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Monitoring Fish in Lower Danube River Main Channel by Applying Various Sampling Methodologies

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Abstract: In European countries, electrofishing by wading is widely applied to sample fish communities in rivers. In deeper rivers, electrofishing even by boat is considered only suitable to sample the shallow, littoral zone. The monitoring sampling methods concerning fish in the Bulgarian sector of the Danube River are electrofishing and drifting gill nets. The scope of this study is to compare different fish sampling approaches in order to identify the most appropriate for this sector, which could be also applicable for the whole lower Danube River stretch. According to the results, concerning Lower Danube River upstream of its delta, fish monitoring by boat electrofishing during day and night altogether with beach seine should be used; drifting gill nets could contribute valuable data in some cases. These sampling methods could also unveil the basic characteristics of alien fish populations.

Key words: fish monitoring, lower Danube River, large rivers, WFD, alien species, sampling methodology

Introduction

Currently, different fish-based ecological assessment methods are used in Europe, while most countries have included fish in their routine monitoring programs. The successful implementation of the WFD depends on the provision of reliable and standardised assessment tools. However, a paucity of standardised sampling programmes in combination with the lack of natural, undisturbed conditions pose specific challenges to developing fish-based assessment tools for large rivers as a prerequisite for pan-European assessment methods (Pont et al. 2006). Consequently, ecological assessment of large floodplain rivers differs from (and lags behind) methods developed for other river types. Large rivers are defined as having a main channel deeper than 2 m, a wetted width larger than 30 m and a mean annual discharge >50 $m^3 s^{-1}$ (de Leeuw et al. 2007).

To summarise the responses of the fish community to human impact, rheophilic and diadromous species are most sensitive to migration barriers, river regulation and water quality deterioration, while limnophilic species are most sensitive to floodplain reclamation and changes in duration and frequency of inundation (de Leeuw et al. 2007).

In European countries, electrofishing by wading is most widely used to sample fish communities in rivers (Beier et al. 2007). However, it can only be effectively applied in river sections that are shallow (less than 0.8 m average depth) and structured. In deeper rivers, electrofishing even by boat is considered as obligatory to sample the shallow, littoral zone. The middle of the channel can be best sampled by bottom trawls, benthic long lines and anchor nets, the littoral zones and side channels by boat electrofishing, gill nets, fyke nets or beach seines, depending on water depth, water flow and slope of

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the littoral zone. For stagnant water bodies in the floodplains, besides electrofishing, seines, multi-mesh gill nets or fyke nets are suitable. A total of 11 fish sampling methods are applicable in big rivers (de Leeuw et al. 2007).

Catch statistics from commercial and recreational fisheries may represent important time series to detect changes in fish communities. However, care should be taken for consistencies in those data because of changes in fishing effort or shifts in relative value of commercial species that affect the catch compositions over time. Most of the indicative, long-distance migratory fish species are of exceptional value, e.g. Danube barbel, nase and sturgeons. For some species, local catch data date back to centuries ago, which offers unique information on historical longitudinal connectivity. Multi-species fisheries are known for many large rivers, especially in Eastern Europe, and often catch statistics are registered in sufficient detail to identify changes in fish communities (de Leeuw et al. 2007).

Danube River as a trans-boundary river faces a lot of challenges and problems, due to human impacts water quality, regulation, dams (Schiemer et al. 2004), alien species (Piria et al. 2018), pollution (Jovičić et al. 2014) as well as embankment, commercial fishing, loss of floodplains, etc. Moreover, a relatively high number of endemic fish species inhabit the Danube River basin, some of them endangered (Weiss et al. 2018). According to these assumptions, monitoring based on adequate sampling methods, which contribute fast and accurate results, should be considered as a must. Danube River fish monitoring is regularly performed every six years within the frame of the Joint Danube Survey (JDS), with electrofishing as the main sampling method. Trammel nets and bottom electric trawls are also used, although rarely, in the Bulgarian/Romanian sector (Liška et al. 2015).

In Bulgaria, the main monitoring authority is the Ministry of Environment and Water, altogether with its regional structures (Regional Inspections of Environment and Water). The sampling methods applied in the monitoring of the Bulgarian sector of the Danube River are electrofishing and drifting gill nets. According to WFD, harmonisation with other EU countries has to be achieved: from one side a monitoring system should fulfil the requirements of the Directive, and from the other the sampling methodology should contribute best results, according to the local conditions. There are some previous bibliographic sources concerning the Danubian fish fauna in Bulgaria but abundance data are lacking (Marinov 1978, Stefanov 2007, Vassilev & Pehlivanov 2005). Recently, under the JDS, there have been performed modern fish sampling activities (Liška et al. 2015) but comparative data per method are lacking.

