JDS-2 Fish

Technical report with results from the fish sampling and analyses from the Joint Danube Survey 2007

Christian Wiesner, Nikolaus Schotzko, Jaroslav Cerny, Gabor Guti,

Grigore Davideanu & Niels Jepsen

JDS-2 Fish

Technical report with results from the fish sampling and analyses from the Joint Danube Survey 2007

Christian Wiesner, Nikolaus Schotzko, Jaroslav Cerny, Gabor Guti,

Grigore Davideanu & Niels Jepsen

Title page fotos:

Top: Danube at Nagymaros, nearby JDS26, Szob, Hungary.

Bottom left: Core team (left) and Austrian National Team 1 (right) performing "joint" fish sampling (Foto: Wolfgang Rodinger, BAW).

Bottom right: Team leader Christian Wiesner presents an asp, *Aspius aspius* (Foto: Wolfgang Rodinger, BAW).

Recommended citation:

Wiesner, C., Schotzko, N., Cerny, J., Guti, G., Davideanu, G. & Jepsen, N. (2007). Technical report with results from the fish sampling and analyses from the Joint Danube Survey 2007. International Commission for the Protection of the Danube River, Vienna. 73pp.

Table of content

1 Introduction

The Joint Danube Survey 2 (JDS-2) took place from 13 August till 28 September 2007. Six years earlier, the first JDS was organized by the International Commission for the Protection of the Danube River (*ICPDR*). The idea was to make a joint survey to monitor and evaluate the status of the whole river. Until then, the Danube was suffering from a very fragmented management, with large differences in monitoring and environmental legislation between the many "Danube countries". During the JDS, an international team of experts were making standardized samplings and analyses in the main Danube from Germany to the Black Sea. The plan was to repeat the successful survey in 2007, but while the JDS "only" monitored water chemistry, plankton, plants and invertebrates, this time also the ***fish*** should be included. In general the Danube River is in a much degraded state, mainly because of hydrological modifications (damming, canalization and draining), pollution (chemicals and nutrients) and other issues like fishing and navigation. One of the major direct effects of this is the declining fisheries in the Danube, both commercial and recreational as well as the threatened status of several fish species. Most of the spectacular Danube sturgeon populations are extinct or very close to extinction.

More than 70 species of freshwater fish inhabit the Danube along its entire course, covering various ecological guilds. Yet, the ecology of many species is still poorly known. Although fish stocks declined and species became endangered or even extinct in the last decades, fish still are of economical importance, in the lower river in terms of commercial fishing but recreational fishing is becoming more and more important along the whole basin.

Due to the special nature of fish sampling, compared to sampling water, phytoplankton or invertebrates, the fish survey was performed under a separate strategy as applied for JDS-2 but kept as a parallel activity using an independent vessel (Vienna 115) with an electrofishing boat. The whole exercise was managed by an international Core Team of fish experts (3 persons on board) in cooperation with national fish teams and harmonized with the JDS-2 programme.

In order to decide upon the best practise and sampling method, a field workshop was arranged in Göd, Hungary, 4 months before the survey. Here representatives for both all national teams and the core-team met to test and evaluate the suggested methods and agree upon a sampling strategy.

The whole JDS-2 is financed mainly by in-kind contributions from the different ICPDR member states, and this was also the case for the fish part. However, European Commission supported the survey through the engagement of JRC (Joint Research Centre), Ispra, Italy, in the organisation and financing of the fish survey. Thus, JRC coordinated the planning, financed the sampling workshop in Hungary and paid for the charter of the research vessel (Vienna 115).

In this report, the results from the 2007 survey are presented in detail and hopefully with sufficient explanations and description of the methodology to provide a clear picture of the JDS-2 fish sampling. The report focuses mostly on methodological and technical issues and not so much on presenting analyses and ecological conclusions of the results. This is partly because these methodological information are important when the samplings will be repeated, but also because the results from the JDS-2 are too scattered and few to warrant in-depth ecological analyses and conclusions.

Links to the Water Framework Directive (WFD)

The status of fish populations in rivers is a key element in the assessment process of the ecological status according to the EU Water Framework Directive. According to the requirements of the directive, biomass, species composition and population structure are the key elements to be analysed.

However, fish sampling in large rivers is challenging and not a routine task and both sampling methodology and assessment tools are still in development. So, apart from the creation of a standardised data set, being representative for the entire Danube course, methodological harmonisation and improvements across different countries, even outside the EU, was a key task of this first fish survey of the entire Danube.

There are several obvious links between the JDS-2 fish sampling and the ongoing work to develop and intercalibrate metrics for using fish as indicators of ecological status of rivers. Much effort has been exerted to develop WFD-compliant methods to evaluate the ecological quality (EQ) of rivers and streams by monitoring the fish populations. This work is rather advanced (several national methods, a common metrics under development), but a major shortcoming has been the lack of fish data from large rivers. To be able to include the larger rivers in the national methods and the common metrics, data from standardized sampling is needed. We hope that the data from the JDS-2, will contribute significantly to test a common approach for sampling and evaluating fish populations in the large rivers. A major goal of the EU-funded EFI+ project aims directly at incorporating larger rivers in the index by using existing data to develop functional metrics. The JDS-2 has much overlap (in aim and persons) with the EFI+ and thus we can be certain that sampling and data analyses will be standardized and relevant. The fact that only Germany and Austria (of the Danube countries) have developed national methods for evaluating EQ from fish data, mean that the other countries may cooperate closely through the JDS-2 to develop and agree upon common methods to be used in their WFD-monitoring.

2 Methods

2.1 Organisation of the work

The fish sampling was organised as a joint effort between a core-team, based on the Vienna 115, moving downriver with the other survey ships, and National teams. The core-team constituted of 5 persons of which 3 were always present:

Aug 12th - Sep 2nd	Christian Wiesner (team leader), Jaroslav Cerny, Nikolaus Schotzko
Sep 2nd - Sep 29th	Christian Wiesner (team leader), Grigore Davideanu, Gabor Guti

In the section 3.2 a table with the details is presented. The core-team had a full set of electrofishing equipment mounted on a small Zodiac and thus could principally perform all the sampling, but due to the effort required it was mainly the national teams of fish experts that were doing the sampling under the supervision of at least one core-team member. Thus, a firm logistic planning and close cooperation between the national teams and the core-team was necessary to ensure effective sampling. Germany, Austria, Hungary, Croatia, Serbia and Romania had organised fully equipped national electro-fishing teams, including more than 50 people. Unfortunately Slovakia and Bulgaria did not manage to establish teams so the sampling in their territory was done by the core-team only or by the help of other national teams.

There were 5 sites in the main Danube sampled by the national teams alone and, additionally, 21 sites in the main tributaries were sampled by national teams alone. These data were kindly supplied to the JDS-2 database and thus can be used in the present analysis. On the use of these additional data see chapter 2.2.

