

Productivity Enhancement Through Carp Fish Seed Stocking and its Ecological Ramifications in Govind Sagar & Pong Reservoir of Himachal Pradesh.

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Abstract

Production and productivity of aquatic products in freshwater reservoirs of Himachal Pradesh has become a matter of deep concerns among the departmental fisheries biologists and associated researchers in this field. Downward sliding catch trends have impelled the policy makers & managers of the department to score out the strategies of one-way action of intensive stocking of carp fingerlings (>100mm) irrespective of weight parameter since a couple of decades ago. Stress is also on conservation by enforcing closed – season under section III, sub section 3 article (d) of the H.P. Fisheries Act 16, 1976 to ensure the natural breeding in two reservoirs i.e. Pong reservoir with av. spread area 15000ha. and Gobind Sagar with av. water spread area of 10000ha. Restriction on use of fishing gill nets with minimum mesh aperture not less than 4 inches from knot to knot when stretched across. Despite the application of technical tools, the situation of production and productivity in both reservoirs is not resurrecting up to the optimum sustainable levels. The outcomes of the applied efforts indicate the existence of ecological and technical management gaps. The improvement in these fields could help to improve the planktonic food populations and stocking of appropriate number of grazer fish species of economic importance, hence the productivity of the water bodies and significant fish yields. Improvement in stocking methodologies keeping in view the ecology of seed stocking grounds, availability of the appropriately sized food particles for the stocked fingerlings is of great significance. Seed grading shall also be of great importance prior to their releasing in the reservoir. Ecological aspects like standing crop of appropriate planktons, physiology of stocking fingerlings i.e. response to new eco-system of reservoir, morphology of fingerlings i.e. shape & size and body conformity of stocking fingerlings, adaptability to new water environment, acclimatization of fingerlings prior to stocking in the reservoirs, water chemistry, physical parameters like pH, temperature, transparency, thermal stratification, turbidity etc. are equally significant to be considered before stocking. The article is to throw a focus on the issues coming out of the studies and to find out suggestive techniques to improve the productivities of the reservoirs.

Key words: Productivity, standing crop, aquatic products, closed season, fingerlings, zooplanktons, phytoplankton, grazers, food chain, exotic carps, Indian major carps, morphology, physiology, ecological niche, physical parameters, acclimatisation, adaptability etc.

Background: Sutlej river and Beas rivers are two major river systems running across the Himalayan state, Himachal Pradesh. Bhakra Dam and Pong Dam are built across these river

systems at Bhakra and Pong villages of Himachal Pradesh. Resultantly, two mega reservoirs came into existence and became a prominent sources of livelihood through fish production and power generation (Economic activities). The fish fauna of Sutlej rivers consisted of (Kaushal et.al. 1980), Bhatnagar (1964) *Tor putitora*, *Cyprinus carpio*, *A. seenghala*, *Labeo dero*, *L. bata*, *Mystus (Bleekeri) bleekeri*, *Crossocheilus latus Latius*, *Garra gotyla*, snow trout (*Schizothorax plagiostomus*, *clupisoma montana* and *mastacembelus armatus* and the fish fauna of Beas River consisted of mainly cat fishes, minor carps and few coarse fishes. Cat fishes included *Aorichthys seenghala*, *Wallago attu*, *Channa marulius*, *Tor putitora* and minor carps included *labeo dero*, *L. bata*, *Garra gotyla*, *Gaonce*, *mastacembelus armatus* and local minors were major catches in the basket of river fishermen at the time of pre impoundment of the pong reservoir. Tandon and Sharma 1976 reported that before its impoundment river Beas supported diverse fish fauna of 47 species which included:

Schizothoracines: snow trout (*S. plagiostomus*)

Tor species: *Tor tor*, *Tor putitora*, *Tor khudree*, etc.

Labeo species: *Labeo bata* and *Labeo dero* etc.

Barilius species like *B. bendalensis*, *B. barila*, *Putius* species etc.

Additionally, *Crossocheilus*, *diplocheilus*, *Garra gotyla*, *Glyptothorax* and *Glyptosternum*, *Schizothoracines* like *S. richardsonii*,

Labeo species like *L. dero*, *L. bata*, and *L. dyocheilus*, *Crossocheilus Latius*, *Glyptothorax pectinopterus*, *Glyptothorax cavia*, *zenentodon cancila*, *channa punctatus* and *mastacembelus armatus*. The catch composition of both river systems indicates that exotic carps and Indian Major Carps were never been the inhabitant and native species of these river systems and were introduced manually by state fisheries department after these impoundments came to existence. Exotic carps namely *cyprinus carpio* var. *specularis* was introduced in Gobind Sagar reservoir in 1962. This species introduced into Indian waters in 1939 and entered the region in 1955 when it was cultured in a tank at Nahan District Sirmour H.P. stocking of mirror carp became regular after the fish seed farm Deoli (Bilaspur H.P.) was built in 1964. Till 1979 on an average 0.55 million fingerlings of size 55 to 80mm were stocked annually. In fact, mirror carp was the only fish stocked regularly as the seed of Indian Major Carps was still hard to produce by hypophysation. Based on general opinion of the leading biologists that none of the local fish would be able to offer viable commercial fishery and it was recommended that the reservoir should be stocked with IMC and Exotic carps. Taking it into consideration during 1967-71 state fisheries department stocked 3500 gravid spawners and 0.5 million fingerlings of IMC

ranging in size from 100mm to 150mm(6inches). By 1979 Indian Major Carps had established themselves in the reservoirs and started breeding in Gobind Sagar Reservoir.

