

# Suraha Tal

*Prospects for Fisheries Development*



Bulletin No. 64



April 1992

**CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE**  
(Indian Council of Agricultural Research)  
**Barrackpore 743 101 West Bengal**

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Prospects for Fisheries Development

Y.S. Yadava & V.V. Sugunan



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Suryana Tal

Prospects for Fisheries Development

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## MESSAGE

The floodplains, since time immemorial, have provided man with more than one source of livelihood. While the rich mantle of alluvium in the floodplains provides a nourishment for his winter crops, the lakes that get enriched with fish juveniles bring in a bounty of catch till the next floods come in. The nature's benevolence has, however, been marred by man's quest for achieving more and more and the floodplain lakes are no exception to this tirade.

*Suraha Tal* is one of the largest floodplain lakes in the Gandak basin of Eastern Uttar Pradesh, which has undergone conspicuous changes over the years, leaving a trail of adverse effects on the ecosystem. In the process, the lake has lost much of its production potentiality, depriving the lake-side community its prime source of livelihood.

This comprehensive report portrays a detailed account on the present state of affairs of the lake and provides a step-by-step approach to its development. It will act as a handy manual for the developmental agencies to adopt a holistic approach in augmenting the ecosystem and its constituent fisheries. The CICFRI's team of scientists and technicians, who undertook the assignment has done a laudable job in bringing out this manual. I am confident that the implementation of the recommendations contained in the report will go a long way in transforming *Suraha Tal* into a healthy and vibrant ecosystem.

P. V. Dehadrai  
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## FOREWORD

Since the Earth summit and the Rio declaration in 1992 laying down the international environment policy, the riverine wetlands have become the focus of attention by virtue of their role in conservation of bio-diversity. It is increasingly accepted that the shift towards sustainable development has several critical implications for food security, economic growth and social transformation. An anthropocentric approach on sustainable development entails ensuring sustained quality of life for humans. Thus, environmental protection by extension of national and international laws should relate as much to the protection of human welfare as the wildlife and other natural resources. The riverine wetlands of the Indo-Gangetic plain are subjected to enormous environmental stress on account of population growth and the attendant industrialisation and urbanisation.

Suraha lake of Uttar Pradesh and the associated water bodies are used for a variety of human activities including agriculture, irrigation, navigation, aquaculture and fisheries. The varying land and water use patterns often result in conflicts among the developmental activities. The rapid rate of eutrophication and reclamation of the Suraha ecosystem causes concern, especially due to the diverse flora and fauna it sustains. Fisheries development of Suraha is aimed at fostering the natural fish population, encompasses conservation of food chain comprising flora and fauna at all trophic levels. Thus, conservation of biodiversity is in harmony with the norms of fisheries development. This document is an outcome of CIFRI's attempt to study the ecosystem from a fisheries perspective and highlights the problems and potentialities of the lake. I hope the preliminary findings, portrayed in this report, will form the basis for future studies leading to policy guidelines aimed at conservation and sustainable development of the resource.

S. P. Ayyar  
Director  
CIFRI

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# *Suraha Tal - Prospects for Fisheries Development*

Central Inland Capture Fisheries Research Institute  
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## 1. INTRODUCTION

Natural lakes in the floodplains of river Ganga and its tributaries abound in Eastern Uttar Pradesh. Lake Bakhira (Basti), Ramgarh, Chilwa (Gorakhpur), Suraha and Dah (Ballia) are some large floodplain lakes providing lucrative source of fisheries in the region. Traditionally, the fish harvest from these lakes, locally referred to as Tal, has been considered as a renewable natural resource available for maximum exploitation. However, a combination of the processes of river bed evolution, extensive works for irrigation, drainage, flood control and poor watershed management practices in the basin have resulted in annihilation of many of the original features. Notwithstanding the excessive anthropogenic degradation over the decades, these versatile water bodies, by virtue of their unique position and carrying capacity, harbour a vast store of fertility and provide ample scope of fish production. This report highlights the problems and potentialities of Suraha Lake in order to make a proper and pragmatic approach towards conservation and sustainable development of the lake.

## 2. THE LAKE PROFILE

Suraha, an oval shaped oxbow lake in the floodplains of river Ganga, extends between the parallels 25°48' and 25°52' N latitude and 84°8' and 84°13' E longitude. The lake is situated about 7 km north of Ballia town, covering Beruarbari, Hanumanganj and Dubhar revenue blocks (Fig. 1).

### 2.1 *Physiography and morphometry*

The average depth for the littoral and pelagic zones of the saucer-shaped basin ranges from 103.0 to 390.0 cm, with a mean of 225.0 cm. The lake is connected with river Ganga through Katehar nullah (approx. length 8.0 km), which acts both as inlet and outlet depending upon the water level of the river Ganga. A concrete barrier with wire mesh screen (0.5" mesh size) is provided in the nullah to prevent entry of aquatic weeds, mainly *Eichhornia crassipes*. Besides, the lake receives water through two other inlets, the Garari (Aunra) nullah and Madhaha (Nakehar) nullah. These inlets mainly drain the rain water to the lake. The Nakata drain and the Suraha Lake canal system drain the water from the lake for irrigation. The vast catchment of the lake comprises the agricultural fields and the human habitation spread all along the periphery.

### 2.2 *Water balance*

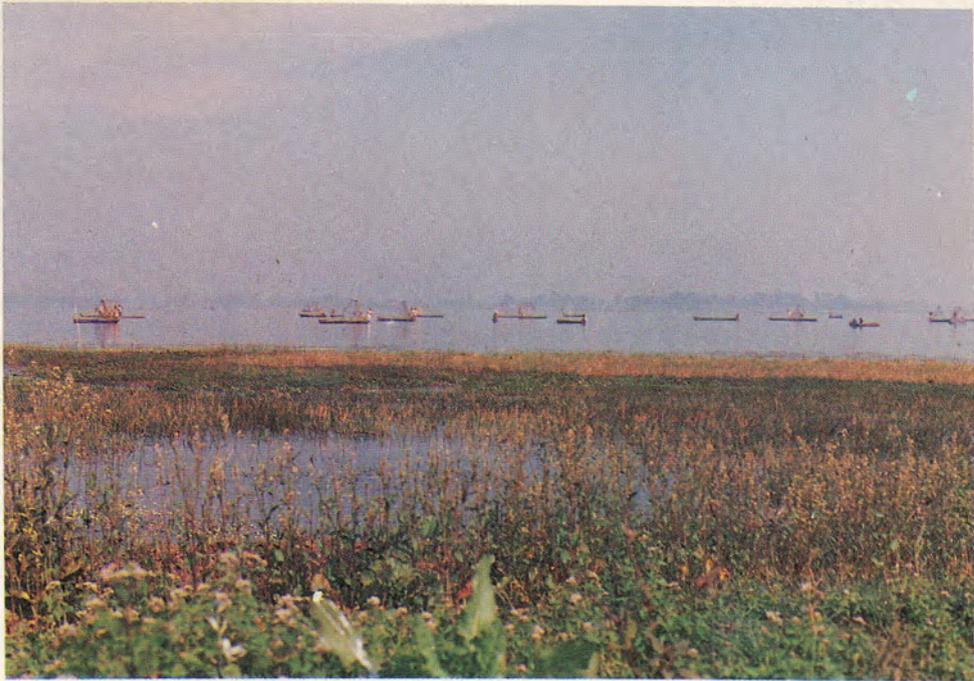
The lake encompasses an area of 3 422.0 ha (191' above MSL) at full storage level (FSL) and 1 260.0 ha (182' above MSL) at dead storage level (DSL), with an average area of approximately 2 000 -2 2000 ha. The submergence at FSL and DSL is 100% and 36.7% respectively (Table 1 & Fig. 2). The lake expands consequent to the incursion of water from the inlets and annual precipitation and inundates vast low lying areas. The two flap regulators on the Katehar nullah, which are closed from time to time, largely determine the water level of the lake. During the late winter and summer, the lake becomes a chain of discontinuous water patches with intermittent islands. A sizeable quantity of water is drawn for irrigating the rabi crops in the district.

