

CASE STUDY OF GANDHI SAGAR RESERVOIR
MADHYA PRADESH, INDIA

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Abstract

Gandhi Sagar is the second largest man-made lake in India. It is being managed for fisheries by the introduction of new species, the continued stocking with juvenile fish and control measures for predatory species. A fishery has been developed by encouraging the setting up of cooperatives for catching and a federation for marketing the fish. Legislation for conservation and management of the fishery has established a closed season, sanctuaries and mesh size restrictions. The present mean catch for the lake is only equivalent to 7.26 kg hm⁻², but it is expected that this will increase in coming years.

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1. INTRODUCTION

Gandhi Sagar is the second biggest man-made lake in India. Constructed on the River Chambal, the largest tributary of the River Yamuna, the dam is located at lat. 24°44' north, long. 75°33' east, at an altitude of 1324 MSL (top of dam) in the Mandsaur district of Madhya Pradesh. The dam was primarily constructed for power generation and to increase irrigation potential, and was completed in 1960. It covers an area of 66 000 hm² at 1312 MSL, with a maximum depth of 49.52 m and a drawdown of 18.89 m.

Gandhi Sagar is the first of the four major hydraulic structures, constructed under the scheme for the integrated development of the Chambal Valley, a joint venture of the two states of Madhya Pradesh and Rajasthan. Under this joint venture three dams have been completed; Gandhi Sagar, Rana Pra-tap Sagar and Jawahar Sagar, with power stations at the foot of each dam and a barrage for irrigation purposes. The River Chambal is thus one of the best harnessed rivers of India today.

A pre-impoundment survey was conducted (Dubey and Mehra, 1959) which showed that the bottom of the river was sandy to gravel, although some parts were rocky. The survey included a study of the topography, hydro-biology, flora and fish fauna. Information was also collected regarding the population of fishermen, boats, fishing gear and pollution. With this background, the fisheries development plan was introduced in 1958. The stock development plan was initiated in 1959 and commercial fishing began in 1962-63.

2. THE RIVER CHAMBAL

The River Chambal is the largest tributary of River Yamuna of the Gangetic system. It originates among the Vindhyan Mountains near Janapav Temple, about 24 km southwest of Mhow at an elevation of 854.3 m above MSL. It is one of the few rivers which flows for a considerable distance from south to north. During its course of over 966 km, the river drops through nearly 731 m, of which 244 m lie in the first few kilometres, and another 122 m in a distance of 80 km. The slope of the river basin from Basai Village, near the end of the reservoir up to the dam is approximately 40 cm per km.

The most important tributaries of the River Chambal, discharging their waters in the reservoir are the Shipra, Shivna, Chhoti Kali Sindh, Ansar, Rupnia, Tilsoi, Ratum and Edar Rivers.

3. PHYSICAL FEATURES

At the dam site and the upstream end, the reservoir is rather narrow. From Chaurasigarh Fort to the dam (a distance of about 8 km), the reservoir is encased by a deep, narrow gorge, taking a northeast course. This is the deepest portion of the reservoir, with a maximum depth of 49.52 m. Similarly, at the upstream end of the reservoir, commencing at Tatka Village on the River Chambal and Kalakhedi on the River Shipra (a distance of about 12 km) and extending up to Garara Village, the reservoir is narrow and runs through a gorge. This area exhibits great fluctuation in water level. The area from the end of the Basai gorge up to Chaurasigarh Fort is fairly extensive, the maximum width being about 16 km, and constitutes the main fishing area.

The central basin has a shallow terraced shore, a slope and region of deep water along the old river course. The basin is rocky with submerged forests, while clearer grounds exist in patches around the submerged villages. There are small islands which were formed as a result of the submergence of knolls and hills. Fifty five villages were completely submerged by the reservoir and a further 169 villages were partially inundated. The flooded forest land, which prohibits the use of active gear, is approximately 24 000 hm². The shallow littoral zone is infested with patches of submerged aquatic weeds. Silt deposition is mainly due to the inflowing water from the catchment, but the detritus charge of the inflow has not been estimated. The reservoir can be considered as being closed downstream since there is no possibility of any fish migrating upstream because of the dam.

4. LIMNOLOGICAL FEATURES

The limnological characteristics of water samples collected from the reservoir between April and September 1975 are given in Tables 1 and 2.

