and 103 Mg in 2006.

Index of Production

Data on the change in fish production during the four years at different landing sites are presented in Table 2. The data show that the annual fish production declined progressively more in successive years. The decline was the greatest at landing site II. Only at the landing sites III and V, the fish catch increased slightly in 2004 over that in 2003 but declined in later years.

Water Quality

The data on water quality (Table 3) for a period of two years did not reveal any significant fluctuation.

The heavy metal concentration in water (Table 4) varied seasonally, with higher concentrations of Zn, Mn, Se during the monsoon season..

Table 4. Monthly variation in concentration (ppm) of heavy metals in the water of Garjan beel

Month	Zn	Pb	Cd	Cu	Mn	Se
June 2005	0.01	0.03	0.01	0.008	0.20	2.19
July	0.29	0.07	0.01	ND	0.87	0.96
August	0.35	0.04	0.03	ND	0.05	1.27
September	0.18	0.01	0.01	ND	0.71	0.69
October	0.36	0.06	0.01	ND	0.12	1.47
November	0.42	0.05	0.01	0.02	0.07	0.008
December	0.13	0.03	0.01	ND	0.03	0.011
January '06	0.16	0.03	0.02	0.01	0.02	0.005
February	0.11	ND	0.02	ND	0.17	0.005
March	0.12	0.03	0.01	ND	0.24	0.006
April	0.02	ND	ND	0.03	0.12	0.009
May	0.11	0.06	0.01	0.04	0.44	0.069

Table 2. Index of production of catch of Garjan beel in the years 2003 to 2006.

Landing Site	Average Production (Catch), Mg				Index of production of catch (%)		
	2003	2004	2005	2006	2004 w.r.t 2003	2005 w.r.t 2004	2006 w.r.t 2005
I	34.32	32.28	27.84	22.91	94.06	86.25	82.29
II	64.4	59.76	32.24	13.70	92.8	53.95	42.49
III	31.18	31.06	30.52	25.47	101.2	96.7	83.45
IV	34.12	33.24	30.68	28.45	97.4	92.3	92.73
V	33.5	34.2	Nil	Nil	102	Nil	Nil

Table 3. Monthly variation of air temperature (^{0}C) and physico-chemical characteristics of water of Garjan beel

Month	Air Temp. (°C)	Water Temp (°C)	pH	Conductivity mS	Free CO_2	DO	T.A.	TH	PO_4-P	NO_3-N	TDS
July 2005	27	29	8.1	270	4.62	2.83	33.51	74	0.19	0.10	206.4
August	30	31	7.3	158	5.35	2.61	28.50	66	0.64	0.40	16.8
September	29	30	8.3	149	2.71	4.68	56.61	56.6	0.14	0.09	17.2
October	28	29	6.6	184	2.09	3.05	38.25	57	0.45	0.25	32.4
November	20.5	23	7.4	252	2.07	4.0	45.15	100.6	0.09	0.05	87.2
December	18	19	7.5	287	1.75	5.96	71.95	106	0.05	0.08	150.8
January 2006	13	16	7.9	353	2.32	4.02	65.45	122.6	0.01	0.02	99.2
February	19.5	19	7.5	302	3.15	4.81	66.33	105.2	0.03	0.02	90.2
March	19	16	6.9	336	4.31	4.5	57.23	126	0.04	0.01	93.1
April	23	24	7	277	4.66	5.21	32.06	97.2	0.10	0.09	97.3
May	27	23.5	6.1	272	3.09	2.24	25.2	95.2	0.12	0.1	82.4
June	31	29	6.5	235	3.11	2.41	30.32	80	0.14	0.3	100.6

FISHING GEARS IN GARJAN BEEL

Twenty-five fishing gears and fish catching devices have been developed over a period of time by the fishers to capture the wide range of fish species in the Garjan beel. These are described below and some are shown in Figure 2a-2o.

