



When Institutional Scales Contradict Ecological Ones: the Case Study of Mesta (Nestos) River

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Abstract: The adequate management and protection of aquatic ecosystems is based on solid knowledge, including various multidisciplinary methods, reflecting work at various levels (scales). Rarely, distant methodological approaches contribute to scale mismatches, even for the same issue. The case of the Mesta (Nestos) River is such an example: in different official documents the whole catchment is accepted as in the Alpine biogeographical zone. In parallel, part of the catchment belongs to R5 and R13 national type rivers (lowland rivers). In order to clarify this discrepancy, the controversial fish communities were compared with typical lowland ones of the same type (R5 and R13), as well as typical alpine ones (R1 national river type). It was established, that typology aligns more closely with the observed fish community structure than biogeographical zonation, in terms of species composition and abundance. Thus, an essential part of the Lower Mesta River catchment should be placed in the Continental biogeographical zone, and relevant regulatory documents should be changed accordingly.

Key words: Bulgarian legislation, aquatic ecosystems, assessment, Mesta River

Introduction

Current major threats to freshwater biodiversity include climate change, habitat modification and pollution, habitat fragmentation and flow regime homogenization by dams, non-native species, water abstraction, and over-exploitation of natural resources (Stendera et al. 2012, Dudgeon 2019). Recently, various efforts have been made on increasing the awareness of integrated management and protection of transboundary waters (Ridder et al. 2005).

The adequate management and protection of such aquatic ecosystems is based on solid knowledge, (Guerry et al. 2015) including various methods and levels (scales). The concept of scale is used in subtly different ways in sociology and ecology (Gibson et al. 2000). It is based on the concept of sustainable development, in which societies and ecosystems interact over many spatial and temporal scales. Social and ecological scales are often, but not always, aligned. Humans may interact with ecosystems as individuals or as representatives of organizations. Human actions are influenced by institutions, percep-

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tions of how ecosystems function, and perceptions of future change. (Cumming et al. 2006).

Nevertheless, there is a discrepancy in the boundaries of the water bodies, determined according to the national typology and the specific characteristics of the biogeographical regions in which the Mesta R. falls, contributing to a mismatch even on a single scale – the institutional. Such a mismatch in the institutional scale could be reflected in further decisions and policies, if not entirely clarified.

According to the national surface water body typology, the lower sector of Mesta R. in Bulgaria belongs to R5 river type or semi-mountainous gravel river in Ecoregion 7 with a slope <2% (Chesmedjiev et al. 2010). Moreover, according to this classification, one small tributary (Matnitsa R) belongs to R13 type (small and medium floodplain river in Ecoregion 7) (MOEW, National Rivers Management Plans, 2025). Based on a recently proposed fish biozonation (Apostolou et al. 2023), type-specific fish communities of R5 type in the Western Aegean Basin Directory (where the Bulgarian part of the Mesta R. belongs) are characterized by sensitive migratory, as well as mid-tolerant species, if belonging to the hyporhythral zone of Illies (Illies 1961).

In parallel, the whole river catchment of Mesta R. in Bulgarian territory belongs to the Alpine biogeographic region, according to ETC/BNP classification (European Environmental Agency, 2016: Biogeographical regions in Europe). Thus, mainly trout and minnow should hypothetically form the fish community in the metarhythral zone.

Following the controversial information provided, there can be derived three hypotheses:

1. There is a mismatch and the lower sector of Mesta R. belongs to the Illies' zones epi-/metarhythral or trout zone from one side, and to the hyporhythral (rheophilic cyprinids) zone from the other. Under these circumstances, clarification of the real situation is needed;

2. It represents a contact zone with mixed fauna: rheophilic cyprinids, minnow and trout;

3. A different classification for river typology should be applicable if this particular fish fauna does not match to either this of the trout zone, or that of the R5 river type (Vardar nase, Orpheus dace, Struma barbel, Bulgarian stone loach, etc.)

Under these assumptions, the study aims to clarify the affiliation of the lower sector of Mesta/Nestos R. concerning two official, but controversial classification systems, or, to propose a new one if necessary, based on the structure of the local fish communities.