5. THE STOCK DEVELOPMENT PLAN

5.1 Stocking

As is common with all natural impoundments, Gandhi Sagar contained only native riverine species. A faunistic survey revealed the presence of 39 species, including the major carps *Cirrhinus mrigala*, *Tor tor* and *Labeo calbasu* besides a number of predatory and commercially uneconomic species. *Catla catla* and *Labeo rohita* were, however, not present. The first step in the development of the reservoir was, therefore, the introduction and propagation of quick growing species (Indian major carps) to utilize the natural food available and to create a catla-rohu dominated fishery. The reservoir was stocked on a phased basis. The stocking has proved effective as catla catches have risen from zero to over 70 percent by weight of the total catch. The particulars of stocking since the inception of the programme are given in Table 3.

5.2 Fish farm

In order to facilitate the rearing of fish seed, a fish farm of approximately 3.5 hm² and consisting of 52 nursery and rearing ponds was constructed at Neemthur Village. Initially, the farm was used for rearing fish seed obtained from Calcutta and other districts of the state, but since 1971-72 induced breeding of carps by hypophysation has also been used. The adjacent village pond was utilized for stocking breeders. Three more storage ponds for maintaining the broodstock are presently under construction. The fingerlings raised in the farm are stocked in the central basin of the reservoir.

5.3 Natural spawning

Evidence of natural spawning by carps has been recorded but scientific exploitation of the fish seed resources has not been possible so far. During the monsoons, there is a mass migration of fish upstream of the reservoir as far as Nagda on the River Chambal and beyond Mehidpur on the River Shipra. The fish also ascend the Rivers Chhoti Kali Sindh and Shivna. Spawn collections have been reported from Mehidpur on the River Shipra. Sample collections were made at Basai Village, but as the area is not suitable for the operation of seine nets (Benchhi Jal) large-scale collections have not so far been possible. Collections of catla fingerlings from Rampura area in 1973-74, and catla, rohu, mrigal and calbasu fingerlings near Bhamori Village during the same year after the monsoons confirms natural spawning in the reservoir. The stocking operations are being continued from external sources to supplement natural recruitment.

5.4 Control of predators and competitors

In order to reduce and control predatory pressure, the elimination of predatory and other uneconomic species is necessary. This is being achieved at Gandhi Sagar by keeping the royalty rates low so as to attract more and more fishermen to catch these species. Another measure taken to achieve this end is to encourage longline fishing with live baits.

6. EXPLOITATION

The royalty system of exploitation has been adopted at Gandhi Sagar since fishing was started. The fish extracted are grouped according to catch composition and economic importance into three broad categories; major carps, local major species and local minor species. The major carps include catla, rohu, mrigal, mahseer and the common carp. The local major species consist of calbasu, wallago, silonia, *Mystus aor*, *M. seenghala*, and all other varieties are included in the local minor species group. The prevalent rates of royalty for the above categories are :

- (i) Major carps I.Rs. 20 000 per quintal
- (ii) Local major sp. I.Rs. 10 000 per quintal
- (iii) Local minor sp. I.Rs. 3 000 per quintal

The main advantages of the royalty system of exploitation are :

- (a) Fishing can be easily regulated and conservation measures enforced with comparative ease.
- (b) Reliable statistics on weight, size composition, etc., can be collected.
- (c) It yields the optimum revenue for catch as every fish caught has to be weighed.

7. BOATS AND GEAR

As is common in most Indian reservoirs, the clearance of submerged obstructions from the reservoir basin was not carried out before impoundment. This excludes the use of seines. Surface gillnets are thus the most successful gear in the reservoir. Nylon twines of 210/2/3 and 210/3/3 are commonly used for making nets. For the floatline nylon twine of 210/6/3 is commonly used. The hanging coefficient is usually 50 percent. Gillnets are devoid of sinkers and a minimum number of floats are used. The mesh size varies from 500 mm to 450 mm. The bigger meshes are usually operated in deeper waters for catla fishing. In addition to gillnets, longlines using live bait are also used on a limited scale, particularly for fishing murels and catfishes. Experimental fishing conducted recently with dragnets in shallower parts of the reservoir is also encouraging.