A. Gill Nets

These are passive gears. Gill nets are wall like nets with floats attached to the head rope and sinkers fixed to the foot rope. They are made of cotton or hemp and are of various sizes of mesh. The net is set in transverse direction obstructing the path of migratory fish so that when the fish tries to swim through a net wall, the meshes form a noose round its head and the fish is caught. This net is very popular among small-scale fishermen. In Garjan beel they are operated in surface layer of water column and are known as drift gill nets. Nets are called "jal" in Assamese.

AI. Langi Jal

These are rectangular nets, which are provided with head and foot ropes. The foot and head ropes are provided respectively with sinkers and floats. . These nets vary in size and meshes and operated as bottom set, encircling or dragged gill net depending upon the behaviour of the species sought. The net is set by fastening to an anchor. Sometimes the net is tied against the current and allowed to remain overnight. Fishes get entangled in the net by their operculum. Langi jals are of different types. They are named on the basis of the fish captured.

AIa. Puthilangi: Mesh size of this net is only 8-10mm and made of Nylon rope. It is operated round the year, and catch comprises *Puntius* sp., *Clarias* sp., fingerlings of *Chitala*, *Labeo, Catla* and *Rasbora* sp., *Ompok* sp., *Esomus* sp., etc.

AIb. Kaoilangi: It has a mesh size of about 17mm. This net is also operated throughout the year. *Anabas* sp., *Heteropneustes* sp and *Clarias* sp are caught in this net.

AIc. Goroilangi: It is operated during winter when the water level is low. The mesh size is 20 mm.The net is usually set near weed infested shore areas. Fishes are driven into the net with "Polo". To operate the net 3-5 persons are needed for 1-2 hours. When "Polo" is used water depth is 60-90 cm.

It is also used when "Shak jal" is operated in the beel. In this operation, initially a part of the beel containing water hyacinth is covered by Goroilangi net. After water hyacinth is removed, fishes within this area are covered by Shak jal to catch them. Two different types of gears like "Soli" and "Tiara" are used simultaneously in this operation. Soli is a bamboo spear which has pointed iron cone to pin up the fishes from Shak jal. Tiara is used for searching the fish which are enclosed by Shak jal. When water is 2.0-2.5 m deep, the Shak jal is used to capture all types of fishes.

B. Encircling Gear

BIa. *Mohori jal*: Also called as Mosarijal (Mosquito net) by fisherman, it is used throughout the year. The net is made of 2-5 pieces of rectangular nylon nets of mesh size 1-1.2mm. Each piece of net varies 20-30 m in length and 6-8 m in breadth, tied together by nylon threads. Along the upper margin of the net a stout jute rope passes, which is known as 'head rope' and along the lower margin another jute rope, the "ground rope" or the footrope. Flats of soft wood or banana shoot and sinkers of lead or bricks are used in the head rope and footrope, respectively. Long ropes are tied on either side of the net.

The net is taken into the deep portion of the beel, stretched and the bottom rope is allowed to settle. The two ends are dragged towards the shore and brought together. As the central portion of the net comes to the shore, the net is lifted to form an effective bag. Generally 8-14 persons are required depending upon the size of the net for a single operation. With the help of 2-3 boats a single operation needs about 5-7 hours.

The catch composition comprises all types of fishes mainly surface and column feeder including prawn. This net is detrimental for the fauna and use is prohibited during breeding season.

BIb. *Asra jal*: The net is conical in shape which is a cast net with 8-15mm mesh size. The length of the net is 2-2.5m. The circular edge of the bottom of the cone is doubled and sewn into a number of pockets, a foot or two in height. Along the inner edge of the mouth of the pockets run a chain of iron drum-shaped weights. A rope is attached to the apex of the cone. The fishermen stand knee-deep in water with the end of the rope in his left hand and the net folder on his right arm. By a dextrous sweep of the arms he whirls the net above his head and coats it on the water which fall in the form of a perfect circle. The weights pull the net down uniformly in the form of a cone into the water. The net is pulled gently by the rope, when the cone shrinks gradually and the enmeshed fish find their way into the pockets. The catch comprises both small and big sized fishes. It is used mainly in the channel but in beel also where water flows freely.

