

Fish Catch Composition from Gobind Sagar Reservoir during 2006-2012

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Abstract—Gobind Sagar Reservoir has been created in Himachal Pradesh, India (31° 25' N and 76 ° 25'E) by damming River Sutlej at village Bhakra in 1963. The average water spread area of this reservoir is 10,000 hectares. Fishermen have organized themselves in the form of co-operative societies. 26 fisheries co-operative societies were working in Gobind Sagar Reservoir up till 2012. June and July months were observed as closed season, no fishing was done during this period. Proper record maintaining of fish catch was done at different levels by the state fisheries department. Different measures like minimum harvestable size, mesh size regulation and prohibition of illegal fishing etc. were taken for fish conservation. Fishermen were actively involved in the management. Gill nets were used for catching fishes from this reservoir. State fisheries department is realizing 15% royalty of the sold fish. Data used in this paper is about the fish catch during 2006-2012 and were obtained from the state fisheries department, Himachal Pradesh. *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Sperata seenghala*, *Cyprinus carpio*, *Tor putitora*, *Hypophthalmichthys molitrix*, *Labeo calbasu*, *Labeo dero* and *Ctenopharyngodon idella* etc., were the fish species exploited for commercial purposes. Total number of individuals of all species caught was 3141236 weighing 5637108.9 kg during 2006-2012. *H. molitrix* was introduced accidentally in this reservoir and was making a good share of fish catch in this reservoir. The annual catch of this species was varying between 161279.6 kg, caught in 2011 and 788030.8 kg caught in 2009. Total numbers of individuals of *C. idella* caught were 8966 weighing 64320.2 kg. The catch of *Cyprinus carpio* was varying between 144826.1 kg caught in 2006 and 214480.1 kg caught in 2010. Total catch of *Tor putitora* was 180263.2 kg during 2006-2012. Total catch of *L. dero*, *S. seenghala* and *Catla catla* remained 100637.4 kg, 75297.8 kg and 561802.9 kg, respectively, during 2006-2012. Maximum fish catch was observed during the months of August (after observing Closed Season). Maximum catch of exotic carps was from Bhakra area of the reservoir which has fewer fluctuations in water levels. The reservoir has been divided into eight beats for administrative purpose, to avoid conflicts between operating fisheries co-operative societies for area of operation. Fish catch was more by co-operative societies operating in the area of reservoir having fewer fluctuations in water level and catch was less by co-operative societies operating in the area of more fluctuations in water level. Species-wise fish catch by different co-operative societies from their allotted area was studied. This reservoir is one of most scientifically managed reservoirs.

Keywords—Co-operative societies, fish catch, fish species, reservoir.

I. INTRODUCTION

GOBIND Sagar Reservoir is one of largest reservoirs in Himachal Pradesh. Bhakra dam which was constructed for multipurpose use across the river Sutlej resulted in the creation of this reservoir. The height of this dam is 226 meters. Average water spread area is 10,000 hectares. After the creation of the reservoir, the ecological conditions of the river changed. According to Sugunan [1], fishing operations began in this reservoir with use of 16 nets, in 1964-65. *Labeo dero*, Mahseers and *Schizothorax* spp., were caught mainly by angling and use of cast nets targeted against them, before the creation of Gobind Sagar reservoir in 1959 [1]. Indian major carps and common carp are being regularly stocked in this reservoir. *H. molitrix* were accidentally introduced into this reservoir due to flash floods at Deoli Fish Farm in 1971. Now it is proliferating in this reservoir due to auto stocking. Different measures for fish conservation are being taken continuously. Fisheries of this reservoir are providing employment and animal protein to many people. The government is generating very high revenue from fisheries of this reservoir. Fisheries co-operative societies operated in this reservoir till 2012 were Jaishree, Lathiani, Koshrian, Jabblu, Jyor, Jaddu, Kutlehar, Mandli, Dobar, Piungali, Dari Bhari, Dohak, Bhakra, Jagat Khana, Gah Ghori, Nakrana, Bilaspur, Beri Darolan, Daula Dhar, Berrian Wala, Kehloor, Bela, Dee Pee Eff, Matla, Balghar and Badi Wala. Fish landing was done at eight landing centers located at located at Lathiani, Mandli, Dobar, Bhakra, Jaddu, Nakrana, Jyor and Bilaspur.