2.2 Sampling sites

The basic unit for the JDS-2 is the sampling site. A site is defined as a dot on a map, but in reality it is a river stretch where all the sampling should take place. The official JDS-2 sites were approximately covering a river segment of up to 2 km. Because of the large difference between taking a water or sediment sample and actually catching enough fish to represent the population at the site, the fish sampling sites were longer (2-14) km and they did not always overlap fully with the JDS-2 sites due to practical sampling issues. So the fish sampling sites were up to 14 km away from the original JDS-2 site.

The original list of JDS-2 sampling sites includes 96 sites in the Danube and mouths of major tributaries. Out of these, a set of 40 sites was chosen for the Danube plus 21 sites in tributaries by the national delegates for fish data sampling.

The reduction in Danube sampling sites was a necessary compromise between minimum effort per site and number of sites sampled. In 44 days (August 14th – September 26th), excluding five "free days" (press events), one JDS2-site per day should be sampled. Thus, the 40 Danube sites were supposed to be sampled directly during the survey by the Core Team and the national teams. The additional sites as well as the tributary sites should be sampled after the survey by the national teams. Thus, we received results from 5 Danube and 21 tributary sites sampled during national monitoring programmes. Most of these data were collected with less than the agreed effort. Therefore they are treated as additional information in respect of species distribution for instance. In total there are now 45 Danube and 21 tributary fish sites.

2.3 Sampling design

At the workshop in Göd, an optimised sampling design was agreed upon, as sampling time per site was limited to one day. It was clear that this was a compromise because ideally a thorough sampling with both netting and electro-fishing requires more time than was available. Despite the clear benefits of combining several methods, it was decided to principally only use two sampling methods: drift netting and electrofishing. These standardized **non-lethal** sampling methods provided a comparable indication of the status of the fish community at each site.

The minimum sampling design was supposed to be a joint effort by the Core Team and the national teams with possibilities of exchanging team members for methodological harmonisation and exchange of experience.

At each site a set of at least 10 single electrofishing subsamples (strips of 200-400 m length according to riparian habitat availability, 8 during day, 2 during night) using different devices of electrofishing gear (handheld and fixed boom anode) and, wherever possible, 3-4 drift net samples should be collected, thus optimising capture efficiency on different species and age classes. The electrofishing was supposed to be done by the national teams and the drift net fishing by the Core Team.

However, according to available time and sampling gear, weather conditions and water level, the sampling design had to be adjusted individually. Especially the Core Team was often restricted to limited time frames for sampling and had to spend most of the time with electrofishing as several national teams could themselves not fulfil the proposed program in time and sometimes even lacked the required equipment. As Slovakia and Bulgaria could not provide a national team, the Core Team provided all Danube main channel data in these countries. Due to these constraints, drift net fishing could be performed only occasionally. Finally, data from 40 sampling sites could be collected during the time of the survey (for total site number see chapter 2.2).

From the* Fish–SOP** (Standard Operational Procedure), ***written before the survey:

Sampling, processing, preservation and storage
The sampling acts on the basis of the EU Water Framework Directive and the European Standard "Water Analysis – Fishing with Electricity (EN 14011; CEN, 2003) for wadable and non-wadable rivers.

The methods that will be used to investigate the composition of the fish fauna on the different sites along the Danube:

- *Electric fishing*
- *Drift netting with trammel-nets*

Electric fishing is the most used method worldwide to sample fish in smaller rivers or shallow waters. A generator (in a boat) establishes an electric field in the water between the fixed cathode and the mobile anode. This electric field attracts and stuns the fish, so they can be collected with a net. Under normal conditions this method does not harm or damage the fish that recover very fast. However, especially with juvenile fish casualties can happen, but in general electric fishing is a non-lethal sampling method. The method is also CEN-standardized and is recommended for use as the basic sampling methods for WFD purposes.

As mentioned above, electric fishing is mostly effective in shallow waters (0 – 1.5m) and to sample fish from the main channel of the Danube, different methods must be used. We decided to use trammel nets that we will let drift app.1.000 m downstream and thus catch some of the benthic species. A trammel net is a combination of two nets, one with very large meshes and another with small mesh size. The fish is then trapped in "pockets" of fine meshed net and thus they are not killed like in normal "gill-nets". With the drifting trammel nets that have been tested in German rivers we expect to be able to catch a number of different fish species in a wide range of sizes, in a non-lethal way.

Sampling

At official JDS-2 sampling sites stretches from 3 -6 km will be selected by the national teams. Within these sites, the sampling program (electro-fishing) will be carried out by the national team, including one member of the core-team. The electro-fishing is only done in shallow, littoral areas and the deeper main channel will be sampled using trammel-nets.

Strips (transects) will be selected by the national teams to include most of the available habitat types in the stretch.

The proposed effort per site:
***Electrofishing during daylight** in the main channel*
8 strips according to habitat distribution, length: 300 -500 m per strip
***Electrofishing at night** (min. 0,5 hrs after dusk),*
2 strips at night with light, length: 300 - 500 m per strip.
Maximum depth of sampled habitat: 2,5 m
minimal total length of all strips: 3.000 m
(=> resulting in appr. 1- max. 2 sites per day)

***Min. equipment**:*
Power 7,5 kW generator, hand-held anode and boom anode, most suitable equipment to be used for different structures / mesohabitats. (See detailed list of equipment used during the survey in appendix 2.)

***Driftnet-fishing** performed by the core-team. A total of 3-5 drifts of ca. 1.000 m will be done depending on the speed of the current and the conditions regarding the river bed (if there are large rocks or tree trunks, we cannot sample).*
In the German sampling sites, only e-fishing will be used because it was impossible to obtain permission to do the netting.

***In addition backwaters** and oxbow lakes should be sampled representatively according to their natural occurrence with suitable methods by the national teams.*

***The tributaries** should be sampled with a similar minimal effort as long as they are large, not wadeable rivers.*

If wadeable we would prefer a sampling strategy according to EN 14011, i.e. a removal method (Moran-Zippin, De Lury) on a segment-length of 10-20 times the wetted width.
The survey units will be determined by handheld GPS and documented by digital photographs.

Sample processing, preservation and storage

Most of the fish will be identified in the field. During each strip, all fish will be held in a large aerated tank and then identified, measured and weighed. Juvenile fish or schooling small fish, will not be measured or weighed individually, but only counted. All fish will then be released. Information about the fish will be directly entered into the field-spreadsheet prepared in advance. After the whole site is sampled, all data will be entered into the DanuFishbase. In case of capture of fish where there is doubt about the identification (juveniles or hybrids), one individual will be killed and stored in a labelled plastic bag and frozen for further analyses. Tissue samples (liver & muscle) will be taken from 2-3 bream > 300g from 20 sites to be analysed for toxicants. Additional tissue samples will be taken from a range of bream of different ages from 10 – 15 sites to be analysed at JRC. These samples will be frozen for analyses in a lab after the survey.

Analysis

The final analyses will be performed using all the data in the fish database. Scores for Ecological Quality will be calculated using both EFI and FIA.

Results from the upper Danube will also be analysed in the German FIBS index.

