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Research Article

Analysis of size-composition of endangered *Tor putitora* in the critical breeding and nursery grounds of the Nayar (Western Himalaya)

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Abstract

Size composition gives an overall estimate of the prevalent length of individuals in the fish stock and, hence, the stock's health. The present study analyzed the size-composition and population structure of Golden Mahseer, *Tor putitora* in the river Nayar that form their breeding and nursery grounds. The Nayar is located in the critical stretch of Devpryaag and Rishikesh (Garhwal Himalaya), free of any dam/barrage in the river Ganga. The Nayar basin is undergoing rapid land use changes due to increased mining and fellow land formations. This analysis was based on length frequency analysis data obtained from three sampling stations, S1, S2, and S3, in the Nayar River. The highest length frequency (53.3%) of Mahseer was recorded from the size class ranging between 10-20 cm, like earlier records, while only one individual measuring 121.9cm was procured. The length frequency decreases with increasing size beyond 30cm. In contrast to the past, the present study revealed a comparatively distorted population structure in the Nayar, where the pre-reproductive size groups showed dominance over the reproductive population. The reduced spawning biomass could jeopardize the recruitment of the next generation.

Keywords: Endangered, Ganga River basin, Length-frequency, Nayar, Population structure, *Tor putitora*

INTRODUCTION

The Golden Mahseer (*Tor putitora*) stands as a symbol of both ecological vitality and cultural heritage in the freshwater systems of South Asia. Native to the Himalayan region and found in the rivers and streams of countries such as India, Nepal, Bhutan, and Pakistan, the Golden Mahseer is also familiar as Himalayan Mahseer. Moreover, due to its ecological implications, the Golden Mahseer is considered an umbrella species, as it plays a crucial role in shaping prey populations and maintaining environmental balance within aquatic ecosystems (Gupta *et al*., 2014). Renowned for its remarkable size, strength, and the challenge it presents to anglers, the Golden Mahseer has garnered attention as a charismatic and iconic species (Everard *et al*., 2021).

However, the ongoing interplay of various anthropogenic factors and environmental changes has posed significant threats to its populations, raising concerns about its long-term survival. Despite its significance, the Golden Mahseer's population facing various challenges that have led to declining numbers. Habitat degradation due to dam construction, deforestation, and sedimentation has directly impacted its spawning and feeding grounds (Jha *et al*., 2018). Additionally, pollution and overfishing have exacerbated the situation, while climate change-induced alterations in temperature and water flow patterns have further stressed its already vulnerable populations (Pinder *et al*., 2019).

The ascending migratory movements of Himalayan Mahseer within the Ganga River system have been documented by several authors (Bhatt *et al*., 2016). However, fishing of female brooders during upward breeding migration in the spawning season and young immature ones in breeding and nursery grounds is a concerning issue for the declining status of Himalayan Mahseer (Sarkar *et al*., 2015). Therefore, the present study aimed to analyze the population structure of

Himalayan Golden Mahseer within their breeding and nursery grounds in the Nayar located upstream of the Gangetic population inhabiting between Rishikesh and Haridwar.

MATERIALS AND METHODS

Study area
The present study was conducted in the critical breeding and nursery grounds of Nayar River, which confluences with the river Ganga at Vyasghat, located about 10 km downstream from the Devprayag. For the length frequency analysis, three sampling sites within the Nayar, Bhatkul Ka Sain (S1, upstream), Banghat (S2, midstream) and Vyasghat (S3, downstream) were selected (Fig. 1) based on the availability of Putitor samples through fishermen of local fish markets. The study was conducted at weekly intervals from July 2021 to June 2022.

Analysis of the Data's methodology
A total of 1173 specimens of Golden Mahseer were examined for their total length (in cm) at each sampling station. The fish samples were categorized into nine different classes with a class interval of 10 cm, while the fry and fingerlings were categorized into 5 cm class intervals. The data was expressed in percentage composition by taking the percentage of the total number of fishes in that size group and comparing it with the previous population structure in Nayar. The past data on length frequency from Nayar was taken from a previous study by Nautiyal (2011). The statistical analysis was performed in M.S. Excel 2013 software.

Ethical committee approval
The Putitor (Golden Mahseer), samples were collected from local fishermen at fish markets. Therefore, ethical approval was not required for the study.

RESULTS AND DISCUSSION

The specimens of Himalayan Golden Mahseer (*T. putitora*), procured from the different stations in the Nayar, majorly ranged below 80 cm, while individuals beyond that were rare. The largest size procured during the study was 121.9 cm. The present study failed to procure any fry stages measuring below 5 cm from the Nayar that could exist in the upstream stretches. The highest size composition of 53.3% was recorded from the size group of 10-20 cm, followed by 20-30 cm, contributing about 35% of the total population. In contrast to the past, a comparative decline in size composition above 30 cm was observed, which formed only 10% of the total share (Fig. 2). A previous study in the Alaknanda (located upstream of Devpryaag) recorded the maximum size composition of Mahseer in the size group between 30 to 40 cm (Singh and Nautiyal, 2018). In the present study, the dominance of lower-size groups in the Nayar may be either due to a more suitable environment or food conditions for the growth and development of juveniles of Mahseer.