On the basis of these assumptions, the scope of this study is to compare different fish sampling

Fig. 1. Sampling monitoring points in the Bulgarian sector of lower Danube River (at Tutrakan, two sampling points are disposed). The total number of sampling points is 15.

Table 1. Various fish sampling methods used in the 2014-2015 Danube River monitoring campaign per sampling station.

Fish sampling method	Number	CPUE/transect length
Beach seine	3	Transects at least 10 m each
Gillnet NORDIC	1	Per night (12 h)
Traps unbaited	3	Per night (12 h)
Drift net	2	Transects, at least 500 m each
Boat electrofishing during night	5	Transects x 100 m each
Boat electrofishing during day	10	Transects x 100 m each

strategies, in order to identify the most appropriate for the Bulgarian sector of the Danube River, which could be applicable also for the whole Lower Danube River. These methods should unify lower time consumption as well as best results (higher species' and specimens' detectability).

Materials and Methods

The sampling area covers the whole Bulgarian sector of the Danube River. For the purpose, 15 sampling sites were selected, so as the distance between them to be of approximately equal. Six sampling methods as described in Fig.1 were applied to each sampling site.

Electrofishing was performed during September 2014 and August 2015. The strategy was multihabitat sampling near shore, at each site a middle stream electrofishing sampling was performed for control and also included in the database. All sampling procedures and protocols were performed according to "Water Analysis – Fishing with Electricity" (EN 14011, CEN, 2003) and by Schmutz et al. (2001) for wadeable and non-wadeable rivers. Standards for other sampling methods, adapted per site, are described in Table 1:

Species determination followed Kottelat & Freyhof (2007). Captured specimens were released alive immediately after being measured. We calculated relative abundance of every registered species and relative effectiveness of each sampling method (% of specimens per species per method).

Results

During the monitoring, a total of 21,109 specimens, belonging to 42 species has been captured (Table 2). Two registered cyprinid hybrids were also referred to this family.

Table 2. Numbers of fish species and fish specimens by family registered during the 2014–2015 fish monitoring period in the Bulgarian Danube River sector.

Family	Species	Specimens
Cyprinidae	21	15,485
Gobiidae	6	4,769
Percidae	5	230
Cobitidae	3	367
Anguillidae	1	5
Centrarchidae	1	62
Esocidae	1	39
Odontobutidae	1	1
Petromyzontidae	1	65
Siluridae	1	9
Syngnathidae	1	77
Total	42	21,109

Regarding effectiveness, electrofishing and beach seine netting were classified as adequate, whereas traps, as well as drifting nets and gill nets - as poorly effective. The overall effectiveness of the applied sampling methods was ordered as follows: day electrofishing, beach seine, night electrofishing, gillnet, traps, drift net (Table 3). Nine species were registered by a single method only, three of them were alien. Cyprinids predominated in the samples. The most abundant was *Alburnus alburnus* (L., 1758) (Fig. 2). Gobiids and mostly *Neogobius melanostomus* (Pallas, 1814) and *N. fluviatilis* (Pallas, 1814) showed higher relative abundance compared to other abundant cyprinids as well as to registered species of other families.

When taken into account the total amount of alien species, *Lepomis gibbosus* (L., 1758) and *Pseudorasbora parva* (Temminck & Schlegel, 1846) predominated. All specimens were recorded by electrofishing (day and night) and beach seine. *Hypophthalmichthys molitrix* (Valenciennes, 1844), *Ctenopharyngodon idella* (Valenciennes, 1844) and *Perccottus glenii* Dybowski, 1877 were represented by a single specimen per species (Fig. 3).