As per various estimates the reservoir is to be stocked annually with 20 million fingerlings of IMC, but the average stocking rate was only 0.3million fingerlings which was just 1.5% of the total requirement. Stocked seed was also of small size i.e. 20mm to 30mm against the recommended 125mm to 150mm. No study was conducted on the survival of the stocked seed in the reservoirs.

*In Pong reservoir stocking of 130000 fingerlings of mirror carp was done in 1974 followed by 1,49,000 fingerlings of IMC in 1976-77. It had been estimated that 30 million fish seed comprising of *L. rohita*, *C. catla*, *C. mrigala* and *C. carpio* had so far been stocked in the reservoir in the ratio of 2:2:1:1 till 1989-90. The arrival catch of these species was reported at landing centres during 1980-81. It took almost 5 years to establish IMC in Pong reservoir eco-system where as it took 8-10 years to establish to catchable/breeding size.*

The procedure adopted for stocking of major carp was prior the stocking of IMC seed in these reservoirs was rearing and preconditioning of fry at nalagarh fish seed farm and Deoli seed farm and raise them up to advanced fingerlings stage and released in to Bhakra Dam and mirror carp seed used to be produced at Deoli (Bilaspur) and Nehla - Kushiala Farms (District Una) built in the vicinity of the reservoir to minimize the travel distance. Auto stocking was in practice. Similar procedure used to be followed in the kangra farm and then stocked into the Pong reservoir. in order to ensure the fingerling size of seed, National Fish Seed Milwan and Deoli fish seed farm (Garget Una) started by the department to increase the adequate rearing space in the periphery of both mega reservoirs. Two big seed rearing farms in the nearby area of pong reservoir were started appears to be not successful in meeting out the objectives of seed stocking. Presently, seed procured from other states is being stocked directly without seed standardization and disease diagnosis and hence failed to gain the sustainable levels of fish yields from both reservoirs. In order to enhance the fish production in mega reservoirs, methodologies exercised for seed stocking required to be standardized scientifically. The practice of seed stunting then stocking in the reservoir will may help to enhance the fish production swiftly in the reservoirs.

Methodology:

I. **Fish production** and productivity of a water body depends mainly up on established food chain of plankton type size & seed species subject to culture, availability & abundance of food in a particular ecological nitch, water quality physical parameters like temperature, thermal

stratification, pH, Total alkalinity, transparency, DO, CO₂, auto recruitment of live food, stage of fish being caught in the gill nets, size of the catch and method of fishing. With the impoundment of a river lotic conditions are converted into lentic. River eco-system changes into a new ecosystem. The process of succession takes place in which old food chain gets fragmented and replaces with new one. Some species of plants and fish fauna gets perished and new species are introduced in the new eco-system. After the impoundment in pong reservoir, the fish catches sustained with the native coarse fish fauna and total production sustained to 596mt. during 1979-80. From this level the fish production started declining. With the introduction of exotic carp (mirror carp) and Indian Major Carps during 1974, the production levels of pong reservoir remained between 597mt to 797mt. during the period of 1980-81 to 1987-88 possibly due to jump in production of Indian Major Carps especially 339mt rohu and 77mt *C. mrigala* (Table 1). Similarly, the catch trends have shown upwards trend in Gobind Sagar reservoir due to rise in production of Silver carp (*H. molitrix*) from 10.0 ton (1977-78) to 690.0 ton (1992-93) and total production from 171.0mt (1974-75) to 964.0mt (1992-93) in between this period boost in fish production of Gobind Sagar reservoir have shown increasing trend of 707mt due to enhancement of IMC of 366mt to 202.0mt. Two-way movement of fish production and reciprocal to each other in silver carp and IMC is observed may be indicative of replacement of IMC by exotic carps in the reservoir (Table 2.0). The production of coarse fish fauna of Gobind Sagar diminished from 249.0mt to 44.0mt during 1974-75 to 1992-93 years and continued till date, indicative of replacement of coarse fishery to commercial fishery in both reservoirs. Reciprocal movement of silver carp versus IMC have been seen in catch trends. Ecologically silver carp have occupied the ecological niche of IMC in Gobind Sagar reservoir. Apart from species of commercial fishery, the production of reservoir also depends upon the fishing gears applied and fishing methodology applied by fishermen.

