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The State of Population of the Brown Trout in Rivers of Armenia

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Abstract: This study is aimed at studying the state of population of the brown trout (*Salmo trutta m. fario*) in the rivers of Armenia and includes collection of data on the species abundance, water quality, conditions of food supply and habitats, their degradation and major factors of human impact. Monitoring of population of brown trout was carried out in seven provinces of Armenia, on 20 rivers and their tributaries, in the period from 1992 to 2010. In addition, the local people were interviewed for clarification of the applicable fishing practices in the settlements adjacent to the area of field work (23 villages). Summarizing the data for the entire study period, we observed extensive decline in populations of brown trout, but the most dramatic and significant reduction of that happened between 1994 and 1997. Analysis of physical-chemical parameters of water, assessment of degradation of habitats and food supply in 20 surveyed rivers, showed that 18 of them completely satisfy the requirements of the species to habitats. Whereas, the results of the surveys of the local population revealed widespread and long-term practice of prohibited methods of fishing that are most likely the main reason for the recorded population decline. Revision of the conservation status of the species, changes in legislation in terms of administrative and criminal consequences for the practice of prohibited methods and introduction of significant penalties for unauthorized capture and later initiation of reintroduction of the species appear to be the most effective measures for the restoration and management of populations of brown trout in Armenia.

Key words: Overfishing · Population Decline · Conservation Status · Reintroduction

INTRODUCTION

After collapse of Soviet Union, during the decade of 1990s, Armenia went through an economic and energy crisis that resulted in significant impact on natural resources including biodiversity and fishery became one of the significant incomes. Brown trout in Armenia traditionally was a fishing object, however the period of the economic instability provoked uncontrolled harvest of that species.

The study of brown trout in Armenia was conducted starting from the 1940s, but mainly covered the study of taxonomy, caryology and morphology [1-5] and have also included its distribution, biology, epizootology and the food supply [6-8]. In the literature, there are notes on the volume of the brown trout fishery for 1950s [9], however there are no investigations implemented on the population dynamics of the species, mainly because the species did not have a commercial value and it was not considered important for conservation.

We have focused our studies on changes in abundance of brown trout and its habitat conditions.

MATERIALS AND METHODS

The monitoring of population of the brown trout was conducted in 7 administrative regions of Armenia (hereafter called provinces) during 1992-2010. The monitoring was not implemented in Yerevan, Armavir, Aragatsotn and Gegharkunik provinces. The intensity of the surveys varies in different periods. In the period from 1992 to 1994 we surveyed the same rivers every year, in the period from 1995 to 1998 once per two years, in the period from 1999 to 2002 annually and in the period 2003 to 2010-once per three years (Fig. 1).

The works on the rivers have been conducted in warm and cold seasons. During the counting period each location was surveyed at least once. At each river we selected study sites of 1.5-2 km in length. To characterize the study site, we have been measuring the geographical

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Fig. 1: Monitoring sites of Brown Trout in the rivers of Armenia

Fig. 2: Brown trout captured in the river Getik, Tavush province

Fig. 3: Typical habitat of brown trout in upper reach of Azat river

coordinates, elevation above sea level, water level in the river and temperature of water. To characterize the population we have been using a relative abundance, which was calculated as number of observed or caught specimens on a linear kilometer of the river. Surveys of brown trout during walking upstream have been conducted by method of capturing and walking downstream-by method of visual sightings. Caught specimens have been measured, photographed (Fig. 2) and released. The typical habitats have been photographed (Fig. 3), as well as presence of the obvious anthropogenic influence. The fair assumption could be made that the counting method is questionable, however the statistics below (see section Results) can demonstrate that in the beginning of 1990s the brown trout was presented in almost all rivers of Armenia and the double counting method was quite justified, while in later years, to catch the fish or to record its presence visually was hardly possible.

Fig. 4: Water and zoobenthos sampling at the tributaries of river Vorotan (left), Syunik province and Akhuryan (right), Shirak province

The survey data have been recorded in the field note-books and later on have been inputted into a database. The average relative abundance of captured and observed fish specimens was calculated for each year and for all rivers. To analyze the tendency of abundance change and its significance we used regression analysis. To characterize the trend of change of abundance of the trout throughout the study period we have used *F* statistics which was considered as statistically significant at the confidence level of $P < 0.05$. To study the habitat conditions, we measured some parameters associated with water and food supply. At the study site we have been designating three sampling spots: in lower, medium and higher areas of the river part-locations where we have been sampling the water and the zoobenthos. In total, we have collected and analyzed 66 samples of water and zoobenthos.

Water sampling was implemented in accordance to standard protocol of USGS [10]. All samples were measured for pH, dissolved oxygen (mg/L), ammonia (mg/L) and carbon dioxide (mg/L). During the warm period of the year we have conducted analysis of water samples at study sites using titration method with HI Ecological Test Kit and photometry with HI Photometer (model #39823). In the procedure of water analysis we have been following the protocols of Hanna Instruments specific for each instrument.

