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## Status of trout fishes *versus* climate change in Himachal Pradesh, North Western Himalaya

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### Abstract

Trout Fishery in Himachal Pradesh has been introduced for the recreational purpose to promote the tourism. Two species of the trout *i.e.* *Oncorhynchus mykiss* (Smith and Stearby) and *Salmo trutta fario* Linnaeus are found in the higher altitudes of snow-fed rivers of Beas, Sutlej and Ravi of the state. The commercialization of the fish begins in the state with the breeding of the rainbow trout at the hatcheries in 1990. During the recent past it has been realized that the in the wild the trout is declining due to human intrusion, pollution and climate change.

**Keywords:** aquaculture, commercialization, pollution

### Introduction

Himachal Pradesh is situated in the North Western Himalaya between 30°22' and 30°12' north latitude and between 75°47' and 79°4' east longitude and altitude ranges from 320 to 7000 meters above the mean sea level. It has four physiographic zones i) Shiwalik zone ii) Lower Himalayan zone iii) Higher Himalayan zone iii) Trans Himalayan zone. The state has a vast network of rivers traversed by Satluj, Beas, Ravi, Chenab and Yamuna River System along with their tributaries. Pong dam, and Gobind Sagar Wetland, Chamera Reservoir are the source of commercial fishery in the state. Perusal of literature reveals that lots of work regarding diversity, ecology has been undertaken from state by various workers. Some of the recent contributions are of Sharma and Tandon (1990), Johal *et al.* (2002, 2003), Dhanze and Dhanze (2004), Mehta and Uniyal (2005), Mehta and Sharma (2008), Sharma and Dhanze (2013) and Sharma (2014) [1, 2, 3, 4, 5, 6, 7, 8]. The state is blessed with one of the richest fauna of the country *viz.* Trout, Mahseer, Carps and Hill stream fishes.

Trout is the common name for the cold water fishes belonging to order Salmoniformes, family Salmonidae and genera *Oncorhynchus*, *Salmo* and *Salvelinus*. Trout fish is native to the Pacific drainages of North America, ranging from Alaska to Mexico. They form the most important cold-water commercial and game fisheries all over the world. It has been introduced to waters on all continents except Antarctica, for recreational and aquaculture purposes. Of the 15 species of trout which are found worldwide, Brown trout (*Salmo trutta fario*) and Rainbow trout (*Oncorhynchus mykiss*) are found in the country. British were the first to introduce trout in the country from Europe for recreational fishing. Beside from sport fisheries, culture of trout is undertaken for commercial purposes. Trout are an important food source for humans. It is rich source of protein, high in omega-3 fatty acids, rich in potassium, phosphorus, B-vitamin complex and low in contaminants.

In India, the history of the trout culture dates back to 1900 when the eyed ova of brown trout were transplanted independently in the Ooty hills and Kashmir. The history of subsequent transplantation and successful establishment of trout farms in various places of the country has been reviewed by Sehgal (1974) [9]. The major trout producing states are Himachal Pradesh, Jammu and Kashmir, Uttarakhand, Tamil Nadu and Kerala. These states have established a well-developed infrastructure for trout production. No studies have been conducted on the status of the trout fisheries and climate change. Thus, during the present studies efforts have been undertaken to know the status of trout fisheries in the Himachal Pradesh.

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## Materials and Methods

The extensive survey of the various streams of the River of Beas, Satluj and Ravi have been undertaken in the past decade to know the status of the trout fishery in the state. The various trout hatcheries have also been assessed.

## Results and Discussions

Two trout fish's viz. (*Oncorhynchus mykiss*) and (*Salmo trutta fario*) have introduced in the cold water of the state. These fishes have introduced with the main objective to make use of the barren cold water. Both brown and rainbow trout are found in the higher altitudes of snow-fed rivers of Beas, Sutlej and Ravi of the state. The Systematic accounts of these fishes are as:

Order Salmoniformes

Family Salmonidae

*Oncorhynchus mykiss* (Smith and Stearby)

Common Name: Rainbow trout

1836. *Salmo gairdnerii* Richardson, *Fauna boreali Amer., Fish*, (3): 221 (Type-locality: Columbia River at Port Vancouver).

1991. *Salmo gairdnerii gairdnerii*: Talwar and Jhingran, *Inland Fishes*, 2:719, fig.234.

