FORESTRY IDEAS, 2010, vol. 16, No 2 (40)

DENSITY AND BIOMASS OF THE WILD TROUT IN SOME BULGARIAN RIVERS

Vasil Kolev

Department of Wildlife Management, University of Forestry, 1756, 10 St. Kl. Ohridski Blvd., 1756 Sofia, Bulgaria. E-mail: vassilie@abv.bg

UDC 639.2

Received: 26 May 2010
Accepted: 18 June 2011

Abstract

The wild trout biomass density in four tributary streams of the Maritza river (Topolnitsa, Stryama, Yadenitsa and Chepinska) was investigated by electrofishing. The study was carried out in 100 m long closed test areas, from mid summer to autumn 2008. The theoretical density for two consecutive catches was calculated. It was found that the areas of populations of wild trout in the Topolnitsa and Stryama creeks are fragmented and with a very low-rate density. The theoretical density of wild trout estimated is as follows: for the Chepinska stream – 446 ha^{-1} and for the Yadenitsa stream – 608 ha^{-1}. The theoretical number of wild trout with a length of 23 cm and more was calculated for the Stryama stream – 15 ha^{-1}, for the Yadenitsa stream – 12 ha^{-1}, and for the Chepinska stream – 4 ha^{-1} respectively. Within the four studied creeks the highest rate of wild trout theoretical biomass was found to be that of the Yadenitsa stream – 26.27 $kg.ha^{-1}$, followed by stream Chepinska with 20.43 $kg.ha^{-1}$. The quantity of fish allowed for fishing, with a length of 23 cm and more, according to the Law (Anonymous 2006), was very low in all the four creeks that were studied.

Key words: electro-fishing, specimens allowed to catch, streams, theoretical biomass of population, theoretical density of population, wild trout.

Introduction

The stock and the biomass of wild trout were examined by many authors in connection with managing of trout streams as well as in order to estimate the influence of some factors on trout populations. For example in the Pyrenees (France) many studies were conducted on trout populations and the results are as follows: in the river Pique et Ger Lim et al. (1993) estimated the mean number of brown trout to be 2469 ha^{-1} and the biomass – 278 $kg.ha^{-1}$. Baran et al. (1993) reported an mean density of wild trout in the river Neste d'Aure between 5 and 126 trout per 100 m^2 and the mean biomass between 183 and 3242 kg per 100 m^2. Lagarrigue et al. (2001) studying river Neste d'Ouie estimated the number of wild trout to range between 2201 and 11,516 ha^{-1} and the biomass between 94.6 and 212.5 $kg.ha^{-1}$. A study of the river Luz made by the Federation of Fishermen in Hautes Pyrenées (Fédération … 2007) showed the following mean density of brown trout – 60.1 trout per 100 m^2 and the mean biomass turned to be 1.32 kg per 100 m^2 and the number of

brown trout longer than 18 cm was 4.2 trout per 100 m^2.

The investigation of the Federation of fishermen in Friburg (Fédération ... 2004) of the river Petite Sarine (Switzerland) showed an mean density of wild trout of 1445 ha^{-1} in 2000, 1147 ha^{-1} in 2003 and 1808 ha^{-1} in 2003.

In the river Lima (Portugal) Maia and Valente (1999) studying the population of brown trout estimated the mean density to be between 10 and 20 trout per 100 m^2 and the mean biomass – 285.5 kg per 100 m^2.

Bergstedt et al. (2005) explored the impact of mining and reclamation efforts from 1999 up to 2004 on the population of brown trout in the Arkansas River (Colorado, USA). From their results can be estimated that in the unpolluted part of the river the mean number of brown trout for the six years was approximately 1500 ha^{-1} and the mean biomass was approximately 102 $kg.ha^{-1}$.

The most extensive study of wild trout in the Danube catchment and in the Aegean catchment, in Bulgaria, was conducted in the doctorate thesis of Yankov (1988), an ichthyologist from the Union of hunters and fishermen in Bulgaria. Yankov explored the catch areas of the rivers Iskar and Vit as well as in the Aegean catchment – the catch areas of the rivers Mesta, Vucha, Chaya and Struma. Yankov also examined the dynamics of wild trout population, the state of wild trout stocking, the rates of growth of wild trout, the sexual maturity and fertility of wild trout. For all studied rivers Yankov (1988) calculated an mean density of trout population of 1123 ha^{-1} and an mean biomass of 52.81 $kg.ha^{-1}$.

