

Population dynamics and conservation status of *Salmo labrax* in the Strugarnitsa River, North-Western Bulgaria

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Abstract

This study investigates the population dynamics of river trout (*Salmo labrax*) in the Strugarnitsa River, a protected tributary of the Ogosta River in North-Western Bulgaria. Utilising electrofishing across two transects in winter 2023 and summer 2024, the study assessed abundance, biomass, size structure, and age composition. The calculations were made using the Seber and Le Cren (1967) removal method based on two-pass electrofishing. The objective of the study is to quantify and evaluate the population dynamics of river trout in the Strugarnitsa River. The average trout density was 368 ind.·ha⁻¹, and the biomass was 15.2 kg·ha⁻¹, with a notable 50 % higher abundance in summer compared to the breeding season in November. The population consisted primarily of one- two three-year-old fish, with no zero-year-olds observed in the lower trout zone during summer, suggesting spatial segregation of juveniles. These values are among the lowest reported in Bulgaria, likely due to low summer water flow and water diversion. The absence of stocking and presence of natural reproduction indicate a self-sustaining population, albeit with limited fish production capacity. The findings provide baseline data for future management, recommending minimal exploitation and catch-and-release fishing to maintain population equilibrium.

Key words: population density, biomass, river trout.

Introduction

River trouts are globally valued for recreational fishing and their important role as indicators of mountain river ecosystem health, prompting extensive research to ensure their sustainable management.

Two species of local trout inhabiting mountain rivers were distinguished in

Bulgaria, in recent years. In the Danube and Black Sea catchment areas, both connected to the Black Sea, they are inhabited by *Salmo labrax* Pallas, 1814. In the rivers of the southern part of the country, in the Aegean catchment area, the native trout was assumed to be *Salmo macedonicus* Karaman, 1924 (Kottelat and Freihof 2007). However,

for decades, rivers in Bulgaria have also been stocked with non-native trout, primarily *Salmo trutta fario* Linnaeus, 1758. In the recent past, it was believed that this was the native species of trout in the country. In scientific studies, all trout in the inland rivers of Bulgaria were referred to as *Salmo trutta fario*. In Bulgaria, trout fish have been studied comprehensively to support sustainable management, balancing recreational use with the preservation of montane stream health. Early research by Dikov and Yankov (1985a) laid the foundation for understanding trout population dynamics in Bulgaria, reporting an average density of 192 ind. $\cdot$ ha $^{-1}$ and biomass of 34 kg $\cdot$ ha $^{-1}$ in the Iliina and Rilska rivers of the Rila Mountains. In a comprehensive study, Yankov (1988) expanded this work to survey trout stocks across Bulgaria's two major watersheds: the Danube catchment (Iskar and Vit rivers) and the Aegean catchment (Mesta, Vacha, Chaya, and Struma rivers). Across these systems, he reported a mean trout density of 1123 ind. $\cdot$ ha $^{-1}$ and biomass of 52.81 kg $\cdot$ ha $^{-1}$, alongside biological insights into growth rates and reproductive potential. The author also reported the average growth in length of trout for Bulgaria as follows: L_1 – 103 mm, L_2 – 157 mm, L_3 – 198 mm, L_4 – 251 mm, and L_5 – 271 mm. For the Vit River, from the Danube catchment area, Yankov (1988) provided the following data on trout growth: L_1 – 96 mm, L_2 – 137 mm, L_3 – 160 mm, L_4 – 180 mm, and L_5 – 220 mm.

This pioneering work, the most comprehensive of its time, surveyed trout stocks across Bulgaria's major watersheds, providing important baseline data for subsequent ecological and conservation studies.

