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Vishavjeet Singh
Department of Zoology and Applied Aquaculture, Barkatullah University, Bhopal, Madhya Pradesh, India

Vipin Vyas
Department of Zoology and Applied Aquaculture, Barkatullah University, Bhopal, Madhya Pradesh, India

Anubhuti Minare
Department of Zoology and Applied Aquaculture, Barkatullah University, Bhopal, Madhya Pradesh, India

Paramveer Singh
College of Fisheries Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Paramveer Singh
College of Fisheries Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Survival rate and growth performance of rainbow trout (*Oncorhynchus mykiss*) under lentic condition in cage of Koldam reservoir

Vishavjeet Singh, Vipin Vyas, Anubhuti Minare and Paramveer Singh

Abstract
This experiment of four months on *Oncorhynchus mykiss* stocking density, growth performance, and survival rate were measured in the cages of Koldam Reservoir in Bilaspur, Himachal Pradesh. During this study, 10,000 rainbow trout fingerlings with an average weight of 5g were raised in net cages with size of 643 meters long. This experiment was performed just to understand the survival rate and growth of rainbow trout under cages (Koldam Reservoir) in lentic conditions with minimum flow of water during these months. Moreover, many factors influenced survival rate and growth of Rainbow Trout (*O. mykiss*) fingerlings, including water quality parameters such as water temperature, pH and food quality under cage culture. In the current study, the total average weight gain was 33 g, and the total average length gain was 17cm throughout the study period. Despite a total stocking density of 10,000, just 30% of the fish fingerlings survived in the cages of Koldam Reservoir in Bilaspur, Himachal Pradesh. The most critical element impacting growth was temperature, which resulted in considerable death of fish fingerlings in cages during early phase of study.

Keywords: Cage, survival, weight, stocking density, reservoir

Introduction
The Indian fishing industry contributes significantly to the country's economy by providing a living for a substantial portion of the economically disadvantaged population, important foreign exchange, and employment to millions of people (Ayyappan and Diwan, 2006) [2]. There are around 10,000 km of streams and rivers, 20,500 ha of natural lakes, 50,000 ha of natural and constructed reservoirs, and 2500 ha of brackish water lakes at high altitude (Mahanta and Sarma, 2010) [13]. Coldwater fisheries are essential in India's fishing industry. Cages are enclosures in which the bottom and sides are enclosed by wooden, wire mesh, or net screens (Beveridae and Little, 2002) [4]. They have grown in popularity in recent years because they ensure a high rate of retrieval of stocked fishes and can be practiced in inland open water bodies such as freshwater ponds, lakes, and reservoirs (Schmittou, 1991) [18]. A gravity fish cage system is made up of four parts: a float collar system, a cage net system, a sinker system, and a mooring system. The float collar system, which provides buoyancy, and the sinker system, which provides weight, keep the overall cage system stable (Olivares, 2003) [17]. Cage culture is significant in the cultivation of high-value fin fishes and has recently achieved broad favor due to the development of low-cost cages in coastal locations. CMFRI pioneered cage culture in India in 2007 with the installation of marine cages at Munambam in Ernakulam District, Kerala, with the assistance of the Department of Animal Husbandry, Dairying, and Fisheries (DAHD&F), Ministry of Agriculture, Government of India. The CMFRI's successful front-line demonstrations of cage farming in coastal waters in 2009 led to its widespread adoption in brackish water locations as well. Cage culture is the practice of rearing fish in existing water resources while contained in a net cage that permits free passage of water. It is an aquaculture production system that consists of a floating frame, net materials, and mooring system (with rope, buoy, anchor, and so on) with a circular or square shape floating net to contain and culture a large number of fishes and may be deployed in a reservoir, river, lake, or sea (Marte *et al.* 2000) [14]. The word 'coldwater' often refers to an aquatic system where the temperature is within the tolerance limits of trout and salmons from the Salmonidae family (20 °C). Water temperature, dissolved oxygen, velocity, turbidity, substratum, trophic status, food availability, and other physical, chemical, and biological parameters influence the distribution and abundance of various cold-water species (Sundar *et al.* 1999) [20].