II. MATERIALS AND METHODS

Data used in this paper were obtained from state fisheries department, Government of Himachal Pradesh. Tabulation and interpretation was done. Gobind Sagar reservoir has been divided into eight beats (areas for fisheries operation), particular area (beat) was allotted to an operating fisheries co-operative society. There were eight landing centers in this reservoir. Fish landing was done at these landing centers and record of landed fish was maintained by state fisheries department.

III. RESULTS AND DISCUSSION

Catla catla, *Labeo rohita*, *Sperata seenghala*, *Bangana dero*, *Labeo calbasu*, *Tor putitora*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, and *Ctenopharyngodon idella* were fishes of commercial importance in this reservoir. Species-wise catch composition (Table I):

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Catla catla

Total catch of *Catla catla* remained 561802.9 kg by all fisheries co-operative societies during 2006-2012. Maximum yearly catch of *C. catla* by all 26 operating fisheries co-operative societies was 153594.5 kg recorded during 2012 and minimum catch 34225.3 kg was recorded during 2009 by all 24 operating co-operative societies. Total catch of *Catla catla* by all fisheries co-operative societies was 36678.6 kg in 2006, it increased to 55066.6 kg in 2007, and thereafter, it decreased to 35326.4 kg during 2008, it further decreased to 34225.3 kg during 2009, and increased to 132952.2 kg in 2010. The catch of *Catla catla* remained 113959.3 kg, 153594.5 kg during 2011 and 2012, respectively.

Labeo rohita

Total catch of *L. rohita* recorded during 2006-2012 was 38104 weighing 62839.2 kg. Variation in total yearly catch of *L. rohita* was between 3013.4 kg (in 2010) to 16841.6 kg (in 2007). Yearly catch of *L. rohita* was 12655 kg during 2006, which increased to 16841.6 kg during 2007 and then declined to 9166 kg in 2008. This catch further decreased to 3172.4 kg during 2009 and 3013.4 kg during 2010. After 2010, an increasing trend was recorded in the yearly catch of this fish reaching 6178.9 kg (during 2011) and 11811.9 kg (during 2012).

Cirrhinus mrigala

Total catch of *Cirrhinus mrigala* by all co-operative societies was 62654 kg during 2006 to 2012. Yearly total catch by all co-operative societies together, during 2006 was 4083.1 kg. This catch showed a decreasing trend, reaching 2581.2 kg, 1831.6 kg during 2007 and 2008, respectively. After 2008, it showed a continuously increasing trend and reached 28157.9 kg (maximum) in 2012. Annual total catch of *Cirrhinus mrigala* during the study period was varying between 28157.9 kg in 2012 and 1831.6 kg in 2008.

Sperata seenghala

Total catch of *Sperata seenghala* by all fisheries co-operatives societies together remained 75297.8 kg during 2006-2012. Annual total catch of this fish by all fisheries co-operative societies varied between a minimum of 7634.8 kg (during 2011) and a maximum of 13555.9 kg (during 2009). Catch of *S. seenghala* recorded was 13483.3 kg during 2006. It decreased to 8985.5 kg during 2007; thereafter, it showed increasing trend, attaining 13555.9 kg until 2009. After 2009, it decreased to 9842.1 kg (during 2010) which it further decreased to 7634.8 kg (during 2011). This fish catch showed an increase to 11275.6 kg during 2012. Annual catch of *Sperata (Aorichthys) seenghala* by all co-operatives remained between 7634.8 kg (in 2011) and 13555.9 kg (in 2009).

Cyprinus carpio

Some 1268013.6 kg of *Cyprinus carpio* was caught during 2006-2012 by all fisheries co-operative societies. Minimum catch (144826.1 kg) of *C. carpio* was recorded in 2006 and the maximum (214480.1 kg) in 2010. There was an increasing trend in total yearly catch of *C. carpio* during 2006-2008.

Catch of *C. carpio* recorded was 144826.1 kg, 195094 kg and 203949.5 kg during 2006, 2007 and 2008, respectively. Catch declined to 184961.7 kg (during 2009), which again increased to 214480.1 kg during 2010. Thereafter, a decrease in catch was recorded as catch remained 163373.1 kg (during 2011) and 161329.1 kg (during 2012).