At present two types of fishing craft are in use. The most common is a plank-built flat bottomed canoe, 2 to 3 m in length and 0.6 to 0.7 m in width. These canoes have a depth of 0.3 m and are rectangular in shape but cannot stand rough weather conditions, nor exploit distant fishing grounds. Bengal type "dinghies" of 5 to 7 m in length, introduced by fishermen displaced from Bangladesh are now gaining popularity with local fishermen because of their better stability and speed. The Dinghies can be wind-propelled, as they are provided with sails. Local fishermen from the Rampura and Sanjeet Cooperatives have already started acquiring these dinghies.

The cooperative societies use mechanized boats provided by the department on a rental basis for reaching the fishing grounds and for transporting the catch to the landing centres. The fleet of mechanized boats consists of seven 9.2 m boats and four boats ranging from 6 m to 7.6 m, fitted with inboard marine diesel engines. Mechanization has resulted in speedier transport of the catch and a better coverage of the reservoir. For repairs and maintenance of the underwater parts of these boats, workshop facilities have been provided at Gandhi Sagar.

8. FISHERY COOPERATIVES

8.1 Organization

Realizing the need for adequate manpower for the proper exploitation of the reservoir, the fishermen of the area were identified and organized into small fishing parties and then induced to form cooperative societies. The royalty system of exploitation further protected their rights to fish in the reservoir. The initial survey indicated the presence of approximately 225 families of fishermen (Dubey, 1973) around the reservoir.

The first fishermen's cooperative society was organized at Rampura with a membership of 43 in January 1962. The societies of Sanjeet and Basai were organized in 1964 and 1968, respectively, followed by Kohala in April 1970 and Chandwasa in August 1971. Three societies of fishermen displaced from Bangladesh and resettled at Gandhi Sagar, were organized in September 1971. Thus, by and large, all the fishermen of the area have been brought into cooperatives, and at present eight fishery cooperatives are fishing at Gandhi Sagar.

These primary societies have an authorized share capital of I.Rs. 10 000 and the value of each share is I.Rs. 10. All the primary societies are affiliated with the Machua Sahakari Sangh, the federal body of the primaries.

8.2 Structure

The structure of the fishery cooperatives is of a two-tier type. It consists of :

- (i) primary cooperative societies with individual fishermen as members and
- (ii) regional federation to which the primary societies are affiliated.

The primary societies are mainly fishing societies, while the federation looks after marketing and services. Both the primaries and the federation are credit-orientated and, in conformity with the recommendations of the 1962 All India Rural Credit Survey Committee and the study group on fishermen cooperatives, credit facilities to the primary societies have been linked to marketing through the federation.

8.3 Rehabilitation of displaced fishermen from Bangladesh

Looking to the vast manpower the reservoir could support, a scheme for the permanent settlement of 200 fishermen from Bangladesh was sanctioned in 1970-71. The scheme envisaged providing adequate employment for the displaced fishermen so as to enable them to derive sufficient income from fisheries for their livelihood. Under the scheme, every fisherman is given a fishery loan amounting to I.Rs. 1 765 to equip him to pursue the trade of fishing in the initial stages.

Besides the loan, every family is given a housing loan of I.Rs. 1 250. The rehabilitation department has also provided three mechanized boats of 9.2 m in length to be used as carrier vessels. As a safety measure for boat-to-shore communication, four radio-telephone sets have also been provided by the department. Three primary fishermen cooperative societies of displaced fishermen are functioning at present.

9. MARKETING

9.1 Federation of cooperatives

The cooperative structure remains incomplete without the formation of a federation of the primary societies. In order to free the primary societies from middlemen it is important that their functions are taken over by the federation. It has been observed that the "functions of middlemen cannot be eliminated but functionaries can be eliminated". Szczepanik (1960) has observed that middlemen have at their disposal a wide range of means of exploitation. The study group on "Fishermen Cooperatives in India" (1965), in their recommendations have also suggested the formation of a cooperative federation of primaries to undertake the responsibilities and functions of the middlemen. With this view, a federation of 12 primary cooperative societies was registered in 1966, with headquarters at Indore and a branch office at Rampura. Subsequently, due to the demand from the eight primary cooperatives of Gandhi Sagar area, the headquarters of the federation was shifted to Rampura in 1974. Besides strengthening the cooperative spirit among the primaries, the main functions of the federation are marketing and supply.