The fish may be artificially fed and can endure temperatures as high as 26.6 °C for brief periods of time. The key factors influencing the survival and production of naturalized populations in open waterways are water temperature and precipitation (Sehgal, 1999) [19]. Because Rainbow Trout, *Oncorhynchus mykiss*, is very easy to cultivate in a variety of aquaculture systems, it has become more popular and has been farmed in sea cages in the Black Sea from early 1990 (Akabulut *et al.* 2002) [1]. Rainbow trout (*Oncorhynchus mykiss*) is a popular aquaculture species because to its various advantages, which include adaptation to the farming environment, reproductive efficiency, and disease resistance (Caimi *et al.* 2020) [5]. Rainbow trout have a long, thin body with an iridescent pink or red lateral line. They have silvery sides (sometimes with a greenish tint in landlocked individuals), a dark blue to olive back, and a white underside. Dark markings cover their sides and all of their fins (including their tail). Cage aquaculture will play an important role in the overall process of providing enough (and acceptable) fish for everyone, particularly because of the opportunities for integrating species and production systems in near shore areas, as well as the expansion possibilities with the installation of cages far from the coast. Cage culture has recently gained popularity as one of the most productive aquaculture techniques commonly utilized for intensive fish culture (Chua and Teng, 1980; Guo and Li, 2003) [7, 10], attracting the interest of both researchers and commercial producers. The significance of trout culture to our country has been well established. Cages have been a substantial contributor to output (Chua and Tech, 2002; Liao *et al.* 2004) [8, 12].

Hence, it is felt that more technological and engineering interventions in cage farming coupled with large-scale hatchery production of high value and fast-growing finfishes can pave the way for the development of cage farming industry in our country in near future.

Materials and Methods

Study Area

The Koldam Reservoir, situated in a small village Kasol, Bilaspur, Himachal Pradesh. Since 2019, a total of 24 cages have been erected in the reservoir. Fish samples were collected throughout the year.

Fig 1: Floating cages in Koldam Reservoir in Bilaspur, Himachal Pradesh

During this investigation, the fish fingerlings were fed a pelleted floating feed called Growel (NUTRILA-Nutrition for Rainbow Trout). The feed was obtained from a private feed facility. The experiment lasted 120 days (from October 20, 2021 to January 20, 2022).

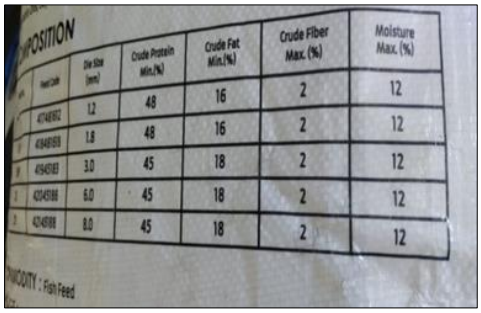


Fig 2, 3 and 4: Represents the Rainbow Trout fish feed

Stocking Density

The quantity of fry or fingerlings per unit of water space is referred to as stocking density, also known as per-unit stocking number of fish or stocking rate. It is often given as the weight of fish per mu. Ten thousand rainbow trout fingerlings with an average beginning weight of 5 g were grown in net cages measuring 643 m in length.

Growth Performance

Fish body weights per gram were measured at the start of the study and then every 15 days for the next 140 days to determine the growth rate of the fish fingerlings. During the study period, the following formulas were employed to calculate the growth performance of fish fingerlings:

Average Weight Gain ((Nasrollahzadeh, 2008) [15] = (Average Final weight - Average Initial weight)

Average Length Gain (Nasrollahzadeh, 2008) [15] = (Average Final Length – Average Initial Length)

Survival Rate

After 4 months of this study period, fish fingerlings were counted to determine the survival rate according to the following formulae (Cheikyula, 2003) [6]:

$$\text{Survival Rate} = \frac{\text{Number of fish harvested}}{\text{Number of fish stocked}} \times 100$$

Water quality

Important water quality parameters for cage culture has been estimated with the help of digital Temperature meter (℃), Secchi disk for Transparency (cm), digital meter for pH and Aquasol DO testing kit for DO (mg/l).

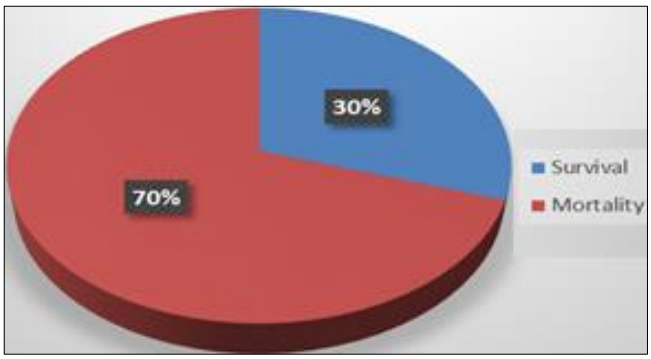
Results and Discussion

The current study was done on *Oncorhynchus mykiss* for four months (October 2021 - January 2022), and its stocking density, growth performance, and survival rate were measured in the cages of Koldam Reservoir in Bilaspur, Himachal Pradesh.

