FINDINGS OF THE FISH INVENTORY WITHIN LOWER DANUBE RIVER
FROM 2008 TO 2020

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Abstract
The Lower Danube River is an important river both as a navigation pathway that connects Western and Eastern Europe and as a natural environment providing the carrying capacity for a variety of important fish species. In the Lower Danube, the most complex studies on fish fauna inventory date back to Grigore Antipa and Petru Bănărescu. This current study aims to contribute to the updating of the knowledge base regarding the identification of the fish species from the Lower Danube River, using data from the monitoring campaigns undertaken by the expert teams of the INCIDPM Bucharest as well as data collected form the literature.

The data collection methods for the fish inventory undertaken by the INCIDPM Bucharest's experts consisted of two techniques depending on the ecological requirements of the investigated species: standardized method for electrofishing (SR EN 14011/2003) and drift netting.

A total of 66 species were identified on the entire Lower Danube River, representing 80.49% of the baseline. The river stretch between Iron Gates II (rkm 853) and Danube Delta (rkm 0 – Black Sea) has the highest species richness with 53 species. These represent 80.30% of the total identified fish species of the Lower Danube. Both the river sectors Călărași – Isaccea (rkm 375-100) and the Danube Delta- Black Sea (rkm 100-0) had the highest number of species of Community interest – 22 fish species.

Further research is recommended in the area between the Iron Damn I and II where the newly formed lentic ecosystem requires more monitoring campaigns.

Keywords: fish inventory, Lower Danube, species richness

1. INTRODUCTION
The Danube River is the second longest river in Europe with a length of 2,857 km and a basin area of approximatively 817,000 km². The river begins in the Black Forest mountain ranges in Germany and enters the Black Sea with a mean annual discharge of 6,500 m³/s. Due to its geographical position, the river is an important navigation route that connects Western and Eastern Europe.

The Danube River course has been divided into three main sections: the Upper Danube, the Middle Danube and the Lower Danube (Laszloffy, 1965; Velcea, 2001; Sommerhauser et.al., 2003; Baltălungă & Dumitrescu, 2008). The Danube enters Romania at Baziaş and flows for a distance of 1.075 km till it feeds into the Black Sea through the three distributaries that form the Danube Delta.
(Chilia, Sulina and Sfântul Gheorghe). The river represents the shared border between Romania, Serbia, Ukraine and the republic of Moldova.

On account of the importance of the Danube River as the carrying capacity of the fish populations, in their work published in 1986, Tomescu and Gaboș mention the fact that 65 fish species were found on the Lower Danube from which 75% were of economic interest and subjected to commercial fishing.

A large part of the fish species that can be found in the Lower Danube are concentrated in the river’s delta area which, at the European level, forms an unique ecosystem complex listed as an UNESCO Biosphere Reserve and Heritage Site and a Ramsar Wetland of International Importance. Regarding fish species distribution in the Danube Delta, previous research concluded 53 fish species can be found on the 3 main branches of the Delta with an additional 22 identified species in the coastal water bodies (Otel, 2007).

This current study is of particular importance because, in Romania, the most complex studies on fish fauna inventory date back to Grigore Antipa (1909) and Petru Bănărescu (1959). Consequently, at present, the exact number of fish species that can be found in the inner waters of Romania is unknown. Moreover, there are knowledge gaps on the state of their populations as a consequence of changes in the Danube River’s course from the last decades.

This study aims to contribute to the updating of the knowledge base regarding the identification of the fish species from the Lower Danube River course, using data collected from the literatures as well as data from the monitoring campaigns undertaken by the expert teams of the INCDPM Bucharest. The monitoring campaigns have included scientific fishing campaigns on the Danube River to identify the fish communities as well as determining the behavior during migration of the sturgeon species using ultrasonic transmitters (Deak et al., 2014) and the patented receiver stations DKTB and DKMR-01T.

The main objective of this study is to evaluate the species richness of the entire Lower Danube River course and compare the results with the baseline from the literature (Marsiliius, 1726; Heckel and Kner, 1858; Balon et al., 1986; Gomoiu and Munteanu, 1991; Gomoiu et al., 1995; Schiemer et al., 2003).