The reservoir fishing in Himachal Pradesh is operated by gill nets. Registered fishermen are employed by the fishermen co-operative societies for this job. During the fishing operations, 80m X 6m gill nets with 4" mesh aperture from knot to knot when stretched across are suspended in the allotted fishing beat by the state fisheries department. Gill nets with larger aperture are also employed in the netting operations to catch larger sized Rohu, Catla, Mrigal and silver carps and mirror carps. Minimum aperture of mesh of gill net should not be less than 4 inch as specified in the H.P. Fisheries rules 1979 and section III of sub-section 3 clause (a)(iii) of the H.P. Fisheries Act 16, 1976. As per procedure laid down, the timing of fishing is also specified. No fisherman is allowed to sell their production in the open market and is

compulsory to bring their catch to their specific fish landing centre fixed by the department. Fishing in reservoirs is prohibited in the day time. Two-month fishing closed season is imposed by the fisheries department during spawning season of IMC to ensure regular spawning and new recruitment of commercial species. The closed season is imposed from 16th June to 15th August of every year which covers only breeding of IMC. Exotic carps breed earlier to this period. Therefore, technically the closed season does not cover the breeding season of highly prolific and highly productive fish species. Mahseer breed in batches throughout the year. Whereas, when the exotic carps are laden with eggs and ready to breed, there is no fishing ban in the state reservoirs generally in the month of March to May of every year and most of the breeders are caught by operating fishermen and fail to propagate their progeny. This practice is going on since 1974 onwards till date. Consequently, the production of exotic carps has also started declining in both the reservoirs too. This practice is going on since 1974 without assessing the impact of closed season on the fish production of IMC. However, other *Labeo* species do breed in the closed season in the lotic waters like *Reba cirrhina*, *L. dero*, *L. dyocheilus*, *L. bata* etc. only *L. rohita*, *C. catla* & *Cirrhinus mrigala* are premier fishes from commercial point of view. Whereas, the catch status of reservoirs indicates the declining trends of Indian Major Carps. To certain extent, the threshold catches of the two reservoirs are due to high catches of *M. seenghala* in Pong reservoirs and silver carp in Gobind Sagar reservoir. *On contrary, neither the breeding season of these two species is covered under closed season nor the fingerlings of them are stocked in the reservoirs.* It can be easily concluded that the ecological niches of IMC are shared by these two species. There could be a food competition in their respective ecological niches and stocked fingerlings of IMC failed to replace the populations of silver carp and *M. seenghala*. In order to compete and share the ecological niches of silver carp in Gobind Sagar and *M. seenghala* in Pong reservoir, larger sized or advanced fingerlings are suggested to be stocked in these reservoirs. 150mm or 6 inches long fingerlings of IMC were suggested by management of the department when the ecological niche was to be established by the IMC in these water bodies. Bigger sized fingerlings are suggested to be stocked in the reservoirs when the invasive species have occupied most of the ecological niche and is difficult to replace them with modest species IMC fingerlings.

Determination of fishing periods further would have helped to maintain the fish populations of specific species e.g. imposition of closed season during monsoon spell. It is true that spawning of IMC takes place during the 1st shower & flooding of monsoon, but the process of oogenesis and spermatogenesis is initiated with the rise in temperature in the month of April

last to May of every year and are ready to release the mature eggs in the month of June. Which means most of the fishes laden with large quantities of ripe eggs are caught in the month of May/June every year when the fishing operation are in progress. Or the most of the brood fishes are caught before they breed before the commencement of closed season. Only fraction of them get opportunity to breed in closed season. To make the closed season more effective, it requires more scientific studies and the matter may be referred to expert committee of the department which will conduct appropriate studies and design a suitable framework of closed season period to ensure the maximum of the fish brooders be allowed to breed in a season.

II. Closed Season: The close season may be imposed only from the development of oocytes in female fishes till the process of breeding is complete with the onset of monsoon. This will contribute significantly to raise the populations of IMC in the reservoirs. The populations of exotic carps can be increased by regular stocking of advanced fingerlings (stunted stock). Fishing ban of specific fishes will also help to increase the fish populations.

The fishing grounds should also be specified as per provisions in the fisheries act 16, 1976 Himachal Pradesh and specifically protected during the closed season. The mandate of the closed season is “*let every fish be given opportunity to breed at least twice in the life*”. If smaller fish are caught before the onset of the closed season, it will prevent the future brooders be deprived of opportunity to breed in its life cycle and hence, poor rate of multiplication of productive fish populations. Therefore, the aperture of gill nets may be relaxed and re-standardized to ensure not to be caught before its spawning in the reservoir.

III. Seed Stocking: Seed stocking in a water body to enhance fish yields is considered as one of the best alternative tool in fisheries management. To gain the best retrieval from the fish seed stocking is the major challenge in reservoir fishery. Prior to the stocking of seed following parameters or characteristics should be taken into considerations: -

- » Morphology of the species
- » Physiology of the seed
- » Ecological requirements of the species to be introduced & plankton populations
- » Physical parameters of the stocking grounds
- » Water chemistry and other demographic parameters
- » Adaptability and compatibility of the introducing seed species.
- » Methodologies of seed stocking in deep waters and proper counting of stock.
- » Pre-conditioning and acclimatization of seed prior to stocking in the reservoir.

Based on the recommendations of the departmental expert committee, it was decided to

introduce the exotic carps and Indian Major Carps in the two reservoirs of H.P. to ensure regular and sustainable fish yields for operative fishermen. The exotic mirror carp (*Cyprinus carpio* var. *specularis*) was introduced into Indian waters in 1939, entered the region in 1955 when it was cultured in a tank at Nahan district Sirmour of H.P. Because it thrives in cold waters and at high altitudes, this species preferred and introduced into newly created Gobind Sagar reservoir in 1962. Stocking of mirror carp became regular after the seed production was started at carp seed farm Deoli in Bilaspur H.P. In fact, mirror carp was the only fish stocked regularly as the seed of IMC was still hard to produce in the state. Taking into consideration of consensus of leading fish biologists, the state fisheries department stocked 3500 gravid spawners of IMC and 0.5 million fingerlings of 6 inches' size in the Gobind Sagar reservoir during 1967-71 years. It took about 8 years to establish in the new ecology of lentic waters of reservoir to become brooders of IMC by 1979.