The examined size composition has shown a fall below 2% (or nil) in Mahseer population during the winter period at stations S2 and S3, while station S1 has shown a continuous population of Mahseer throughout the study period (Fig. 2). The larger size groups were majorly recorded from S3 which forms the connecting point for the Gangetic stock of Mahseer within the Nayar followed by S2 (located upstream S3). However, size groups above 30 cm were not recorded at S1, possibly due to the shallow nature of the habitat, continuous riffles and runs and lack of proper refuge
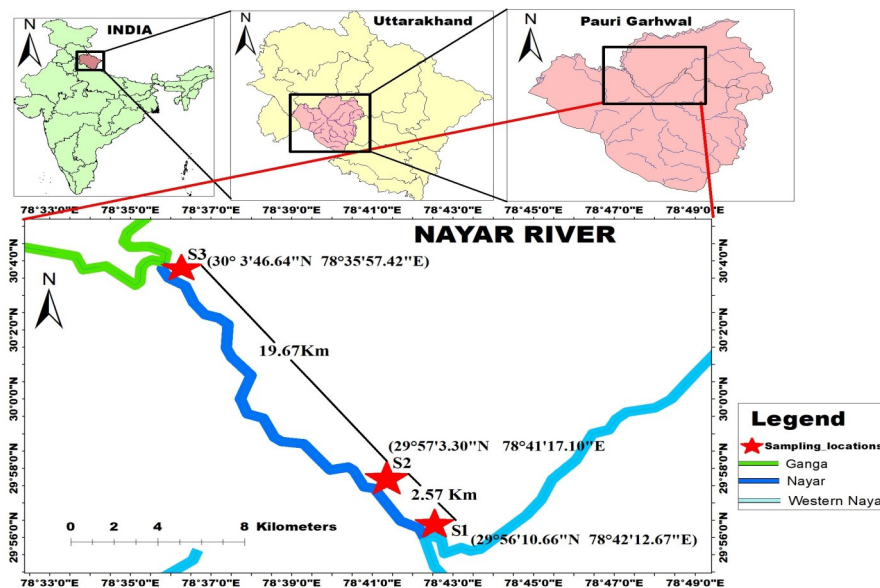

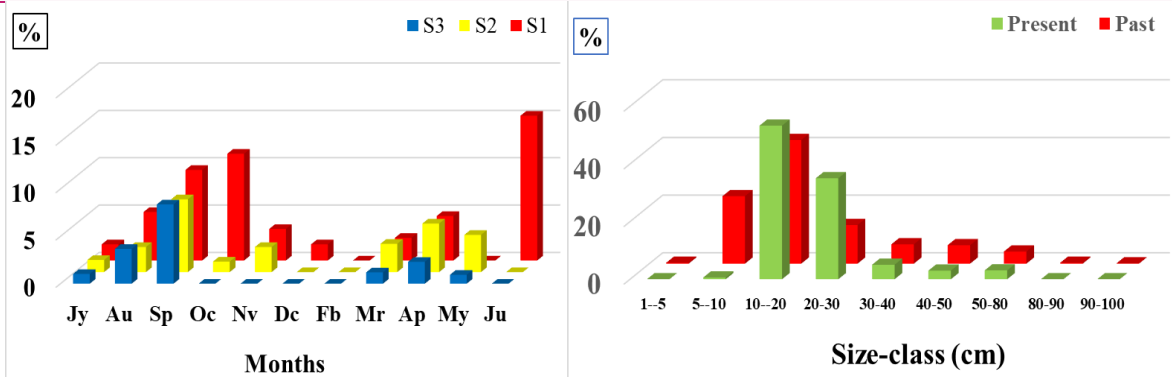**Fig. 1**. *Study area map showing location of sampling stations in Nayar River*

Fig 2. *Monthly length frequency percentage of Himalayan Mahseer at S1, S2 and S3 (left) and comparison with an earlier study (Nautiyal, 2011) (right)*
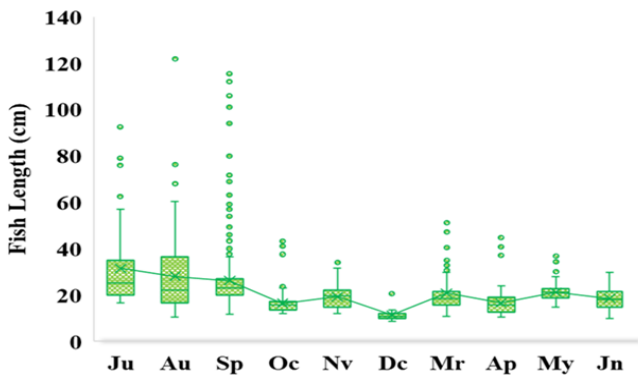