According to the SOP, the following sampling routine was as follows:

Electrofishing was done in individual strips along the bank or shallow areas (water depth <3m) with handheld anode or fixed boom. The electric boom was used along homogenous and little structured riparian areas or slightly off-bank wherever water-depth is suitable. The handheld anode was used in complex riparian structures (e.g. branches, rip-rap) as additional tool to catch fish hidden in such structures more efficiently. As this second sampling strategy is rather time consuming (more detailed fishing, more fish to count), the focus of electrofishing is put on the boom fishing.

The mid-water zone was sampled using drift nets.

Start- and end-point of each strip or drift net run was marked with GPS. Water depth was monitored by echo-sounding device to assure electrofishing in sufficiently shallow water (depth <3m) and the average value recorded on the field protocol.

In Austria national monitoring was temporally harmonized with the JDS-2 as far as electrofishing was concerned. The minimum program of electrofishing for national purposes was set to 50 % of the site length, at least 5.000 m strip length during daylight and additional 20 % of the site length or at least 2.000 m at night.

In addition to electrofishing the Austrian National teams applied a bundle of additional methods for this pilot phase of fish monitoring in large rivers in order to evaluate and develop a suitable program for the future monitoring program. These methods are in accordance with the European Standards EN 14962 and 14757 and were notably the following per site: 3.000 m of driftnetting, 10 standardised longline nights, multi-mesh gill nets in river bays and backwaters. Hydroacustic survey of the water column in the main channel with vertical split beam scientific echo sounder day and night, and additional sampling of existing backwaters according to the extent of their natural occurrence.

1 of total 5 sites in Austria was sampled by the National team (ezb) only, namely Ybbs (JDS09).

The same sampling program was performed on 2 national sites on the river Inn along the Austrian / Bavarian national border in the first two week of October 2007 by the team of the Federal Agency of Water Management led by Nikolaus Schotzko.

However, for reasons of comparability the results of the additional methods in Austria beyond the agreed set of methods for JDS-2 (electrofishing day and night and driftnetting) were not included into the final data set of this survey.

2.4 Database

Background

To ensure the best use of the results from the JDS-2 fish samplings, it was decided to build a special database, the "Danufishbase" where the present results would be the first data-series, but with the clear scope of adding of more results from future fish samplings by the Danube countries. The task of building the database was done by the Austrian Federal Agency of Water Management.

The existing Austrian National fish database (FISCH DATENBANK AUSTRIA, FDA) located at the Institute for Water Ecology, Fisheries and Lake Biology of the Austrian Federal Agency of Water Management Austria is an applied tool for the administration and analysis of fish metrics according to the demands of the river monitoring program. This new fish data base rests upon single fish data and provides all procedures for standard data analysis – as well as the calculation of both fish indices: the Fish Index Austria (FIA) and the European Fish Index (EFI). The FDA is a Microsoft SQL Server 2005 database, the framework performing calculations and statistics consists of programs written in C#. The web-based front-end allows web-application and connection to GIS is provided using OGC standards.
A copy of this database was adapted to the demands of the fish sampling during the second Joint Danube Survey and all relevant data were processed using this powerful tool. Data input was done by using common MS Excel templates, filled in by the different teams. However, a huge effort in terms of man hours was involved to validate and correct the delivered datasets before importing them into the database.
The database with the raw data from the JDS-2 fish survey is not publicly available and these data are not included in this report! The database will be owned and maintained by ICPDR & BAW.

2.5 Equipment (Core Team)

The main features of the core team equipment can be found in the table. Two different arrangements for electrofishing were possible: (1) using the handheld anode on a long cable (detailed fishing of riparian structures from the boat or wading), or (2) using the fixed electric boom (strip fishing from the boat along the banks or slightly off bank in shallow water <3m depth). The latter could be demounted or just detached and pushed backwards when driving at speed for longer distances or fishing in complex riparian structures (wood, branches). For night fishing, front spotlights were mounted on the railing and connected with a portable car battery. For practical reasons, these spotlights remained attached even during day and transport but were disconnected from the battery.

A working table, also used as protective device, was put over the electric generator. The fish tank was placed in front of the generator, so the catch team (1-2 persons on front platform) could easily put in the collected fish. GPS and echosounder were usually located on the table. Although oxygen supply for the fish tank was carried on the boat, it did not prove necessary and was thus not used.

The electronic scale used had a range of 1 to 6.000 g with an accuracy of 2 grams. However, due to the dense sampling schedule of the core team, only a fraction of the fish caught by the core team were weighed.

Fish measuring devices and field protocols were carried all through each sampling day as well as reserve tanks (generator, outboard engine). Thus the Core Team was able to do all protocol work in situ on the boat after sampling each individual strip and did not need to return to a land-based station.

When using the drift nets, the electric boom was usually not demounted but kept in "driving"-position. Thus the long arms (surf sticks with smooth surface) helped exposing and retrieving the net.

The drift net used by the core team was a 3-layered trammel net with mesh sizes 200 / 10 / 200 mm, a length of 50 m and a depth of 3 m; material: Polyamid. At each end we used 1 kg of steel weights on lines attached to the lead line of the net. One of these lines was led by the boat and the other one equipped with a 5 l plastic jerry-can as a float. Unfortunately the thread size (twine) of the inner 10

mm–mesh was too heavy due to some misunderstandings with the supplier. Therefore it can be assumed, that catch efficiency was lower than usual.

However, the use of the drift net by the core team was restricted to a few occasions due to shortage of time.

Zodiac tied at rear end of Vienna 115 for transport (left), electric generator, outboard engine with tank and battery (right)

Echosounder (left) and fish measuring device (right)

Exposing and retrieving the drift net

Drift net used in the appropriate way (left) and adapted as beach seine (bottom right)

Driftnet detail

Electrofishing with handheld anode, wading (left) or from boat (right)

Electrofishing with boom anode (left) and field protocol writing (right)

Core team on the cruise (left) with fuel tanks ready on deck of "Vienna 115" (right)

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... JDS2 Core team
Team leader: ..... Christian Wiesner
Contact email: ..... christian.wiesner@boku.ac.at
Contact phone: 00431476545234

2 **Fishing boat**

Fabric / type ..... Zodiac / Futura Mark 3 HD
Material ..... inflatable rubber boat, aluminium floor
Length (m) 4.50
Width (m) 2.05
Weight (kg) empty / fully equipped ..... 116 / ~300

Engine (PS/kW, 2- or 4-stroke) ..... outboard motor , Mercury 60 PS, 2 stroke
Action radius of the boat (km) ..... ~50

3 **Electrofishing generator**

Fabric / type ..... Efko / FEG 8000
Current type ..... DC
Power (kW, maximum A, V) 10kW, 12A, 250-450V
Voltage and amperage during fishing ..... 400-450 V
Amperage during fishing ..... 12-13 A
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**

Anode (boom): materials ..... 2x 4m glass fibre surf sticks, 4m stainless steel wire
Anode (boom): number ..... 7 stainless steel wire anodes (each 1m)
Anode (boom): configuration of anodes ..... all activated simultaneously by foot pedal

Anode (handheld): materials ..... glass fiber stick, metal ring with net
Anode (handheld): number 1

Anode (handheld): diameter (cm) 30
Anode (handheld): net/no net, mesh size .....net, mesh size 5mm
Anode (handheld): cable length (m).....6
Anode (handheld): stick length (m).....2