The federation purchases fish from the primary societies on minimum guaranteed basis and the rates are revised from time to time depending upon the trading profits. The societies are also given a bonus at the rate of 1 percent on the total sale price of the fish handed over to the federation for marketing. In addition, a rebate at 10 percent of the net profit and a dividend of 6 percent on the shares contributed by the societies are also paid.

9.2 Marketing functions

The daily catches are assembled at six landing centres: Rampura, Sanjeet, Basai, Chandwasa, Kohla and Gandhi Sagar by the primary fishermen cooperatives; mechanized boats are used for the transport of fish from the fishing grounds to the landing centres. After gradation and weighing catches are handed over to the federation for disposal.

9.3 Packing and transport

Packing and distribution is looked after by the federation. Fish are packed in ice in wicker baskets and transported by road to the nearest rail heads: Shamgarh, Neemuch and Kota, from where they are despatched to Howrah and Delhi wholesale markets. The channel of distribution is thus from the primary producers to the federation and then to the wholesalers or commission agents. To protect the interest of the local population, a part of the catch is used for internal consumption. For this purpose two fish stalls at Indore and Dewas, under the cooperative sector, and one stall at Bhopal under the Government sector, are regularly supplied with fish from Gandhi Sagar by the federation.

9.4 Infrastructure

It is difficult to keep fish without deterioration in quality, and the usual practice is to despatch the fish on the same day it is caught. In spite of this, some storage facilities are needed when the catch is obtained during the late hours or during heavy catches. A cold storage unit of 2 tons capacity has been provided by the department for the purpose. Since use of ice checks spoilage during transport, the department has commissioned one block ice plant of 3 tons capacity and a sliced ice plant of 2.5 tons capacity at Gandhi Sagar. The department has also provided packing sheds at Gandhi Sagar and Rampura landing centres, and similar facilities in the remaining centres are to be provided soon.

10. PRODUCTION AND REVENUE

10.1 Total catch

Fishing on a modest scale was started in May 1962. The annual fish landings (April-March) over a period of 14 years with the corresponding revenue is shown in Table 4.

The annual fish landings show great fluctuations. The landings for the years 1962-63 exhibit an increasing trend, while from 1966-67 to 1968-69 they show a decreasing trend. Improvement in the annual landings were, however, recorded from 1969-70 and maximum yield from the reservoir was obtained in 1973-74. There was an abrupt fall in production in 1974-75, which was primarily due to failure in conservation efforts and lower fishing effort. The position has again improved in 1975-76.

10.2 Production per unit area

The production per hm^2 , from Gandhi Sagar Reservoir, on the basis of its full bank level area, i.e., 66 000 hm^2 at F.L. 1312, for five years is given in Table 5.

10.3 Monthly catches

Fishing is carried out throughout the year except for a closed season from 16 June to 31 August. September is the best month for fishing. The possible causes for the higher catches during the month could be due to the high turbidity of water and the somewhat sluggish condition of the fish as a result of the spawning migration. The maximum catch during this period is obtained from the upper reaches of the reservoir, particularly near the river mouths. The rate of spoilage of fish harvested in September is also higher. January and February can also be regarded as good fishing months, but from March onwards the catch declines, primarily due to an increase in wind velocity which renders the gillnets less effective. The fishing effort also fluctuates from month to month. From October to December some fishermen are engaged in the *Trapa* harvest and during the summer in riverbed cultivation, resulting in a drop in fishing efforts. The monthly catches (in kg) from 1971 to 1975 are shown in Table 6 below:

11. POPULATION STUDIES

11.1 Species present

The commercial landings in Gandhi Sagar Reservoir are dominated by the major carps. The following nine species constitute the main fishery of the reservoir :

Carps : *Catla catla* (Ham.)
Cirrhinus mrigala (Ham.)
Labeo calbasu (Ham.)
Labeo rohita (Ham.)
Barbus tor tor (Ham.)

Catfish : *Silonia silondia* (Ham.)
Mystus seenghala (Sykes)
Mystus aor (Sykes)
Wallago attu (Schn.)

11.2 Composition of catches

Catch composition is an important aspect of the study of the reservoir as it reflects the trend of the fishery. The percentage of species (major carps) in the total annual landings are shown in Table 7. Catfishes are grouped under local major species and all other species have been grouped as local minor species.