Building on early studies, some

authors documented the growth rates of river trout in the Stara Ribaritsa River, a tributary of the Vit River, highlighting regional differences in trout biology (Dikov and Yankov 1985b). Further studies by Karapetkova et al. (2000) explored trout populations along the Bulgarian Black Sea coast, reporting an average density of 301 ind. $\cdot$ ha $^{-1}$ and biomass of 14.6 kg $\cdot$ ha $^{-1}$ in the Veleka, Mladezhka, and Aydere creeks, with notable variability across river sectors. Kolev (2010) investigated trout abundance and biomass in tributaries of the Maritsa River, identifying stark contrasts between the Sredna Gora Mountains rivers (Topolnitsa and Stryama, with 110 ind. $\cdot$ ha $^{-1}$ and 3.1 kg $\cdot$ ha $^{-1}$) and those in the Rhodope Mountains (Yadenitsa and Chepinska, with 526 ind. $\cdot$ ha $^{-1}$ and 23.3 kg $\cdot$ ha $^{-1}$). More recently, Raikova-Petrova et al. (2018) provided insights into growth rate, mortality, and survival of trout in the Iliina River. Despite this extensive research, data on trout populations in smaller, protected streams like the Strugarnitsa River in North-Western Bulgaria remain scarce, underscoring the need for targeted studies to inform conservation and management strategies in these unique ecosystems.

This study focuses on the river trout (*Salmo labrax*) population in the Strugarnitsa River; the trout being an important species for informing future conservation and management strategies in Bulgaria's montane ecosystems. Currently, no data exist on this river's trout population dynamics, highlighting the need for targeted research to support effective species management.

This study aims to assess the quantitative characteristics and seasonal dynamics of the river trout population in the Strugarnitsa River.

Materials and Methods

Study area

The study area is North-Western Bulgaria and the extreme north-western parts of the Stara Planina Mountains. This part of the territory of Bulgaria is drained mainly by four watercourses – the rivers: Vidbol, Lom, Tsibritsa and Ogosta, right tributaries of the Danube River. These rivers are characterised by snow-rain feeding, with a spring maximum of the flow and a minimum in autumn (Dimitrov 1973). The largest and most significant watercourse in this region is the Ogosta River. The Ogosta River is one of longest rivers in Bulgaria, with length 144.1 km (Hristova 2012). In the bed of the Ogosta River, in the immediate vicinity of the town of Montana, one of the biggest Dams in Bulgaria has been built – Ogosta Dam. Ogosta River has numerous tributaries. The Burzia River is one of its tributaries, and the Stru-

garnitsa River flows into it (Fig. 1). Two zones are distinguished in the Burzia River – high mountain, so-called trout zone and mid-mountain, so-called barbel zone (Dimitrov 1973). Strugarnitsa is a small stream that falls into a special purpose area. This is a hunting enclosure built in the last century with a view to sustainable game management. Fishing is prohibited here. According to forestry officials, no stocking material has been introduced into the stream from outside in recent years.

Equipment, methods and layout

The studied transects were located in the protected area. The river's width there was no more than 3.5–4 m. The depth of the water only in the pools reached 1.5 m.

The material was collected by moving upstream by two participants in the electrofishing, i.e. one cap-anode and one cap behind the operator with the unit. The river was surveyed completely from one bank