## 3. ECO-BIOLOGICAL STATUS

### 3.1 *Nutrient dynamics*

Physico-chemical parameters of both soil and water phase, having bearing on the biotic assemblages, were assessed to determine the prevailing nutrient dynamics in the lake. Soil with marginally above neutral

## Suraha Lake



*A panoramic view of the Lake*

*Fishing activities*



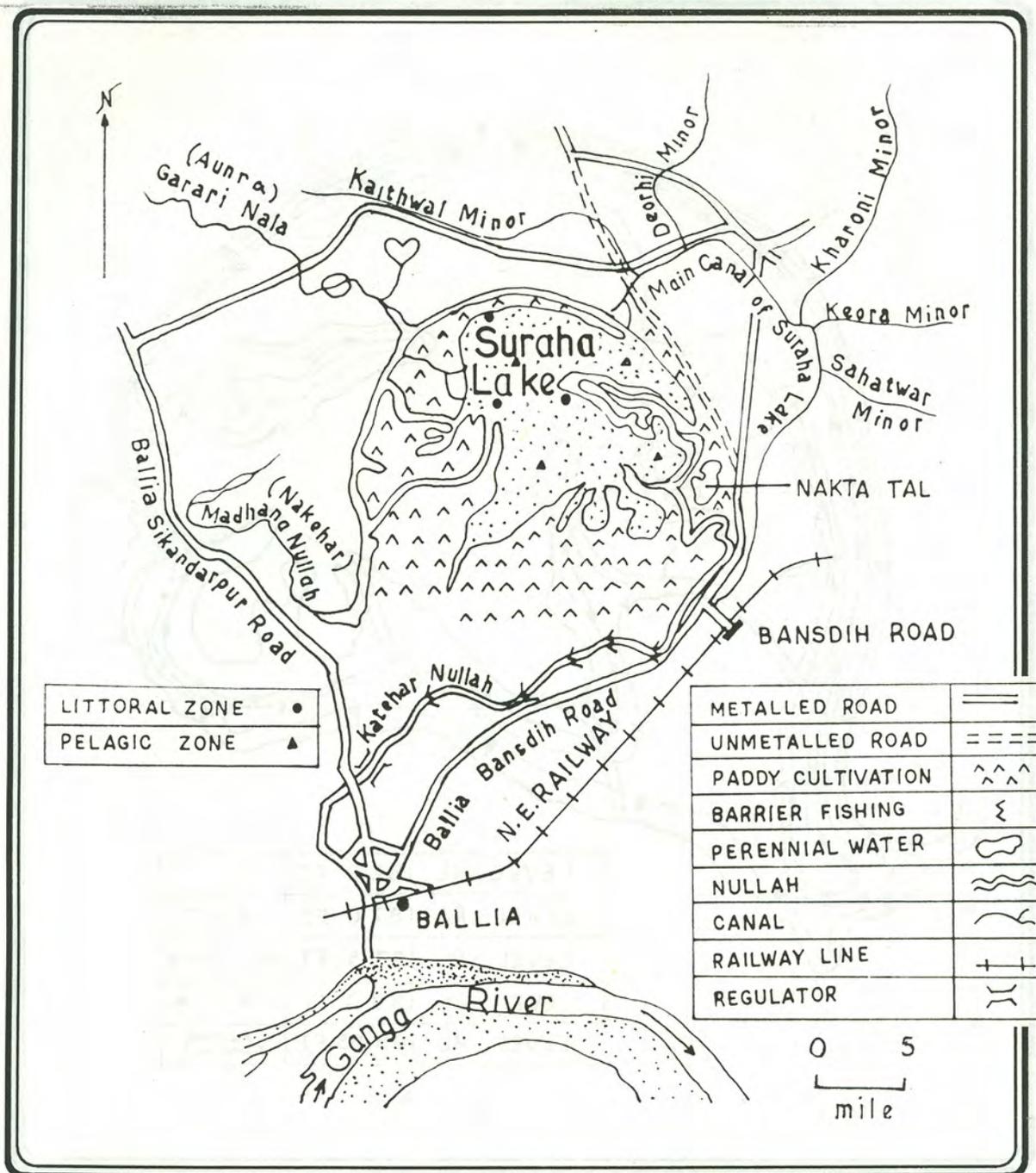
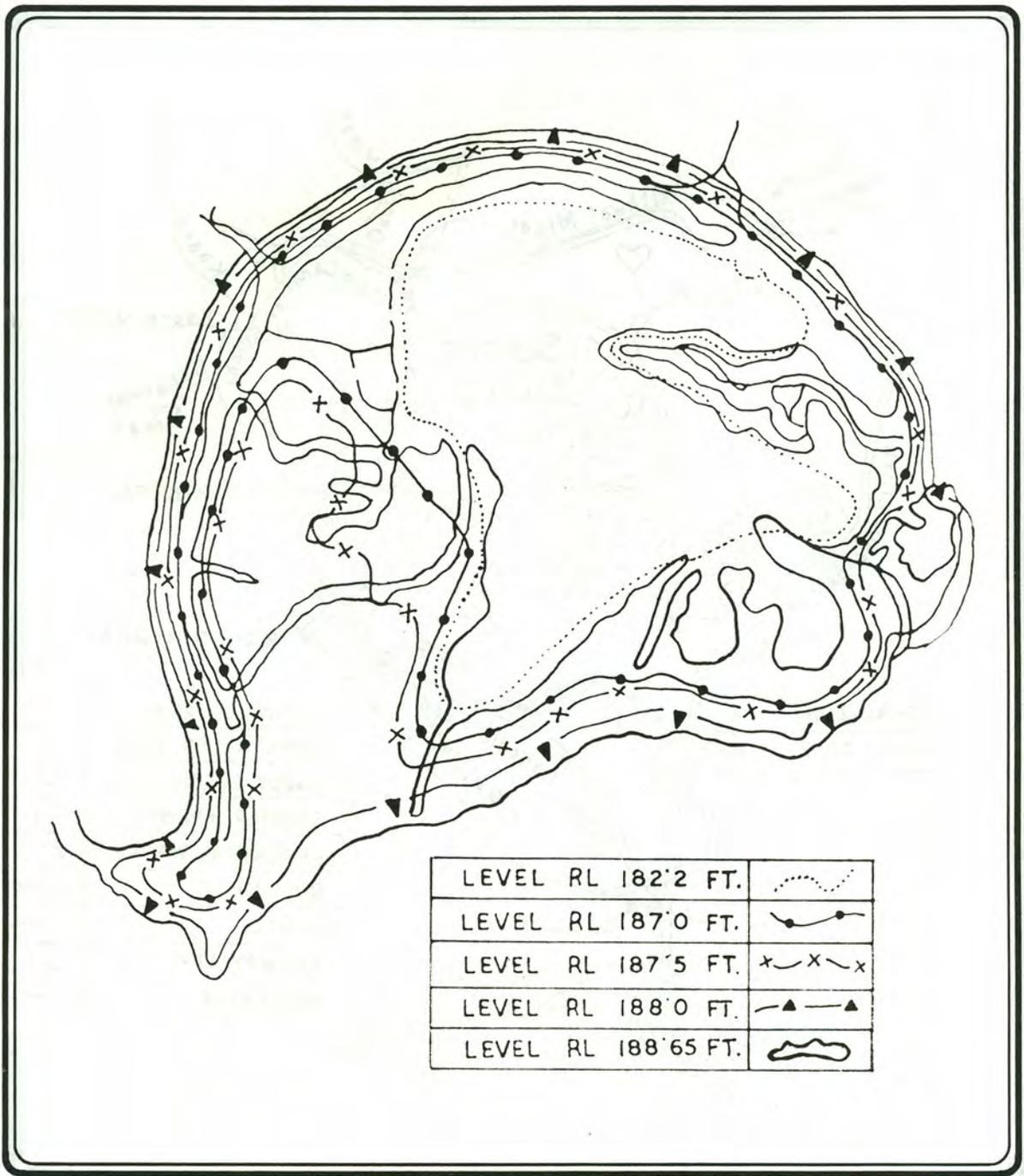


Fig. 1 Suraha Lake and its surroundings



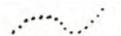
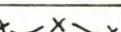
LEVEL RL 182'2 FT.	
LEVEL RL 187'0 FT.	
LEVEL RL 187'5 FT.	
LEVEL RL 188'0 FT.	
LEVEL RL 188'65 FT.	