Cathode: materials: .....stainless steel wire
Cathode: number.....1
Cathode: length.....4x 1m wires bundled
Cathode: configuration .....see anode (boom)

Security device (dead-man switch) .....1 foot pedal on fishing platform

5 **Dip-nets**
Material.....wooden stick, steel frame with net sack
Number .....1 (using handheld anode) or 2 (using boom anode)
Net opening (diameter or height x width) 50x60cm
Depth of net-sack (cm) 50
Mesh width (mm) 5
Stick length (m) 2

6 **fish tanks on boat**
Material.....poly-carbon
Number 1
Size/volume .....40x40x75 (120 lt)
Permanent freshwater supply .....no
Oxygen supply.....not used

7 **Additional night fishing equipment**
Type of spotlights .....halogen car spotlights
Lamp power (W).....50 (per spotlight)
Number 2
Position .....front, mounted on reling
Power supply (battery, generator) .....12V car battery

8 **Other equipment**
GPS-type / fabric .....handheld / Garmin eTrax
Sonar type / fabric.....handheld, mounted at rear end of boat / Garmin Synergy, GPSMAP 178 SOUNDER
Maps (scale).....navigation maps (based on Carte de Pilotage)

9 **Personnel**
Fish team (sampling unit) total number on boat 3
Total crew involved per site (incl. landbased) 3
Number of cars .....- (transport by “Vienna 115”)
Number of trailers.....- (transport by “Vienna 115”)
Number of boats 1

2.6 Equipment (National Teams)

It was very important that all the samples were taken in a comparable manner to limit the inherent high variation in sampling efficiency. Effort was made to ensure that all the sampling teams were using similar equipment and sampling strategies but availability or financial aspects finally led to considerable variations in the kind of equipment used.

Although the electric generators were usually of equal quality, the rest of the sampling gear was not. Electric booms were only provided by the German, Austrian, Hungarian and Croatian teams. The size and shape of used dip nets or handheld- anodes also varied considerably and affected the catch efficiency. Therefore, a brief description of each team’s performance will be given. This should not be seen as criticism but as objective background information as availability and handling of equipment in each country depends a lot on the background of the teams (e.g. previous needs to sample according to the EU-WFD) and all teams did their best to fulfil the goals. Wherever possible, the sampling gear and strategy of the core team is used as reference. However, it has to be considered that the limited preparation time and funds did not allow an optimal arrangement even for the core team.

Regarding the samplings performed by the national teams in the tributaries, basically the described equipment was used, but there could be considerable variations in methods, due to the smaller size of the sampled rivers.

2.6.1 Germany

The German team used only electrofishing equipment. The boom fishing method was comparable to that of the core team. Their use of handheld anodes was a little bit different in arrangement. Two handheld anodes were used simultaneously (instead of one) for shocking and catching fish (instead of dip-net use). However, the way the handhelds were used was efficient in its way, but rather comparable to boom fishing than the handheld fishing of the core team. As the German team was not equipped to do the fishing by wading and only few shallow areas occurred at their sampling sites, they were sampled only by boat. Thus, juvenile or small fish were not sampled with equal efficiency compared to other teams but sufficiently according to annex V of WFD.

The team made an experienced impression. In the beginning their sampling strategy (habitat type, start / end point) was harmonized with the overall fish survey's strategy, as some habitats did not reach the minimum length for fishing strips.

Species determination in the field was done correctly. Determination of the recently in Bavaria occurring species *Gymnocephalus baloni* from *G. cernuus* was discussed with the core team. All protocol work was done in situ on the boat.

Handheld anode fishing alongside (left) and off (right) the bank

Boom anode fishing (left) and outlet of fish tank with permanent freshwater supply and floating cathode (right)

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Germany
Team leader: ..... Andreas Kolbinger
Contact email: ..... Andreas.Kolbinger@lfu.bayern.de
Contact phone: ..... +49 881 185110

2 **Fishing boat**

Fabric / type ..... Vollmuth / MB 570
Material ..... aluminium boat
Length (m) 5.70
Width (m) 1.75
Weight (kg) empty / fully equipped ..... 335 / 1000

Engine (PS/kW, 2- or 4-stroke) ..... 50 PS, 4 stroke
Action radius of the boat (km) ..... ~50

3 **Electrofishing generator**

Fabric / type ..... Efko / FEG 13000
Current type ..... DC
Power (kW, maximum A, V) 13kW, 20A, 300-600V
Voltage and amperage during fishing ..... var.
Amperage during fishing ..... var.
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**

Anode (boom): materials ..... 2x 3.6m aluminium telescope sticks, 3.6m steel wire
Anode (boom): number ..... 10 steel wire anodes (each 1.5m)
Anode (boom): configuration of anodes ..... all activated simultaneously by foot pedal

Anode (handheld): materials ..... glass fiber stick, metal ring with net
Anode (handheld): number 2
Anode (handheld): diameter (cm) ..... 50 and 35
Anode (handheld): net/no net, mesh size ..... net, mesh size 25mm(50¢), 10mm(35¢)
Anode (handheld): cable length (m) 10
Anode (handheld): stick length (m) 2.5

Cathode: materials: ..... copper strands
Cathode: number 1
Cathode: length 4x 1.2m
Cathode: configuration ..... floating suspension

Security device (dead-man switch) ..... 1 foot pedal on fishing platform

5 **Dip-nets**

Material ..... glass fiber stick, metal ring with net
Number ..... 2 (using boom anode)
Net opening (diameter or height x width) ..... ¢50cm/ ¢35cm
Depth of net-sack (cm) 30
Mesh width (mm) ..... 25mm(50¢), 10mm(35¢)
Stick length (m) 2.5

6 **fish tanks on boat**

Material ..... aluminium, permanently fitted
Number 1
Size/volume (cm) ..... 100x60x35 (210 lt)
Permanent freshwater supply ..... yes
Oxygen supply ..... not used

7 **Additional night fishing equipment**

Type of spotlights ..... halogen car spotlights
Lamp power (W) ..... 55 (per spotlight)
Number 3
Position ..... front, mounted on boom
Power supply (battery, generator) ..... 12V car battery

8 **Other equipment**

GPS-type / fabric ..... handheld / Magellan GPS 315
Sonar type / fabric ..... not used
Maps (scale) ..... not used

9 **Personnel**

Fish team (sampling unit) total number on boat 4
Total crew involved per site (incl. landbased) 6
Number of cars 2
Number of trailers 1
Number of boats 1

2.6.2 Austria – sampling team 1 (ezb)

The first Austrian team was responsible for all Danube sites except JDS13 (Wildungsmauer/ Hainburg). Electrofishing (handheld, boom) was performed in the same way as by the core team. The additional sampling methods used by this team could not be observed, as they were performed after the finalization of electrofishing efforts in the sites. The team was very efficient and experienced and adapted their sampling strategy to the habitat (fishing by boat or wading). The excellent navigation skills of the team leader enabled fishing close to the bank even in rather shallow water. Species determination in the field was done correctly. The additional, adjustable or handheld strong spotlight proved very useful for orientation during night fishing. All protocol work was done in situ on the boat.