Another detailed study of wild trout was made by Karapetkova et al. (2000), an ichthyologist from the Bulgarian Academy of Sciences (whose works are dedicated to fish systematics) and by Dikov and Yochev (2000), ichthyologists from the Complex experimental station of Fishery of the Union of hunters and fishermen in Bulgaria, both working on some problems of the dynamics of fish populations, density and biomass of the populations of some fish species in Bulgaria. Karapetkova et al. (2000), Dikov and Yochev (2000) studied the density, the biomass, and the dynamics of wild trout populations in the creeks of Veleka, Mladezhka and Aydere, belonging to the Black see catchment. These authors found that the mean density of trout population was between 48 and 656 ha^{-1} and the mean biomass varied between 5.071 and 56.531 $kg.ha^{-1}$.

A study of wild trout population was made by Dikov and Yankov (1985) for some streams in the Rila Mountains, namely the Rilska, Iliina, Bela Mesta and Cherna Mesta, all belonging to the Aegean catchment,. The authors studied the growth rate of wild trout in the streams mentioned above. Yankov (1985) made an investigation of trout stocks in the streams Rilska, Iliina, Bela Mesta and Cherna Mesta. The author indicated that in the fourth of the studied streams the mean density of trout population varied between 33 and 192 da^{-1} and the mean biomass – between 1.08 and 7.61 $kg.da^{-1}$.

Materials and Methods

Study area

The study area (Fig. 1) includes four tributaries of the Maritza river

– Chepinska, Yadenitsa, both in the Rhodope Mountains, as well as Stryama and Topolnitsa, located in the Sredna gora Mountains. All the studied creeks belong to the Aegean cathment.

The creek Topolnitsa, a left tributary of the river Maritza, is 100 км long. The trout zone of this stream ranges from the spring to the Dushantsi dam and it is 25 km long.

The creek Stryama is another left tributary of the river Maritza with a length of 110 км, 9 km of which are a trout habitat.

The creek Yadenitsa, a right tributary of the stream Maritza, is 16 км long; two-thirds of which is a trout zone.

The creek Chepiska (70 km long) is also a right tributary of the river Maritza. Wild trout inhabit 35 km of this creek, upstream from the city of Velingrad.

All of the studied streams had local populations of trout in the past. After the 50^{s} of the 20th century, stocking started everywhere with young trout of different origins. In 2008 in the fourth of the investigated streams a stoking was made with young trout with provenance from the aquaculture "Toshkov chark" in the Rhodope Mountains (an unpublished report of the National Agency for Fishing and Aquaculture – NAFA).

Equipment, methods and layout

The study material was caught by electrofishing, according to Seber and Le Cren removal method (1967) by two catching passes. This method is reliable when during the first pass a minimum of 50% of the individuals in the catching area are eliminated. This method, as the

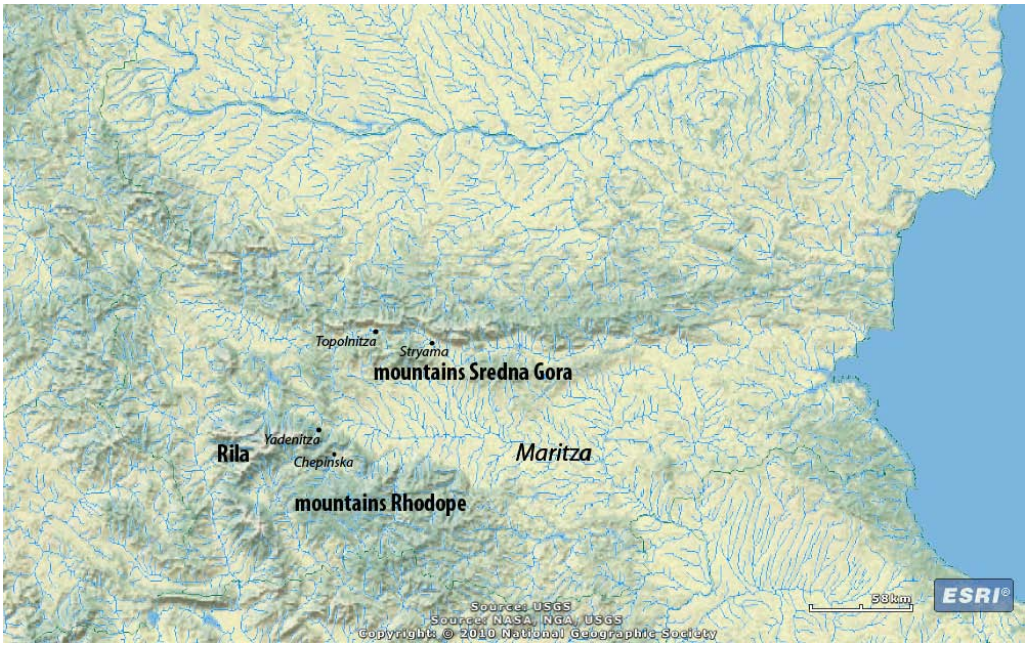

Fig. 1. Location of studied streams.

most suitable one for studies of inner Bulgarian creeks, is recommended by Yankov (1988).