Fig. 2 Area of Suraha Lake at different contour levels

Suraha Lake



*Barrier with wire mesh on the Katchar Nullah*



*A close view of the wire mesh ( 0.5 " mesh)*

Table 1. Area, capacity and submergence of Suraha Lake at various levels

Level (feet above MSL)	Area (ha)	Capacity ( m cft.)	Submergence (%)
191	3432	2415	100
190	3104	2160	90.10
189	2800	1840	81.30
188	2578	1550	75.10
187	2220	1290	64.70
186	2018	1060	58.80
185	1846	850	53.60
184	1688	660	48.00
183	1400	845	40.80
182	1260	350	36.70

pH (7.2) was found to be indicative of moderate to high productivity, further corroborated with high values of organic matter (2.30%), organic carbon (5.52%), available phosphorus (10.40 ppm) and available nitrogen (119.00) ppm. The clayey texture (53.73%) was suitable for supporting a varied faunal and floral life. The granulometric composition presented optimal conditions and floral life. The granulometric composition presented optimal conditions as it was neither very sandy to allow leaching nor too clayey for the absorption of nutrients (Table 2).

Table 2. Characteristics of Suraha Lake Sediments

Parameters	Values
Sand (%)	13.18
Silt (%)	28.34
Clay (%)	53.73
pH	7.20
Organic matter (%)	2.30
Organic carbon (%)	5.52
Available P (ppm)	10.40
Available N (ppm)	119.00

The rich nutrient status of the soil was, however, not adequately reflected in the water phase (Table 3). Trapping of nutrients by the dense submerged vegetation resulted in moderate to poor availability of major nutrients *viz.*, phosphate (0.12 mg l<sup>-1</sup>) and nitrate (0.32 mg l<sup>-1</sup>) in the aquatic regime. Nevertheless, with alkaline pH (8.4), the water phase contained high values of carbonate (19.7 mg l<sup>-1</sup>), bicarbonate (80.3 mg l<sup>-1</sup>), calcium (39.4 mg l<sup>-1</sup>) and hardness (81.2 mg l<sup>-1</sup>). Significantly, a substantial portion of the water column lying within the euphotic zone, the lake portrayed a healthy picture in terms

of dissolved oxygen, its diel fluctuations and other related parameters of biogenic productivity.

Table 3. Water quality of Suraha Lake

Parameters	Values
Water temperature (°C)	23.3
Depth (cm)	225.0
Trasparency (cm)	80.0
pH	8.4
Dissolved oxygen (mg l <sup>-1</sup> )	10.2
Free Carbon dioxide (mg l <sup>-1</sup> )	Nil
Carbonate (mg l <sup>-1</sup> )	19.7
Bicarbonate (mg l <sup>-1</sup> )	80.3
Hardness (mg l <sup>-1</sup> )	81.3
Calcium (mg l <sup>-1</sup> )	39.4
Magnesium (mg l <sup>-1</sup> )	41.8
Chloride (mg l <sup>-1</sup> )	20.2
Iron (mg l <sup>-1</sup> )	0.50
Silicate (mg l <sup>-1</sup> )	2.80
Phosphate (mg l <sup>-1</sup> )	0.12
Nitrate (mg l <sup>-1</sup> )	0.32
Dissolved organic matter (mg l <sup>-1</sup> )	2.28
TDS (mg l <sup>-1</sup> )	75.5
Sp. Conductance (µmhos cm <sup>-1</sup> )	154.4

Average values for the lake on 6.2.91

### 3.2 Biotic productivity

The shallow nature of the basin with greater percentage of euphotic zone, high average temperature and the rich nutrient status were conducive to both primary and secondary productivity of the lake.

**3.2.1 Plannkton :** The lake harboured rich and varied phytoplankton (4 625 - 77 050 u l<sup>-1</sup>), owing to the blooms of *Microcystis aeruginosa* (Table 4). Phytoplankton community structure revealed a typical oxbow lake flora (Bacillariophyceae > Chlorophyceae > Cyanophyceae > Dinophyceae). The pattern of microflora distribution in the lake was suggestive of two distinct limnological zones *viz.*, Eutrophic or baltic zone with greater abundance of blue green (*M. aeruginosa* in particular) and a mesotrophic zone with comparatively lesser abundance of blue greens and enhanced representation of desmids. It is needed to rechannelise the available energy in the lake through plankton chain by reducing the density of xacrophytes. This will also check the blooming of blue greens in the lake.

Table 4. Plankton density in different zones of Suraha Lake

Organisms	Zone I	Zone II	Zone III
<b>Phytoplankton</b>			
<i>Microcystis aeruginosa</i>	75000	5000	2250
<i>M. aeruginosa</i> (f. <i>flos-aquae</i> )	850	1000	600
<i>Gloeocapsa</i>	100	-	-
<i>Eudorina</i>	100	150	-
<i>Coelastrum</i>	25	100	-
<i>Scenedesmus</i>	75	100	75
<i>Crucigenia</i>	50	-	-
<i>Euastrum</i>	50	-	-
<i>Cosmarium</i>	125	100	425
<i>Staurastrum</i>	100	250	350
<i>Micrasterias</i>	-	50	250
<i>Synedra</i>	75	150	50
<i>Fragilaria</i>	50	-	-
<i>Navicula</i>	125	200	75
<i>Rhopalodia</i>	325	300	250
<i>Stauroneis</i>	-	-	75
<i>Tabellaria</i>	-	-	75
<i>Achnanthes</i>	-	-	100
<i>Epithemia</i>	-	-	50
<i>Pinnularia</i>	-	50	-
<i>Melosira</i>	-	100	-
<i>Ceratium</i>	-	250	-
<b>Phytoplankton</b>	<b>77050</b>	<b>7800</b>	<b>4625</b>
<b>Zooplankton</b>			
<i>Arcella</i>	-	-	25
<i>Keratella</i>	75	65	50
<i>Brachionus</i>	37	25	-
<i>Moina</i>	42	50	75
<i>Daphnia</i>	25	-	-
<i>Ceriodaphnia</i>	-	45	-
<i>Cyclops</i>	160	150	125
<i>Nauplii</i>	180	155	150
<b>Zooplankton</b>	<b>519</b>	<b>490</b>	<b>425</b>
<b>Dry wt. mg/50 l (net plankton)</b>	<b>0.0618</b>	<b>0.0590</b>	<b>0.0031</b>

3.2.2 *Macrophytes* : The lake exhibited dense infestation of submerged macrophytes, with the wet biomass ranging from 7.0 to 17.0 kg m<sup>-2</sup> in different zones. The average dry biomass of 0.960 kg m<sup>-2</sup> was relatively high in terms of macrophytic productivity, signalling accelerated eutrophication of the lake. Macrophytes have an expurgative action on the system and utilise maximum nutrients for their biomass production, inhibiting phytoplankton growth and governing the production rhythm of the lake. Represented by 27 species of submerged, emergent and floating

vegetation, the lake was virtually dominated by submerged forms (Table 5). While *Hydrilla verticillata* formed dominant strands in the littoral areas, *Ceratophyllum demersum* had an overwhelming population in the profundal zones. Both these species along with other submerged macrophytes (*Najas* sp., *Aponogeton* sp., *Potamogeton* sp., *Chara* sp. etc.) formed ideal forage for the grass carp.