Fishing platform with foot pedal of safety switch (left) and electro fishing with boom anode (right)

Electro fishing by wading with handheld anode on long cable (left) and protective working table with scale on boat (right)

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Austria
Team leader: ..... Gerald Zauner
Contact email: ..... zauner@ezb-fluss.at
Contact phone: ..... +43 7717 / 7176 11

2 **Fishing boat**

Fabric / type ..... Barro / customised type
Material ..... aluminium boat
Length (m) 5.00
Width (m) 1.90
Weight (kg) empty / fully equipped ..... ~260 / ~400 kg

Engine (PS/kW, 2- or 4-stroke) ..... 50 PS, 2 stroke
Action radius of the boat (km) ..... ~50 km ?

3 **Electrofishing generator**

Fabric / type ..... Efko
Current type ..... DC
Power (kW, maximum A, V) ..... 8 kW, 12A, 600V
Voltage and amperage during fishing ..... 450 V
Amperage during fishing ..... ~ 10-12A
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**

Anode (boom): materials ..... 2x 4m surf sticks, 3.20 m stainless steel wire
Anode (boom): number ..... 10 stainless steel wire anodes (each ~1,2 m)
Anode (boom): configuration of anodes ..... all activated simultaneously by foot pedal

Anode (handheld): materials ..... glass fiber stick, metal ring with net
Anode (handheld): number 1
Anode (handheld): diameter (cm) 32
Anode (handheld): net/no net, mesh size ..... net, mesh size 5mm
Anode (handheld): cable length (m) 6
Anode (handheld): stick length (m) 2

Cathode: materials: ..... stainless steel wire
Cathode: number 2
Cathode: length 2m
Cathode: configuration ..... see anode (boom)

Security device (dead-man switch) ..... 1 foot pedal on fishing platform

5 **Dip-nets**

Material ..... isolated aluminium / wood stick with net sack
Number ..... 1 (using handheld anode) or 2 (using boom anode)
Net opening (diameter or height x width) ..... ~ 30 x 50 cm (using handheld anode) / 40x60cm (using boom anode)
Depth of net-sack (cm) ..... 50 – 70 cm
Mesh width (mm) ..... 5 / 10 mm
Stick length (m) ..... 2m / 3m

6 **fish tanks on boat**

Material ..... aluminium
Number 1
Size/volume ..... ~ 40x90x70 (250 l)
Permanent freshwater supply ..... no
Oxygen supply ..... not used

7 **Additional night fishing equipment**

Type of spotlights ..... halogen car spotlights
Lamp power (W) ..... 50 / 100 W
Number 4
Position ..... 2 x front, mounted on reling; 1 x side
Power supply (battery, generator) ..... Engine battery

8 **Other equipment**

GPS-type / fabric ..... handheld / Garmin
Sonar type / fabric ..... -
Maps (scale) ..... navigation maps (based on Carte de Pilotage)

9 **Personnel**

Fish team (sampling unit) total number on boat 4
Total crew involved per site (incl. landbased) 4
Number of cars 1
Number of trailers 1
Number of boats 1

2.6.3 Austria – sampling team 2 (TBS)

The second Austrian team was responsible for JDS13 (Wildungsmauer/Hainburg). Basically, electrofishing was performed in the same way as by the core team and the Austrian team 1, but handheld fishing was done only from boat and not wading during observation. Like the German team, this Austrian team was not equipped for wading but did drive the boat closer to the bank than the German team. The additional sampling methods used by this team could not be observed, as they were performed after the finalization of electrofishing efforts in the sites. Species determination in the field was done correctly. All protocol work was done in situ on the boat.

Electrofishing with handheld anode (left) and boom anode (right)

Floating cathode

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Austria
Team leader: ..... Thomas Spindler/Michael Schabuss
Contact email: ..... office@tb-spindler.at
Contact phone: ..... +43 2245 89776

2 **Fishing boat**

Fabric / type ..... Barro
Material ..... aluminium
Length (m) 5
Width (m) 1,5
Weight (kg) empty / fully equipped ..... 400 /800

Engine (PS/kW, 2- or 4-stroke) ..... outboard motor , Honda 40 PS, 4 stroke
Action radius of the boat (km) ..... ~100

3 **Electrofishing generator**

Fabric / type ..... Efko / FEG 11000
Current type ..... DC

Power (kW, maximum A, V) 11kW, 30A, 300-600V
Voltage and amperage during fishing 500V
Amperage during fishing 20A
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**

Anode (boom): materials ..... 2x 3m glass fibre surf sticks, 2m stainless steel wire
Anode (boom): number ..... 10 stainless steel wire anodes (each 1,5m)
Anode (boom): configuration of anodes ..... all activated simultaneously by foot pedal

Anode (handheld): materials ..... glass fiber stick, metal ring with net
Anode (handheld): number 1
Anode (handheld): diameter (cm) 50
Anode (handheld): net/no net, mesh size ..... net, mesh size 5mm
Anode (handheld): cable length (m) 6
Anode (handheld): stick length (m) 3

Cathode: materials: ..... copper wire
Cathode: number 1
Cathode: length ..... 2m wires bundled
Cathode: configuration ..... wire

Security device (dead-man switch) ..... 1 foot pedal on fishing platform

5 **Dip-nets**

Material ..... GFK stick, steel frame with net sack
Number ..... 1 (using handheld anode) or 2 (using boom anode)
Net opening (diameter or height x width) 50x60cm
Depth of net-sack (cm) 50
Mesh width (mm) 5
Stick length (m) 2

6 **fish tanks on boat**

Material ..... poly-carbon
Number 2
Size/volume ..... 40x40x75 (120 lt)
Permanent freshwater supply ..... no
Oxygen supply ..... yes

7 **Additional night fishing equipment**

Type of spotlights ..... halogen car spotlights
Lamp power (W) ..... 50 (per spotlight)
Number 2
Position ..... front, mounted on reling
Power supply (battery, generator) ..... 12V car battery

8 **Other equipment**

GPS-type / fabric ..... handheld / Garmin eTrax
Sonar type / fabric ..... no
Maps (scale) 25000

9 **Personnel**

Fish team (sampling unit) total number on boat 4
Total crew involved per site (incl. landbased) 4
Number of cars ..... 2 (transport by “Vienna 115”)
Number of trailers ..... 1 (transport by “Vienna 115”)
Number of boats 1

2.6.4 Austria – tributary sampling team (BAW)

A third Austrian team was responsible for all tributary sites. Sampling equipment and design was comparable to that of the core team.

The river Inn, the main tributary of the upper Danube, was sampled at 2 sites by the team of the Federal Agency of Water Management (BAW-IGF), led by Nikolaus Schotzko in October 2007

Electrofishing (handheld, boom) was performed in the same way as by the core team. Two similar boats were used at the same time – one for boom and one for handheld fishing. Additional sampling effort and methods beyond the agreed minimum for JDS-2 was applied (see above). The participation of Nikolaus Schotzko guarantees for comparable methodology. The team was very experienced and working professionally on different river types across Austria. Species determination in the field was done correctly. All protocol work was done in situ on the boat.