Discussion

Totally, 102 fish species inhabit the Danube River along its entire course, covering various ecological and functional guilds (Schiemer 2003, Eros et al. 2005), which represents the highest species rich-

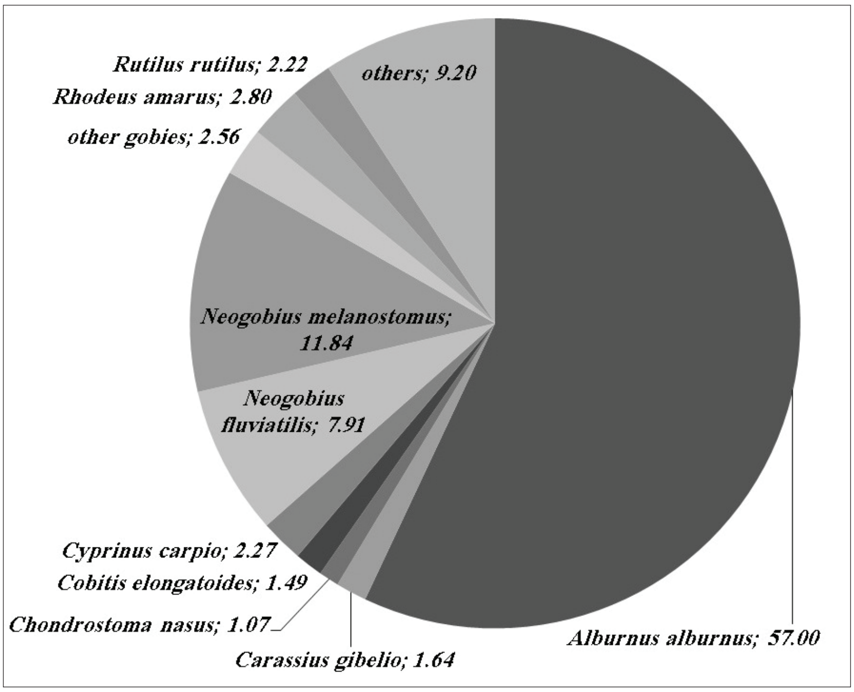

Fig. 2. Relative abundance in % of most common species registered by 6 fish monitoring methods in the Bulgarian Danube River sector during the 2014-2015 fish monitoring period.

Table 3. Total number of species, relative effectiveness and unique species registered by various sampling methods in the Bulgarian Danube River sector during the 2014-2015 fish monitoring period.

Sampling method	Species registered	Relative effectiveness %	Unique species registered by method
Boat electrofishing, day	40	45.6	*Abramis brama, Abramis sapa, Anguilla anguilla, Ctenopharyngodon idella, Gymnocephalus baloni, Hypophthalmichthys molitrix, Perccotus glenii*
Boat electrofishing, night	31	21.02	*Zingel zingel*
Seine	26	33.33	*Benthophilus nudus*
Drift net	1	0.004	-
Gill net	3	0.023	-
Traps	1	0.023	-

ness in a single European river. Of these, 41 % have been registered under this survey. However, these are less than 67 %, which have been registered during JDS 3. In accordance to JDS3, *Alburnus alburnus* and *Neogobius melanostsomus* are the most abundant.

The achieved percentage is rather satisfying, due to the fact that various fish groups are hardly detectable in the main channel, e.g. sturgeons, some backwater inhabitants such as *Umbra krameri* Walbaum, 1792 and *Misgurnus fossilis* (L., 1758) as well as rare species such as *Ballerus ballerus* (L., 1758). Pontic shads and sturgeons were not recorded during the survey. Their ecological peculiarities contribute to increased difficulties concerning monitoring. Shads enter the Danube River from April to June and can be sampled by surface drifting nets or detected using hydroacoustics. All anadromous sturgeon species are critically endangered in the Danube River (Guti 2014). As it is almost impossible to capture them with non-selective methods, their monitoring should be separated and scheduled especially for the group. E-DNA could be a good alternative for their registration. The Upper Danube River endemic forms (e.g. *Rutilus virgo* Heckel, 1851 and *R. meidingeri* Heckel, 1851) are expectably absent, since they do not inhabit the Lower Danube River. The observed absence of the genus *Gymnocephalus* in the samples is, however, alarming. The absence of other species can be explained by their cryptic biology, environmental factors (e.g. temperature, water level) or rarity. The relative abundance of alien