It is to be noted that IMC took 8 years to establish in new eco-system, when the whole feeding grounds were full of planktonic food and there was no inter-specific as well as intra-specific food competition, natural breeding in new environment. The principle of "survival of the fittest" playing its vital role and much more time is required to grow the IMC to a size of brooder. This factor is yet to be established in research that actually its happening in the IMC with present practice of fishing. Indly, how much time it takes to grow actually to a catchable size in IMC. The method of tagging of fingerlings and staining of intestine of fingerlings prior to its stocking in a particular feeding ground can be useful in this methodology. Gauging the size and age assessment can be carried out at fish landing centres fixed around the periphery of the reservoir. Study of retrieval of stocked fingerlings is yet to be established. However, the catch data of both reservoirs indicates a very poor recovery percentage of Catla 0.001% to 0.30%, Rohu 0.06% to 0.13%, silver carp 0.16% to 1.0% and *Cyprinus carpio* 17.2% to 17.4% (the seed of *Cyprinus* is reared at departmental farms) in Gobind Sagar reservoir. Similarly, catla 0.016% to 0.55%, rohu 0.95% to 3.0% and 3.3% common carp in Pong reservoir (ADF Bilaspur Division & ADF Pong Reservoir Division). It is also observed from this data, the seed stocking is increasing progressively and recovery percentage of IMC population is declining drastically. Whereas exotic carps are sustaining the catch population in the same water body. Prior to stocking of fish fingerlings it has to be ascertained that: -

- The baby fish is in full conformity without any injury on the body or fins are not damaged.
- The stock is free from any contagious disease or infection.

- The stock is of only desired species and is free from weed fishes.
- The fingerlings transported from hatcheries is active, alert and do not contain food residue in the intestine or faecal contents in the cloaca or large intestine.
- The fingerlings stock should be identifiable of the species features and could be declared of a particular species.
- Small sized fish/fries, fingerlings cannot be distinguished easily of a particular species.
- Weight of stocking fingerlings should also be taken into consideration.
- Stocking grounds should be diagnosed by scanning the abundance of planktonic food chain for a particular species by plankton collection net. It should not be less than 1.0ml to 1.5ml/50 litre sample water. (Nursery Pond Management –practical guidelines) by G. Gopal Krishna, Asha T. Landge CIFE.
- A particular ecological niche has a specific stock bearing capacity. Therefore, more than one stocking grounds should have been identified while planning the seed stocking programme in a particular reservoir.
- The stocking fingerlings should have environmental and thermal shock bearing capacity to resist with changed new environmental conditions like physico-chemical parameters, environmental stress and change in water chemistry etc.
- The stocking fingerlings should be capable of searching and accept the available planktonic food in the stocking grounds of the reservoir. Absence of such characteristics of the stocking grounds will lead to severe starvation of stocked fingerlings and mass disappearance of the stocked fingerlings from that particular ecological niche.
- Depending upon the planktonic populations in a particular ecological niche do have a particular livestock bearing capacity and fish seed stocking in that particular niche should be strictly fixed in a particular number. Overstocking leads to overgrazing of standing crop of planktons and damage the retrieval process planktons in that particular niche and leads to the grazing area redundant.
- The pong reservoir is rich in organic nutrients, planktonic and periphytic assemblages.

Reservoir Ecology: The planktonic community of the Pong reservoir is very rich qualitatively and quantitatively. The planktonic density of 1053 to 18661 individuals per litre is matched by the phytoplankton. Means gross primary production is estimated at 50777mg cubic centimetre per day. With high net gross production ratio of 0.55 diatoms represented by 16 taxa constitute the largest component of plankton (69.75%) followed by green algae (22.22%) blue green algae (3.72%) and dinoflagellates (0.7%). Chlorophyceae with 18 genera exhibited the maximum

diversity. The average standing crop benthic macro fauna from 496 to 513 individuals per square metre. Oligochaetes, dipterans, ephemeropteran and molluscs represent the major benthic organisms in the reservoir.

The gross primary production in Gobind Sagar reservoir observed during seven years has an average range of 316.86 to 1088mg per meter cubic per day. The annual average plankton biomass ranges from 2-1ml to 16ml/sq.mtr. increases from September onwards reaching maximum in December and February. The ratio between zooplankton and phytoplankton as estimated by various workers is 1:6.5. zooplanktons dominate only in September and October, while in other months the phytoplankton are dominant. The benthic macro fauna of the Gobind Sagar is not very rich both in terms of qualitative and quantitative. The density varies from 345 individuals/m² to 677 in Lunkhar khadd sector. Oligochaetes (58.8%) culicids (22.4%) chironomids (12.6%) and molluscs (3.0%) from the benthic community. Benthos shows a bimodal pattern of fluctuation with two peaks. One in winter (January) and other in summer (May). The overall abundance of benthos is high in intermediate sector whereas moderate in lotic and poor in the lentic sectors due to their gravelly and rocky beds. The seed stocking should be preferred by identifying the ecological niches with rich macro fauna as per preferred faunal food by stocked fingerlings.