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Austria
Team leader: ..... Nikolaus Schotzko
Contact email: ..... nikolaus.schotzko@baw.at
Contact phone: ..... +43 6232 3847 16

2 **Fishing boat**

Fabric / type ..... Zodiac Mk III GR
Material ..... inflatable rubber boat, aluminium bottom
Length (m) 4.70
Width (m) 1.90
Weigth (kg) empty / fully equipped ..... 110 / 280 kg

Engine (PS/kW, 2- or 4-stroke) ..... 25 PS, 2 stroke
Action radius of the boat (km) ..... 40 km

3 **Electrofishing generator**

Fabric / type ..... Grassl EL 65 II Honda
Current type ..... DC
Power (kW, maximum A, V) ..... 13 kW, 20A, 550V
Voltage and amperage during fishing ..... 500 V
Amperage during fishing ..... 18 A
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**

Anode (boom): materials ..... 2x 4m surf sticks, 4 m stainless steel wire
Anode (boom): number ..... 8 stainless steel wire anodes (each 0,8 m)
Anode (boom): configuration of anodes ..... all activated simultaneously by foot pedal

Anode (handheld): materials ..... fiberglass stick, stainless steel ring
Anode (handheld): number 1
Anode (handheld): diameter (cm) 40
Anode (handheld): net/no net, mesh size ..... no net
Anode (handheld): cable length (m) 8
Anode (handheld): stick length (m) 3

Cathode: materials: ..... stainless steel
Cathode: number 2
Cathode: length ..... 2 x 4 x 1,2m
Cathode: configuration ..... see anode (boom)
Security device (dead-man switch) ..... 1 foot pedal on fishing platform

5 **Dip-nets**

Material ..... fibreglass stick with net sack

Number ..... 1 (using handheld anode) or 2 (using boom anode)
Net opening (diameter or height x width) ..... 50 cm
Depth of net-sack (cm) ..... 40 cm
Mesh width (mm) ..... 5 / 8 mm
Stick length (m) ..... 3 m

6 **fish tanks on boat**
Material ..... fibreglass
Number 2
Size/volume ..... 50x80x70 (280 l) & Ø 60 cm x 60 cm (50 l)
Permanent freshwater supply ..... no
Oxygen supply ..... yes

7 **Additional night fishing equipment**
Type of spotlights ..... halogen car spotlights
Lamp power (W) ..... 50 W
Number 2
Position ..... 2 x front, mounted up on T-bar
Power supply (battery, generator) ..... add. car battery (12 V, 48 Ah)

8 **Other equipment**
GPS-type / fabric ..... handheld / Garmin e-trex Legend Cx
Sonar type / fabric ..... Lowrance echosounder / LCX-15MT
Maps (scale) ..... ÖK 1: 50.000 & Google earth aerial view

9 **Personnel**
Fish team (sampling unit) total number on boat 3
Total crew involved per site (incl. landbased) 6
Number of cars 2
Number of trailers 2
Number of boats 2

2.6.5 Slovakia

The Slovakian team did no sampling at the main Danube sites because of insufficient equipment, but in tributaries/backwaters and was thus not observed by the Core Team. No night sampling was performed. Because of the small size of the boat, the electro-shocker was placed on the bank and linked to the handheld anode on the boat with a long wire. Two persons rowed the boat and the third person in front operated the handheld anode which was also used as dip net for collecting the fish. At each site, the stretch investigated was 60-100 m long but if necessary, depending on the number of fishes, the investigated stretch was longer. Sampling occurred mostly at the littoral zone.


Slovak fishing team

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**
Nationality: ..... Slovakia
Team leader: ..... Dr. Jaroslav Cerny
Contact email: ..... jaroslav.cerny@savba.sk
Contact phone: 00421903386648

2 **Fishing boat**

Fabric / type	T68 Sevylor
Material	inflatable rubber boat
Length (m)	~3.2
Width (m)	~1.3
Weight (kg) empty / fully equipped	50 / 50 (land-based electric generator)
Engine (PS/kW, 2- or 4-stroke)	no engine, used rows instead
Action radius of the boat (km)	3-5

3 **Electrofishing generator**

Fabric / type	ML3 Nela with Briggs & Stratton engine
Current type	DC
Power (kW, maximum A, V)	kW, 4A, 250/500V, 20-140 Hz
Voltage and amperage during fishing	300V, 1A
Amperage during fishing	0.5-1
Type of current used (direct, pulsing)	direct, pulsing

4 **Electric devices - anodes**

Anode (boom): materials	-
Anode (boom): number	-
Anode (boom): configuration of anodes	-
Anode (handheld): materials	plastic stick + metal ring with net
Anode (handheld): number	1
Anode (handheld): diameter (cm)	30
Anode (handheld): net/no net, mesh size	net, mesh size 14 mm
Anode (handheld): cable length (m)	generator placed on bank, handheld anode on long cable
Anode (handheld): stick length (m)	3
Cathode: materials:	copper bundle
Cathode: number	1
Cathode: length	1 m
Cathode: configuration	see anode (handheld)
Security device (dead-man switch)	switch on the handheld anode

5 **Dip-nets**

Material	wooden stick, steel frame with net sack
Number	1
Net opening (diameter or height x width)	30 cm
Depth of net-sack (cm)	30
Mesh width (mm)	5 and 14
Stick length (m)	2

6 **fish tanks on boat**

Material	plastic
Number	1
Size/volume	30 lt
Permanent freshwater supply	no
Oxygen supply	no

7 **Additional night fishing equipment**

Type of spotlights	-
Lamp power (W)	-
Number	-
Position	-
Power supply (battery, generator)	-

8 **Other equipment**

GPS-type / fabric	Garmin
Sonar type / fabric	-
Maps (scale)	1:25000

9 **Personnel**

Fish team (sampling unit) total number on boat	3
Total crew involved per site (incl. landbased)	4
Number of cars	1
Number of trailers	-
Number of boats	1

2.6.6 Czech Republic

The Czech team sampled exclusively tributary sites and was not observed by the Core Team. The monitoring of fish assemblages by electrofishing was performed on 21 and 22 August 2007 on the

Morava (river km 79.5-76.5) and Dyje (river km 17.0-14.0) rivers. Sampling was performed by drifting downstream on ten 300 m stripes per stretch, 2-7 m distant from the river bank.