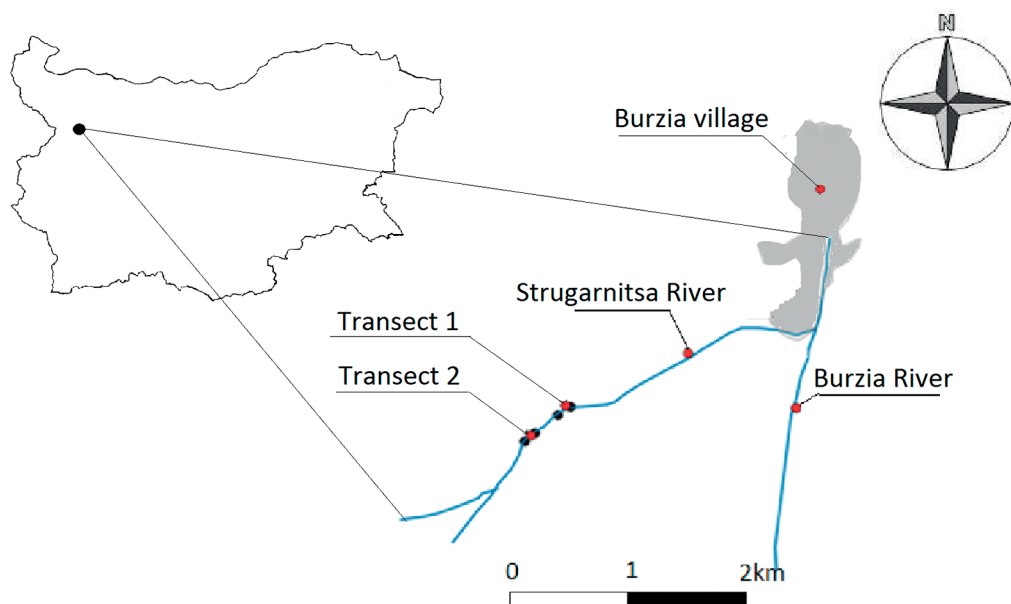


Fig. 1. Location of studied stream.

to the other. Two transects with a length of more than 100 m were used. Each transect was searched twice in succession (Table 1). The study was conducted in two stages, in the winter of 2023 and in the summer of 2024. A total of 48 individuals of river trout were caught. Electrofishing was performed using direct current with a backpack electrofisher (Samus 25G), delivering DC impulses at frequencies ranging from 5 to 100 Hz and durations between 0.03 and 3 ms. The device operated with a maximum power output of 650 W and a load current ranging from 5 to 65 A. The fish total length was measured

by a ruler with an accuracy of 1 mm and the total weight – with an electronic portable scale with an accuracy of 1 g. Using the average growth rate of the species in length in the Vit River (Yankov 1988) and the measured lengths of the fish in the Strugarnitsa River, we determined the age groups in the sample.

The length of the transect was calculated from the coordinates detected with a portable GPS 'Garmin-Oregon' 600. The average width was obtained as the arithmetic mean of the 3 measured transect widths. The measurement was made with a meter.

Table 1. Transects in the Strugarnitsa River.

Transect	Coordinates		Altitude	Transect length, m	Transect area, m ²
	N	E			
I	43°11'026"	23°07'970"	680m	174	522
	43°10'984"	23° 07'879"	735m		
II	43°11'890"	23°07'730"	774m	203	772
	43°10'847"	23° 07'661"	777m		

The estimation of fish abundance was made according to Seber and Le Cren (1967) formulas for two catching passes. The theoretical number of fish (N_e) is determined by formula (1).

$$N_e = \frac{c_1^2}{c_2 - c_1}, \quad (1)$$

where: C_1 and C_2 are, respectively, the number of fishes from the first and from the second catch passes.

The theoretical biomass B_e calculates according to Mahon et al. (1979) by formula (2).

$$B_e = \frac{B \cdot N_e}{N}, \quad (2)$$

where: B_e – theoretical biomass, g; B – biomass of caught individuals, g; N – number of caught individuals.

Theoretical abundance and biomass were calculated by using MS-Excel 2010.

Results

Despite the relatively low altitude of 700 m, the large slopes and the cold climate are the reason why the studied section of the Strugarnitsa River represents the trout zone. In winter, the water temperature was 1.7°C, pH 6.2, and dissolved oxygen varied between 8.9 and 9.0 mg·L⁻¹. These living conditions in the Strugarnitsa River meet the requirements of the river trout there.

River trout were the only fish we found in the stream. The largest specimen had a total length of 22 cm and a total weight of 63 g. The smallest one was 9.7 cm long and weighed 3.8 g. Fish with a length of 130 to 200 mm predominated in the sampling areas (figs 2 and 3).