2. MATERIALS AND METHODS

In situ data collection methods by the INCDPM Bucharest’s experts consisted of two techniques:

1. Scientific fishing using drift netting

Fishing using drift netting was practiced especially for the species belonging to the Clupeidae and Acipenseridae families, whose capturing by use of electrofishing is almost impossible because of the species’ ecological requirements. In the case of species belonging to the Acipenseridae family, capturing using electrofishing method is not possible because of their preferred swimming depths of 15-20 m, while in the case of Clupeids the usage of electrofishing is not suitable because the species swim in the middle of the channel, very close to the water surface. Consequently, drift netting tools such as trammel nets and gill nets were used for the monitoring these species. These tools have the capacity to float on the water surface or near the river bed.

2. Scientific electrofishing

Electrofishing is based on the interaction of the electric current produced by an approved apparatus and the nervous system of the fish species. As in other vertebrates, the nervous system of fish species functions by transmitting electrical impulses. The goal of the electrofishing method is to
produce interferences between the neural system and the central nervous system, thus obtaining an involuntary effect of fish swimming toward the anode. During scientific electrofishing only direct current (DC) is used which can be transmitted as impulses and does not led to fish mortality. Sometimes, especially in the case of juvenile fish, casualties can happen, but in general electrofishing is a non-lethal sampling method. Since, on large waterways, illegal fishing is taking place that uses electric current that causes serious lesions to the fish’s organism (often times leading to death), it is most important that the differences between the different utilized methods is presented hereby. Poaching of fish is done by using alternative current (AC), while scientific fishing uses DC which has a short and reversible effect on fish’s behavior and physiology. Moreover, scientific electrofishing is a standardized method of fishing (SR EN 14011/2003) which is utilized worldwide due to its demonstrated efficiency during field inventories, conservation state evaluation and management fishing to control the fish stocks, remove sick fish and invasive species. This method is also the standard sampling approach for the biological assessment or water bodies used by the Water Framework Directive (Directive 2000/60/EC).

In order to update the database from the field surveys done by INCDPM Bucharest’s experts, information from the monitoring campaigns that were undertaken in order to fulfill the obligations of the provisions of the Water Framework Directive and were extracted and collated from the literature. These data were made available by the International Commission for the Protection of the Danube River (ICPDR) through their Joint Danube Surveys (JDS) 2 and 3 (Joint Danube Survey 2: Final Scientific Report, 2008; Joint Danube Survey 3: Final Scientific Report, 2015). These monitoring campaigns contain a fish fauna monitoring component in order to evaluate the ecological quality of the Danube River and to highlight the impact of anthropogenic alterations to the aquatic ecosystems. With these additional data from the ICDPR, it has been possible to extend the time period of analysis of the fish fauna to 15 years, from 2005 to 2020. The results of the fish inventory were classified by dividing the river into four river sectors of interest. This was made following the methodology of Sommerhouser et al. (2003), and is the same methodology used by the ICDPR in their surveys. All data analyses and graphs were made using Microsoft Excel 2013.

3. RESULTS AND DISCUSSIONS

The previous studies that were consulted and their associated data indicate that in the timeframe 1726 and 2003, at the level of the entire river course, 102 total fish species have been identified. In order to establish a baseline, the distribution of the fish species was done on three Danube River sectors: Upper Danube River (rmk 2497 – rkm 1794) – 61 species, Middle Danube River (rmk 1794-rkm 941) – 74 species and Lower Danube (rmk 941 – rkm 0) – 78 species. Because our study area spanned from rkm 1074 to the mouths of the Danube River, the literature baseline was extended to a total of 82 fish species.

Table 1 presents the fish fauna presence divided into four sectors that are representative of the different ecological characteristics of the Lower Danube. The findings in table 1 have been acquired from the field campaigns undertaken by the INCDPM Bucharest’s experts during the time period between 2001 and 2020 (INCDPM, 2011-2018; 2009-2019 – Core Program; 2014-2015; 2015-2017) and from the data collected from the literature (Schiemer et al., 2003; Joint Danube Survey 2: Final Scientific Report, 2008; Joint Danube Survey 3: Final Scientific Report, 2015; Joint Danube Survey 2 and 3).

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During 2020, the INCDPM Bucharest experts have performed field trips in order to survey the ichthyofauna from the Borcea branch area, the Old Danube (rkms 375-252), the Danube-Black Sea Channel, the area adjacent to Cernavodă City and the Epurașu branch identifying a total of 11 fish species. The small number of identified fish coincided with high water turbidity, a phenomenon that increases the electrical conductivity of the water thus lowering the efficiency of electrofishing. An additional explanation of the low number of fish present species was the high water temperature from the shore areas, which may have caused the fish to retreat into deeper waters.