Table 5. Common aquatic macrophytes of Suraha Lake

Habitat	Species
Free-floating	<i>Pistia stratiotes</i> , <i>Azolla</i> sp., <i>Eichhornia crassipes</i>
Free-floating (Rooted)	<i>Nymphaea</i> sp., <i>Nymphoides indicum</i> , <i>Trapa bispinosa</i>
Submerged	<i>Hydrilla verticillata</i> , <i>Najas minor</i> , <i>Ceratophyllum demersum</i> , <i>Aponogeton natans</i> , <i>Potamogeton pectinatus</i> , <i>Chara</i> spp., <i>Vallisneria</i> sp., <i>Myriophyllum intermedium</i>
Marginal (Emergent)	<i>Jussiaea repens</i> , <i>Ipomea aquatica</i> , <i>I. fistulosa</i> , <i>Polygonum glabrum</i> , <i>Ottelia alismoides</i> , <i>Tenagocharis latifolia</i> , <i>Hygrophiza</i> sp., <i>Scripus articulatus</i> , <i>Sagittaria</i> sp., <i>Typha</i> sp., <i>Oryza</i> sp., <i>Eleocharis</i> sp., <i>Carex</i> sp.

The lake, till recently, had a thick infestation of water hyacinth, *Eichhornia crassipes*. Although a substantial portion of the lake has been cleared of the weed manually, there was every likelihood of reinfestation. Recently, bio-control of the water hyacinth was undertaken by introducing two species of weevils viz., *Neochetina eichhorniae* and *N. bruchi* in the lake. They are considered to be efficient bio-controllers with specificity for *E. crassipes*. However, the impact of this measure is yet to be confirmed. Use of weed cutters may not be an ideal proposition in Lake Suraha due to its shallow basin.

3.2.3 *Benthos and weed enmeshed fauna* : The lake bottom supported a relatively poor benthic fauna, primarily due to the dense macrophytic vegetation. The average faunal density of 630 nos. m<sup>-2</sup> was represented by four species of common gastropods (Table 6). On the contrary, the submerged macrophytes harboured a very rich community of animals (average 1 060 nos. m<sup>-2</sup>). The species spectrum portrayed richness, both qualitatively and quantitatively (Table 7). *Lymnaea* spp., a dominant weed enmeshed form was a lucrative bait, employed by the fishermen in angling of catfishes. Other than the allochthonous inputs and the death and decay of macrophytes, the benthic population contributed to the detrital reserves of the lake.

Suraha Lake



*Submerged macrophytes*  
*Marginal and floating vegetation*



3.2.4 *Primary production* : Investigations of  $^{14}\text{C}$  technique were undertaken to assess the rate of carbon synthesis in the lake. Phytoplankton was estimated to fix  $774.34 \text{ mg C m}^{-3} \text{ d}^{-1}$  and the submerged macrophytes  $3\,455.66 \text{ mg C m}^{-3} \text{ d}^{-1}$ . Thus, between the two primary producers, the macrophytes accounted for 81.69% of the total carbon synthesised. In terms of energy assimilated by the primary producers in the lake, phytoplankton accounted for  $7604 \text{ cal m}^{-3} \text{ d}^{-1}$  and the rest  $33\,935 \text{ cal m}^{-3} \text{ d}^{-1}$  by the macrophytes (Fig. 3).

3.2.5 *Detrital load and bottom energy* : The lake was assessed to be very rich in organic detritus, the average values being  $429.4 \text{ g m}^{-1}$ . The energy available in this niche amounted to  $56.5 \times 10^4 \text{ cal m}^{-2}$ , largely remain underutilized due to poor representation of detritivores in the catches. Besides organic detritus, the vast energy resource in the form of semi-decomposed organic matter at the bottom was estimated to be  $226.52 \times 10^4 \text{ cal m}^{-2}$ . Thus, taking these two unshared niches into consideration, the lake has huge energy reserves ( $283.02 \times 10^4 \text{ cal m}^{-2}$ ) ready to be tapped by detritivores like *Cirrhinus mrigala*, *Cirrhinus reba* and *Cyprinus carpio*.

Table 6. Benthic fauna in Suraha Lake

Sl.No.	ORGANISM	Nos. $\text{m}^{-2}$
1.	<i>Gyraulus convexiusculus</i>	280
2.	<i>Lymna ovata</i>	210
3.	<i>Bellamyia bengalensis</i>	70
4.	<i>Indoplanorbis exustus</i>	70
Total		630

Species are ranked according to numbers

Table 7. Weed enmeshed fauna in Suraha Lake

Sl.No.	ORGANISM	Nos. $\text{m}^{-2}$
1.	<i>Odonate nyumphs</i>	380
2.	<i>Lymnaea ovata</i>	220
3.	Water spider	140
4.	<i>Sphaerodema rusticum</i>	80
5.	<i>Diplonychus annulatum</i>	40
6.	<i>Cybister rugulosus</i>	40
7.	<i>Lymnaea sp.</i>	40
8.	<i>Atya sp.</i>	40
9.	Cybister larvae	20
10.	<i>Microlepidoptera sp.</i>	20
11.	<i>Reginbertia attenuata</i>	20
12.	<i>Pila globosa</i>	20
Total		1060

Organisms are ranked according to numbers

#### 4. FISH AND FISHERIES

##### 4.1 Fish fauna

The fish fauna of Suraha comprised 51 fishes, which included 22 commercially important species. A list of fish species recorded from the lake is as follows :

##### CLUPEIFORMES :

*Setipinna phasa* (Ham.),  
*Gudusia chapra* (Ham.),  
*Notopterus notopterus* (Pallas),  
*N. chitala* (Pallas),  
*Gonialosa manmina* (Ham.),

##### CYPRINIFORMES :

*Oxygaster bacaila* (Ham.),  
*O. gora* (Ham.),  
*Amblypharyngodon mola* (Ham.),  
*Cirrhinus reba* (Ham.),  
*C. mrigala* (Ham.),  
*Puntius sophore* (Ham.),  
*P. chola* (Ham.),  
*P. sarana* (Ham.),  
*P. ticto* (Ham.),  
*Osteobrama cotio* (Ham.),  
*Aspidoparia morar* (Ham.),  
*Labeo rohita* (Ham.),  
*Labeo bata* (Ham.),  
*Labeo calbasu* (Ham.),  
*Catla catla* (Ham.),  
*Ompok bimaculatus* (Bl.),  
*Pseudeutropius atherenoides* (Bl.),  
*Clupisoma garua* (Ham.),  
*Mystus vittatus* (Bl.),  
*Mystus aor* (Ham.),  
*Clarias batrachus* (Linn.),  
*Heteropneustes fossilis* (Bl.),  
*Ailia coila* (Ham.),  
*Wallago attu* (Bl. & Schn.),  
*Rasbora daniconius* (Ham.),  
*Clupisoma garua* (Ham.),  
*Eutropiichthys vacha* (Ham.),  
*Lepidocephalichthys guntea* (Ham.),  
*Botia dario* (Ham.),