BIc. *Ber jal*: The use and the mode of operation of berjal are same as that of Mohorijal. The design details of the two are also similar except that the mesh size is considerably bigger (25-30 mm) in Berjal.

BId. *Jata jal*: This is a lift net used only during rainy season (May-July). It is a large triangular net stretched across two bamboos tied near the thick ends. The net is balanced in front of a bamboo platform raised in the bed of the beel about 2 m above the water level. The fisherman standing on the platform releases the cross piece from its fastening to the platform when the net drops down into the water. After 30-45 minutes the fisherman puts his weight on the crosspiece when the net slowly swings up in the air. The fishes caught slide down to the apex of the frame, where the fisherman gathers them. Almost all sizes of fishes are caught due to its small (7.5-12.5mm) mesh size.

BIe. *Ghoka jal*: A lift net, triangular in shape, tied in a bamboo frame. One pole of bamboo framework is extended by about 1m for operating the net. The size of the net varies considerably. Mesh size also varies from 5mm-8mm. A single person operates the net by dipping and subsequent lifting in water. Catch comprises small sized fishes like *Anabas* sp., *Clarias* sp., *H. fossilis, Lepidocephalus* sp., *Mastacembelus* sp., Prawn etc. It is operated round the year.

BIf. *Shak Jal*: This device is circular in shape so it is known as shak jal. It isused in combination with other devices like Goroilingi jal. All types of fishes are caught in this net.

C. Traps

Trap fishing is a passive fishing technique of ancient origin. Traps are fishing devices of various designs and fabrications. Generally, the operation of traps depends, in order to match specific local conditions and behaviour of the target fish species. The various types of traps in Garjan beel are as follows: -

CIa. *Sepa:* This is a sieve bamboo trap resembling a drum tapering at both ends. One opening is closed by a piece of wood and half of the opening at the other end is closed by another piece of wood. There is an opening at one side of the trap with bamboo strips extended inward, so that fishes get an easy entry to the trap while the extended gill like bamboo strips prevent them from escaping. The trap is set facing the opening against the current. The diameter of the opening is 20-40 cm. The total length varies from 90 to150cm. This trap is used from April to June.

Small sized fishes like *Puntius* sp., *Amblypharyngon mola, Rasbora* sp., *Colisa* sp., *H. fossilis* and *C. batrachus* are caught with this device.

CIb. *Polo*: This is a cover basket, conical in shape and open at both ends. This is made of bamboo strips laced together by cane or ropes and operated only during winter months (October to February). The opening at the top is 15-25 cm and the bottom is 60-90 cm in circumference. The height of the trap is 0.6-0.9 m. One man carries the trap in hand, slowly wades and plunges it into water where fishes are suspected to be present, and pressed firmly. One hand is placed through the top opening and fishes inside are searched and taken out. Sometimes this trap is used in combination with Goroilangi.

All types of fishes mainly bottom dwellers are caught by this trap.

CIc. *Dingora*: The trap is made of bamboo strips, rectangular in shape having two mouth in both side with the sieves directed inward, like spines. The length varies from 0.5m to 2 m and the breadth varies from 0.5m to1.3 m. The trap is operated against the current. It is mainly used during monsoon months (May to July).

Live fishes like *A. testudineus, C. batrachus, Channa striatus* and other small fishes which have migratory tendency were caught by this trap. Large sized Dingora is also found to capture large sized fishes like *Labeo rohita, Catla catla, Cirrhinus mrigala*, etc

CId. *Darki*: This device is not indigenous in origin. This technique is used in Bihar.The design and mode of operation is same as those of Dingora. But this trap has several openings (smaller than Dingora) and no spine like inward directed structure is made in this trap. Instead, the wall of the trap is folded directing inward at the openings. The length of the trap is 1-1.5m and breadth is 0.2-0.3m. Hundreds of Darki is placed in a row and small sized fishes (1cm and above) like *Puntius* sp., *Colisa* sp., *Mystus tengra*, *Esomus* sp., *Rasbora* sp., *Chanda* sp., *Botia* sp., *A. mola* are captured by this trap. It is used in the monsoon months.