The electrofishing was conducted by direct current (DC) at two upstream passes. We used the backpack electrofisher SAMUS 725G – (Samus special electronics, Poland), powered by a 12 V accumulator battery with a capacity of 75 Ah.

The elctrofisher converter provides DC impulses with a frequency ranging between 5 and 100 Hz, duration 0.03–3 ms and a maximum power of 650 W. The electrofisher is suitable for water resistance from 25 to 1000 Ω. The amperage in load condition is from 5 to 65 A.

The catch areas are 100 m long, blocked off at the upper and the lower borders by 5 mm square mesh nets.

Four catch areas were put in each creek, and 5 – in the Yadenitsa stream.

The catch was carried out by two persons, each with a fishing keep net, passing along together into the catch areas upstream. One of the nets was a single 28 cm hoop anode. The cable cathode was immersed into the creek some meters ahead.

The fish length was measured by a ruler with an accuracy of 1 mm and the weight – with an electronic portable scale with an accuracy of 1 g. The caught fish were kept alive in a wire basket and a plastic pail and after the measurement were released back.

The fish species identification was made according to Kottelat and Frayhof (2007).

The estimation of fish abundance was made according to Seber and Le Cren (1967) formulas for two catching passes. The theoretical number of fish is determined as follows:

$$N_e = \frac{C_1^2}{C_2 - C_1} \qquad (1),$$

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

The variation of the real number of fish N_e is defined by the following equation:

$$Var[N_e] = \frac{N_e.q.(1+\bar{q})}{\bar{p}^3} \qquad (2),$$

where $\bar{q}$ is the mean catchability for each removal pass, $\bar{q} = \frac{C_2}{C_1}$; $\bar{p} = 1 - \bar{q}$.

The study results are reliable if

$$N_e.p^3 > 16q^2.(1+\bar{q}) \qquad (3).$$

The biomass B is calculated as a sum of individual weights of all the wild trout individuals located in each of the catch areas.

The theoretical biomass B_e calculates according to Mahon et al. (1979),

$$B_e = \frac{B.N_e}{N} \qquad (4).$$

where B_e is theoretical biomass,

B – biomass of catch individuals;

N – number of catch individuals.

The parameters of all the 17 studied catch areas satisfied the requirements of the formula.

The classifying of the studied streams was made by the classification of Yankov (1988) for Bulgarian trout streams (according Sherbowsky's method).

• streams with very high-rated trout abundance, where trout abundance is more than 1500 ha^{-1}, respectively biomass is more than 65 $kg.ha^{-1}$;

• streams with high-rated trout abundance, where trout abundance is between 1000–1500 ha^{-1}, respectively biomass is between 40–65 $kg.ha^{-1}$;

• streams with middle-rated trout abundance, where trout abundance is between 500–1000 ha^{-1}, respectively biomass is between 30–45 $kg.ha^{-1}$;

• streams with small-rated trout abundance, where trout abundance is between 300–500 n/ha, respectively biomass is between 15–30 kg/ha;

• streams with very small-rated trout abundance, where trout abundance is less than 300 ha^{-1}, respectively biomass is less than 15 $kg.ha^{-1}$.

Results and Discussion

Species structure, density and size structure of catches

In the studied streams 465 individuals from 7 species belonging to 3 families were caught (see table 1) as follows:

• Wild trout (Salmonidae);
• Maritza barbel (Cyprinidae);
• Minnow (Cyprinidae);
• Maritza chub (Cyprinidae);
• Aegean goudgeon (Cyprinidae);
• Struma spined loach (Cobitidae);
• Balkan golden loach (Cobitidae).

Generally, the number of wild trout individuals is predominating in the catches, but the number of Maritza barbell is also very large, probably due to the fact that the study included trout-barbel mixed zone.