Czech fishing team

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Czech
Team leader: ..... Zdenek Adamek
Contact email: ..... adamek@ivb.cz
Contact phone: ..... +420 543422523

2 **Fishing boat**

Fabric / type ..... regular pond fishing boat
Material ..... aluminium
Length (m) 3.80
Width (m) 1.40
Weight (kg) empty / fully equipped ..... 70 / ~150

Engine (PS/kW, 2- or 4-stroke) ..... 4 kW, 2-stroke
Action radius of the boat (km) ..... ~ 8km

3 **Electrofishing generator**

Fabric / type ..... Efko / FEG 13000
Current type ..... DC
Power (kW, maximum A, V) ..... 13kW, 60A, 250-450V, I.level 150-300V, II.level 300-600 V
Voltage and amperage during fishing ..... cca 300 V
Amperage during fishing ..... 17 A
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**

Anode (boom): materials ..... -
Anode (boom): number ..... -
Anode (boom): configuration of anodes ..... -
Anode (handheld): materials ..... glass fiber stick, metal ring with net
Anode (handheld): number 1
Anode (handheld): diameter (cm) 50
Anode (handheld): net/no net, mesh size ..... net, mesh size 15mm
Anode (handheld): cable length (m) ..... 5m + 3m stick
Anode (handheld): stick length (m) 3

Cathode: materials: ..... copper bundle
Cathode: number 1
Cathode: length ..... 4x 1m wires bundled
Cathode: configuration ..... -
Security device (dead-man switch) ..... 1 finger switch off

5 **Dip-nets**

Material ..... glass fiber stick, steel frame with net sack
Number 1
Net opening (diameter or height x width) 45cm
Depth of net-sack (cm) 45

Mesh width (mm) 5
Stick length (m) 2,5

6 **fish tanks on boat**
Material.....fibre glass
Number 2
Size/volume .....40x40x35 (50 lt)
Permanent freshwater supply .....no
Oxygen supply.....not used

7 **Additional night fishing equipment**
Type of spotlights .....-
Lamp power (W).....-
Number .....-
Position .....-
Power supply (battery, generator) .....-

8 **Other equipment**
GPS-type / fabric .....handheld / GARMIN
Sonar type / fabric.....
Maps (scale).....internet maps (www.mapy.cz)

9 **Personnel**
Fish team (sampling unit) total number on boat 3
Total crew involved per site (incl. landbased) 8
Number of cars 3
Number of trailers.....1
Number of boats 1

2.6.7 Hungary

The Hungarian team used only electrofishing equipment and, as the only team, pulsed DC. The boom anode was constructed in a different way, having two "spiders" of anode wires, one at the left and right front end of the construction each (See photo). Thus the electric field extended farther sideways as it did with the equipment of other teams. Fish detection and capture efficiency in the front centre was therefore limited, because the crew members on the platform, responsible for catching the fish, had their focus not on the front but to the sides of the boat. Therefore advantages and disadvantages of this arrangement kept balance and the effective strip-width was comparable to that of the other boom constructions.

The Hungarian team did not use handheld anodes and generally avoided shallow water (0.5m) for safety reasons but these gaps in sampling were agreed to be filled by the core team. The equipment was effective on large fish but it could not fully compensate for keeping some distance to the bank and the lack of shallow habitat strips completely. Although the equipment was state of the art, the type and arrangement of LED lamps for night fishing provided less light intensity than other equipment used throughout the survey. However, practice and experience in detecting fish in time compensated for this small disadvantage. An additionally used spot-light proved useful for navigation but could only be used during the first day.

Species determination in the field was done correctly, except the rare and unexpected occurrence of *Alburnoides bipunctatus*. All protocol work was done in situ on the boat.

“Spider” boom anode (left) and protective/working table with steering console (right)

Night sampling using LED lamps (left) and electro fishing with boom anode (right)

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Hungary
Team leader: ..... Gabor Guti
Contact email: ..... guti.g@t-online.hu
Contact phone: ..... +36 302 414 714

2 **Fishing boat**

Fabric / type ..... self-made (no-name)
Material ..... aluminium
Length (m) 5.2
Width (m) 1.8
Weight (kg) empty / fully equipped ..... ~900/~1100
Engine (PS/kW, 2- or 4-stroke) ..... 50 PS, 4 stroke + electric engine (thrust: 26 kg)
Action radius of the boat (km) ..... ~70

3 **Electrofishing generator**

Fabric / type ..... Hans Grassl (EL65 IIGI)
Current type ..... PDC/DC
Power (kW, maximum A, V) ..... 13kW (pulse 160 kW), 27/15 A, 600/300-600 V
Voltage and amperage during fishing ..... ~ 450 V
Amperage during fishing ..... ~ 12 A
Type of current used (direct, pulsing) ..... pulsing
Frequency ..... 10-100 Hz
Frequency during fishing ..... 50 Hz

4 **Electric devices - anodes**

Anode (boom): materials ..... 2 x 2.5m glass fibre sticks, 2 x 2 m stainless steel chains
Anode (boom): number ..... 2 x 12 stainless steel wire anodes (each 0.5 m)
Anode (boom): configuration of anodes ..... all activated simultaneously by foot pedals

Cathode: materials: ..... stainless steel wires + aluminium boat hull

Cathode: number 3
Cathode: length ..... 2 x 1.8 m wires (separated) + 5 m^2 boat hull
Cathode: configuration ..... umbrella

Security device (dead-man switch) ..... 2 foot pedals on fishing platform, 1 switch in seat of navigator, .
3 additional security switches on side-rails

5 **Dip-nets**
Material ..... isolated aluminium stick, aluminium frame with net sack
Number 2
Net opening (diameter or height x width) ..... 65 x 60 cm
Depth of net-sack (cm) 25
Mesh width (mm) 6
Stick length (m) 3

6 **fish tanks on boat**
Material ..... plastic + aluminium
Number ..... 2 + 1
Size/volume ..... plastic: 30 x 40 x 65 cm (75 l), aluminium: 50 x 30 x 100 cm (150 l)
Permanent freshwater supply ..... no
Oxygen supply ..... no

7 **Additional night fishing equipment**
Type of ~~spot~~lights ..... halogen navigational spotlight, led lamps, fluorescent lamp
Lamp power (W) ..... 100 W (spotlight), 10 W (led lamps, fluorescent lamp)
Number ..... 1 spotlight, 8 led lamps (45 leds/lamp), 1 fluorescent lamp
Position ..... central, mounted on instrument panel; led lamps on side-rails
Power supply (battery, generator) ..... 12V car battery

8 **Other equipment**
GPS-type / fabric ..... handheld / Garmin Trex, mounted / Lowrance LCX 15 MT
Sonar type / fabric ..... mounted at rear end of boat / Lowrance LCX 15 MT
Maps (scale) ..... navigation maps (1:25.000)

9 **Personnel**
Fish team (sampling unit) total number on boat 4
Total crew involved per site (incl. landbased) 4
Number of cars 1
Number of trailers 1
Number of boats 1

2.6.8 Croatia

The Croatian team had equipment according to the requirements and thus performed handheld and boom electrofishing comparable to the Core Team. However, before the core team arrived, they used both anodes simultaneously but immediately changed this according to our intervention. A disadvantage was, due to the smaller boat size, the reduced extension of the electric field, as the distance between anode and cathode was limited by the boat's length. Furthermore, it led to the choice of an unsuitable fish tank on board with a bottleneck opening and positioned at the rear end of the boat, directly in front of the driver. Thus, difficulties in emptying the dip-nets occurred. The provided dip-nets were standard recreational angling support tools and not very suitable for electrofishing purposes.

Positive was the caging of fish in-stream and permanent freshwater supply for captured fish in the tanks on land. The team had a separate land-based crew, responsible for determining, measuring and weighing the fish. Although this could save some time during work, the full tanks from each strip had to be delivered by a second boat and exchanged in time for the next strip. As the land-based team took a considerable amount of time for measuring and weighing the individual fish for scientific purposes and their carrier boat was rather slow, no time could be gained.