CIe. *Boldha*: The structure of boldha is same as Dingora but the breadth is smaller with 0.1-0.15m and length 0.2-0.25m. A bait with snail flesh is kept inside. Fishes caught by this trap are *Clarias* sp., *Heteropneustes* sp., *Channa* spp and other small sized carnivorous spp. It is operated throughout the year.

CIf. *Jakoi*: It is generally operated by women round the year. The trap is triangular in shape with a wide mouth (circumference about 2 m). It is constructed by bamboo sieves woven at intervals of 0.3-0.7 cm. The trap is dragged along the shallow margin of the beels and lifted sharply to catch fish.

Catch composition included all small fishes which are surface and column feeders.

CIg. *Chalani*: It has round shape mainly made up of bamboo sieves in which edges are tied with nylon rope. It is operated in winter when the depth of water is low, mainly after dewatering of beel area. With this trap Anabas sp., *Channa sp., Colisa* sp., *Heteropneustes* sp., *N. notopterus* are normally captured.

CIh. *Riha*: This is bamboo made gear bearing wide mouth in one side. When water depth is 2-3 feet in beel area, it is used to capture only *H. fossilis*. Generally it is used in the muddy area where *H. fossilis* get entangled in its wide mouth. Fishes are caught with mud during the period from November to March.

D. **Indigenous Fish Trapping Techniques**

Four different techniques of trapping fishes have been recorded in Garjan beel.

DIa. *Katal fishing*, and Dib. *Sera Katal*: Katal fishing is an indigenous method in Garjan beel. Though the method is very simple and requires low investment it takes long time between installation and harvesting. Katals are set by dumping tree branches, bamboo shoots and water hyacinth in the form of a circle, during August to September. Other gears particularly Mohorijal are subsequently operated in the beel so that fishes are driven into the Katal. After 2-3 months i.e., in late November to February the Katal is encircled by dragnets (Katalmarajal and Berjal, mesh size 2-5 cm, height 10-25 m) and by "Banas" which is closely woven bamboo matting. When the actual fishing starts a group of 20-30 fishermen depending upon the size of the Katal enter the encirclements. The vegetation and the other objects from inside the circle are thrown out. Nets and banas are drawn inwards slowly reducing the circumference. Cast nets are operated simultaneously. The foot ropes of the net are finally brought together to form a bag and fishes are caught. The operation is carried out from boat and it lasts for 8-12 hours where by harvesting the complete "Katal" at a stretch.

Figure 2 a. Puthilangi Jal and a Tola (in hand)

