

Ecology and Economics of Coldwater

Inland Fisheries in Sikkim

An Executive Summary Submitted

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By

Kul Bahadur Chettri

Department of Economics

School of Social Sciences

Gangtok -737102

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EXECUTIVE SUMMARY

India has significant coldwater resources in terms of upland rivers/streams, high and low altitudes of natural lakes in addition to man-made reservoirs existing both in Himalayan regions and Western Ghats. These resources hold a considerable population of food, sport and ornamental fish species. Fisheries in the hill region provide employment opportunities as well as nutritional security in the form of fish protein. The hill region of the country has immense potential for the development of coldwater fisheries and fish based eco-tourism in the country. It is an important resource for the people residing in the uplands of India. This sector in India is small but vibrant with potential for growth. Coldwater fish resources present an opportunity as well as challenge for harnessing the full potential of the fisheries sector. But the major issue in the coldwater sector is to increase production and sustainable utilisation of aquatic resources as well as upliftment of the socio-economic status of the people while preserving the fragile ecosystem.

The mountain fishery resources of India consisted of around 258 fish species distributed in the Himalayan and peninsular region of the country of which indigenous mahseer, snow trout, exotic trout, and common carp are commercially important. There are three prolonged fish farming systems in the Himalayas; - farming of rainbow and brown trout at the high altitudinal zone, both trout and carp farming at mid altitudinal zone as per the suitability of environmental conditions while at the low altitudinal zone carp species such as minor Indian carp, grass carp and common carp etc. are cultured.

The work of this thesis is divided into eight chapters that deal with the various aspects of the research work. Chapter 1 is an introductory chapter that deals with an overview of inland fisheries. Chapter 2 gives a theoretical framework and extensive survey of previous literature. Chapter 3 discusses the ecology and the economic performances of coldwater

inland fisheries in the Himalayan states of India. This chapter is entirely based on secondary data and the results have been analysed through tabular representation, percentages, growth rates etc. The study found that the coldwater fisheries have been steadily progressing in the Himalaya during the last two decades. There was an increment in fish production in all the five Himalayan Indian states. The decadal growth of coldwater fish production in the Himalayas was 31.61% during 1995-96 to 2005-06 and 25.92% during 2005-06 to 2015-16.

One of the most important commercial and sport cultured fish species is rainbow trout in the Himalayas. It is cultivated in different parts of North western, Central and North eastern Himalayan regions. Although there are fluctuations in production over the years, the production of rainbow trout has progressed gradually during the last decades in the Indian Himalayas. The total rainbow trout production in India has increased from a mere 147.0 tonnes in 2004-05 to 602.0 tonnes in 2013-2014, 755 tonnes in 2014-15 and 842 tonnes in 2015-16. The annual growth rate of trout production in this duration remained 25.42% in 2014-15 and 11.52 % in 2015-16. Himachal Pradesh, Jammu and Kashmir and Sikkim are the leading trout producers in India which contributed 50%, 30% and 14% respectively to total production in India during 2015-16.

Chapter 4 outlines an overview of inland fishery and fishery resources of Sikkim. The state has various water resources in the form of rivers, springs and streams, natural lakes, ponds and tanks etc., which are conducive for both the capture and culture fisheries. The trout and carp infrastructure and fish production have been growing steadily in the state during the last decade. The total production of fish stood at 420 tonnes that comprised of 120 tonnes of trout, 180 tonnes of carp and 120 tonnes of fish catch from rivers in the state during 2015-16.

Chapter 5 deals with the socio-economic conditions of the fish farmers and the role of fisheries in the rural economy of Sikkim. A primary data was collected from 200 sample