Though the ecological conditions and availability of suitable food chain were in abundance in both reservoirs despite the establishment of IMC and Exotic carps took 8 years to establish in reservoir ecology. The key factor for this reason is noticed as low temperature conditions (22.3- 24.0°C in Pong reservoir and 16.0 – 29°C in Gobind Sagar reservoir) and short span of suitable temperature for growth and gonadal development in IMC. These temperature conditions are ideal for exotic carps for gonadal development and growth of brooders. It leads to slower growth rate and poor gonadal development. Low temperatures are suitable for cyprinids and Hypophthalmichthys molitrix species are well adapted in the state reservoirs and thrives in low temperature. Hence, good growth and adaptations even in low temperature conditions. Optimum temperature range for IMC is maximum from March to October in Pong reservoir. Thus, most of the physical parameters support to IMC in Pong reservoir whereas low temperature conditions are suitable for exotic carps in Gobind Sagar.

Acclimatization:

The conditioning of seed stock is very important and essential step prior to its introduction into open water bodies. This process ensures and determines the strength of fingerlings to withstand the adverse conditions like scarcity of food, unsuitable environmental

conditions, capacity to compete the intra-specific and inter-specific food competition, struggle for existence, predation from invasive fishes, sharing of food with weed fishes and other physico-chemical parameters etc. Initially, IMC and Exotic carps were acclimatized at the Nalagarh Fish seed farm (Jagaatkhana) and grown to fingerlings stage under controlled feeding conditions for better survivals. Similarly, silver carp and mirror carp (exotic carps) were reared at Deoli farm (Bilaspur H.P.) and conditioned before they were released in the Gobind Sagar. This phenomenon helped the fisheries biologists to establish the species in the reservoir. Large sized fingerlings (1.5cm) are capable to counter the food competition with small and narrow mouthed species, predation from most of the cat fishes [evident from the aquaculture practice in A.P. when *clarius batrachus* is reared together in the same water body with large sized IMC and small sized cat fish and reported to be successful and in Ranchi Bihar similar practice has been seen in past] whereas fry stage or small sized fingerlings perform poorly in terms of catch recovery. Since, the process of acclimatization has been cut short and 100mm fingerlings are being directly stocked in densely catfish populations and deep waters depending upon the easy approach to the water body. Location of stocking and catfish free zones are required to be identified in the reservoir before the fingerlings are stocked in it.

The process of fingerlings stocking in reservoir follows as under:

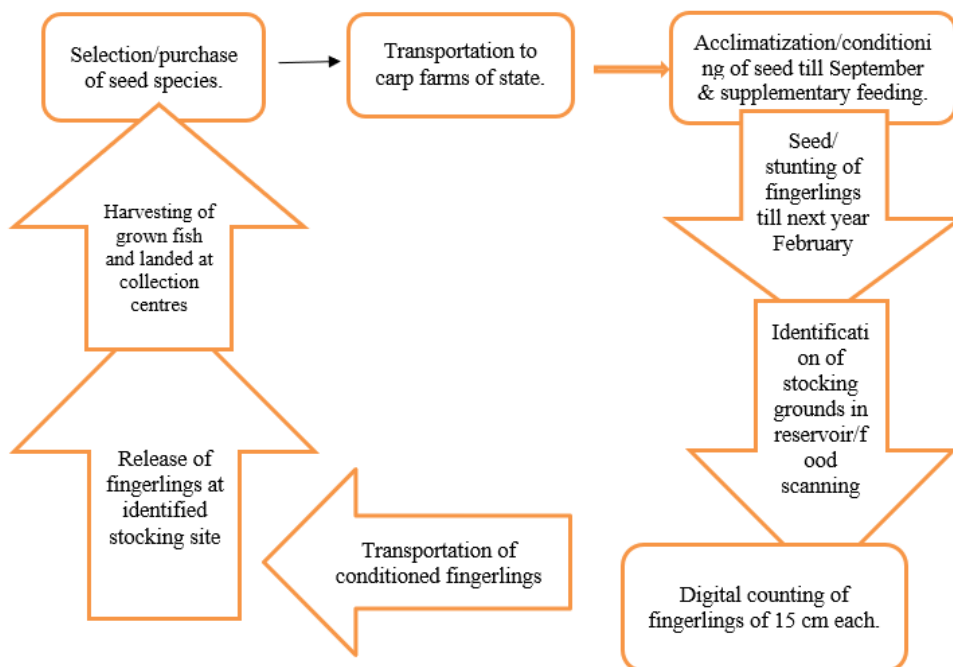


Fig: 1.0 Present practices of seed stocking in reservoirs of Himachal Pradesh.

Breeding of IMC has been reported to successful in Alsu carp farm Mandi, Deoli at Ghagus in Bilaspur.H.P.and carp farm Nalagarh in district Solan H.P. in the circumference of Gobind

Sagar having the rearing capacity to rear the IMC fries to fingerlings of desired size for stocking in the reservoir.