Materials and Methods

Study area

Mesta/Nestos is a typical transboundary, partially modified river located in the Eastern Balkans, (Koutarakis et al. 2013), entering Greece from Bulgaria at 412 m. above sea level. Moreover, Mesta River has been designated as one of the Bulgarian sites included in the European network for long-term research LTER (Uzunov et al. 2013). This is related

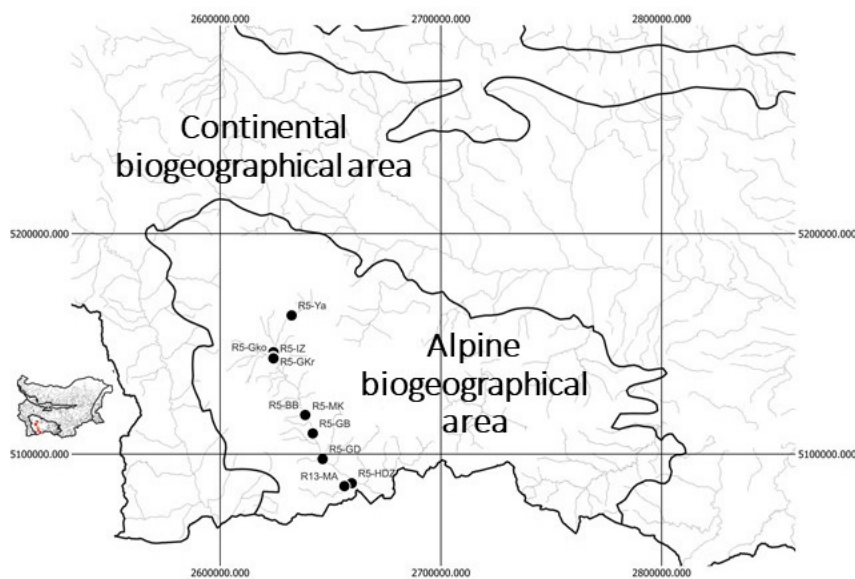


Fig. 1. Sampling points on Mesta R. catchment during 2021, in order to specify the exact biogeographic classification of the local fish faunas.

to the accumulation of data sets on key communities of particular aquatic ecosystems. Fish sampling was accomplished in the Bulgarian sector of the river and one of the main tributaries (Matnitsa R.) In total, 10 sites were sampled for the scope of the study. The monitoring was performed during 2021 by electrofishing, according to the CEN 14011 protocol. The sampled sites (9 of R5 type and 1 of R13 type) are visualized by Quantum GIS 3.22.3 (<http://www.qgis.org>) in Figure 1.

Sample processing and analysis

Species were determined in situ, and afterward, the relative proportion of each species was calculated, concerning each sample. All registered specimens were returned in the water alive, according to the sampling protocol. Fish communities of each sam-

pling site were compared with typically recognized similar Continental faunas of R5 and R13 type accordingly (control), as previously determined by Apostolou et al. 2023. This was achieved on the basis of the relative abundance of each species (number of individuals per species as a percentage of the total catch per site). The faunistic distance between the control and the studied fish faunas was estimated by Bray-Curtis similarity and Principal Components Analysis (PCA) using PAST 4.11 software (Hammer et al. 2001).

Results

Fifteen species were established in the sampled area (Table 1). Only one of them (the native Balkan brown trout) is typical of the mountainous, alpine

Table 1. Fish relative abundance, as established from 10 sampling points on Mesta R. catchment during 2021, in order to specify the biogeographic classification of the local fish faunas. Control standardized faunas as determined by the bibliography (Apostolou et al, 2023) were also added.