The catch composition studies show that *Catla catla*, once non-existent in the reservoir, made its first appearance in the landings in 1964-65, almost five years after the commencement of stocking operations, and in 1965-66 constituted only 3.92 percent of the total catch. From 1966-67 the percentage of *Catla* increased rapidly. From 1971-72 the *Catla* landings were more or less stable, indicating that the species has established well in the reservoir. The rise in *Catla* landings was followed by a corresponding decline in the landings of *Cirrhinus mrigala*, once dominant in the reservoir. Another notable feature is that, although the stocking of *Labeo rohita* was carried out simultaneously with *Catla catla*, it has never exceeded 2 percent of the total landings, probably indicating the species cannot thrive well in the reservoir.

11.3 Catch per unit effort

The catch per unit effort (quantity in kg of fish caught in a gillnet in one night) from the different zones of the reservoir over a period of three years is given in Table 8.

The table shows the continuous decrease in c.p.u.e. effort from 1972 to 1975.

As length frequency studies do not indicate any reduction in size of the major carps, which constitute the main fishery of the reservoir, overfishing is probably not occurring.

11.4 Length frequency distribution

The length frequency data in respect of the major carps, *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* for a period of three years are given in Table 9 to give an idea of the participant size groups, their strength and trend of the major carp fishery.

12. POLLUTION

Due to lack of industrialization in the vicinity of the reservoir, pollution has posed no serious problems so far. Instances of fish mortality have, however, been reported from River Chambal near Nagda during early monsoons. The pollution effects of viscose rayon wastes from Gwalior Rayon Silk Mfg. (Wvg.) Co., Nagda have been studied in detail by Khare and Sastry (1970). Two types of waste water are produced in a viscose rayon factory, one being acidic and the other alkaline. Investigations by the above authors have shown that

the composite waste was highly acidic and contained zinc. Acidic effluents form the strongest wastes, contributing to the pollution load of the composite waste. The composite waste water is let out by the factory in an open channel leading to the River Chambal. The waste water is discharged into the Chambal River without any treatment, and has affected the chemical quality of water of the river up to a stretch of 20 km below the factory.

13. CONSERVATION AND MANAGEMENT

13.1 Closed season

The riverine fishery rules framed by the State Government prohibit fishing in the reservoir from 16 June to 15 August every year. The closed season is to allow the brood fishes to migrate uninterrupted for spawning and thereby increase the natural recruitment in the reservoir.

As far as Gandhi Sagar is concerned, the main difficulties encountered for the strict implementation of the closed season are :

- (a) The River Chambal and its main tributaries, Rivers Chhoti Kali Sindh and Shipra, form the boundaries of the State of Madhya Pradesh and Rajasthan for a considerable distance. The legislation of both the states do not cover rivers forming inter-state boundaries at present, and as such legal measures for strict implementation of the closed season pose difficulties. Steps have been taken to frame separate rules for the rivers forming inter-state boundaries.
- (b) Restrictions on the loading of fish by the railways from some of the railway stations is another remedial measure, but since fish is not covered under the Essential Commodities Act, this measure has not yet been enforced.

The loss of fish during the closed season is considerable, and in some years, particularly when the rainfall is scanty, the estimated loss is 200 to 300 t.

13.2 Sanctuaries

A stretch of 10 km of the River Shipra, commencing from the confluence of River Shipra and Chambal, has been declared a sanctuary where the fish congregate for breeding.

13.3 Mesh size limitations

Use of nets below 25 mm bar size is prohibited, and no serious problems for enforcement have arisen so far. In fact, attracted by the size of the fish and the remuneration, the fishermen are tempted to catch more and more *Catla* which already constitutes more than 70 percent of the total landings. They therefore have the tendency to operate only nets of bigger meshes and have to be persuaded to use smaller mesh nets as well.

13.4 Limit on size of fish

Catching of major carps below 1 kg size (with the exception of *Catla*, where it is 4 kg), is prohibited in the reservoir.

14. GENERAL

Fish production from Gandhi Sagar has attained the level of 7.26 kg hm⁻² during the last five years, which is rather low compared to some of the better developed reservoirs, such as the Mettur Dam. There are several limitations in the present stage of reservoir development in India. Artificial measures such as mass fertilization, mass poisoning, levelling of the reservoir bottom for commercial fishing, e.g., trawling etc. (Jhingran, 1974) as adopted in the U.S.A. and the U.S.S.R. are not possible.