One, two and three-years-old fish represented the sample. In the summer,

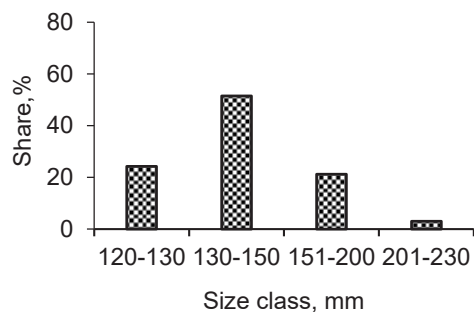


Fig. 2. Size composition of the catch in winter of 2023.

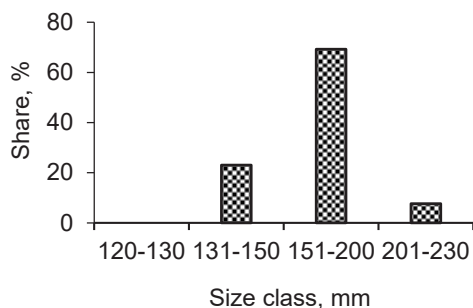


Fig. 3. Size composition of the catch in summer of 2024.

yearlings were not found in the sampling area. It is likely that they stayed upstream during this period (figs 4 and 5).

Some differences were observed in the results of the summer and winter studies. In the summer, the number of fishes was about 50 % higher than in November, when

is the breeding season for river trout. In addition, more large individuals are observed in the study area during the summer.

The average density and biomass values of river trout in the studied river were 368 ind.·ha⁻¹ and biomass 15.2 kg·ha⁻¹, respectively (Table 2).

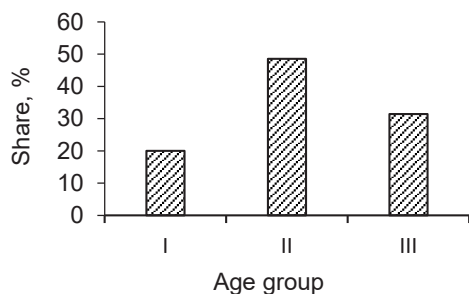


Fig. 4. Age groups of the catch in winter of 2023.

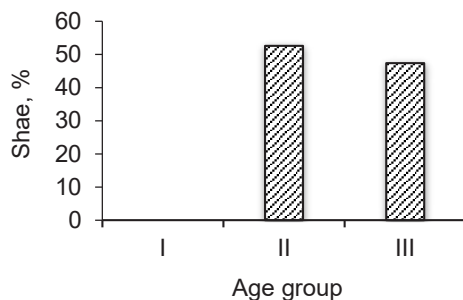


Fig. 5. Age groups of the catch in summer of 2024.

Table 2. Mean calculated density (N_e) and biomass (B_e) of the river trout in the streams Strugarnitsa.

Year	Month	Transect	N_e , ind.·ha ⁻¹	N_e , ind.·km	B_e , kg·ha ⁻¹	B_e , kg·km
2023	November	I	310	93	12.9	6.7
2023	November	II	331	126	9.9	7.7
2024	July	I	462	138	22,7	11,9
Average			368	119	15.2	8.8

Discussion

Despite the connection between the Strugarnitsa River and the Burzia River, the large stone steps, along with increasing slope and current velocity, probably prevent other fish species, such as *Barbus petenyi* Heckel, 1852 and *Squalius cephalus* Linnaeus, 1758, from moving upstream.

When surveying the river in summer and late autumn, we found a difference in the density of fish populations in the two seasons. The number of trout found in summer was about 50 % higher than in November. Probably one third of the trout left the study area in November. It is possible that these were sexually mature individuals migrating to the breeding grounds.

During the summer, only two- and three-year-old fish were present in the study area. It is likely that the younger fish still inhabited the upper reaches and have not reached the study area, which falls in the lower part of the trout zone. The lack of older specimens in the river is perhaps related to downstream migration.