Species/site	R5_Yak	R5_Gok	R5_GeK	R5_Izt	R5_BB	R5_MK	R5_GB	R5_GD	R5_Hdj	R13_Mtn	R5MR control	R5HR control	R13 control
<i>Alburnoides bipunctatus</i>	0.00	0.00	0.00	0.00	0.55	5.49	15.87	3.51	0.00	0.00	0.00	5.00	6.00
<i>Alburnus alburnus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.42	0.00	0.00	0.00	0.00
<i>Barbus strumicae</i>	97.04	93.46	81.29	80.00	81.22	69.45	61.27	75.00	37.57	39.39	0.00	35.00	35.00
<i>Carassius gibelio</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00
<i>Chondrostoma vardarensae</i>	0.00	0.00	1.11	0.00	0.00	0.00	1.59	7.02	0.38	0.00	0.00	5.00	0.00
<i>Cobitis strumicae</i>	0.00	2.80	1.34	10.53	0.00	0.00	3.81	0.00	0.00	10.39	0.00	0.00	6.00
<i>Gobio bulgaricus</i>	0.00	0.00	0.45	0.00	0.00	0.00	1.59	0.00	0.21	2.60	0.00	5.00	6.00
<i>Oxynoemacheilus bureschi</i>	0.00	0.00	0.00	0.00	17.68	24.82	12.06	0.44	15.67	2.60	0.00	14.00	6.00
<i>Perca fluviatilis</i>	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Phoxinus phoxinus</i>	0.00	3.74	5.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00
<i>Rhodeus amarus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32	25.79	14.72	0.00	0.00	6.00
<i>Sabanejewia balcanica</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.66	1.73	0.00	0.00	0.00
<i>Salmo macedonicus</i>	2.39	0.00	0.22	1.05	0.00	0.00	0.00	0.00	0.00	0.00	75.00	0.00	0
<i>Squalius orpheus</i>	0.57	0.00	9.80	8.42	0.55	0.24	3.81	11.84	15.16	28.57	0.00	35.00	35
<i>Vimba melanops</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0

Table 2. Bray-Curtis similarity/distance indices as established from 10 sampling points on Mesta R. catchment during 2021, in order to specify the biogeographic classification of the local fish faunas. Control standardized faunas as determined by the bibliography (Apostolou et al, 2023) were also added.

	R5_Yak	R5_Gok	R5_GeK	R5_Izt	R5_BB	R5_MK	R5_GB	R5_GD	R5_Hdj	R13_Mtn	R5MR_control	R5HR_control	R13EP_control
R5_Yak	1	0.9346	0.8208	0.8162	0.8177	0.6969	0.6184	0.755662	0.381419	0.3996	0.0239	0.3557	0.3557
R5_Gok	0.9346	1	0.8637	0.828	0.8122	0.6945	0.6407	0.749963	0.375719	0.4219	0.0374	0.35	0.378
R5_GeK	0.8208	0.8637	1	0.8998	0.8177	0.6969	0.6798	0.859057	0.479624	0.5098	0.0579	0.4636	0.4659
R5_Izt	0.8162	0.828	0.8998	1	0.8055	0.6969	0.6889	0.834158	0.459923	0.582	0.0105	0.4342	0.4942
R5_BB	0.8177	0.8122	0.8177	0.8055	1	0.8792	0.7443	0.765362	0.537927	0.4254	0	0.501	0.421
R5_MK	0.6969	0.6945	0.6969	0.6969	0.8792	1	0.7906	0.736363	0.534827	0.4223	0	0.5424	0.4673
R5_GB	0.6184	0.6407	0.6798	0.6889	0.7443	0.7906	1	0.706165	0.540327	0.512	0	0.5905	0.5621
R5_GD	0.755662	0.749963	0.859057	0.834158	0.765362	0.736363	0.706165	1	0.5197	0.529874	0	0.55787211	0.52107395
R5_Hdj	0.381419	0.375719	0.479624	0.459923	0.537927	0.534827	0.540327	0.5197	1	0.719936	0	0.64753238	0.62373119
R13_Mtn	0.3996	0.4219	0.5098	0.582	0.4254	0.4223	0.512	0.529874	0.719936	1	0	0.6877	0.8077
R5MR_control	0.0239	0.0374	0.0579	0.0105	0	0	0	0	0	0	1	0	0
R5HR_control	0.3557	0.35	0.4636	0.4342	0.501	0.5424	0.5905	0.557872	0.647532	0.6877	0	1	0.86
R13EP_control	0.3557	0.378	0.4659	0.4942	0.421	0.4673	0.5621	0.521074	0.623731	0.8077	0	0.86	1

streams according to the current Bulgarian legislation – which divides national rivers into two categories (salmonid and cyprinid). The other registered species were cyprinids, cobitids, balitorids, and percids. They mainly belong to sensitive or mid-tolerant rheophilic guilds, except the gibel carp and the perch, which are tolerant inhabitants of lower river sectors. *Phoxinus phoxinus* is typical of the Alpine and the upper Continental biogeographical regions.

The calculated Bray-Curtis similarity/distance index between the studied fish faunas and controls pointed the trout community (R5MR control-typical for alpine streams in Bulgaria) as an outgroup (Table 2).