Table 1: Represents the weight and length measurements during the period of four months experiment (October 2021 – January 2022).

S. No.	October	November	December	January
Average Length Gain (cm)	9	11	13.5	17
Average Weight Gain (gm)	7.5	19	25	33

In this study, 10,000 fingerlings/cage *Oncorhynchus mykiss* fingerlings weighing 6g were supplied in September 2021. Fish, specifically Growel, were given more nutrition. The fish length was 9 cm and weighed 7.5gm during the first month, October 2021. The fish measured 11 cm in length and 19gm in weight in the second month, November 2021. Fish were seen to be 13.5 cm long and 25g in weight in December 2021. The largest length of fish seen during the last phase of the research was 17 cm, and the weight was 33gm. The fingerling survival rate in this research was 30% of the overall stocking density (10.000). As a result, just 3,000 fingerlings survived during this experiment.



Graph 1: Represents the Survival rate of *Oncorhynchus mykiss*

The growth performance and survival rate of Rainbow Trout (*O. mykiss*) fingerlings were impacted by many environmental variables such as water quality parameters such as water temperature, pH, food amount, and food quality. The weight growth in the current study was 33 g, and the length gain was 17cm over the study period. Only 30% of the fish fingerlings survived in the cages of Koldam Reservoir in Bilaspur, Himachal Pradesh, despite a total stocking density of 10,000. Temperature was the most important factor influencing growth, resulting in significant mortality of fish fingerlings in cages. Fish development was clearly not a continuous component and might have been influenced by a variety of environmental elements (Physical, chemical/biochemical, or a mix of these) (Bajaj, 2017) [3]. One of the most important physical parameters influencing fish development and productivity was water temperature. For example, *O. mykiss* can survive in temperatures ranging from 1 to 26 °C. However, depending on the source, the "optimum" temperature for growth ranges from 13 to 21 °C (Viadero, 2005) [21]. To the best of our knowledge, no previous research on growth performance or stocking density in this species during the fingerling stage have been identified. Various research, however, have been undertaken to determine the growth performance and survival rate of Rainbow Trout in various environmental situations. Kayim *et al.* (2007) [11] attempted four replicates of Rainbow trout culture in net cages with stocking levels of 4 kg m-3. At the end of the experiment, the live weight increment was calculated to be 165.91g, and the specific growth rate was estimated to be 0.915. Farabi *et al.* (2020) [9] investigated the growth performance and survival rate of rainbow trout (*Oncorhynchus mykiss*) in floating cages in the Caspian Sea's south. The results demonstrated that the development performance of Rainbow trout in floating cages was adequate in the brackish water of the Caspian Sea. Nepal *et al.* (2020) [16] installed three cages, 6 m 4 m 2 m in size, in a shallow-reservoir developed for hydropower to analyze its development and productivity. For 91 days, trout juveniles weighing 57.615.4 g (average weight SD) were stocked and fed a 33% crude protein diet twice daily at a maximum of 3% of body weight. When stocked 10-20 fish.m-3, the results revealed that it is feasible to obtain excellent survival (96.61.7%) with reasonable growth rate (0.80 g fish-1) and productivity (8927 kg cage-1) with fair condition factor (1.20.1).

Water quality parameters

Table 2: Represents the water quality parameters during the period of four months (October 2021 – January 2022).

S. No.	Average Temperature °C	Average Transparency (cm)	Average pH	Average DO (mg/l)
1.	26	80	7.7	6.5
2.	16	100	7.9	7.0
3.	10	150	8.3	6.5
4.	8	150	8.5	6.5

Conclusion

The Rainbow trout, *Oncorhynchus mykiss*, lives in cold water. The species can tolerate wide temperature variations (0-27 °C), however spawning and growth occur in a limited range (9-14 °C). The ideal water temperature for rainbow trout cultivation is below 21 degrees Celsius. The fish were placed in warm water cages in the Koldam Reservoir in Bilaspur, Himachal Pradesh. During this investigation, the fish fingerlings were fed a pelleted floating feed called Growel (NUTRILA-Nutrition for Rainbow Trout). The growth performance of the fish fingerlings was higher as compared to the survival rate of the fish fingerlings. During this experiment, just 30% of the fingerlings or 3000 fingerlings survived. This was owing to the influence of unfavorable climatic conditions, with temperature being the primary cause of their high death rate during the starting period of experiment.