**Diagnostic Characters:** Body elongated, Head smaller than depth of body, Mouth large, Dorsal fin placed in advance of pelvic fin, Adipose dorsal fin placed above anal fin, Pectoral fin much shorter than head, Scales very small, Colour of body steel blue with star shaped back spot scattered over body.

**Distribution India:** Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh.

**Elsewhere:** North America, Mexico, Pakistan, Sri Lanka.

*Salmo trutta fario* Linnaeus

Common Name: Brown trout

1758. *Salmo fario* Linnaeus, *Systema Naturae*. 1, ed. 10: 309 (Type-locality: Rivers of Switzerland).

1991. *Salmo trutta fario*: Talwar and Jhingran, *Inland Fishes*, 2: 721.

**Diagnostic Characters:** Body torpedo shaped, Mouth wide, Dorsal fin placed in advance of pelvic fin, Adipose dorsal fin placed above posterior part of anal fin, Pectoral fin much shorter than head, Scales very small, Colour of body brown with scattered orange spot over body and has red tipped adipose fin edges.

**Distribution India:** Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh.

**Elsewhere:** Western Europe, North America (Introduced), New Zealand, Japan.

Himachal Pradesh has approximately 3000 kms of riverine length and divided into two categories i.e. General water and Trout waters having length of about 2400 kms and 600 kms respectively. The upper reaches of rivers (length of about 600 kms) are cold water streams and conducive for trout farming. The agro climatic conditions of the area are very congenial for cold water aquaculture. In Himachal Pradesh the eyed-eggs of

brown trout were brought to Kullu, Kangra and Chamba of Himachal Pradesh from Kashmir. The eyed eggs of the brown trout first hatched successfully at Katrain in the Mahili Hatchery, district Kullu in 1909-10. Subsequently, from Katrain brown and rainbow trout were transferred to Chamba, Barot, Chirgaon and Sangla trout hatcheries (Anon., 1993)<sup>[10]</sup>. These trout fishes have become acclimatized in streams and lakes and are self-sustaining population. The rainbow trout is also cultured in ponds. Its growth is good and can tolerate temperature up to 25°C in captivity. However, the commercialization of the rainbow trout begins with launching of Norwegian project in 1988. The project, initiated in 1989, was executed in two phases: transfer of technology and production phase. Based on the imported technology trout farms have been renovated. At the same time the State Department of Himachal Pradesh also initiated genetic rejuvenation of brown trout (Kumar, 1992)<sup>[11]</sup>. At present, there are five trout seed farms in the state. The trout fish hatcheries are: Patlikuhl, district Kullu; Barot, district Mandi; Holi, district Chamba; Dhamwari, district Shimla; Sangla, district Kinnaur. The mandate of these farms is to produce the seed of trout and stock it in rivers and reservoirs with an aim of stock up the water bodies. With the advancement in fish farming it has been now possible to produce fish for human consumption at these farms and thus making them revenue-earning centers. The fish farming has been started at the farmer level in Kullu, Chamba, Shimla, Kinnaur and Mandi districts in the state. The following stretches has been found as potential fishing spots for trout culture in the state i) River Pabbar from village Mahia to village Hatkoti in Shimla district. ii) River Beas and its tributaries from its source to its confluence with Sarvari stream in Kullu district including Sarvari stream. iii) Sainj and its tributaries in Kullu district. iv) Kurpan stream and its tributaries in Satluj river system in Kullu district. v) Parvati River, Gadsa streams and their tributaries in Kullu district. vi) Tirthan streams and its tributaries above the area of its confluence with river Beas in Kullu district. vii) Uhl River and its tributaries in Mandi and Kangra district including balancing reservoir and feeder channels at Barot. viii) Baspa River, Bhawa streams and Chisso stream in Satluj river system in Kinnaur district. ix) Bhandal Nallah and its tributaries up streams Chakoli bridge in Chamba district. x) Neugal stream and its tributaries up streams Mainjha Bridge and 10 km stretch of Baner khad up stream suspension bridge at Tikker Doli in Kangra district. To start the trout fish farming at the farmer level, it requires technical dissemination, management, feeding, disease control and marketing. There are three important factors for the success of the trout farming i.e. quantity and quality of water supply, quality feed supply and maintenance of hygiene. It requires the requisite physico-chemical parameters for the culture of trout. *Temperature and flow of water* plays utmost role in the trout farming. The fish inhabits within the temperature range of 5 to 18°C, but it has been found to tolerate the water temperature up to 25°C without any mortality (Personal observation). However, the maximum growth and breeding occurs within the temperature range of 10 to 18°C. The water supply in trout farm should be through a filter bed/sedimentation tank. It is necessary to regulate the flow of water very carefully. The pH of the water should be neutral in the range of 7-8. It requires clear oxygenated water. The turbidity should not be more than 23 cm of Secchi disc transparency. The oxygen concentration range is from 5.8 to 9.5 mg/l. The fries of 5 to 50g can be stocked at the rate of 20