Apart from departmental seed farms, private seed hatcheries have been established under PMMSY 2020 in 4 districts adjoining to Gobind Sagar and a couple of non-functional departmental carp farms like Nehla seed farm in Bilaspur district and Kushiala Farm in Una district collectively constitute adequate seed rearing space and supply the desired fingerlings having capacity of 35.0 million spawn rearing space yielding 23.8875 lakh fingerlings of 15cm size each which is ideal for stocking in large or mega reservoirs. This will hardly cost 1.0 million INR inclusive of rearing cost at our farms with cost of IMC spawn/fry of 25mm length. Whereas present practice of stocking includes purchase of 100mm fingerlings and directly stocking from pond to reservoirs without following the stocking protocol without proper morphological scanning, acclimatization, food assessment of the stocking grounds, ecological conditions and following the physico-chemical parameters. Whereas same number of advanced fingerlings would cost to Rs.119.44lacs INR. Similarly, in pong reservoir periphery do have Deoli carp seed farm (gagret, Una), kangra seed farm, national fish seed farm Milwan (defunct) as departmental seed farms and Bhogarwan carp hatchery, Indora carp seed farm, Fatehpur & Sathana private farms collectively constitute a large rearing space having a capacity to hold 51.0million imc spawn which will produce 34.8075 lacs advanced fingerlings of 15cm suitable to stock in catfish & weed fish infested Pong reservoir. This methodology is suitable for IMC fingerlings stocking than directly putting in the seed in the reservoir. This practice adopted for stocking has not shown encouraging performance in terms of retrieval of IMC fish from both the reservoirs. The recoveries performance of IMC and Exotic carps shown are: -

Catla	0.30% to	0.006%
Rohu	0.13% to	0.06%
Silver carp	1.00% to	0.16%
Common carp	17.4% to	17.29% in Gobind Sagar reservoir of Bilaspur district H.P. whereas
Catla	0.55% to	0.016%
Rohu	3.8% to	0.96% in Pong reservoir of district kangra H.P.

Despite the intensive stocking of IMC in both reservoirs, the production results are not impressive indicating the gap in methodologies of stocking adopted by the agency concerned assuming that auto breeding during closed season is unsuccessful in both the reservoirs. This percentage recovery dips down to new lows if the breeding of acclimatized IMC brooders is

partially successful. The mechanism of recovery percentage can be brought more accurate by using *Calitri digital counters* for stocking of fingerlings and digital tagging of fish fingerlings and checking by scanners at fish landing centres of respective reservoir division of fisheries in H.P.

Table 1.0 Fish landings(tons) from Pong reservoir Himachal Pradesh.

YE AR	Cat la	Ro hu	L.de ro	L.culb asu	C. mrig ala	Cypri nus carpio	Tor putito ra	Seengh ala	Walla go attu	othe rs	Tot al
1976 -77	-	~	61.0	-	~	-	10.0	19.0	5.0	3.0	98. 0
1977 -78	-	~	164. 0	11.0	~	3.0	18.0	48.0	13.0	8.0	265 .0
1978 -79	-	~	91.0	53.0	~	45	60	145	44	99	537
1979 -80	-	~	108	55	-	48	66	158	54	107	596
1980 -81	-	-	102	57	6	44	64	155	40	111	579
1981 -82	-	-	75	69	7	33	43	119	48	49	443
1982 -83	-	2	71	83	27	29	102	142	35	6	499
1983 -84	-	6	43	74	31	22	98	161	32	3	470
1984 -85	1	21	22	76	35	15	86	181	34	5	479
1985 -86	3	84	24	80	51	19	98	143	36	14	552
1986 -87	4	97	26	74	49	23	72	130	33	11	519
1987 -88	7	339	20	68	77	31	87	128	30	9	797

1988 -89	4	145	13	56	43	32	55	97	24	7	476
1989 -90	8	168	13	50	25	13	54	106	28	23	489
1990 -91	7	128	3	42	17	5	65	121	24	20	442
1991 -92	12	150	3	49	14	4	60	164	20	9	485
1992 -93	15	95	1	39	7	2	71	199	14	5	448
1993 -94	19	84	1	18	5	3	50	180	9	4	373
1994 -95	34	57	0	9	4	3	62	193	6	3	371
1995 -96	22	36	0	12	3	3	59	185	5	5	330
1996 -97	22	49	0	9	3	14	64	236	4	4	397
1997 -98	12	41	0	5	3	17	81	241	3	4	415

Table 1.2 Fish Landings from Gobindsagar in 1974-92 (tons)

Year	Silver carp	Minor carp	mahseers	A.seenghala	IMC	Mirror carp	others	total
1974- 75	-	24.0	28.7	3.1	67.7	46.4	0.8	171
1975- 76	-	104.0	46.3	9.2	252.3	64.2	-	476
1976- 77	-	91.0	38.4	8.0	258.8	92.7	19.6	509
1977- 78	10.0	184.0	58.0	16.0	366.0	76.0	-	707
1978-	13.0	209.0	67.0	7.0	364.0	94.0	-	754