Fig 3. *Box-whisker plots of monthly size composition of Himalayan Mahseer in the Nayar*

(deep pools) to avoid predatory attacks besides intense fishing pressure between S1 to S3 stretch. These larger-sized groups were recorded only during the monsoon period (July to September), their peak spawning period. The largest mean length was recorded as 31.4 ± 3.8 cm in July, followed by 28 ± 4.9 cm and 26.2 ± 4.08 cm in August and September, respectively, after which the monthly mean length ranged between 11.3 ± 0.8 to 21.7 ±0.9 cm (Fig. 3). Therefore, the study further confirms the ongoing migratory movements of Mahseer from the Ganga (Rishikesh to Haridwar) toward the upstream Vyasghat (Nautiyal, 2011).

The size-composition analysis further revealed the asymmetric population structure of Himalayan Mahseer

within their breeding and nursery grounds of Nayar (Fig. 4). The population structure of the previous study seems more stable in comparison to the present population of Mahseer within Nayar (Fig.4). The present Mahseer population has shown pre-dominance of pre-reproductive age group (forming about 88.9% of the total Mahseer population) over the reproductive age group (-10%). The present study has also shown a phenomenal reduction in the large-sized brooders (>40cm) of Mahseer in the Nayar (Fig. 2,3). However, during 1980-81 and in 1996, a comparatively larger size group, ranging between 61 to 111 cm, was also recorded from the Alaknanda River which is located even upstream to the confluence of the Nayar river (Singh and Nautiyal, 2018). Their study also reported a reduction in the size group above 40 cm in the Alaknanda River at Srinagar. The reduction in the size-composition of larger size groups of Himalayan Mahseer may be attributed to the blocked migratory path due to Chilla Hydropower projects or intense fishing pressure in the ascending migratory tract (Nautiyal, 2011). Earlier, the reduction in the upstream migration of Mahseer at Srinagar was also attributed to the occurrence of the Srinagar hydroelectric project at Alaknanda River. The obstruction in the ascending migratory route of the spawning biomass (inhabiting between Rishikesh and Haridwar) can potentially delay/ hamper the spawning activities (Bao *et al.*, 2022).
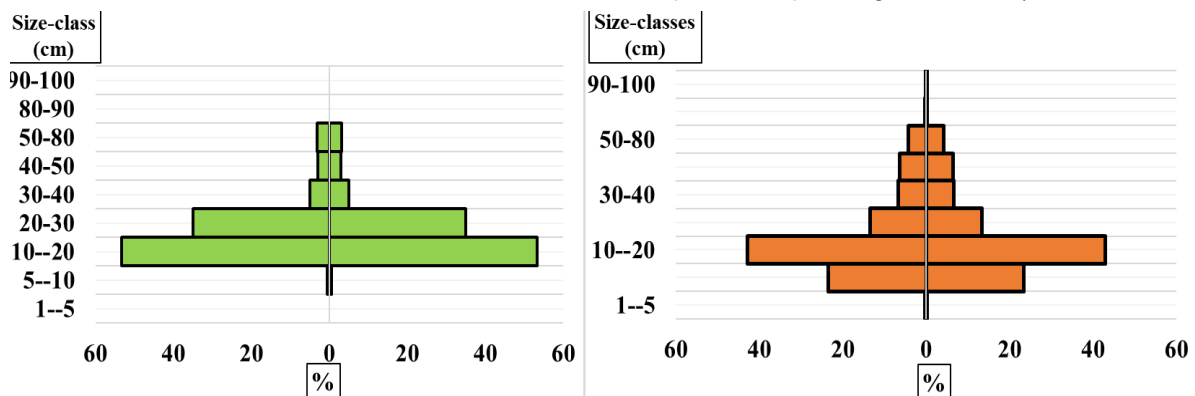

Fig 4. *Population structure of Himalayan Mahseer within Nayar for present (left) and earlier study (right)*

Insufficient brooders in breeding grounds would lead to a reduced quantity of eggs and, subsequently, a scarcity of larvae in the habitats where new individuals are recruited (Camp *et al.*, 2020). Accordingly, a small number of adult brooders will restrict the future population.

Conclusion

The study shows a shift in the size composition of golden Mahseer towards smaller size in their critical breeding and nursery grounds of Nayar River. However, large-sized Mahseer individuals in the upstream Alaknanda River indicate that only a small subset of the Golden Mahseer population is allowed to ascend and engage in reproductive activities. The reduced spawning biomass may pose a greater threat to the declining population of the Himalayan Mahseer in the Ganga and possibly other Himalayan River systems.

ACKNOWLEDGEMENTS

Conflict of interest
The authors declare that they have no conflict of interest.

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