Tor putitora

Total catch of *Tor putitora* by all fisheries co-operatives during 2006-2012 remained at 180263.2 kg. Minimum catch (16925.3 kg) of *T. putitora* was recorded during 2006 and maximum catch (43926.5 kg) was recorded in 2008. After 2008, decrease in total yearly catch of *Tor putitora* by all fisheries co-operatives was recorded and it reached to 33389.3 kg in 2009, reached to 23745.5 kg in 2010 and 19463.5 kg in 2011. Catch increased to 20328.8 kg during 2012.

Bangana (Labeo) dero

Total catch of *Bangana (Labeo) dero* was 100637.4 kg by all fisheries co-operatives during 2006-2012. Minimum yearly catch of *L. dero* was 1545.8 kg in 2007 and maximum yearly catch of *B. dero* was 32343.5 kg in 2011. Increase in total yearly catch of *B. dero* was recorded from 2007-2009. During 2007, the catch was 1545.8 kg and increased to 5089.2 kg during 2008 and to 9740 kg in 2009. This catch remained 17140 kg in 2012.

Hypophthalmichthys molitrix

Total catch of *Hypophthalmichthys molitrix* remained 3256559.6 kg during 2006-2012. Maximum catch of *H. molitrix* (788030.8 kg) was recorded during 2009 and minimum catch (161279.6 kg) was recorded in 2011. Total catch of *H. molitrix* during 2006 was 222766.3 kg. It increased to 330458.2 kg during 2007, 703439.2 kg in 2008 and reached to 788030.8 kg during 2009. Thereafter, it decreased to 396600.5 kg during 2010, reaching to 161279.6 kg in 2011. To enhance the decreasing catch of *H. molitrix*, it was stocked during the months of August and September of 2011 by the state fisheries department. Thereafter, it again got increased to 653985 kg during 2012. Annual total catch of *Hypophthalmichthys molitrix* (silver carp) remained between 788,030.8 kg and 161, 279.6 kg in 2009 and 2011, respectively.

Ctenopharyngodon idella

Total yearly catch of *Ctenopharyngodon idella* recorded by all fisheries co-operatives was 64320.2 kg. Year wise variation was recorded between 6078.6 kg in 2012 and 12270.4 kg in 2009. During 2006-2008, a decreasing trend was recorded in the yearly catch of *C. idella*. This catch was 11468.9 kg, 10874.8 kg and 8528.4 kg during 2006, 2007 and 2008, respectively. During 2009, catch of this fish increased to 12270.4 kg which again dwindled to 7071.9 kg during 2010. Again during 2011, an increase in yearly catch of this fish was recorded and it reached 8027.2 kg which showed decline to 6078.6 kg during 2012. Maximum annual catch of *C. idella* was 12270.4 kg in 2009 and the minimum, 6078.6 kg during, in 2012.

Labeo calbasu

Total catch of *Labeo calbasu* by all fisheries co-operatives remained 3695.7 kg during 2006-2012. Variation in the total annual catch of *L. calbasu* recorded was between 191.8 kg (in 2010) and 801 kg (in 2006). A decreasing trend in the yearly total catch of *L. calbasu* was recorded during 2006-2010. This catch increased to 240 kg during 2011 which further increased to 521.5 kg during 2012. Total catch of *Labeo calbasu* from all co-operatives was 801 kg (maximum) during 2006 and it

remained 191.8 kg (minimum) during 2010.

“Others”

Total catch of “others” remained 1025.3 kg by all fisheries co-operatives during 2006-2012. Maximum annual catch of “Others” by all co-operatives was 927.3 kg in 2006 and minimum was 98 kg in 2012.

Fishes included under “Others” were *Labeo dyocheilus*, *Systomus (Puntius) sarana*, *Mastacembelus armatus*, *Schizothorax* spp., *Garra gotyla* etc.