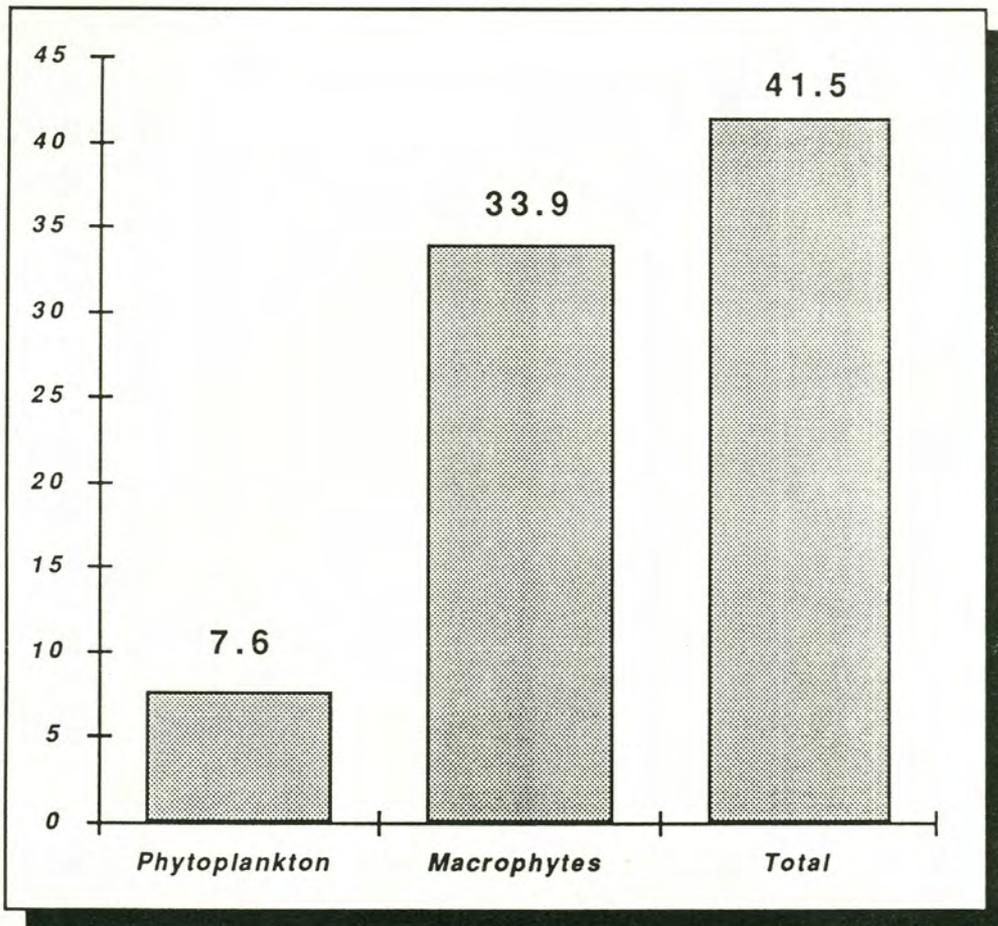


Fig. 3 Rate of energy fixation by producers  
( $\text{K cal m}^{-3} \text{ day}^{-1}$ )

**HELONIFORMES :**

*Xenentodon cancila* (Ham.),

**OPHIOCEPHALIFORMES :**

*C. marulius* (Ham.),

*C. punctuatus* (Bl.),

*C. striatus* (Bl.),

*C. gachua* (Ham.).

**SYMBRANCHIFORMES :**

*Amphipnous cuchia* (Ham.).

**PERCIFORMES :**

*Colisa fasciatus* (Bl.),

*C. lalius* (Bl.),

*Chanda nama* (Ham.),

*C. ranga* (Ham.),

*Nandus nandus* (Ham.),

*Glossogobius giuris* (Ham.),

*Johnius coitor* (Ham.),

*Anabas testudineus* (Bloch).

**MASTACEMBELIFORMES :**

*Mastacembelus armatus* (Lac.),

*M. puncalus* (Ham.).

**TETRADONTIFORMES :**

*Tetradon fluviatilis* (Ham.).

The recent introduction of exotic carps; *Ctenopharyngodon idella* and *Cyprinus carpio*, has further enlarged the species spectrum of the lake.

**4.2 Present production trend**

The major and minor carps, catfishes, murrels, feather bnacks, livefishes and the forage fishes (weed fishes etc.) comprise the multispecies commercial fishery of the lake. The composition of various groups in the catches of Suraha Lake was as follows (Table 8) :

Table 8. Fish catch composition of Suraha Lake

Groups		% Composition
Major carps	<i>Labeo rohita</i> , <i>Catla catla</i> , <i>Cirrhinus mrigala</i> and <i>Labeo calbasu</i>	25-30
Minor carps	<i>Cirrhinus reba</i> , <i>L. goni</i> , and <i>L. bata</i>	5-8
Catfishes	<i>Wallago attu</i> , <i>Mystus spp.</i> , <i>Clupisoma garua</i> , <i>Eutropiichthys</i> <i>vacha</i> etc.	30-35
Featherbacks	<i>Notopterus spp.</i>	8-10
Live fishes	<i>Heteropneustes fossilis</i> , <i>Clarias batrachus</i>	15-12
Forage fishes	<i>Chela spp.</i> , <i>Puntius spp.</i> , <i>Chanda spp.</i> , etc.	20-25

Major fishing in the lake coincided with the decreasing water level during February to May. With the onset of monsoon and the corresponding increase of water level in the lake, the fishing declined gradually. No accurate estimate of fish catch from the lake could be documented. In the absence of reliable catch estimates, data collected from the field were substantiated through discussions with fishermen, fish merchants and fishery officials. The various estimates of annual fish production ranged from 230 to 260 tonnes, with an average of 240 t.

#### 4.3 Production potential

The present annual fish catch of Suraha Lake is estimated at 240.0 t. With an effective water spread of 2 000 ha at present, the per hectare yield works out to be 120 kg ha<sup>-1</sup> yr<sup>-1</sup>. Based on the rate of energy transformation and the available food reserves, the estimated fish production potential of the lake is well above 1 000 kg ha<sup>-1</sup> yr<sup>-1</sup>. Even at 50% utilisation of the potential, a fish yield of 500 kg ha<sup>-1</sup> yr<sup>-1</sup> can be harvested. This entails an increase of over four times above the present fish yield of the lake.

#### 4.4 *Crafts and gear*

Lack of vividity is the hallmark of fish capture from Suraha Lake. Crafts comprised either dugout canoes or plank-built boats, both fabricated locally. Dimensions of these boats ranged between 17' x 3' to 18' x 4'. Dugout canoes (local name : Ekkateri) were more popular than their counterpart - the plank-built boats (local name : Pateli). the plank-built boats were estimated to cost around Rs. 5 000-6 000 with life span of 10-11 years.

The dense submerged weeds restricted the extensive use of drag nets and gill nets in the Lake, placing more reliance on traps and lures. Kurel, conical bamboo trap with inner net lining was a popular fishing tackle in the lake. Gill nets (*Hati, Phasla, Sarela and Karant*) of varying mesh sizes (2' to 6'), fine-meshed drag nets, cast net (*Thungri*), and hooks and lines (*Bhansi*) were the other common gear in vogue. The nets, both cotoon and nylon (except fine meshed nylon drag nets) were fabricated locally. the seasonal periodicity of different gear was markedly determined by the lake depth.

#### 4.5 *Marketing*

The Suraha Lake fishermen were observed to alternate their activities between catching and marketing of fish. Most of the catch was purchased by the fish merchants in the lake itself. The remaining came to the landing grounds scattered in the peripheral villages. Barring local consumption, the catch was sold in Ballia and Bansdih townships. In Ballia, the main fish markets were near Dharamshala, Mandi and Beheri mor. During summer months, when catches were exceptionally high, fish (about 10% of the total catch) was also sent to markets in Eastern and North Eastern states. Data revealed that during May-June 1990, 7.1 t of fishes were despatched to Howrah, Siliguri and Katihar from Ballia.

The retail price of various commercial species ranged between Rs. 14.00 - Rs. 30.00 in the Ballia markets (Table 9). While the Indian major carps commanded a marginally higher price than the other species, no distinct consumer preference was discernible.