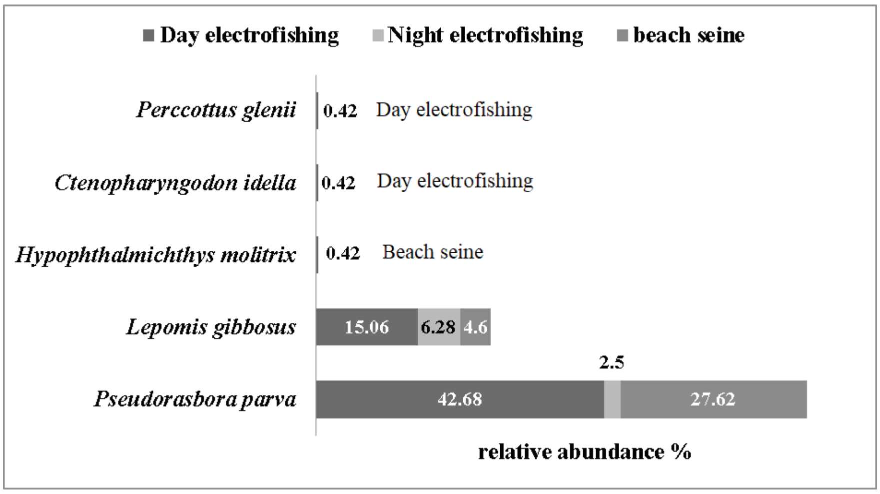

Fig. 3. Relative abundance in % of alien species by various fish monitoring methods in the Bulgarian Danube River sector during the 2014–2015 fish monitoring period.

specimens was relatively low, representing 1.78 % of all captured specimens.

The transect length per site was evaluated as adequate to cover all available habitats in the eupotamon. Selection of an appropriate sampling spatial unit is a basic requirement for the assessment of the ecological status of large rivers (Frissell et al. 1986, Habersack 2000). This selection can be made by choosing a river segment representative for the whole water body, or alternatively, by random sampling of river segments of certain length in relation to width or total length of the water body. In the Austrian sector of the Danube River, all type-specific habitats of anabranching sections under pristine conditions were found in river stretches of about 8–10 km, whereas type-specific habitats of breakthrough sections occurred over a length of approximately 6 km (Hohensinner et al. 2004). By contrast, the CEN (2005) standards require sampling units of approximately 10 times the river width. However, at the lower River Oder (width 250 m), a random stratified sampling was found to best cover all available habitats. At each representative habitat only 400 m of shore line was sampled by electrofishing instead of numerous monotonous kilometres according to the river-width criteria (Wolter et al. 2004). This is probably applicable to more undisturbed rivers with rich fish fauna and habitat variety, not typical to the Lower Danube River. Main floodplains in the Bulgarian sector of the Danube River are lacking because of massive embankment and drained swamps during the second half of the 20th century. The proposed sampling area/CPUE per method within this survey was evaluated as adequate concerning the same sampling site as described in Table 1. Greater fishing efforts could contribute different results but are connected with larger amount of resources and time accordingly.

According to de Leeuw et al. (2007), there are 11 applicable fish sampling methods that can be used in rivers wider than 30 m and deeper than 2 m. Some of them are not appropriate for the Lower Danube River due to logistics or other restrictive circumstances such as recreational angling and fish counter/ power plant screens). During JDS3, additional electric trawl and beach seine were used in the Lower Danube River; comparative data by method are lacking (Liška et al. 2015). In the Lower Danube River, where the current is not so strong, electric trawls could be applied only in commercial fishing areas - cleaned from obstacles for drift netting. Long lines could be useful to register some predators, some benthic fish such as barbel, wels, streber as well as carp. Such data could also be obtained from scientific and/ or commercial fishing statistics performed with drifting gill nets. Nevertheless, the data from drift nets including commercial fisheries are often dependent on the local environmental (water level, flow velocity, etc.) and biological (diurnal and seasonal movements, etc.) or other factors (target species).

As in large rivers, appropriate fish sampling methods are still a challenging task and there is no agreed standardised procedure yet (Liška et al. 2015) and every piece of information on this issue is valuable.

In conclusion, for the Lower Danube River upstream of its delta, fish monitoring by boat electrofishing during day and night altogether with beach seine should be obligatory; drifting gill nets could contribute valuable data in some cases. These sampling methods also unveil the basic characteristics of alien fish populations.

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References

Beier U., Degerman E., Melcher A., Rogers C. & Wirlöf H. 2007. Processes of collating a European fisheries database to meet the objectives of the European Union Water Framework Directive. Fisheries Management and Ecology 14: 407–416.

CEN - EN 14011, 2003. Water quality - Sampling of fish with electricity. Brussels, 16 p.

CEN - EN 14962, 2006. Water Quality. Guidance on the Scope and Selection of Fish Sampling Methods. Brussels, 15 p.

de Leeuw J., Buijse A., Haidvogl G., Lapinska M., Noble R., Repecka R., Virbickas T., Wisniewolski W. & Wolter C. 2007. Challenges in developing fish-based ecological assessment methods for large floodplain rivers. Fisheries Management and Ecology 14: 483–494.