TABLE I
FISH CATCH OF DIFFERENT SPECIES FROM GOBIND SAGAR RESERVOIR (WEIGHT IN KG) [2]

Sr. No.	Fish Species	Fish catch	2006	2007	2008	2009	2010	2011	2012	Total
1	<i>Catla catla</i>	No.	5072	6149	3301	12048	51857	32018	26295	136740
		Wt.	36678.6	55066.6	35326.4	34225.3	132952.2	113959.3	153594.5	561802.9
2	<i>L. rohita</i>	No.	8719	10032	4648	1563	1696	3940	7506	38104
		Wt.	12655	16841.6	9166	3172.4	3013.4	6178.9	11811.9	62839.2
3	<i>C. mrigala</i>	No.	2918	1577	993	2932	5307	13353	30097	57177
		Wt.	4083.1	2581.2	1831.6	3844	7280.1	14876.1	28157.9	62654
4	<i>S. seenghala</i>	No.	11233	7184	8289	10978	7378	6216	10174	61452
		Wt.	13483.3	8985.5	10520.6	13555.9	9842.1	7634.8	11275.6	75297.8
5	<i>C. carpio</i>	No.	148980	222510	210463	176554	196026	163863	162985	1281381
		Wt.	144826.1	195094	203949.5	184961.7	214480.1	163373.1	161329.1	1268013.6
6	<i>Tor putitora</i>	No.	10075	17255	37463	27241	15195	12983	12485	132697
		Wt.	16925.3	22484.3	43926.5	33389.3	23745.5	19463.5	20328.8	180263.2
7	<i>Bangana dero</i>	No.	93906	5155	19626	36930	34394	104991	52516	347518
		Wt.	25553.9	1545.8	5089.2	9740	9225	32343.5	17140	100637.4
8	<i>H. molitrix</i>	No.	57333	96792	224140	227060	106322	52293	301690	1065630
		Wt.	222766.3	330458.2	703439.2	788030.8	396600.5	161279.6	653985	3256559.6
9	<i>C. idella</i>	No.	1411	1463	1390	1561	1157	992	992	8966
		Wt.	11468.9	10874.8	8528.4	12270.4	7071.9	8027.2	6078.6	64320.2
10	<i>L. calbasu</i>	No.	981	1005	813	651	219	230	524	4423
		Wt.	801	785.4	648.6	507.4	191.8	240	521.5	3695.7
11	“Others”	No.	6041	-	-	-	-	-	1107	7148
		Wt.	927.3	-	-	-	-	-	98	1025.3
Total		No.	346669	369122	511126	497518	419551	390879	606371	3141236
		Wt.	490168.8	644717.4	1022426	1083697.2	804402.6	527376	1064320.9	5637108.9

According to Jhingran [3], estimated fish yield was 276 kg/ha/yr from Gobind Sagar Reservoir. With the scientific management, 149.2 kg/ha/year fish yield has been achieved from this reservoir during 2013-14. Maximum catch of *H. molitrix* (788030.8 kg) was recorded during 2009, when catch of *C. catla* remained minimum (34225.3 kg). Maximum catch (153594.5 kg) of *C. catla* was recorded during 2012. Minimum catch (161279.6 kg) of *H. molitrix* was recorded in 2011. It may be attributed to the competition between these two species. Out of the total commercial catch from this reservoir, catch of *H. molitrix* was 72.71% (by weight) during 2009. It declined to 49.3% during 2010 and further to 30.3% during 2011. Stocking of this species (*H. molitrix*) was also done during 2011, which raised its quantity to 61.44% in 2012. There should be construction of fish ways at dams to allow fish migration from one side of the dam to the other during the breeding season. According to Sandhu and Toor [4], fish ways constructed at Hussainiwala, Harike and Ropar on Sutlej and at Madhopur barrage on Ravi were used by Indian Major Carps for migration during breeding season as

fish ways were reported to be found full of Indian Major Carps during breeding season.

According to Dua [5], raised water temperature caused by deposition of silt, drastic declining trend was shown in the catch of *Labeo dero*, *Schizothorax plagiostomus* and *Tor putitora* from Gobindsagar reservoir. According to Sandhu et al. [6], downwards trend was recorded in catch of *Tor putitora* due to the establishment of *C. carpio* in 1975-76 and *H. molitrix* in 1984-85 in the Gobind Sagar reservoir. Management strategies for enhancing the fish production in Madhya Pradesh Reservoirs were studied by Das et al. [7], mesh size regulation, active involvement of co-operatives, complete ban on fishing during the monsoon, self-sufficiency in the availability of seeds for stocking were some suggestions for enhancement of fish productivity. Impact of construction of hydropower projects upstream of Sutlej and Beas rivers may have caused decline in total catch both in Gobind Sagar Reservoir and Pong Reservoir observed during 2006-07 [8]. Variation in catch was attributed to the availability of food, the fluctuations in water level and spawning behavior in a study

conducted by [9] on the spatial distribution of fish population in the Gobind Sagar Reservoir. Contribution of *T. putitora* was 26% in Alikhad, 34% in Seerkhad, 35% in Gambharkhad and 6% in River Sutlej, in a study conducted during 1983-1985 [10] on some hill streams joining river Sutlej and a nearby stretch of the main river.