According to the classification of Szczerbowski (1981), the Strugarnitsa River was characterised by low overall trout abundance (Table 3). The abundance and biomass of river trout in this river are

close to the lowest values established for Bulgaria (in the Iskar River – 270 ind.·ha⁻¹ and 9.48 kg·ha⁻¹, Yankov 1988). These indicators are significantly below the national average values of 1123 ind.·ha⁻¹ and 52.8 kg·ha⁻¹, respectively, established by Yankov (1988). The quantity of trout in the Strugarnitsa River is significantly lower than that found in major European rivers such as the Lima and the Garonne's tributaries – the Pique and the Ger (Lim et al. 1993, Maia and Valente 1999). However, similar low trout densities are observed in most other Bulgarian rivers. This is likely due to a combination of factors. One of them is the low water level, a result of the withdrawal of water from the Strugarnitsa River. Another important factor is the substantial annual stocking observed in rivers such as the Garonne's tributaries in France (Lim et al. 1993). In comparison to certain rivers in Turkey (Korkmaz 2005, Tanir and Fakioğlu 2017), the Strugarnitsa River actually supports a higher river trout population. Nonetheless, despite the relatively high abundance, the trout biomass in this river remains low (Table 3). This may indirectly indicate a limited food supply and possibly a shorter life cycle for trout in the Strugarnitsa River.

The reason for the low mass growth and modest trout density is most likely the low runoff in the summer and its diversion

Table 3. Mean calculated density (N_e) and biomass (B_e) of the river trout in some water courses.

River	Country	N_e , ind.·ha ⁻¹	B_e , kg·ha ⁻¹	Source
Pique and Ger	France	1000–2469	125–278	Lim et al. (1993)
Gallo	Spain	1163–3135	67.26–208.22	Almodóvar and Nikola (1998)
Lima	Portugal	1000–2000	23.04–27.04	Maia and Valente (1999)
Kadincik	Turkey	28	26.77	Korkmaz (2005)
Cagliari	Italy	2580	100.15	Zanetti et al. (2010)
Goruh	Turkey	106–167	4.76–10.64	Tanir and Fakioğlu (2017)
Strugarnitsa	Bulgaria	368	15.2	Present data (2025)

for drinking purposes. However, the fact that no stocking material has been introduced into the Strugarnitsa River for years (information from the employees of the state) allows us to assume that the population has enough adult fish, as well as natural reproduction and replenishment. This contributes to the formation of a certain stock of river trout in the Strugarnitsa River and to its reproduction and survival.

Conclusions

The study of river trout in the Strugarnitsa River reveals a stable population density of $368 \text{ ind.} \cdot \text{ha}^{-1}$, accompanied by a relatively low biomass of $15.2 \text{ kg} \cdot \text{ha}^{-1}$. Seasonal variations were observed, with higher abundance and larger individuals recorded in summer.

Given the Strugarnitsa River's limited water flow and fish production capacity, coupled with its protected status, careful management is essential to preserve its river trout population. Recreational fishing should be restricted to catch-and-release practices, enforced rigorously within the protected area to minimize disturbance to the trout's natural reproduction cycles. Additionally, limiting water diversions for drinking purposes is of primary importance to maintain the river's natural flow regime, which supports the ecological conditions of the trout zone. To ensure the population's resilience against stressors such as climate change or reduced water flow, a biennial monitoring program should be implemented to track changes in trout abundance, age structure, and habitat quality. These strategies collectively safeguard the Strugarnitsa River's trout population, ensuring its long-term viability as a self-sustaining ecosystem within Bulgaria's montane landscapes.