79								
1979-80	44.0	249.0	71.0	5.0	243.0	104.0	-	716
1980-81	88.0	213.0	77.0	5.0	202.0	122.0	-	707
1981-82	96.0	163.0	97.0	5.0	99.0	193.0	-	653
1982-83	103.0	17.0	31.0	7.0	56.0	145.0	-	562
1983-84	107.0	144.0	55.0	5.0	36.0	78.0	-	425
1984-85	223.0	113.0	45.0	2.0	55.0	67.0	-	505
1985-86	246.0	123.0	8.5	2.4	40.8	124.6	0.7	547
1986-87	176.0	71.0	7.5	1.7	33.2	87.2	-	377
1987-88	354.0	74.0	31.0	2.6	46.6	27.8	0.6	538
1988-89	687.0	15.0	32.0	2.0	40.0	66.0	2.0	784
1989-90	661.0	10.0	26.0	4.0	62.0	51.0	1.0	815
1990-91	595.0	29.0	37.0	4.0	73.0	77.0	1.0	816
1991-92	617.0	48.0	38.0	4.0	76.0	69.0	3.0	855
1992-93	690.0	44.0	46.0	4.0	98.0	78.0	4.0	964

OBSERVATIONS & CONCLUSIONS

- From the above details it is observed that prior the impoundments of Sutlej & Beas rivers and construction of Govind Sagar & Pong reservoirs, most of the fish fauna consist of cat fishes, local minors, coarse fishery and mahseers etc. Exotic carps and

Indian Major Carps were absent in its initial catches (Table 1.1 & 1.2). Evidently, Indian major carps and exotic carps are not the native species of our river system in Himachal Pradesh. The first species brought to our reservoir system was *Cyprinus carpio* var. *specularis*, then *H. molitrix* were introduced in Gobind Sagar and during the early seventies Indian Major Carps were introduced in both the reservoirs. The objective of introducing exotic carps & IMC was to ensure sustainable fish production and promote commercial fishery in our major reservoirs. Establishment of carps in our reservoirs consumed almost 8 years to gain the maturity and become brooders and reported natural breeding of major carps. Peak productions of Gobind Sagar surged to highest level due to high productions of exotic carp (silver carp) and mirror carp and in pong reservoir the highest peak production recorded due to high productions of Indian Major Carps. Both Exotic & Indian Major Carps were introduced by a particular procedure.

- At the time of introduction IMC & Exotic carp fries were stocked at departmental farms and reared up to 15cm advanced fingerlings at nalagarh & Deoli (Ghagus, Bilaspur) farms.
- The process of acclimatization of new species was observed. Stocking of these advanced fingerlings was resorted to only after the acclimatization in Himachal waters.
- Declining trends of both exotic & indian major carps (inland) has been observed since unscientific and catching of pre mature would be brooders, failure of close season and unconditioned stocking of small size fish seed led the commercial fish species failure to established as abundant brood stock naturally and adapted to new ecology.
- It has also been observed that small size fingerlings are stocked in reservoirs without assessing the abundance of the planktonic food availability at stocking sites. Generally shallow waters are preferred which are infested with weed fishes and catfish dominated sites. Resultantly, minimal stock recovery and decline in catches.
- No, identification of ecological niches suitable for IMC, Exotic Carps is done prior to planning of seed stocking in reservoirs.
- No morphological scanning of the fish fingerlings, physiological examination and disease diagnosis is done prior to stock of fingerlings in to reservoir to ensure disease free and unwanted weed fishes' entry into the reservoir.
- Acclimatization of fingerlings before stocking in deep waters with low temperature conditions of reservoirs in comparison to pond temperature is very essential to protect

from thermal shocks for its survival. This procedure has been omitted in present methodology of seed stocking.

- During the stocking of fingerlings, the stock is counted by average method in numbers. Some biologist proposes the stocking by weighing, but still scope of error exists there. It can be minimised by use of sensor operated counters while stocking in reservoirs or at rearing farms.

Recommendations: Sustainability in fish production is the prime objective in reservoir fisheries. With the impoundment of a river system in to a larger reservoir, lotic ecology. With the change in ecology, the process of succession is initiated during which some of the species gets eliminated/disappear and new species take place in plants and animal kingdom of reservoir. Due to change in ecological conditions the species eliminated creates space for other species to be introduced for its sustainability. Keep in view, the production enhancement in reservoir, the state expert committee of the department proposed the introduction of exotic carps like *H. molitrix*, *Cyprinus carpio* var. *specularis* and Indian Major Carps fingerlings to Gobind Sagar and pong reservoir only after the acclimatization and rearing to advanced fingerlings stage at the departmental farms. In establishing the major carps in our reservoirs, temperature factor and environmental conditions are major hurdles, which can only be countered by acclimatisation and conditioning of IMC fingerlings before stocking them into the reservoirs. Size of the fingerlings too matters to withstand the adverse conditions of new environment in the deep waters. Selection of stocking sites in the reservoirs is too significant from the view point of availability of natural food of their preference. Upgradation of fishing tools (Gill nets) and increasing and increasing the permitted aperture of the gill nets to ensure atleast two breeding in its life span. IMC only after conditioning the studies by the expert committee on fisheries. The option of stunting of fingerlings at the departmental farms, then be stocked in the reservoirs will also help to adapt the species to adverse conditions or reservoir and boost the production. Since most of the stocking grounds preferred penultimate to tailrace of the feeding rivers. Therefore, these sites are more prone to floods, high loads of silt and dissolves silt and stocking time should be either after the monsoon is over or it should be away from the silt sedimentation zone in the reservoir.