fish farmers based on the pre-structured interview schedule from North, East, South and West districts of Sikkim. The fish farming activities are scattered in different locations and farmers are available in cluster form; therefore the purposive random sampling method has been adopted to choose the location area, respondents and ponds. District wise and PFCS wise socio-economic analysis has been carried out through descriptive statistics such as frequency distribution, tables, percentages, average (mean). Gini coefficient has been used to measure the extent of income inequality across the fish farmers of district and PFCS. Logit model was used to ascertain the impact of diverse socio-economic factors on the perceived state of living conditions of the fish farmers, i.e. whether their socio-economic condition has improved or not over the periods. The results revealed that the majority of the farmers have realised improvements in their economic condition. All the fish farmers of the state have access to basic minimum civic amenities like housing, potable drinking water, sanitation, electricity and cooking fuels etc. The fish farmers in the state are earning considerably good amounts and it has been a viable option in the hills. Income inequality is not severe across the fish farmers of districts and PFCS. Per capita income, housing condition and family members who have attained education level above the primary are the major factors that affect the estimated perceived socio-economic conditions of the households.

Chapter 6 analyses the financial performances and environmental sustainability across coldwater PFCS based on the secondary data. The data was collected for six years i.e. from the periods 2013-14 to 2018-2019 for the six PFCS located in four different districts of Sikkim. Financial performances of PFCS were examined through the construction of productivity, profitability and managerial efficiency indices using the concepts of cost, revenue and profit. Environmental sustainability of fish production associated with different PFCS was analysed by using the concept of Maximum Sustainable Yield through the application of Gordon Schaefer Model. The results of this chapter revealed that the PFCS

such as Upper Sribadam, Manebong-Sopakha and Mangshilla had gained higher financial achievements in fish farming; at the same time there is a threat to sustainability in future because in some of the years their actual yield surpasses the Maximum Sustainable Yield (MSY). These cooperatives have paid more attention to financial management and relatively less to environmental sustainability. On the other hand, PFCS like Upper Rimbik, Chujachen and Dalep have not been able to keep their financial management up to the mark because of several kinds of natural, environmental and biological problems they have encountered during the various periods; even then they had put more emphasis on the sustainability criterion and maintained relatively substantial amount of stock for the future generations as compared to the former three cooperatives. Their actual yield is less than the MSY in all the periods.

Chapter 7 discusses the economic valuation of Khecheopalri and Aritar lake ecosystems of Sikkim. A sample of 100 respondents from each lake was selected and the respondents included the local people, pilgrims, and visitors from both within and outside the country. The respondents were interviewed through a structured questionnaires during the two peak tourist seasons from March to May and October to December in 2018-19. Along with this face-to-face interviews were also conducted at the lake sites. The visitors were asked to provide information on their Willingness to Pay (WTP) per year for the maintenance and conservation of lakes, number of trips made to the lake, distance travelled to the site, time taken to reach the site, travel cost, WTP for entrance, socio-economic variables such as age, sex, educational level, occupation, and income, etc. The WTP for the better management and conservation of these two lakes was assessed by contingent valuation method through the application of multiple regression analysis while the recreational value and consumer surplus offered by these two lakes were analysed by travel cost method through the application of truncated poisson regression model. The study found that the visitors are visiting these two

lakes for enjoying pleasant weather and beautiful scenery of the lake site, worshipping lakes and gods, boating, fish watching and photography etc. More than 65 percent visitors were satisfied by visiting the first lake and 58 % in case of the second lake. The average per person per visit willingness to pay for the better management and conservation of lakes are estimated to be ₹ 227.5 and ₹ 235 and that of total WTP are ₹ 22,750 and ₹ 23,500 for Khecheopalri and Aritar lakes respectively. The important factors that affected the visitors' WTP for the management and conservation of lakes are aspiration to visit a site, monthly income of the visitors, education, time spent by them at the site, recreational experience perceived by them and their satisfaction level etc. Similarly, the demand for the lakes are affected by the travel cost, distance, age and income of the visitors etc. An increase in the travel cost, distance and age reduces the demand for the lakes while an increase in the income raises their demand. The total annual recreational benefits received from these two lakes were ₹ 43,91,57,467.6 and ₹ 1,09,28,24,321 and that of total consumer surplus were ₹ 1,34,80,624.59 and ₹ 3,26,91,040.72 respectively.

The last chapter of the thesis viz, chapter 8 summarises the concluding observations and policy recommendations of the study highlighting the importance of coldwater inland fisheries as a sustainable livelihood option in a mountainous state like Sikkim.