Comparing to wild trout caught in the Rhodope Mountain, the individuals of the same species in the Topolnitsa and Stryama streams are less abundant. One of the reasons seem to be: the municipal pollution of the watercourse of Topolnitsa. In both of the streams there are catch areas where no individuals were caught, as well as such where the catch was 1, 2 or 4 individuals per 100 m along the creek. The size structure of wild trout is irregular (see figures 2 and 3) and the large size classes were absent.

The migration of wild trout in the Topolnitsa creek is interrupted because of the polluted part of the water course. Probably the number of wild trout in this

Table 1. Species composition and pleces (N) of the caught fish in the streams: Topolnitsa, Stryama, Yadenica and Chepinska.

Stream / Species	Topolnitsa		Stryama		Yadenica		Chepinska		Total	
	N	%	N	%	N	%	N	%	N	%
Wild trout	14	3	16	3.5	112	24	94	20.2	236	50.7
Maritza barbel	0	0	41	8.8	30	6.5	122	26.2	193	41.5
Minnow	24	5.2	1	0.2	0	0	0	0	25	5.4
Goudgeon	0	0	1	0.2	0	0	0	0	1	0.2
Maritza chub	0	0	3	0.7	0	0	0	0	3	0.7
Struma spined loach	0	0	2	0.4	0	0	0	0	2	0.4
Balkan golden loach	2	0.4	3	0.7	0	0	0	0	5	1.1
Total									465	100

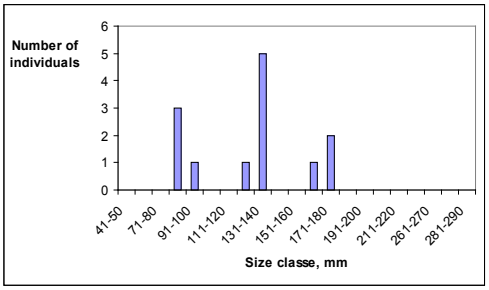

Fig. 2. Size composition of the catch of the wild trout from stream Topolnitsa.

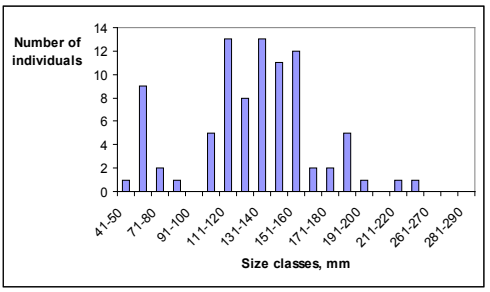

Fig. 4. Size composition of the catch of the wild trout from stream Yadenica.

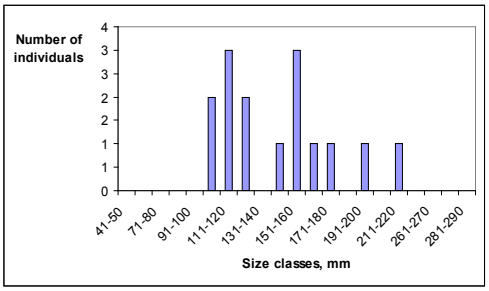

Fig. 3. Size composition of the catch of the wild trout from stream Stryama.

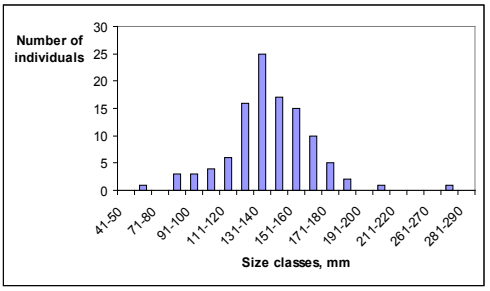

Fig. 5. Size composition of the catch of the wild trout from stream Chepinska.

stream fills up only by young fish stocking. This assumption could be confirmed by the grouping of catches – several groups of similar length were distinguished. Wild trout individuals in the Topolnitsa creek were grouped in 6 size classes, corresponding to 3 age classes (Dikov and Yankov 1985, Yankov 1988), probably a result of young fish stocking in 3 successive years. The wild trout individuals seem to be introduced as follows:

- from size classes of 81–90 mm and 91–100 mm in 2008;
- from size classes of 121–130 mm and 131–140 mm in 2007;
- from size classes of 161–170 mm and 171–180 mm probably in 2006.

The catch composition from the Stryama stream is similar, but the size classes are more. Most of the wild tout in this stream belong to two classes of length: 101–130 mm and 141–180 mm. Wild trout, permitted to catch according to the Law for fishing and aquaculture (LFA), were caught only in the Stryama creek.