The benthic fauna (co- located with water measurements) was sampled at the same spots (Fig. 4) via kick-sampling [11] with the plots measuring of 30x30 cm. Composition, abundance and biomass were all measured. The water macroinvertebrates have been identified down to family. The biomass was measured as a wet weight using analytic weight with the 0.1 gram accuracy. The collected data allow further computation of Saproby index [12] and recalculation of the biomass for 1 m^2 and after that the field data were compared (see section Results, 3rd paragraph) with the literature information about habitat preferences of brown trout [13].

In 1992-1995 the survey of local inhabitants was more sporadic, rather than regular and included documenting of the common fish-capturing practices. However, during later years (from 1997), due to recorded decrease of population of brown trout, the necessity of a more detailed survey emerged and for that reason we have developed a questionnaire that asked more detailed information on the common practices of old and new fishery practices, number of fishermen in villages and presence of fishes in the current river by their knowledge. In total there were 110 interviews in 23 villages in seven provinces conducted. The target group was formed by local inhabitants, who by various reasons have been capturing the brown trout at a regular base. At the beginning of interview the surveyed person was informed about the aim of the questioning and confidentiality.

In results of interview with local inhabitants we have selected the most common categories of capturing methods: “by hand” (the method, traditionally used by local people, when the fish is captured under stones), “by float fishing-rod or spinning” (float fishing-pole or the shy, when the most typical habitats are screened), “by nets or traps” (are usually in use at bigger rivers with slower velocity) and handmade analogues of “electro-fishing tool” (that was prohibited and considered as poaching), all other responses have been categorized as “other methods” (e.g. block of parts of some smaller streams and use of the flowers (*Viburnum lantana*) that have a paralyzing influence).

RESULTS

Monitoring Results: Evaluating the state of population of the brown trout in seven provinces we came to the conclusion (Fig. 5) that during 1990 to 1993 the situation in all the surveyed rivers could be considered acceptable, while in the interval from 1994 to 1997 we recorded strong decline of the population of brown trout at entire study area. Later, from 1998 to the period of finishing the data collection in 2010, the situation was consistently becoming worse however without such sharp fluctuations. Analyzing statistics in a context of administrative regions, we can state that in Shirak province only one river out of four surveyed rivers showed presence of the fishes; in Lori province-none of two surveyed showed presence of brown trout; in Tavush province also in none of three surveyed rivers the fish was not recorded; in Kotayk province-in-two rivers out of five surveyed the trout was sporadically recorded; in Ararat province-the only surveyed river located in State Reserve shows presence of the trout; in Syunik province-only one of four surveyed and in Vayots Dzor province the only surveyed river did not show features of presence of the fish. The trend of the population decline fits the logarithmic curve well and is statistically significant ($F = 186.78$, $P < 0.001$ for captured and $F = 111.38$, $P< 0.001$ for observed fishes).

Assessing the habitat quality we have divided the habitats into two categories: acceptable and non-acceptable [13], using the following characteristics: dissolved oxygen, ammonia, pH, carbon dioxide, Saproby index, biomass [13]. The following threshold values have been selected for acceptable rivers: dissolved oxygen (minimum)-4.0-8.4mg/L, pH (range)-6.5-8.5, ammonia (maximum)-0.02-0.09mg/L, Saproby index (maximum)-1.2-2.1, biomass of zoobenthos (minimum)-0.9-2.7 g/m^2; and for non-acceptable rivers: dissolved oxygen-0-3.9mg/L, pH-1-6.4 and 8.6-14, ammonia–0.1-0.12 mg/L, Saproby index-2.2-2.5, biomass of zoobenthos-0-0.8 g/m^2.

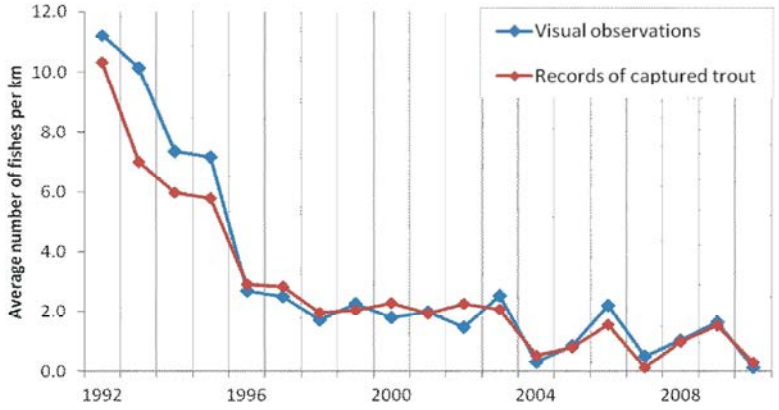

Fig. 5: Change in abundance of Brown Trout in 20 rivers of Armenia

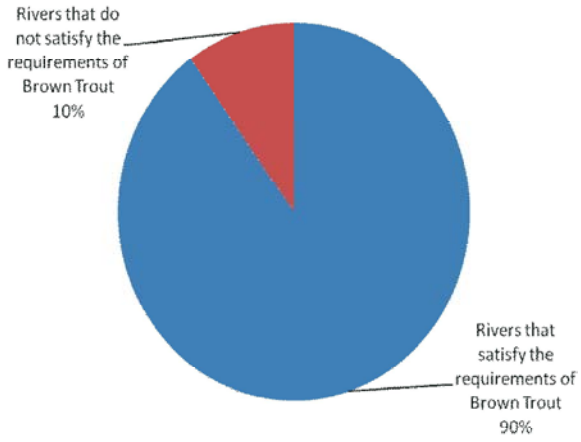

Fig. 6: Conditional division of the rivers by habitat requirements of brown trout