For a better illustration, a PCA plot was constructed (Figure 2). This particular analysis showed a rather homogenous river continuum from lowland to mountainous fish faunas (black arrow). The control for trout fish community/zone, typical for the alpine biogeographic area (R5MR_control), is localized as an outgroup again, distant from all other sampling sites and controls.

Discussion

The study results showed a clear trend: all R5 and R13 sampling sites and controls are grouped, except the R5 metarhythral control, which characterizes the trout zone community and definitely belongs to the Alpine biogeographical zone. R5 and R13 national river types are characterized by sensitive rheophilic species of the middle and lower river courses, where trout is an exception, rather than dominant and type-specific (Apostolou et al. 2023). The data provided resolve the discrepancy between the typology and the biogeographic zonation, as officially accepted (Chesmedjiev et al. 2010, European Environmental Agency 2016). Here, as shown by the results, the official typology matches better, and the boundaries of the alpine biogeographic zonation should be accordingly specified. Under these circumstances, initial hypothesis 1 is verified and resolved. It is clear, that the results support hypothesis 1-Lower Mesta River stretch is inhabited by native, rheophilic cyprinid fish fauna. Thus, it does not belong to the trout/metarhythral zone. Moreover, it does not represent a mixed zone, as no trout was detected, concerning this sector.

Different approaches to specific issues if not harmonized, can lead to wrong estimations. In Mesta R. for example, four NATURA 2000 species inhabit, according to Table 1. These are *Barbus strumicae*, *Cobitis strumicae*, *Rhodeus amarus*

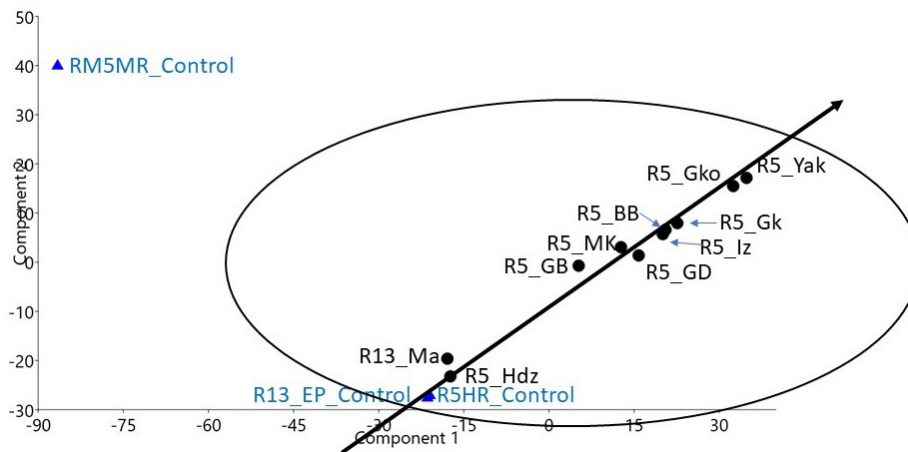


Fig. 2. PCA analysis based on 10 sampling points on Mesta R. catchment during 2021, in order to specify the classification of the local fish faunas. Control standardized faunas as determined by the bibliography (Apostolou et al, 2023) were also added. Variance: PCA1=65.49%; PCA2=23.53%. Black arrow=river continuum from cyprinid to trout zone.

and *Sabanejewia balcanica* (<https://natura2000.egov.bg/EsriBg.Natura.Public.Web.App>). Their population parameters and ranges for Continental or Alpine biogeographical zone should be different, depending on which of them, the lower part of Mesta R. is categorized. Thus, other national and international strategies can be affected, e.g., the parameters supporting the Status of EU Protected Habitats and Species, reported under Article 17 (EU Directive 92/43/EEC 1992).

Rarely, such mismatches on different scales -as mentioned here- can be established. A significant reason for this could be the global shift in the style of governance toward the nation-state, with increased levels of bureaucracy, changes in the distribution of power among individuals, and increasing creation of boundaries, together with a fragmentation of responsibility. One of the most pervasive problems resulting from scale mismatches is the mismanagement of ecosystems (Cumming et al. 2006). For a better national assessment, the current official biogeographical zonation in Bulgaria -especially the Alpine- should be reconsidered.

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