Figure 2 b. Goroilangi Jal

Figure 2 c. Mohorii Jal

Figure 2 d. Asra Jal

Figure 2 e. Chak Jal

Figure 2 f. Sepa

Figure 2 g. Polo

Figure 2 j. Jakoi

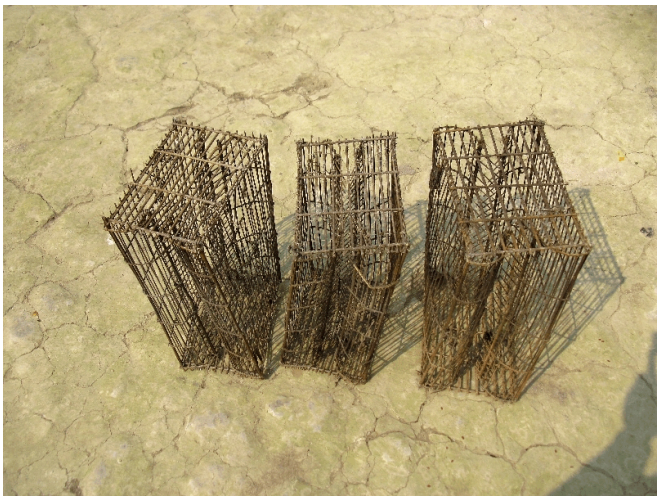

Figure 2 h. Dingara

Figure 2 k. Chalani

Figure 2 i. Darki

Figure 2 l. Split Bamboo Barrier

Figure 2 m. Tiara

Figure 2 n. Dewatering of Fish Pond

Figure 2 o. Ghera Fishing

It has been observed that after one harvest the tree branches and other objects are again dumped together in the original site of the Katal. The Katal is then called Sera Katal. After 15 days to one month the sera Katal is harvested in the same way as that of Katal. Katal fishing is done mainly on the eve of Uruka which is celebrated on the previous day of 'Bhogali Bihu or Makar sankranti'. The catch composition of Katal comprises of *Labeo* sp., *Catla* sp., *Cirrhina sp., Wallago* sp., *Notopterus* sp., *Puntius* sp., *Mystus* sp., *Cyprinus* sp., *Colisa* sp., *Nandus* sp., *Channa* sp. and other miscellaneous varieties.

Fish catch goes up to one Mg per landing site. 26.22% of total catch from katal have been recorded in the Garjan beel during 2004-2005.

DIc. *Banas fishing*: This is a special type of device made of bamboo. It is mainly used from July to October when there is water current in the beel as well as in the channel. Two-bamboo fencing like "V" shaped is constructed in a particular place and together known as "Latha." First one is constructed from shallow region to middle of the channel where depth of water is high. Fishes coming along with current are caught Second one is also "V" shaped but in its one end bamboo mat (Bana) is placed to capture fishes which are already entangled. This bana is constructed from Latha to shallow region accordingly. This helps the total capture of fish present in the Latha in water current. In some cases dewatering is also done for total capture. All types of fishes are captured by banas fishing.

DId. *Split Bamboo Barrier for capturing Mystus* spp.: This is a special device constructed at the junction of beel and channel for trapping of *Mystus* spp. A split bamboo barrier (Figure 2l) is erected in between beel and channel of which two sides are left open. Additional barrier is made with soil to check the flow of water. Water is made to flow through these two openings. Fishes moving against the current of water are being trapped in these openings. When fishes enter the opening one bana (made of bamboo strips) is placed to the first opening and another one at the last by which fishes are trapped inside the stream. Now soil barrier is erected at both the openings to check the flow of water. Dewatering of stream helps in easy capture of fishes by hand picking inside the stream. Generally *Mystus vittatus* and *Mystus bleekeri* migrate from beel to channel during the months of October to December between 7-10 p.m. During this time fishes are trapped by this technique inside the stream.

DIe. *Ghera fishing*: In this technique bamboo split barrier is constructed in the channel producing water current in one side which act as stream. Ghera (Figure 2o) is made up of bamboo strips tied with coir rope. The interspace of the bamboo strip is 2-3 mm and it is woven to form a shape of a bamboo screen. The size of this bamboo screen is about 8 m long and 1.5 m wide. The bamboo screen is now folded forming one triangular opening using five bamboo poles tied with ropes. To facilitate the shoal of fishes moving against the water current, the opening of ghera is placed at least 5cm above the level of water in the stream. Now fishes are captured by one person with the help of ghoka jal. All varieties of small fishes are captured by this technique during pre-monsoon period i.e. from April-June. *Puntius sp.,* comprises major group among small fishes.

E. **Hooks and Line Fishing**

Line fishing is basically composed of a line and a hook. Hooks are made of galvanized or aluminium coated iron, brass, or stainless steel. They are manufactured in different shapes and sizes.

Eia. *Rod and Line* : These common devices are used in the Garjan beel at Hajo. Fishing rods are made of local bamboo. The lines are usually of twisted cotton or hemp thread. The common rods have short lines tied to the top of the rod. The smaller hooks or the local made larger hooks are tied well to the line. The hooks are usually barbed and one to three hooks are used on the same line. Baits are made of earthworm, larvae of wasps and similar other insects. Bottom feeder and predacious fish are caught with the line baits, usually small fish like "cheng" "loti" prawns etc. As the fishes try to get the baits it is indicated by the floats and pole is pulled out of water with great force and the fish species is caught by the hooks. Pole and line fishing was found to be very common method which can be categorised into two types depending on the preparation of the pole.