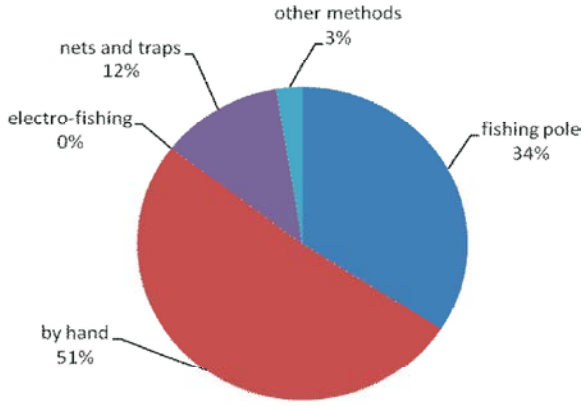

Fig. 7: Capturing methods common at local inhabitants during 1980-1993

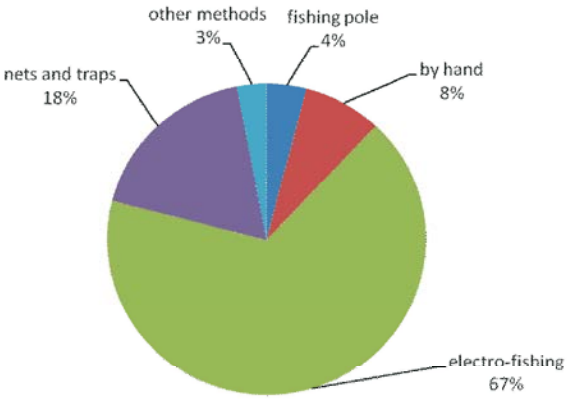

Fig. 8: Capturing methods common at local inhabitants during 1994-2000

By the end of studies we obtained that in Shirak, Lori, Kotayk and Syunik provinces all the surveyed rivers show parameters of acceptable rivers, in Tavush-one of the surveyed rivers show high Saproby index, in Vayots Dzor-one of the three surveyed rivers show relatively high levels of ammonia and Saproby index. Thus only two out of 20 surveyed rivers demonstrated marginal water characteristics for brown trout (Fig. 6).

In result of conducted interviews with local inhabitants we stated the following division of proportions between various methods of capturing (Fig. 7 and 8). It is interesting to note the changes of proportions between capturing methods. Thus, in the period 1980-1993 some capture practices have been dominating while in the post soviet period the others became more common. We should also mention that the variation between proportions of various capturing methods for the same period was insignificant for different provinces.

DISCUSSION

In our opinion the most probable cause of the critical decline of brown trout's abundance is the overfishing by mass-killing methods that not only eliminates the local groups of fishes, but also can support critical decline of entire fauna of zoobenthos, as it is mentioned by some authors [14, 15]. Before beginning of the 1990s the fishing was rather a form of recreation for the local inhabitants and rarely was determined by economic factors, while later the fish became an income source, which resulted in use of unacceptable methods of fishery and extermination of population.

The similar issue of mass-killing methods was observed in other countries as well. Thus in Macedonia the endemic trout species *Salmo macedonicus* Karaman, 1924 was almost exterminated [16]. However the strengthening of legislative norms, change of conservation status of species and complex of measures on reintroduction allow restoring of the population back to the viable level. The similar issue in Germany, but with slightly different accent, promoted launching of complex initiatives on reintroduction, where the main stress was done on the recreational fishing and the care of the population became a natural positive effect [17]. Coming back to the situation in Armenia, it is worth saying that the mass-killing was not discouraged due to low penalties for the fishing with illegal methods and non-actual conservation status of the species [18]. At any rate, in our opinion, there is a need to develop the complex measures to change situation.

CONCLUSION

In fact, it can be stated that the current population of the brown trout in the study sites has declined substantially and it is possible that these rivers may not be able to repopulate the brown trout naturally. Probably, the population degradation includes most of Armenia, except for the protected areas, where the fishing is prohibited.

From a more positive view, based on our assessment of such habitat conditions as water quality parameters and food supply, it would appear that the habitat quality is not responsible for the decline in populations, while the conducted interviews are evidence of strong anthropogenic pressure on the population of brown trout. Thus for restoration and protection of the population of brown trout in the rivers of Armenia, it is necessary to

re-assess the conservation status of the species, which will allow the strengthening of the protection measures, the increase of penalties for the use of prohibited methods and illegal fishing and later to start the program on reintroduction of brown trout, especially because the positive experience of in Armenia exists-the Governmental program of reintroduction of endemic Sevan Trout (*Salmo ishkhan*). The complex of those measures can create preconditions for recreational sports fishing and licensed fishing of brown trout, thus promoting development of rational methods of nature exploitation.

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