The management policies which have been adopted are: the improvement of the stock by the introduction of selected varieties from outside sources to make the maximum use of the available fish food, a phased programme of intensive stocking and providing facilities for natural spawning and thereby ensuring maximum

natural recruitment. Recruitment of fishermen, introduction of improved and new fishing techniques and expansion of fishable areas for the operation of seines, etc., by undertaking reclamation work are some of the measures adopted to increase the catch. Infrastructure facilities for transport and marketing, such as cold storage, ice plant, packing sheds, carrier vessels, workshop facilities, etc., have been provided so that the fishermen get a better return for their catch. The royalty system of exploitation, fishing and marketing through the cooperative sector has given economic benefits to the fishermen. Studies on limnology, biology of fishes, population dynamics, etc., of the reservoir have been made to assess the productivity and to estimate the optimum sustainable yield. Steps to enforce strict conservation measures, which is mainly an administrative problem, have been taken. It is expected that the production from the reservoir will increase in the coming years.

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TABLE 1
LIMNOLOGICAL CHARACTERISTICS OF GANDHI SAGAR
RESERVOIR

	<i>Maximum</i>	<i>Minimum</i>
Temperature-ambient	39°C	28°C
Temperature-water	32.5°C	27°C
Secchi disc transparency	200 cm	11.5 cm
pH	8.9	8.2
CO ₂	Nil	Nil
Dissolved oxygen	11.8 ppm	6.4 ppm
Total alkalinity	124.0 ppm	82.0 ppm
Ammonia nitrogen (N.NH ₄)	1.0 ppm	0.1 ppm
Nitrate (N.NO ₄)	0.9 ppm	BDL
Phosphate (P.PO ₄)	0.3 ppm	BDL
Total dissolved solids	200.0 ppm	170.0 ppm

TABLE 2
PLANKTON IN GANDHI SAGAR RESERVOIR

<i>Sample (vertical haul)</i>	<i>No. of orga- nisms per l</i>	<i>Percentage of:</i>	
		<i>zooplankton</i>	<i>phytoplankton</i>
Surface	8--24	66.6 -- 83.3	16.7 -- 33.4
12.0 m	8--20	83.3 -- 94.7	5.3 -- 16.7
30.0 m	26--28	92.3 -- 93.6	6.4 -- 7.7

TABLE 3
NUMBERS OF FISH STOCKED IN THE GANDHI SAGAR RESERVOIR

Year	<i>Catla catla</i>	<i>L. rohita</i>	<i>C. mrigala</i>	<i>C. carpio</i>	Others	Total
1959 — 60	17 560	25 930	—	—	15 090	58 580
1960 — 61	—	—	—	—	171 900	171 900
1961 — 62	342 911	166 545	60 392	100	229 275	799 223
1962 — 63	450 000	148 440	—	—	125 775	724 215
1963 — 64	148 125	29 137	24 533	500	2 817	205 112
1964 — 65	36 958	55 435	92 392	—	—	184 785
1965 — 66	291 700	102 010	3 200	140	—	397 050
1966 — 67	18 180	17 715	720	—	—	36 615
1967 — 68	186 211	290 027	122 816	—	98 651	697 705
1968 — 69	47 880	55 688	107 654	—	334	211 556
1969 — 70	27 642	59 067	66 944	53	7 424	161 130
1970 — 71	—	91	85	8 142	—	8 318
1971 — 72	266 705	172 738	122 148	23 815	—	585 403
1972 — 73	—	50 565	229 146	—	40 329	320 040
1973 — 74	95 931	33 200	71 419	185 500	—	386 050
1974 — 75	68 971	60 538	203 474	103 348	2 192	438 523
Total	1 998 774	1 267 126	1 104 923	321 598	693 787	5 386 208

TABLE 4
CATCH AND REVENUE FROM GANDHI
SAGAR RESERVOIR

Year	Catch (kg)	Revenue (Royalty) I.Rs.
1962—63	34 077	10 144
1963—64	64 182	22 280
1964—65	312 339	103 754
1965—66	309 901	125 523
1966—67	214 176	118 030
1967—68	128 468	131 487
1968—69	118 324	107 329
1969—70	156 915	169 818
1970—71	171 969	166 622
1971—72	267 334	300 998
1972—73	586 521	746 677
1973—74	697 144	957 582
1974—75	359 257	579 214
1975—76	486 877	813 666