EIb. *Nal barashi*: This type of barashi (Anchor) bears a nal (hard stem portion of a plant) instead of bamboo, which is about 25-30cm long and is tied centrally with a nylon rope (60 cm) with a hook, which can float freely at a right angle to nal. Generally, earthworms are used as bait in the barashi. About 250-300 nal barashis are found floating in the beel at a time and are checked three times a day to catch the hooked fishes. The catch comprises of *Channa* sp., *Anabas* sp. and *Heteropneustes fossilis*. It is used in the monsoon period

EIc. *Sip barashi*: It is made up of "bijuli" bamboo (Bamboo species) which measures about 20-25ft in length and about 5mm in thickness. At the tip of the bamboo a nylon rope with a hook is tied with a grasshopper or ant larvae as bait. The nylon rope measures about 4-4.5ft in length. This type of barashi is used to capture *Heteropneustes* spp and *Clarias* spp.

EII. *Impalling gears*: This method is used for sharp implements for catching fish by wounding, grappling and killing. The different impalling gears found in Garjan beel have been described below: -

EIIa. *Jongar*: It consists of a tapering bundle of 7 or more split "Bijuli" bamboo spears capped with sharp conical iron points. It is heavy and hurled with considerable force at the fish, which is pinned to the ground. Generally it is operated in the pre-monsoon period (March-May). The catch comprises mainly *Wallago* sp., *Labeo* sp., *Channa* sp., etc.

EIIb. *Tiara*: It is made up of only iron bundle of 7-9 spears with sharp conical points. A 3.5 to 4.5 m long Bijuli bamboo is joined to the iron bundle to hurt the fish with considerable force. It is operated in post monsoon period (August to December). Generally big sized fishes like *Labeo* sp. and *Channa* sp. are pinned down at night by this gear with the help of lantern.

F. Dewatering

Dewatering is done during winter when water level of beels is low. Prior to dewatering, all conventional methods are used and the beels are supposed to be left for further outstocking in monsoon. Catch composition comprises species of *Puntius, Channa, Heteropneustes, Amphipnous, Clarias*, prawns and miscellaneous fishes. In this way all size groups of fishes are removed from the system.

SOCIO-ECONOMIC STATUS OF FISHERS

A total of 800 fisher families from 16 village units were surveyed during the study. Among them only 13.6% were literate and the rest illiterate. 56% are educated up to class V to X; 38.3% up to lower primary, 4.8% had passed H.S.L.C and 0.7% High School (Table 5).

Table 5. Socio-economic data of fisher families

Village Unit	Families surveyed/ Village	Total no. of Individuals/ Village	Literate				Av. monthly income from fisheries/family		
			Primary	Secondary	High School	Total	Min	Max	Average
I	76	419	24	20	5	49	1000	10000	5500
II	83	513	25	25	7	57	800	2500	1650
III	131	682	31	73	4	108	800	2700	1750
IV	80	461	27	20	10	57	500	2000	1250
V	68	389	26	33	0	59	800	3000	1900
VI	50	240	19	22	2	43	1000	3500	2250
VII	6	36	1	1	1	3	800	2100	1450
VIII	56	258	16	39	0	55	600	800	700
IX	10	66	6	2	1	9	900	2200	1550
X	23	129	6	11	1	18	1200	10000	5600
XI	27	104	8	8	0	16	500	3000	1750
XII	7	39	0	3	0	3	1000	3000	2000
XIII	12	101	5	2	0	7	1800	2000	1900
XIV	31	136	8	14	2	24	900	3100	2000
XV	122	707	22	51	0	73	800	1500	1150
XVI	18	118	6	12	0	18	800	1500	1150

Depending on the season, monthly income varies from Rs. 500 to Rs 10,000 (Table 5) but with this meagre amount they cannot support their families. According to the Government guidelines, fishing is prohibited during pre-breeding and breeding seasons. This is not strictly followed because fishing is the only source of live-lihood. A part of their income is collected by Mahal-dars who take the beels on lease. Other source of income is poultry farming, daily wage labour, selling of gears and agriculture.