Table 9. Retail price of commercial fish species in Ballia

Species	Price (Rs.)
<b>Indian major carps</b>	
<1.0 kg	18-22
1.0-2.0 kg	24-28
>2.0 kg	28-30
<b>Catfishes</b>	
<i>W. attu</i>	22-26
<b>Murrels</b>	
<i>Channa spp.</i>	22-24
<b>Live fishes</b>	
<i>H. molitrix</i>	22-25
<i>C. carpio</i>	20-26
<b>Others</b>	
<i>Chela spp.</i>	14-18

The virtual absence of professional middlemen/fish merchants has kept the price spread to the barest minimum, ensuring a bigger share of the consumers' Rupee (60-80%) to the actual fishermen. Unlike other small-scale fisheries, the indebtedness of fishermen to middlemen was obviously very low. This was also on account of the interchangeable trades (both capture and marketing) undertaken by the Suraha fishermen.

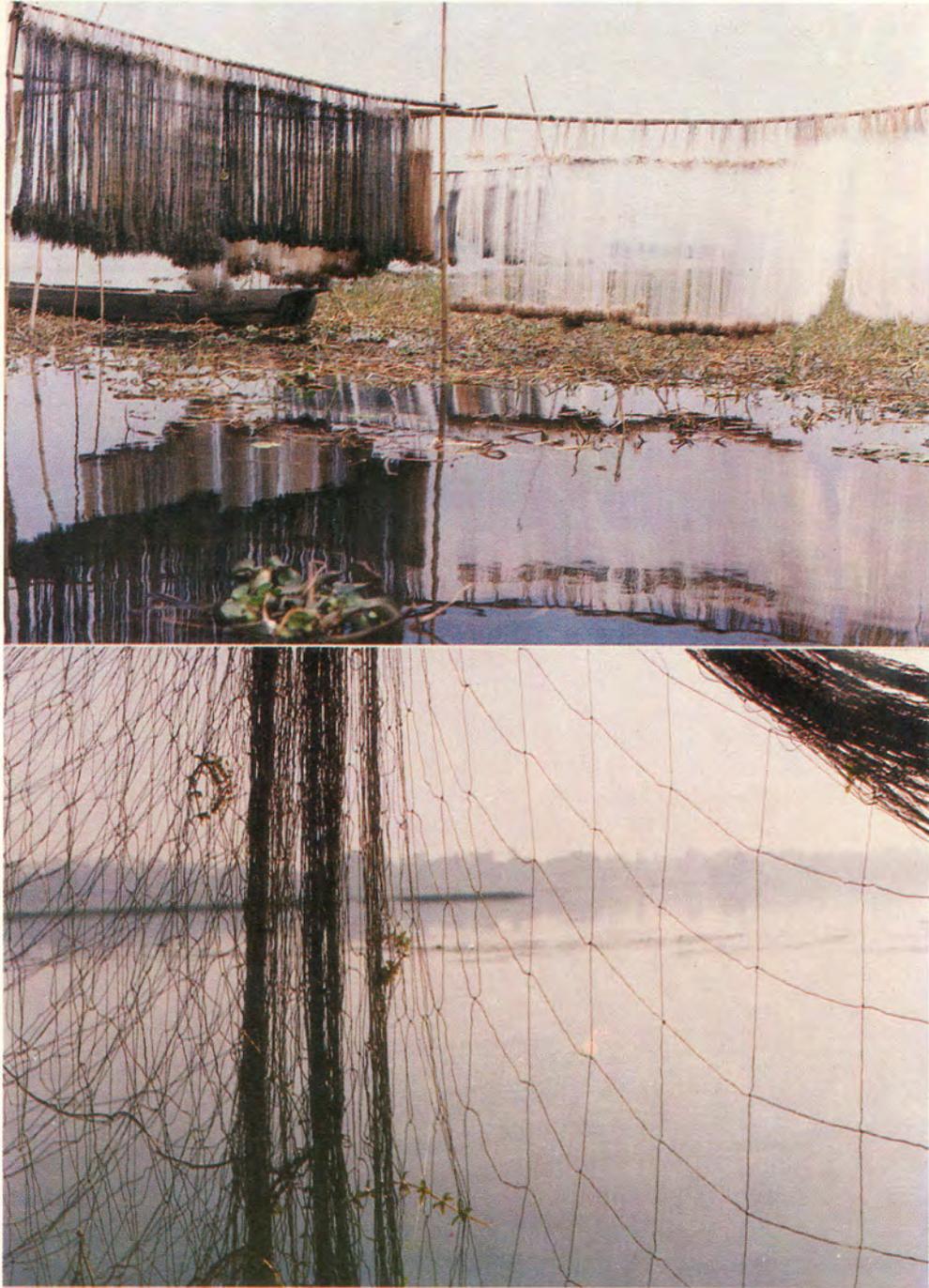
## 5. THE FISHERMEN COMMUNITY

The territorial confines of Suraha Lake extended to Beruarbari, Hanumanganj and Dubhar bnlocks of Ballia district. About 42 villages lie scattered in the vicinity of the lake and the fishermen community was concentrated in about 18 villages, (Basantpur, Basudevpur, Chadhar, Paraspur, Barmahin, Bheepur, Bhikpur, Dumri, Ghagroli, Saraiya, Phulwaria, Maniyari Jatav, Rajpur, Narayanpur, Suryapura, Kathaoli, Meritar and Eshwarpur) located mostly on the peripheri of the lake. the total number of fishermen population was estimated to be 13 00, under 2 117 families. the active fishermen population, deriving their main livelihood from the lake, was estimated at about 4 000. More than 50% of the fishermen families lived below the poverty line and only 22.0% of them earned over Rs. 8 000/- per annum. About 1 000 plank-built and dugout canoes belonging to the fishermen community operate in the lake (Table 10).

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Suroho Lake

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*Gill net - the commonly used gear in the Lake*

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Suraha Lake



*Kurel- a popular fish trap of Suraha Lake*  
*A closer view of Kurel*



Table 10. Socio-economic and technical survey of the fishermen community of Suraha Lake

Sl. No.	Name of the development block	Panchayat	Village	No. of fisher-men families	No. of persons	Annual income			No. of persons engaged in fish business	No. of boats
						upto 4600/-	upto 8000/-	More than 8000/-		
1.	Hanumanganj	Basantpur	Basantpur	172	1341	41	40	91	326	189
2.	Hanumanganj	Basantpur	Basudevpur	28	188	13	8	7	37	14
3.	Hanumanganj	Basantpur	Chadhar	20	152	3	12	5	33	13
4.	Hanumanganj	Basantpur	Paraspur	16	112	-	3	13	29	7
5.	Hanumanganj	Basantpur	Barmahin	26	173	17	9	-	58	3
6.	Hanumanganj	Basantpur	Bheepur	21	162	5	11	5	46	14
7.	Hanumanganj	Basantpur	Bhikpur	38	134	11	21	6	46	14
8.	Dubhar	Dumri	Dumri	318	1865	118	101	99	334	185
9.	Dubhar	Dumri	Ghagroli	120	816	5	31	84	207	94
10.	Dubhar	Dumri	Saraiya	56	398	8	20	28	76	33
11.	Dubhar	Diwli	Phulwaria	70	417	7	16	47	112	45
12.	Dubhar	Diwli	Maniyari Jatav	43	306	4	12	27	82	25
13.	Beruarbari	Rajpur	Rajpur	451	2649	377	71	3	1250	91
14.	Beruarbari	Rajpur	Narayanpur	120	750	89	31	-	326	24
15.	Beruarbari	Kathaoli	Suryapura	56	352	52	4	-	86	53
16.	Beruarbari	Kathaoli	Kathaoli	111	742	84	25	2	323	65
17.	Beruarbari	Kathaoli	Meritar	294	1770	159	96	39	457	84
18.	Beruarbari	Chadaila	Eshwarpur	157	1010	124	21	12	251	54
			<i>Total</i>	<i>2117</i>	<i>13337</i>	<i>1117</i>	<i>532</i>	<i>468</i>	<i>4079</i>	<i>1007</i>

### *Economic indicators of significance in Suraha lake*

The material attributes for fishing in the lake revealed fishing assets worth Rs. 4143.60 per family. The variable cost formed a major component due to opportunity cost for family labour. The higher total cost for the fishermen having their own boat were due to their active engagement in fishery enterprises than those operating with hired crafts (Fig. 4). The latter category also portrayed greater variation ( $\pm 55.80$ ) in total cost due to a wider range of operation period over the year. The economic indicators for capture fishery in the lake depicted higher returns to fishermen with their own boat (Fig. 5). The lake offers ample scope for increasing the return by providing fishing assets to the fishermen, efficient marketing system and a sound organisational set-up.