The prevailing length of the wild trout individuals caught in the Yadenitsa and Chepinska streams ranged between 121 mm and 160 mm – 52% of them (Figures 4 and 5). The individuals longer than 160 mm in both of the rivers weren't numerous – 17%. In these watercourses a few individuals from lower size classes were also caught – 11%. The peak of the size composition of individuals in the Yadenitsa creek plotted in Fig. 4 is 71–80 mm is due to an im-

ported young wild trout stocking within 2008 (an unpublished report of National Agency for Fishing and Aquaculture – NAFA).

According to Yankov (1988), the size of mature wild trout in Bulgarian rivers is 140-250 mm. In the Yadenitsa and Chepinska creeks young immature individuals prevailed. The irregular structure of the catch in the Yadenitsa and Chepinska creeks as well as the small number of individuals from large size groups shows a high-rate of mature individuals mortality (in these watercourses only 3 wild trout individuals were permitted for fishing according to LFA, 2 individuals in the Yadenitsa stream and 1 in the Chepinska). There is a significant difference between the numbers for middle and upper age classes of wild trout in both of the mentioned streams. Probably, the annual rate of fishing in the Yadenitsa and Chepinska streams exceeds the annual production and it injures size and age structure of fish population (Pravdin 1966).

Theoretical abundance and theoretical biomass of wild trout population in the studied streams

The calculated abundance of wild trout in the Topolnitsa and the Stryama, tributaries of the Maritza river is far less than the abundance estimated for the streams Yadenitsa and Chepinska as shown in Table 2. In the Stryama creek the number of individuals is smaller due to the narrower width of the water course. The number per ha and the biomass per ha in the Stryama creek are larger than in the Topolnitsa stream.

Both – theoretical abundance and theoretical biomass of streams of Yadenitsa and Chepinska exceed those of the water courses in the Sredna gora Mountains. Due to stream Yadenitsa is relatively narrower than Chepinska, there is less wild trout per 100 m of the water course, but biomass and density per hectare, respectively, are more.

Wild trout abundance and biomass in the four studied streams are smaller than the mean values estimated by Yankov (1988) for Bulgaria – 1123 ha^{-1} and 52.81 $kg.ha^{-1}$ respectively.

The wild trout number and the biomass for the Yadenitsa creek were smaller than the smallest stock in the water courses in the Rhodope Mountains, calculated by Yankov (1988) for stream Chaya (mean number 531 ha^{-1} and mean biomass 28.17 $kg.ha^{-1}$). The stock of the Yadenitsa stream is similar to those of the Aydere and Mladezhka creeks (Karapetkova et al. 2000) with a mean number ranging between 48 and 656 ha^{-1} and a mean biomass 5.071–56.531 $kg.ha^{-1}$.

Table 2. Mean theoretical density (N_e) and mean theoretical biomass (B_e) of the wild trout in the streams Topolnitsa, Stryama, Yadenica and Chepinska.

Stream	N_e, pleces	N_e, ha^{-1}	N_e, km^{-1}	B_e, kg	B_e, $kg.ha^{-1}$	B_e, $kg.km^{-1}$
Topolnitsa	6	108	56	0.14	2.77	1.44
Stryama	4	112	40	0.12	3.41	1.23
Yadenica	18	608	178	0.79	26.27	7.86
Chepinska	27	446	271	1.25	20.43	12.54

In the pure trout zone of the Yadenica stream the stock of wild trout is relatively large – a mean of 908 ha^{-1}, whereas in the the mixed barbell-trout zone the mean is 157 ha^{-1}. The mean biomass of trout in the pure trout zone of the creek is 33.61 $kg.ha^{-1}$.

In the first blocked off section in the mixed barbel-trout zone of the Yadenitsa stream only one, but the biggest individual, was caught. Probably this is an old individual who has driven out off the territory the other trouts.

Table 3. Mean theoretical density (N_e) and mean theoretical biomass (B_e) of the wild trout with length of 23 cm and more in the streams Topolnitsa, Stryama, Yadenica and Chepinska.

Stream	N_e, pleces	N_e, ha^{-1}	N_e, km^{-1}	B_e, kg	B_e, $kg.ha^{-1}$	B_e, $kg.km^{-1}$
Topolnitsa	6	108	56	0.14	2.77	1.44
Stryama	4	112	40	0.12	3.41	1.23
Yadenica	18	608	178	0.79	26.27	7.86
Chepinska	27	446	271	1.25	20.43	12.54

The wild trout population in the Chepinska stream has lower number and biomass than stream Chaya (Yankov 1988).