Analysis of Additional Income in Comparison to Fisheries

Students t-test was performed to test the significance of difference in the average income between fisheries and cultivation of fishermen. The tabulated value of "t"at 5% level of significance for one tailed test with (15+15-2)=28 d.f. is 1.70 and the calculated value of "t" is 1.81. Since the calculated value of "t"is greater than the tabulated value of "t'hence we reject the hypothesis and may conclude that the average income obtained from fisheries is not sufficient for them and the fishermen are bound to take other options like cultivation for their livelihood

DISCUSSION

Assam abounds in large number of flood plain wetlands (1.12 lakh hectares). These wetlands are mainly enriched by the river Brahmaputra and its tributaries. Wetlands offer a range of hydrological and ecological benefits to the entire life support systems and livelihood of rural communities depend on them. In the present study these beels were monitored for a period of over four years (2003-2007).

Biodiversity of Eastern Himalayan region is characterized by very high level of endemism (Sen 2003). Diversity of fish fauna of the Brahmaputra drainage has been studied by various workers (Sinha 1994, Sen 1985, Nath et al. 1997, Sen et al. 1984, Kar et al. 2007, Nautiyal 2005). During present investigation 72 fish species could be recorded including *Puntius ornatus* which is a new record for the Brahmaputra drainage (Bordoloi and Baishya 2006). Most of these systems are underexplored and there is possibility of finding new records. The fish fauna includes fishes of lotic as well as lentic ecosystems.

Study of ecological parameters of beel water has revealed that the area is free from pollution. In the fringe areas paddy cultivation is done and insecticides are used. Water for analysis was normally collected

from area away from cultivated land. Fishing in these beel goes on unabated throughout the year. Fishery Act 1897, has been implemented and specific Government guidelines are present, but these cannot be implemented strictly as fishing is the only source of livelihood for the families inhabiting the neighbouring areas of beels. Overdependence on fishing is causing fast depletion of natural resources. There is urgent need of alternative income generation activities and associated technologies. Different types of gears are used to exploit all the size ranges of fishes during different seasons. Some of these gears viz., Darki is very detrimental for the sustenance of fish fauna in which all fish species within that size range are captured (economically important and all indigenous fishes). This particular gear can remove all small sized fishes (0.5cm and above) present in the beels. Dewatering is done with pump and all the remaining fishes are caught. This causes damage to the ecosystem as along with fishes other non-target organisms are also removed from the system. As a result natural food organisms of fish characteristic of this type of ecosystem are lost. Replenishment through flood or release of fingerlings of cultured fishes is necessary to check depletion of fish in these natural waters. From last part of April every year to January fish production is higher. During flood fishes from neighbouring water bodies find entry into the beels and hence fish production increases during flood. Due to unprecedented flood in 2004 three most productive beels turned into land mass due to heavy siltation. These areas are being used now for paddy cultivation. In subsequent years 2005 and 2006 seasonal flood did not occur and as a result replenishment of fish was affected. During this period (2005-06) fish catch was much lower (111 tons) than the earlier year (218.64 tons). The study has revealed that these beels are shrinking at an alarming rate due to heavy siltation. Fish stock is depleting at an alarming rate. Various causes can be attributed for depletion of fish stock viz. over exploitation of fish fauna in all seasons, Fishing holiday during breeding season is not followed strictly, heavy weed infestation, gradual change in precipitation pattern, flash flood in place of timely flood etc.

For augmentation of fish production in these beels certain measures can be suggested which could be true for other beels also in the region: a) Maintenance of the beels by concerned authority, b) Desiltation of beels after floods, c) Clearing the feeding channels, d) Preventing use of gears detrimental for all the fishes, e) Strict implementation of fishing holiday during fish breeding season, f) Release of cultured fingerlings in the beels and g) last but not the least, educating the fisher community through extensive awareness program and raising their education level.

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