Sediment accumulates in the reservoir every year through soil erosion from surrounding catchment areas. The magnitude of soil erosion has increased many folds due to mechanical excavation, excavators, cutting of hills for road broadening and excessive landslides in hills due to cloud bursts, heavy rains consequently, heavy load of sand, silts flow down to the rivers

carry it to reservoirs which settled down these on the fish breeding grounds. In Pong reservoir prior to introduction of IMC fingerlings, the seed stock used to rear in pen cages installed in woohal khadd, Dhameta khadd, major tributaries open in to reservoir in Fatehpur area and gajj khadd in nagrota surian that also opening in Pong Reservoir, prior to release of the IMC fingerlings. This way a methodology of conservation *insitu* from cat fishes like seenghala, mullee, Saul was adopted. It is worth noticed that at the time of introduction of IMC seed just after the impoundments most of the fish populations constitute cat fishes despite this situation the IMC fish survived in the better proportion and lead the reservoir to maximum catches at this reservoir. Thus, this methodology had been successful in establishing the major carps in Pong reservoir. Increase in silt contents at stocking sites has further minimised chances of seed development (Egg hatching, development from egg to spawn & then fry stage is the transitional stage and critical stage in the development from egg yolk to fry stage) during the closed season. Although spawning in close season may be successful, but recoveries in terms of fish is very fractional.

Therefore, stocking of conditioned fingerlings is the only best method to increase the fish populations in the reservoirs. Pen cage rearing is also another option to determine the percentage recovery of stocked fingerlings and then released to open water body (reservoir). 15 cm sized fingerlings reared and then released which are capable to defend themselves and escape from predatory fishes and migratory birds hence better survivals and high yields. Based on above discussion it can concluded to boost the fish production in the reservoirs following steps can benefit better to its stake holders. Commercial fish populations can be raised by exercising multi prong action of reservoir management.

- i. By protecting fish breeding grounds from mining and silt generation the sedimentation and maintaining the aquatic ecology ensuring the auto breeding successful during the closed season.
- ii. Introduction of exotic & Indian Major Carps large size (150mm) fingerlings only after acclimatization at Inland Carp farms of nearby locality to avoid the transportation stress at the time of stocking in the reservoir.
- iii. To determine the rate of survival after stocking in reservoir, the methodology of planting pen cages and rearing of fry stage fish seed and then rearing to grow large fingerlings after the monsoon is over and when there is no scope of floods in that area where pen cages are planted. In this method rearing of small sized baby fish in high densities are reared by supplementary feeding. When the fingerlings are grown to 15cm

long and accepting food both naturally and supplementary and well acclimatized fingerlings are released in the reservoir from the cages. (not floating cages). Thus acclimatised fish seed is auto released into the reservoir without transportation from distant farms. This method minimises the mortality rate due to transportation and better recoveries and speedy growth is ensured.

- iv. Advancement of close season period and its extension to 2&^{1/2} months to cover maximum breeding time for IMC rather it should be fixed only after examining the development of oocytes & spermatocytes in fishes. To raise the fish populations in the reservoirs.
- v. Permissible mesh size of fishing gears or gill nets should be revised from 4inch to above depending upon the outcomes of studies of the expert committee of the department. This will ensure the catch of large fishes and not early brooders of IMC specially. The catch size of IMC fish may also be raised to ensure maximum breeding batches are released in the reservoir.
- vi. Enforcement of closed season at the time of gonad development. Whereas presently the eggs laden fish are caught in the month of May or early June. At that time fishing in the state is open and is ready to release mature eggs at the onset of monsoon shower. Most of the IMC brooders release the eggs/spawning takes place at the 1st shower of monsoon in the month of June every year. So it is better to enforce the closed season depending upon the stage of egg development in the reservoir fisheries. It should not be a static practice rather it should be study based every year.
- vii. To assess the recoveries of stocked fish fingerlings, the method of digital tagging is ideal and can be used for assessment of IMC fingerlings and exotic fingerlings too. The recovery of sample can be counted by scanning the caught fish and brought at landing centres which will reveal the data of D.O.S., size, species, source and genetic genome data from where recovery rate can be assessed.
- viii. The method of stunting of fingerlings of a species will further fasten the growth when stocked with high densities even in the reservoir. This method has already demonstrated good performance in aquaculture sector and have high yields in that sector.
- ix. The method of seed counting is also not logically justified in present practice. With use of latest technique of Calitri sensory Counters gives accuracy up to 96-98% in counting, spawn, fry, Fingerlings and fish up to 400gm weight while stocking in reservoirs or rearing farms. It will bring accuracy and refinement in the seed stocking programme

and hence fish yields. Average method of counting in practice has not performed good yields and hence require modification in stocking methodologies. Grave errors have been noticed in seed counting even by weight method. In this method of counting few large sized fingerlings will drastically alter the count significantly.

- x. Strengthening of breeding centres or departmental carp farms and private hatcheries came to existence with the departmental investments through welfare schemes and rearing of fries to fingerlings or spawn to fries then to fingerlings through purchase should be reared at departmental farms and grown up to 15cm fingerlings then be stocked in the selected ecological niches of reservoir will have good yields. Large sized advanced fingerlings are capable to defend itself from predation accept the available natural food in the reservoir eco-system. Hence, better survivals of stocked fingerlings.
- xi. Development of brood banks will ensure the strong bond genetic setup of a particular generation and will avoid the inbreeding among similar species.

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