The trout stock of the Topolnitsa and Stryama creeks is much smaller than the smallest one estimated by Yankov (1988) for the catchment of the Iskar river (a mean density of 270 ha^{-1} and mean biomass 7.62 $kg.ha^{-1}$).

According to Yankov's classification (1988) the density of wild trout population in Yadenitsa creek is rated as a medium one and so is the biomass. The density of wild trout population in the Chepinska strearm is rated as low and so is the biomass. Wild trout populations in the streams Topolnitsa and Stryiama are characterized with very low rate of density as well as of biomass.

The amount of wild trout individuals permitted for fishing according to LFA, in the streams Stryama, Yadenitsa and Chepinska is very limited (see table 3). In the Topolnitsa creek no individual was caught with a length equal or over the permitted size.

Yankov (1988) recommended a stop of fishing if the number of wild trout permitted for fishing is under 120 ha^{-1}, according to LFA, or the total biomass is under 30 $kg.ha^{-1}$ until restoration of the normal stocks.

In the studied streams – Topolnitsa, Stryama and Chepinska, the total biomass doesn't exceed 30 $kg.ha^{-1}$. The number of wild trout with a length over 23 cm (permitted legally for fishing) in none of studied rivers reaches 120 individuals per hectare.

Environmental problems found in the Topolnitsa stream

In the trout zone of the Topolnitsa creek a municipally polluted sector was found. It caused a fragmentation of the population and made the migration of wild trout upstream impossible.

Conclusions

Wild trout stocks in the studied streams are smaller than the medium stocks determined for Bulgaria.

The number of permitted for fishing wild trout individuals according to LFA,

in the streams Stryama, Topolnitsa, Yadenitsa and Chepinska is very limited.

Recommendations

The pollution of the Topolnitsa stream by the town of Koprivstitsa must be stopped by the Ministry of Environment and Waters of Bulgaria.

A stop of fishing is recommended for the four studied creeks until the number of trout with a length of and over 23 cm reaches at least 120 ha^{-1}.

References

Anonymous 2006. Normative documents. Ministry of agriculture and forestry, Executive agency of aquaculture, 301 p.

Baran P., Delacoste M., Lascaux J.M., Belaud A. 1993. Relations entre les caractéristiques de l'habitat et les populations de truites communes (*Salmo trutta* L.) de la vallée de la Neste d'Aure, Bulletin Français de la Pêche et de la Pisciculture 331: 321–340.

Bergstedt L., Chadwick J., Conklin D.Jr., Canton S. 2005. Improvements in brown trout and invertebrate populations in the Arkansas River during reclamation efforts on California Gulch, National Meeting of American society of Mining Reclamation, ASMR, 3134 Montavesta Rd, Lexington, KY 40502: 52–68.

Dikov Ts., Yankov Y. 1985. Growth rate of the river trout in four rivers in the Rila Mountains. International symposium: "The game and environment", Sofia: 517–526.

Fédération des Hautes Pyrenées pour la pêche et la protection des milieux aquatiqes (FDAPPMA 65) 2007. Etude du peuplement piscicole du Luz, 9 p.

Fédération Fribourgeoise des Sociétés de Pêche (FFSP) 2004. Etude de la Petite-Sarine, Rapport final, Projet partiel No 00/24, Fribourg, 9 p.

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.

Kottelat M., Frayhof J. 2007. Handbook of European freshwater fishes. Edition Kottelat, 646 p.

Lagarrigue T., Baran P., Lascaux J.M., Belaud A. 2001. Analyse de la variabilité de la croissance d'une population de truite commune (*Salmo trutta* L.) dans une torrent Pyrénéen. Bulletin Français de la Pêche et de la Pisciculture 375/360: 573–594.

Lim P., Segura G., Belaud A., Sabaton C. 1993. Ētude de l'abitat de la truite fario (*Salmo trutta fario*). Rôle des cahées artificielles et naturelles dans les rivières aménagées. Bulletin Français de la Pêche et de la Pisciculture 331: 373–396.

Maia C., Valente A. 1999. The brown trout *Salmo trutta* L. populations in the river Lima cachement. Acociación Española de Limnlogia, Madrid Spain, Limnetica 17: 119–126.

Pravdin I. 1966. Manual for fish study. Edible industry, Moscow, 338 p.

Yankov Y. 1985. Number and biomass of the river trout in four rivers in Bulgaria. International symposium: "The game and environment", Sofia: 508–517.

Yankov Y. 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.