The waters of the entire Lower Danube River can be considered to have a high species richness with a total of 66 species being identified (80.49 % from the baseline).

**Table 1. Characterization of the fish fauna of the Lower Danube River in the sectors between rkm 1075 and 0.**

| Fish species                        | Baseline 1726 - 2003 | Baziaş – Iron Gates I (rkms 1072-943) | Iron Gates II - Călăraşi (rkms 853-375) | Călăraşi - Isaccea (rkms 375 - 100) | Danube Delta-Black Sea (rkms 100-0) | Entire Lower Danube River |
|-------------------------------------|----------------------|----------------------------------------|----------------------------------------|-----------------------------------|-------------------------------------|--------------------------|
| Abramis ballerus                    |                      |                                        |                                        |                                   |                                     |                          |
| Abramis brama                       |                      |                                        |                                        |                                   |                                     |                          |
| Abramis sapa                         |                      |                                        |                                        |                                   |                                     |                          |
| Acipenser gueldenstaedtii*            |                      |                                        |                                        |                                   |                                     |                          |
| Acipenser nudiventris                |                      |                                        |                                        |                                   |                                     |                          |
| Acipenser ruthenus*                  |                      |                                        |                                        |                                   |                                     |                          |
| Acipenser stellatus*                 |                      |                                        |                                        |                                   |                                     |                          |
| Acipenser sturio                     |                      |                                        |                                        |                                   |                                     |                          |
| Alburnus alburnus                    |                      |                                        |                                        |                                   |                                     |                          |
| Alosa immaculata*                    |                      |                                        |                                        |                                   |                                     |                          |
| Alosa maeotica                       |                      |                                        |                                        |                                   |                                     |                          |
| Alosa tanaica*                      |                      |                                        |                                        |                                   |                                     |                          |
| Ameiurus nebulosus                   |                      |                                        |                                        |                                   |                                     |                          |
| Anguilla anguilla                    |                      |                                        |                                        |                                   |                                     |                          |
| Aspius aspius*                      |                      |                                        |                                        |                                   |                                     |                          |
| Atherina boyeri                      |                      |                                        |                                        |                                   |                                     |                          |
| Barbus barbus*                      |                      |                                        |                                        |                                   |                                     |                          |
| Benthophiloides brauneri             |                      |                                        |                                        |                                   |                                     |                          |

Sources: ICPDR 2007; 2013; INCDPM, 2011 – 2020.

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| Scientific Name            |   |   |   |
|---------------------------|---|---|---|
| Bentophilus nudus         |   |   |   |
| Bentophilus stellatus     |   |   |   |
| Blicca bjoerkna           |   |   |   |
| Carassius carassius       |   |   |   |
| Carassius gibelio         |   |   |   |
| Chalcalburnus chalcoides  |   |   |   |
| Chondrostoma nasus        |   |   |   |
| Clupeonella cultriventris |   |   |   |
| Cobitis elongata*         |   |   |   |
| Cobitis elongatoides*     |   |   |   |
| Cobitis taenia*           |   |   |   |
| Ctenopharyngodon idella   |   |   |   |
| Cyprinus carpio           |   |   |   |
| Esox lucius               |   |   |   |
| Eudontomyzon mariae*      |   |   |   |
| Gasterosteus aculeatus    |   |   |   |
| Gobio albipinnatus*       |   |   |   |
| Gobio gobio*              |   |   |   |
| Gobio kesslerii           |   |   |   |
| Gymnocephalus baloni*     |   |   |   |
| Gymnocephalus cernuus     |   |   |   |
| Gymnocephalus schraetser* |   |   |   |
| Huso huo*                 |   |   |   |
| Hypophthalmichthys molitrix |   |   |   |