References

- ALMODÓVAR A., NIKOLA G.G. 1998. Assessment of a brown trout *Salmo trutta* population in the River Gallo (central Spain): Angling effects and management implications (Salmonidae). Italian Journal of Zoology 65(1): 539–543. doi: 10.1080/11250009809386881
- DIKOV Ts., YANKOV Y. 1985a. Growth rate of the river trout in four rivers in the Rila Mountains. International symposium 'The game and environment', Sofia: 517–526.
- DIKOV Ts., YANKOV Y. 1985b. Dynamics of the river reserves along River Vit. I. Age composition and rate of increase of the River Trout (*Salmo trutta fario* L.) in Stara Ribaritsa River. Bulgarian academy of sciences. Hydrobiology 25: 51–61 (in Bulgarian with English summary).
- DIMITROV D. 1973. Climatology. Atlas of the People's Republic of Bulgaria. Main Department of Geodesy and Cartography. 63 p. (in Bulgarian).
- HRISTOVA N. 2012. River waters of Bulgaria. Top Press Publishing House. 538 p. (in Bulgarian).
- KARAPETKOVA M., YOCHEV S., DIKOV Ts. 2000. The state of fish abundance in Veleka rivers and its tributaries. Report to the Ministry of environment and waters. 43 p.
- KORKMAZ A.Ş. 2005. Density and biomass of fish in Kadincik (Camliyayla-Mersin) Brook. Ankara University Journal of Agricultural Sciences 11(1): 91–97 (in Turkish with English abstract). https://doi.org/10.1501/Tarimbil_00000000493
- KOLEV V. 2010. Density and biomass of the river trout in some Bulgarian rivers. Forestry Ideas 16(2): 221–229.
- KOTTELAT M., FRAYHOF J. 2007. Handbook of European freshwater fishes. Edition Kottelat. 646 p.
- LIM P., SEGURA G., BELAUD A., SABATON C. 1993. Study of the habitat of Brown trout (*Salmo trutta fario*) role of artificial and natural covers on trout populations. Bulletin français de la pêche et de la pisciculture 331: 373–396 (in French with English abstract). <https://doi.org/10.1051/>

- kmae:1993004
- MAHON R., BALON E., NOAKES D. 1979. Distribution, community, structure and production of fishes in the upper Speed river, Ontario; a preimpoundment study. *Environment, Biology, Fishes* 4: 219–244. <https://doi.org/10.1007/BF00005480>
- MAIA C.F.Q., VALENTE A.C.N. 1999. The brown trout *Salmo trutta* L. population in the river Lima catchment. *Limnetica* 17(1): 119–126. doi: 10.23818/limn.17.12
- RAIKOVA-PETROVA G., ROZDINA D., VALKANOV R. 2018. Growth rate of the Bulgarian Brown trout (*Salmo trutta* Linnaeus, 1758) from the river Iliyana, Bulgaria. *International Journal of Aquaculture* 8(16): 121–126. doi: 10.5376/ija.2018.08.0016
- SEBER G., LE CREN E. 1967. Estimating population parameters from catches large relative to the population. *Journal of animal ecology* 36(3): 631–643. <https://www.jstor.org/stable/2818>
- SZCZERBOWSKI J. 1981. Criteria for estimating the rate of growth in fish. *Yearbook of the Institute of Agricultural Sciences (Roczniki Nauk Rolniczych) Seria H* 99(4): 123–136 (in Polish).
- TANIR O.Z., FAKIOĞLU O. 2017. Density and biomass and length-weight relationship of the brown trout (*Salmo trutta* Linnaeus, 1758) population in the Coruh River basin, North-Eastern Anatolia, Turkey. *Journal of Limnology and Freshwater Fisheries Research* 3(3): 129–136. doi: 10.17216/LimnoFish.313520
- YANKOV I. 1988. The dynamic of populations of river trout (*Salmo trutta fario* L.) in the major trout rivers in Bulgaria. PhD thesis. Bulgarian Academy of Sciences, Institute of Zoology. 157 p. (in Bulgarian).
- ZANETTI M., TURIN P., PICCOLO D., BELLIO M., FLORIS B., BUA R., COTTIGLIA C., LIGGI G. 2010. Distribution of fish fauna in the main hydrographic basins of the Province of Cagliari. *Studi Trentini di Scienze Naturali* 87 (2010): 269–271 (in Italian).