## 6. RECOMMENDATIONS

Suraha Lake presents an ideal situation for fish yield optimisation through adoption of environment-friendly management norms. The strategy for optimum exploitation encompasses appropriate water management programme, stocking of desirable fish species for effective utilisation of the available food resources, bio-control of aquatic weeds and utilization of marginal areas for fish husbandry (pen and cage culture) leaving the deeper central portions exclusively for capture fisheries. The major recommendations in this regard are as follows :

Based on the records of the irrigation department, Govt. of Uttar Pradesh, the total submerged area of the lake at 191 ft. above MSL is reported to be 3 432 ha (FSL). This level results in 100% submergence of the lake basin, whereas the dead storage level of 182 ft above MSL results in submergence of 36.7% i.e., 1 260 ha only. It is proposed to maintain a minimum water level ranging between 187 and 189 ft above MSL, assuring submergence of 2 220-2 800 ha even during summer months. Maintenance of water depth between 5' to 6' is essential in view of the regular extraenous stocking of commercial carps in the lake. Desilting of Katehar nullah is recommended to allow greater water exchange between the lake and the river Ganga. This would result in flushing of excess nutrients from the lake, thereby reducing the process of eutrophication.

Consequent to the construction of barrier on the Katehar nullah, the autostocking of Indian major carps from the river Ganga no longer takes place. Development of commercial fishery in the lake now depends entirely on a sound stocking policy. Since the link with the main drainage stands severed, stocking of exotic carps alongwith Indian major carps is highly recommended. Backed up by the food availability in the different niches of the lake and the relative performance of various species of Indian and exotic carps, the following species ratio is suggested :

Suraha Lake



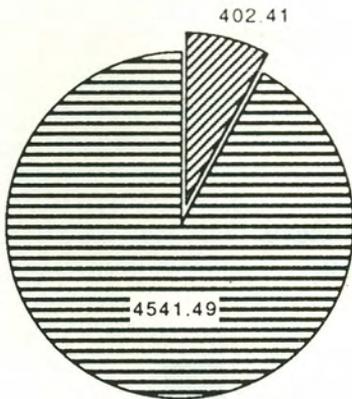
*Labeo rohita*

**Fishes of Suraha Lake**

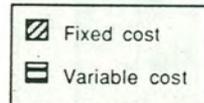
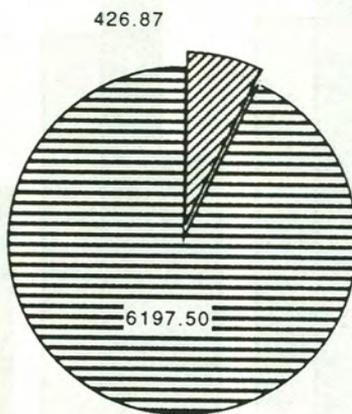
*Chela spp.*



Fishermen with hired boat



Fishermen with own boat



Overall

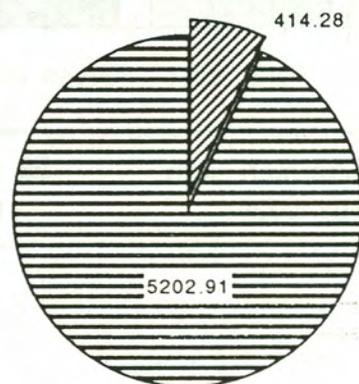
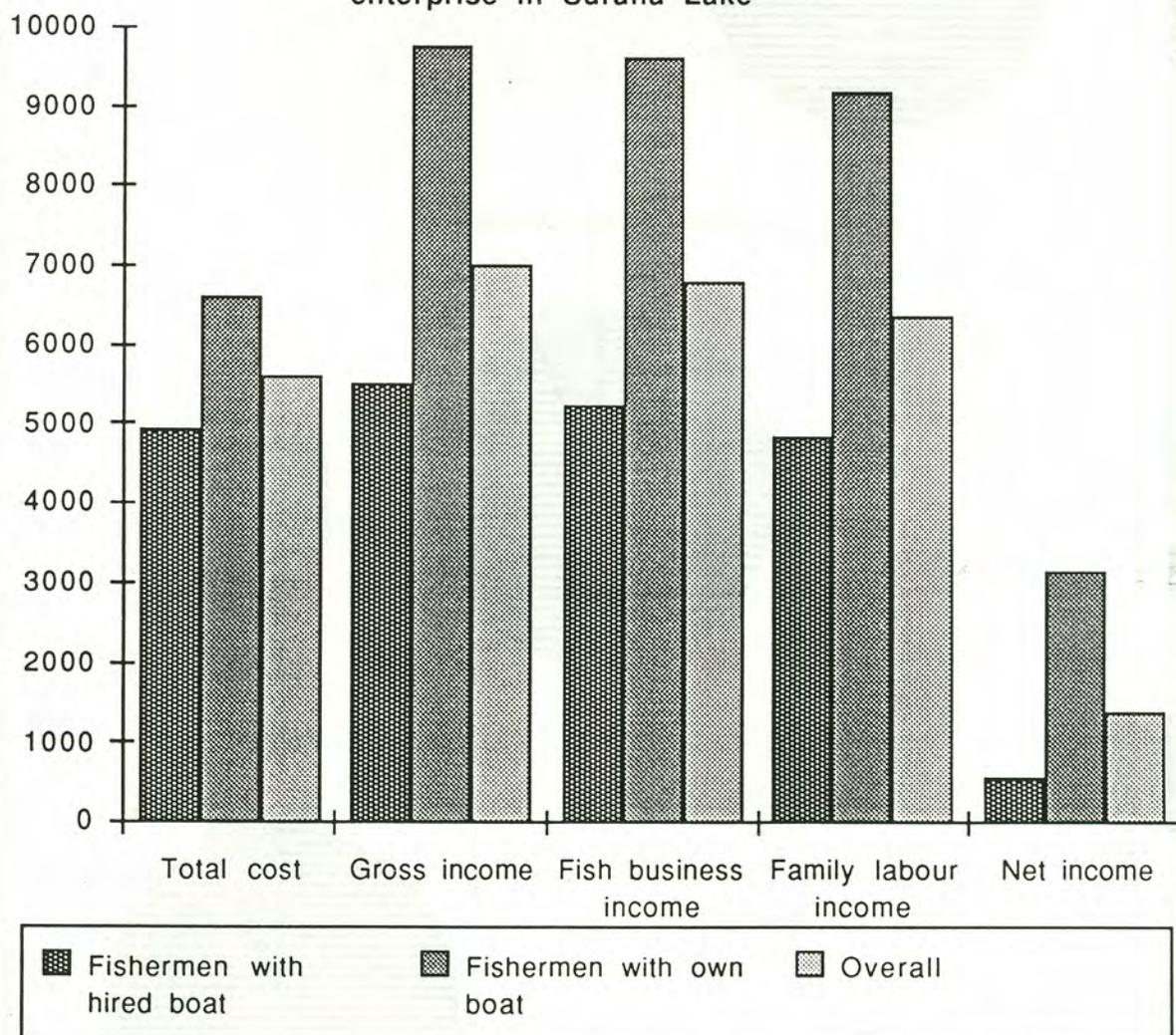


Fig. 4 Material attributes for fishing cost concepts for Suraha Lake

Fig. 5  
Economic indicators for fishery  
enterprise in Suraha Lake



## Recommended species ratio for Suraha Lake

Species	Ratio
<i>Catla catla</i>	1.0
<i>Labeo rohita</i>	2.0
<i>Labeo calbasu</i>	0.5
<i>Cirrhinus mrigala</i>	2.0
<i>Hypophthalmichthys molitrix</i>	1.5
<i>Ctenopharyngodon idella</i>	2.0
<i>Cyprinus carpio</i>	1.0

Keeping in view the dominant predator populations in the lake, stocking of fingerlings above 3" is to be strictly adhered to. Any attempt to stock small-sized fishes would be an exercise in futility.