TABLE 5
PRODUCTION PER UNIT AREA (kg hm⁻²)
FROM GANDHI SAGAR RESERVOIR

<i>Year</i>					<i>Production</i>
1971—72	...	...	...	...	4.05
1972—73	...	...	...	...	8.88
1973—74	...	...	...	...	10.56
1974—75	...	...	...	...	5.44
1975—76	...	...	...	...	7.37

TABLE 6
MONTHLY CATCHES FROM GANDHI SAGAR RESERVOIR

<i>Month</i>	<i>Monthly landings (kg)</i>				
	1971	1972	1973	1974	1975
January ...	19 632	55 413	80 031	79 149	22 401
February...	18 733	27 884	81 626	83 390	41 175
March ...	18 249	51 564	39 841	83 155	36 648
April ...	10 000	55 980	44 348	38 228	37 239
May ...	13 954	42 540	49 258	19 916	24 632
June ...	5 918	27 899	42 591	14 340	13 191
September	38 973	95 501	91 145	112 019	89 456
October ...	25 598	55 770	85 395	31 930	51 102
November	19 757	37 993	93 218	30 067	39 749
December	18 305	69 338	37 889	12 531	51 481

TABLE 7
PERCENTAGE OF MAJOR CARPS IN CATCH

Year	Catla	Rohu	Mrigal	Tor tor	Calbasu	Local major species	Local minor species
Percentage by weight							
1963--64...	...	...	55.00	15.00	25.00	5.00	...
1964--65...	2.30	0.26	29.30	9.35	14.55	16.22	28.02
1965--66...	3.92	1.43	35.05	11.17	21.79	19.66	6.98
1966--67...	17.00	2.00	17.00	15.20	27.20	7.90	13.70
1967--68...	49.90	1.90	3.50	7.40	10.90	9.70	16.60
1968--69...	37.15	0.37	1.31	2.95	15.82	4.46	37.94
1969--70...	65.90	0.75	1.48	2.90	12.65	8.39	9.55
1970--71...	63.05	1.50	1.00	1.65	16.50	8.35	7.95
1971--72...	71.11	0.97	2.23	3.01	12.06	6.50	4.12
1972--73...	77.55	0.98	2.87	3.90	7.58	4.68	2.44
1973--74...	76.07	0.74	3.64	4.96	3.77	8.32	2.50
1974--75...	71.81	0.88	2.37	5.01	6.06	10.88	2.99

TABLE 8
CATCH PER UNIT EFFORT FROM DIFFERENT ZONES
OF THE RESERVOIR

Area	c.p.u.e.				
	1972-73	1973-74	1974-75		
Western Zone Rampura	1.09	0.84	0.41
Southwestern Zone Sarjeet	1.23	0.91	0.63
Southern Zone Bajai	1.00	0.71	0.50
Eastern Zone Kohala	1.76	0.68	0.40
Southeastern Zone Chandwasa	0.90	0.88	0.39

TABLE 9

RELATIVE STRENGTH OF DIFFERENT SIZE GROUPS OF MAJOR
CARPS OVER A PERIOD OF 3 YEARS

Size group (cm)	Percentage of each size group in the commercial landings by number		
	1972--73	1973-74	1974--75
(A) <i>Catla catla</i>			
50--60	0.15
60--65	0.67
65--70	5.55
70--75	11.12
75--80	45.00
80--85	24.00
85--90	6.56
90--95	4.00
95--100	1.34
100--105	0.44
105--110	0.22
110--115
(B) <i>Labeo rohita</i>			
30--35	3.03
35--40
40--45	12.12
45--50	27.27
50--55	15.15
55--60
60--65	6.06
65--70	9.09
70--75	6.06
75--80	9.09
80--85	9.09
85--90	3.04
(C) <i>Cirrhinus mrigala</i>			
35--40	0.11
40--45
45--50	2.02
50--55	7.58
55--60	31.82
60--65	32.32
65--70	18.18
70--75	5.05
75--80	3.03
80--85
85--90