Dominant fish species in catch from Gobind Sagar Reservoir were *T. putitora*, *L. dero* and *Schizothorax plagiostomus*, major carps constituted a low percentage in catch [11]. From Gobind Sagar Reservoir, catch of Indian major carps contributed 40.08% of total catch in 1974 and declined to 8.73% in 1987. Silver carp contributed 25 kg in 1977 and increased to 65% in 1987 [12]. A need of exploiting the *H. molitrix* (silver carp) intensively and stocking of *Catla catla* and *Labeo rohita* fingerlings was felt by [13] to check the dwindling of *Catla catla* from Gobind Sagar Reservoir. Kumar [14] studies employment generation through the development of fisheries of Gobindsagar reservoir and Pong reservoir (Himachal Pradesh). According to Johal et al. [15] native fish species declined in Gobind Sagar Reservoir during 1981-1998 due to rise in silver carp and common carp.

Total world fisheries (capture and aquaculture) remained 117 million tons in 1998 [16]. Total world fisheries (capture and aquaculture) remained 154 million tons, in 2011 [17]. According to Katiha et al. [18] enforcement of conservation measures like mesh size regulation, catch weight regulation and close season and rational fish stocking should be followed for increasing fish production from Gobind Sagar and Pong reservoirs. To allow the fish migration, dams should have fish ladders as an integral part [19].

According to Sharma [20], due to construction of Kol Dam upstream the Gobind Sagar Reservoir, migration of silver carp was restricted, and consequently, catch of silver carp increased (83%) during 2001-02. During 2002-03 again, this phenomenon was repeated and resulted in further increase in catch (85%). Failure of natural breeding of silver carp due to hindrance in migration resulted in the dwindled catch of this fish (76.9 %) in 2003-04.

There were also changes in the conditions of reservoir regularly like deposition of more silt, construction of dams and commercial exploitation of fish species. Construction of Kol Dam upstream Gobind Sagar Reservoir was going on during the study period, and was since completed in 2015. Strict regulations were observed for fishing from Gobind Sagar reservoir. Only licensed fishermen were allowed to catch fishes. Fishes were sold to concerned contractors only through the concerned co-operative societies. The price of fishes was also fixed in a general body meeting. Gill nets with a minimum mesh size of 5 cm were applied. A complete ban on fishing was observed during the months of the June and July every year. Only those fishes which have attained a size above the minimum size fixed for harvesting were caught. In case of fishes having size less than the allowed harvestable size got caught in the net, they were released back into the reservoir unharmed.

IV. CONCLUSION

There were a variable number of fishermen operating in different areas of the reservoir. Large sized fishes were mainly targeted. In Bilaspur areas, co-operative societies Bilaspur, Beri Darolan and Kehloor were operating, and there was more fluctuation of water level in this area. These co-operatives shifted their operations downstream during the summer season and upstream during monsoon season. Fish catch by these co-operatives was not high. Fishes like *C. idella*, *Cyprinus carpio*, *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* were stocked in the reservoir. *H. molitrix* was also stocked during 2011. Exotic carps were more prevalent in the Bhakra region which is one of the deepest regions of the reservoir. Closed season has a positive impact on fish conservation and production. Most of the catch was during the month of August. There was no uniformity in the mesh size of gill nets used. The number of active fishermen varied. In the winter season, the catch was less. There was a decline in catch of *H. molitrix* in 2011. After the stocking of *H. molitrix*, there was an increase in catch of this fish. Fish catch was varying from different areas of the reservoir. In the Jyor area, there were more streams joining the reservoir, so this area has both lotic and lentic conditions. These streams were a suitable habitat for *Bangana (Labeo) dero* and so it was more in catch from this area. In the Lunkhar Khad stream, less shifting in fisheries operations was observed. State fisheries department was earning 15% royalty over the price of the sold fish. Gobind Sagar Reservoir is one of best reservoirs from a commercial fish catch point of view.

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