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References

1. Akbulut B, Sahin T, Aksungur N. Effect of initial size on growth rate of Rainbow Trout, *Oncorhynchus mykiss*, reared in cages on the Turkish Black Sea coast. Turkish journal of fisheries and aquatic sciences. 2002;2:133-136.
2. Ayyappan S, Diwan AD. Fisheries research and development in India. Fishing chimes. 2006;26(1):19-23.

3. Bajaj S. Effect of environmental factors on fish growth. Indian Journal of Science Research. 2017;12(2):87-91.
4. Beveridge MC, Little DC. The history of aquaculture in traditional societies. Ecological aquaculture. The evolution of the Blue Revolution; c2002. p. 3-29.
5. Caimi C, Gasco L, Biasato I, Malfatto V, Varello K, Prearo M, *et al*. Could dietary black soldier fly meal inclusion affect the liver and intestinal histological traits and the oxidative stress biomarkers of Siberian sturgeon (*Acipenser baerii*) juveniles? Animals. 2020;10(1):155.
6. Cheikyula JO, Ofojekwu PC. Growth responses and survival of the gold fish *Carassius auratus* (Cyprinidae) fry reared on Moina (Cladocera) and Cyclops (Copepoda). Journal of Aquatic Science. 2003;18(1):43-46.
7. Chua TE, Teng SK. Economic production of estuary grouper, *Epinephelus salmoides* Maxwell, reared in floating net-cages. Aquaculture. 1980;20:187-228.
8. Chua T, Tech E. Introduction and history of cage culture. Diseases and disorders of finfish in cage culture; c2002. p. 1-39.
9. Farabi SMV, Tabari MR, Hafezieh M. Investigation of rainbow trout (*Oncorhynchus mykiss*) culture in marine floating cages in the Southern Caspian Sea. Journal of Aquaculture Marine Biology. 2020;9(6):203-206.
10. Guo LG, Li ZJ. Effects of nitrogen and phosphorus from the fish cage culture on the communities of a shallow lake in middle Yangtze River Basin of China. Aquaculture. 2003;226:202-212.
11. Kayim K, Suiçmez M, Güner Y, Suiçmez T. Growth of Rainbow Trout (*Oncorhynchus mykiss*, W. 1792) in Net Cages in Almus Dam Lake (Tokat). Pakistan Journal of Biological Sciences. 2007;10(6):964-967.
12. Liao IC, Huang TS, Tsai WS, Hsueh CM, Chang SL, Leaño EM. Cobia culture in Taiwan: current status and problems. Aquaculture. 2004;237(1-4):155-165.
13. Mahanta PC, Sarma D. Coldwater Fisheries Management. DCFR, ICAR, Distt. Nainital (Uttarakhand), India; c2010. p. 1451.
14. Marte CL, Cruz P, Flores EEC. Recent Developments in Freshwater and Marine Cage Aquaculture in the Philippines. In: Liao IC, Lin CK, editors. Proceedings of the First International Symposium on Cage Aquaculture in Asia; 1999 November 2-6; Manila, Philippines: World Aquaculture Society – Southeast Asian Chapter, Bangkok; c2000. p. 75-88.
15. Nasrollahzadeh HS, Din ZB, Foong SY, Makhlough A. Trophic status of the Iranian Caspian Sea based on water quality parameters and phytoplankton diversity. Continental Shelf Research. 2008;28(9):1153-1165.
16. Nepal AP, Sharma S, Bhujel RC, Gurung TB. Condition factor, growth performance, and production of Rainbow trout (*Oncorhynchus mykiss*) in floating cages in a shallow reservoir in Panauti, Nepal: A preliminary study. International Journal of Fisheries and Aquatic Studies. 2021;9:12-21.
17. Olivares E. The effect of lead on the photochemistry of Tithonia divers folia exposed to roadside automotive pollution or grown in pots of Pb-supplemented soil. Brazil Journal of Plant Physiology. 2003;15(3):149-158.
18. Schmittou HR, Rosati R. Cage culture: A method of fish production in Indonesia. A manual of the Fisheries Research and Development Project. Jakarta, Central Res. Inst. Fish; c1991. p. 114.
19. Sehgal KL. Coldwater fish and fisheries in the Indian Himalayas: rivers and streams. p. 4163. In T. Petr (ed.) Fish and fisheries at higher altitudes: Asia. FAO Fisheries Technical Paper; c1999. p. 385.
20. Sunder S, Raina HS, Joshi CB. Fishes of Indian uplands. Bull. No.2, NRC on Coldwater Fisheries, Bhimtal; c1999. p. 64.
21. Viadero RC. Factors affecting fish growth and production. Book of Water Encyclopedia by John Wiley & Sons, Inc. chapter 3: Surface Water Hydrology; c2005.