kg fish per cubic meter of water surface area. In Himachal Pradesh brown trout attains full maturity in mid-November to mid-December in farms receiving snow/glacier-melt water. In spring-fed farms it matures in December-January. The average number of eggs per kilogram of female body weight varies between 1234 and 1342 in brown trout and 1649 to 1850 in rainbow trout.

#### Status of trout Fishes versus Climate Change

During the studies it was found that rainbow and brown trout fishes are found in the altitude above 1200 to 1800m and above 1800m asl respectively. The stretch from Largi to Nagni in Tirthan, Uhl in Barot Valley, Barot to Lohardi in Lambadug, Barot to Kothikhod in Uhl, Katrian to Manali of Beas River; Largi to Ropa in Sainj, Pabbar in the Rohru Valley, Baspa in the Sangla Valley of Satluj River and Holli to Main bridge of Ravi are the potentials sites for both rainbow and brown trouts.

Trout fishes are more vulnerable to the climatic changes as these fishes thrive in the water temperature below of 20°C. These fishes already are living in the upper end of their thermal range and thus modest warming is fit for their habitation. During the studies *Oncorhynchus mykiss* (Linnaeus) were recorded from Beas River in Khoti, Uhl, Tirthan and Sainj streams in the temperature between 21-25°C. These species can withstand vast ranges of temperature variation (0-27°C), but spawning and growth occurs in a narrower range (9-14°C). The optimum water temperature for rainbow trout culture is below 21°C. Therefore, temperature and food availability influence growth and maturation, causing age at maturity to vary; though it is usually 3-4 years. Consequently, the breeding of these fishes is susceptible in these streams. The catch of these fishes was found negligible during the studies. It depicts that breeding of these fishes has greatly influenced in natural water due to gradual increase of temperature. Further, trout fishes were found along with snow trout fishes from the streams of the Beas River, it shows that trout fishes have intruded in the snow trout zone. Being carnivorous, trout fishes feed on the fingerlings of the snow trout fishes. Thus, it is inferred that due to temperature range shift of trout fishes, the habitat of snow trout fishes is under threat and subsequently whole ecosystem will be changed/stressed. State Fishery Department, Himachal Pradesh reported that in the last three to four decades, a sharp decline has been observed in the catches on account of multiple factors such as large scale road construction in the valleys followed by destruction of breeding & feeding grounds of the fishes, emergence of river-valley projects, rapid urbanization, fishing pressure and of course illegal and destructive means of fishing etc.

#### Conclusion

During the studies, various stretches of River Beas, Satluj and Ravi River has been recorded as potential fishing spots for trout culture in the state. Rainbow trout is bred at the hatcheries in the State and revenue-earning venture. The Trout farms have also been started at the farmer level. To make it income generated enterprise, there is necessitate of technical dissemination, management, feeding, disease control and marketing.

The exotic trout fishes *Oncorhynchus mykiss* (Smith and Stearby) and *Salmo trutta fario* (Linnaeus) have been recorded along with the Snow trout fishes (*Schizothorax richardsonii* (Gray) from the streams of the Beas River.

*Schizothorax richardsonii* (Gray) is one of the important indigenous commercial fish. It has been analyzed that due to the temperature range shift both the fisheries (Trout & Snow trout) has affected. The various anthropogenic stresses *i.e.* extraction/mining of stones, pebbles, sand, use of pesticides, floods particularly in the monsoon season enhance the silt loads which in turn increase the turbidity. Due to sedimentation, water velocity reduces and consequently affects the temperature of the stream and thus changes the habitat environs of the hill streams. It is suggested, mass awareness with the involvement of the local people can go a long way for the restoration of the aquatic habitats.

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