To prevent escape of stocked fingerlings, it is recommended to install wire screen (0.5' mesh) on the two inlets, Aunra and nakehar nullahs and in the irrigation canal, opposite to the pump house.

Assuming the total harvestable annual yield at 500 kg ha<sup>-1</sup> and the average individual growth of 0.750 kg, based on the basic productivity level, and allowing an allowance of 20% in terms of escapement and predation loss, the lake is required to be stocked every year with 800 fingerlings per hectare. the recommended stocking density of about 800 fingerlings ha<sup>-1</sup> would entail an annual requirement to the tune of two million fingerlings (based on water area of 2 500 ha) for the lake. Obviously, this would necessitate enormous rearing space for the juveniles, prior to their stocking. the upcoming eco-hatchery complex of the State Fisheries Department at Nidharia (Ballia) would meet the seed requirements of the lake to a substantial extent. However, the farm would be constrained by nursery and rearing space. It is recommended to utilise all available pond resources, in particular, the Gram Sabha ponds in the vicinity of the lake. such ponds may be given on long lease (10 years or more) to the Fishermen Co-operatives.

With the implementation of the recommended stocking density and species ratio, the production from the lake is expected to give an optimum yield of 500 kg ha<sup>-1</sup> yr<sup>-1</sup>.

Collection of natural fish seed from the rivers Ganga and Ghagra around ballia is suggested to augment the hatchery stock. Local fishermen may be trained to collect riverine carp spawn from the potential riparian stretches in the vicinity. this would also help diversify their activities and decrease dependence on the lake proper.

The simple exploitation of the lake by capture fishery does not realize the full fish production potential of the system. Culture-based capture fishery is the right approach in this direction. fish husbandry in pens and cages offers promising avenues of culture in open water bodies. Suraha lake provides ideal habitat for pen and cage culture operations for raising both stocking material as well as table-size fish. Nursery rearing of carps in pens obviates the necessity of constructing cost-intensive farms, especially when regular stocking of large open waters is contemplated.

Split-bamboo mats have proved to be ideal material for construction of pens. Such pens have been successfully tried in oxbow lakes of Assam and Bihar and fish crop of 3-4 t ha<sup>-1</sup> yr<sup>-1</sup> can easily be harvested. The bamboo pens can be used repeatedly with marginal depreciation. Similarly, live fishes (*Singhi*, *Magur* and *Koi*) are ideal recruits for stocking in cages. It is recommended to undertake demonstration projects to popularise pen and cage culture in Suraha Lake.

The lake offers multiple avenues for integrated fish farming. The integration of duck rearing with fisheries is more advantageous to the fishermen, since the commodity mix fits well into the available resources and needs. It is suggested to popularise duck husbandry through demonstration projects. The ducks can either be reared in the pens or separately on the lake periphery.

Suraha Lake is severely infested with submerged weeds. Water hyacinth, till recently, a major menace in the lake has been removed manually. However, with the onset of summers, its re-supporting cannot be ruled out. The practice of manual removal has to be rigidly pursued to check any further infestation. The release of weevil species is also a right step in this direction. Submerged weeds (*Hydrilla* sp., *Ceratophyllum* sp., *Potamogeton* sp., *Vallisneria* sp., *Najas* sp. etc.) can be effectively controlled through Grass carp and other indigenous herbivores like *Puntius pulchellus* and *Puntius dobsonii*. Grass carp is a voracious herbivore with an average consumption rate of 80 kg weed per 1 kg of fish (conversion rate of 70-90 : 1). Concomitant to this, grass carp excretes considerable quantity of semi-digested vegetative mass which could enrich the lake water. *Cyprinus carpio* is also reported to take care of this waste.

The lake is subjected to indiscriminate fishing throughout the year. Regular stocking of Indian and exotic carps would necessitate a well planned fish capture schedule and deployment of optimum effort. This would also entail strict enforcement of mesh size, besides a calendar of fishing practices to be employed in different parts of the year by the fishermen.

The lake attracts a large number of aquatic birds, mostly winter migrants from the central Himalayas. About 27 species of aquatic avians (both migratory and resident forms) have been reported from the lake, making it a bird watchers' delight. The water fowls, besides feeding on the

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## Suraha Lake



*Ponds in the vicinity of the Lake are ideal sites for raising fingerlings of Indian and exotic carps for stocking in the Lake. The plate shows two such ponds in village Basantpur (above) and Bhikpur (below)*



small forage fishes, contribute to the nutrient enrichment of the lake through their droppings (guano).

All the fishermen whose livelihood depends on Suraha lake should be brought under the co-operative fold. At present, the membership comprises only 12% of the fishermen population. The co-operative societies will exercise control both at production and marketing levels so that maximum receipts accrue to the fishermen. The Fishermen co-operatives (existing and proposed) should be members of the District Federation which should take the onus of providing right direction to the primary level societies.

Conflicting interests in regard to land-use discernible in Suraha Lake. Apart from the fish stocks (both commercial and subsistence), the lake provides additional resources to the peripheral community. These resources range from excessive agro-farming on the fertile areas left by receding water level, reclamation for brick construction and pasturage for cattle. This also represents the lake-side community's response to the evolutionary process of the conversion of lake to land. These benefits cannot be totally ignored while formulating development plans. The withdrawal of benefits consequent to the process of development has to be done in a way that reduces the negative effects of other uses. It is imperative that this should be achieved in co-operation with the members of the peripheral community, even where the community claims rights that are only traditional and have no legal foundation.

The fishing community has always been slow in changing their social milieu. This approach is partly due to their low status in the Indian society and partly to the economic drudgery. A participative approach is essential for their active cooperation in the planning and implementation of developmental programmes. Effective participation would also result in increasing self confidence and reliance in the community. It would foster an atmosphere of awareness and help in uplifting their social status.

It is considered that where small-scale fisheries are at the lowest level of development, maximum involvement is required ranging beyond fisheries *per se*. For sustained development of the lake, both micro- and macro- planning approach are required. While micro- planning is essentially project-oriented and would form the base of development, greater attention is needed to be devoted to macro-planning *i.e.*, sector approach. The major issues under the sector approach are :

- |    |                                       |    |                                     |
|----|---------------------------------------|----|-------------------------------------|
| a. | <i>Co-operative development</i>       | b. | <i>Credit &amp; subsidy schemes</i> |
| c. | <i>Marketing</i>                      | d. | <i>Technology transfer</i>          |
| e. | <i>Human resources development</i>    | f. | <i>Insurance programmes and</i>     |
| g. | <i>Socio-economic considerations.</i> |    |                                     |

A single window concept having well-planned integrated course of action has to be created to achieve the target of sustainable development of Suraha Lake.