Eros T. 2005: Life-history diversification in the Middle Danubian fish fauna – a conservation perspective. Archiv fur Hydrobiologie, Suppl. Large Rivers 16 (1-2): 289–305.

Frissell C., Liss W., Warren C. &, Hurley M. 1986. A hierarchical framework for stream habitat classification: viewing streams in a watershed context. Environmental Management 10: 199–214.

Guti G. 2014. Can anadromous sturgeon populations be restored in the Middle Danube River? Acta Zoologica Bulgarica, Suppl. 7: 63–67.

Habersack H. 2000. The river-scaling concept (RSC): a basis for ecological assessments. In: Jungwirth M., Muhar S. & Schmutz S. (Eds.): Assessing the ecological integrity of running waters. Hydrobiologia 422/423: 49–60.

Jovičić K., Lenhardt M., Višnjić-Jeftić ***Ž***., Đikanović V., Skorić S., Smederevac-Lalić M., Jaćimović M., Gačić Z., Jarić I. & Hegediš A. 2014. Assessment of fish stocks and elemental pollution in the Danube, Sava and Kolubara Rivers on the territory of the city of Belgrade, Serbia. Acta Zoologica Bulgarica, Suppl. 7: 179–184.

Kottelat M. & Freyhof J. 2007. Handbook of European freshwater fishes. Publications Kottelat, Cornol and Freyhof, Berlin, 646 p.

Liška I., Wagner F., Deutch K., Slobodnik J. (Eds.) 2015. Joint Danube Survey 3. A comprehensive analysis of Danube water quality. Vienna: ICPDR, Vienna, 369 p.

Marinov B. 1978. Ichthyofauna in the Bulgarian section of the Danube River and its economical significance. – In: Russev B.K. & Naidenov V.T. (Eds.): Limnology of the Bulgarian section of the Danube River. Sofia: Publ. House of the Bulgarian Academy of Sciences, pp. 201-228. (In Bulgarian).

Piria M., Simonović P., Kalogianni E., Vardakas L., Koutsikos N., Zanella D., Ristovska M., Apostolou A., Adrović A., Mrdak D., Serhan Tarkan A., Milošević D., Zanella L. N., Bakiu R., Güler Ekmekçi F., Povž M., Korro K., Nikolić V., Škrijelj R., Kostov V., Gregori A. & Joy M. K.2018. Alien freshwater fish species in the Balkans – vectors and pathways of introduction. Fish and Fisheries 19: 138–169.

Pont D., Hugueny B., Beier U., Goffaux D., Melcher A., Noble R., Rogers C., Roset N. & Schmutz S. 2006. Assessing river biotic condition at a continental scale: a European approach using functional metrics and fish assemblages. Journal of Applied Ecology 43: 370–380.

Schiemer F. 2003. Ecological status and problems of the Danube River and its fish fauna: a review. In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries. Vol. I. Sustaining livelihoods and biodiversity in the new millennium. RAP Publication (FAO), no. 2004/16 (International Symposium on the Management of Large Rivers for Fisheries 2, Phnom Penh (Cambodia), 11-14 February 2003.

Schiemer F., Guti G., Keckeis H. & Staras M. 2004. Ecological status and problems of the Danube River and its fish fauna. A review. In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries. FAO. Vol. 1. http://www.fao.org/docrep/007/ad525e/ad525e0i.htm#bm18.

Schmutz S., Zauner G., Eberstaller J. & Jungwirth M. 2001. "Streifenbefischungsmethode": eine Methode zur Quantifizierung von Fischbeständen mittelgroßer Fließgewässer. Österreichs Fischerei 54: 14–27.

Stefanov T. 2007. Fauna and distribution of fishes in Bulgaria. In: Fet V. & Popov A. (Eds) Biogeography and Ecology of Bulgaria. Dordrecht: Springer, pp. 109–140.

Vassilev M. & Pehlivanov L. 2005. Checklist of Bulgarian freshwater fishes. Acta Zoologica Bulgarica 57: 161–190.

Weiss S., Apostolou A., Đug S., Marčić Z., Oikonomou A., Schumka S., Simonović P. & Zabric D. 2018. Endangered fish species in Balkan rivers: their distributions and threats from hydropower development. RiverWatch & EuroNatur, 161 p.

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