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| Hypophthalmichthys nobilis | Ictalurus punctatus | Knipowitschia cameliae | Knipowitschia caucasica |
|-----------------------------|---------------------|------------------------|------------------------|
| Lepomis gibbosus            |                     |                        |                        |
| Leucaspius delineatus       |                     |                        |                        |
| Leuciscus borysthenicus     |                     |                        |                        |
| Leuciscus cephalus          |                     |                        |                        |
| Leuciscus idus              |                     |                        |                        |
| Liza aurata                 |                     |                        |                        |
| Liza saliens                |                     |                        |                        |
| Lota lota                   |                     |                        |                        |
| Misgurnus fossilis          |                     |                        |                        |
| Mugil cephalus              |                     |                        |                        |
| Neogobius eurycephalus      |                     |                        |                        |
| Neogobius fluviatilis       |                     |                        |                        |
| Neogobius gymnnotrachelus   |                     |                        |                        |
| Neogobius kessleri          |                     |                        |                        |
| Neogobius melanostomus      |                     |                        |                        |
| Neogobius syrman            |                     |                        |                        |
| Pelecus cultratus*          |                     |                        |                        |
| Perca fluviatilis           |                     |                        |                        |
| Percarina demidoffi         |                     |                        |                        |
| Percottus glenii            |                     |                        |                        |
| Platichthys flesus          |                     |                        |                        |
| Proterorhinus marmoratus    |                     |                        |                        |
| Proterorhinus semilunaris   |                     |                        |                        |

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Analyzing the distribution of the fish species from the Lower Danube (Figure 1 below), an increase in the number of species from upstream to downstream can be observed. The river stretch between Iron Gates II (rkm 853) and Danube Delta (rkm 0 – Black Sea) has the highest species richness. In each river sector, 53 fish species are identified. These represent 80.30% of the total identified fish species of the Lower Danube. This high species richness may be explained by the presence of a large amount of heterogeneous habitats in that area.

Both the river sectors Calarași – Isaceea (rkm 375-100) and the Danube Delta- Black Sea (rkm 100-0) had the highest number of species of Community interest – 22 species. The Danube River still

| Species of Community interest | 5 | 17 | 22 | 22 | 24 |
|------------------------------|---|----|----|----|----|
| Total                        | 82| 33 | 53 | 53 | 66 |
has an impressive amount of wetlands. Moreover, the unique complex of aquatic ecosystems present in the Danube Delta is listed as UNESCO World Heritage site. In terms of the number of identified species in this river sector, the results of our study match the results reported by Oțel (2007).

Figure 1. Distribution of fish species on the Lower Danube River course (2005 – 2020)

In his study, Ioniță (1995) highlights the cyprinid character of the novel lentic ecosystem of the Lower Danube from rkm 943 and rkm 853 (between the Iron Gates I and II). A limitation of our study is that this sector was not investigated by the INCDPM Bucharest. The literature study (Ioniță, 1995; Joint Danube Survey 2: Final Scientific Report, 2008; Joint Danube Survey 3: Final Scientific Report, 2015) shows that the changes caused by the two dams caused a disequilibrium in the fish fauna of the area, capturing in general cyprinid stagnophil species and rheophil-stagnophil species like Carassius gibelio, Abramis brama and Alburnus alburnus. The interruption of the migration routes for reproduction has led to a decline in the population sizes of species of recreational and commercial interest like Barbus barbus and Acipenser ruthenus, species that can sparsely be found upstream of the constructions.

4. CONCLUSIONS
The information that were hereby presented are comprised of data collected from the INCDPM Bucharest studies between 2011 and the present which were collated with data extracted from other relevant studies form the literature regarding the Lower Danube River course.

The data collection methods used by INCDPM Bucharest are similar to the ones used by other researchers which evaluated the fish fauna of the Lower Danube: drift netting in the main channel and electrofishing techniques were used.

A total of 66 fish species were identified on the entire Lower Danube. The results highlight that, to date, 80.49 % of the fish species identified in the reference period of 1726-2003 are still present on the Lower Danube River course.

The findings of this study show the fact that the highest species count (53 species) is found in the
river sector spanning from the Iron Gates II to the Black Sea. This can be explained by the fact that this sector did not experience strong hydromorphological alterations and the environment may be more heterogeneous. Furthermore the two rivers sectors Câlăraşi- Isaccea and Danube Delta contain 22 fish species of Community interest.

Additional research is needed regarding the updating of the national database and closing knowledge gaps in the evolution of the fish fauna, especially in the area between the Iron Gates I and II. Further research studies might explore the characteristics of the novel ecosystem which has resulted from river damming.

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conservation (PN 18 26 04 01.1. Study on migration and identification of the populations status of Alosa immaculata (Pontic shad) in the Lower Danube; PN 18 26 04 01.2. Monitoring the migration routes of anadromous migratory sturgeons on the Lower Danube. Case study: Danube bifurcation in the Izvoarele area; PN 18 26 04 01.3. Elaboration of measures to improve conservation status and create preliminary sustainable management for the sustainable exploitation of species), 2018, beneficiary Ministry of Research and Innovation.

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