The use of a separate generator supplying electricity for night fishing instead of battery supply proved a very convenient way. Like with the German team, species determination in the field was done correctly, except uncertainties concerning *Gymnocephalus baloni* and *G. cernuus*. All protocol work was done by a land-based team.

Boom anode (left) and plastic tube railing (right)

Exhaustion tube, electric generator and on board fish tank (left) and land based fish tanks with freshwater pump (right)

Electro fishing by wading with handheld anode (left) and by boat with boom anode (right)

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Croatia
Team leader: ..... Milorad Mrakovčić
Contact email: ..... milorad.mrakovcic@zg.htnet.hr
Contact phone: ..... +385 1 4877732

2 **Fishing boat**

Fabric / type ..... Quick Silver / Sport 430
Material ..... inflatable rubber boat, wooden floor

Length (m) 4.30
Width (m) 1.88
Weight (kg) empty / fully equipped ..... 96 / ~220

Engine (PS/kW, 2- or 4-stroke) ..... 10 PS, 2 stroke
Action radius of the boat (km) ..... ~10

3 **Electrofishing generator**
Fabric / type ..... Hans Grassl / EL65
Current type ..... DC, Pulse
Power (kW, maximum A, V) 11kW, 35A, 300-600V
Voltage and amperage during fishing ..... 250-500 V
Amperage during fishing ..... 25-30 A
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**
Anode (boom): materials ..... 2x 4m glass plastic water pipes
Anode (boom): number ..... 8 inox sling wire anodes (each 1,2m)
Anode (boom): configuration of anodes ..... all activated simultaneously by hand button

Anode (handheld): materials ..... glass fibre stick, metal ring with net
Anode (handheld): number 1
Anode (handheld): diameter (cm) 30
Anode (handheld): net/no net, mesh size ..... net, mesh size 5mm
Anode (handheld): cable length (m) 20
Anode (handheld): stick length (m) 3

Cathode: materials: ..... braided copper wire
Cathode: number 1
Cathode: length ..... /
Cathode: configuration ..... see anode (boom)

Security device (dead-man switch) ..... 1 hand button on fishing platform

5 **Dip-nets**
Material ..... fibreglass rod, steel frame with net sack
Number ..... 1 (using handheld anode) or 2 (using boom anode)
Net opening (diameter or height x width) 30x50cm
Depth of net-sack (cm) 40
Mesh width (mm) 5
Stick length (m) ..... 2 and 3 m

6 **fish tanks on boat**
Material ..... plastic
Number 1
Size/volume ..... 75 lt
Permanent freshwater supply ..... no
Oxygen supply ..... not used

7 **Additional night fishing equipment**
Type of spotlights ..... halogen reflector
Lamp power (W) ..... 150 (per reflector)
Number 2
Position ..... front, mounted on railing
Power supply (battery, generator) ..... 220V Honda motor generator

8 **Other equipment**
GPS-type / fabric ..... handheld / Garmin GPSmap 60c
Sonar type / fabric ..... handheld, mounted at rear end of boat / ?
Maps (scale) ..... navigation maps

9 **Personnel**
Fish team (sampling unit) total number on boat 4
Total crew involved per site (incl. landbased) 7
Number of cars ..... 1 (Renault traffic van)
Number of trailers 1
Number of boats ..... 2 (one on the roof of van)

2.6.9 Serbia

The equipment of the Serbian team was, except the state of the art electric generator, not optimal for field sampling on large rivers. The boat was not equipped with any kind of railing for the fishing crew. The handheld anodes were constructed of heavy iron material, only partly isolated, and not in

compliance with the usually considered normative standards. For safety reasons the handheld anode was tied to the boat which limited its mobility and handling. The initial attempts of using two such anodes in a fixed way instead of a boom did not work and thus only handheld fishing was possible. The latter proved to be not as efficient as handheld fishing of other teams. The provided dip-nets used were standard recreational angling support tools and not optimal for electrofishing purposes. The team had less experience in field samplings in large rivers than the other teams observed throughout the survey and felt rather uneasy at going with their boat across the wider areas of the river, especially when wind and waves became less comfortable for navigation.

The team was also not accustomed to measuring and recording their catch in situ on the boat and had to return to their land-based camp after each strip. As, additionally, their measuring and weighing procedures were more time consuming than needed (no separate land-based team overtaking the job) it limited the work efficiency and daily amount of sampled strips. This reduces the statistical value of the data for further analysis, even if the number of recorded fish and species is comparable to other sites and teams. Species determination in the field was done correctly, except few juvenile specimen. All protocol work was done by the fishing team at a land-based station.

Two handheld anodes (only one was finally used) with only partially isolated sticks

Electro fishing with handheld anode (left) and land based fish measuring station (right)

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... Serbia
Team leader: ..... Predrag Simonović
Contact email: ..... pedja@bf.bio. bg.ac.yu
Contact phone: ..... +381112187266

2 **Fishing boat**

Fabric / type	NELT / Novi Sad
Material	poly-carbon
Length (m)	4.50
Width (m)	1.50
Weigth (kg) empty / fully equipped	140 / ~380
Engine (PS/kW, 2- or 4-stroke)	30 PS, 2 stroke
Action radius of the boat (km)	~35

3 **Electrofishing generator**

Fabric / type	AquaTech / EL63 II GI
Current type	DC
Power (kW, maximum A, V)	5.0kW, 27/15A, 300/600V
Voltage and amperage during fishing	300V
Amperage during fishing	27A
Type of current used (direct, pulsing)	direct

4 **Electric devices - anodes**

Anode (boom): materials	not used
Anode (boom): number	not used
Anode (boom): configuration of anodes	not used
Anode (handheld): materials	isolated metal stick, metal ring without net
Anode (handheld): number	1
Anode (handheld): diameter (cm)	45
Anode (handheld): net/no net, mesh size	net, mesh size 5mm
Anode (handheld): cable length (m)	10m
Anode (handheld): stick length (m)	1.20m without ring
Cathode: materials:	copper wire
Cathode: number	1
Cathode: length	2 x 0.7m wires bundled
Cathode: configuration	activated simultaneously by safety swich
Security device (dead-man switch)	1 safety swich on electrofishing generator

5 **Dip-nets**

Material	aluminium stick, aluminium frame with net sack
Number	1 using handheld anode
Net opening (diameter or height x width)	50x40cm
Depth of net-sack (cm)	50
Mesh width (mm)	6
Stick length (m)	1.65m

6 **fish tanks on boat**

Material	plastic
Number	1
Size/volume	40x40x60 (96 lt)
Permanent freshwater supply	no
Oxygen supply	not used

7 **Additional night fishing equipment**

Type of spotlights	flashlight
Lamp power (W)	5 (per spotlight)
Number	2
Position	all position
Power supply (battery, generator)	3V battery

8 **Other equipment**

GPS-type / fabric	handheld / GARMIN Etrex Venture
Sonar type / fabric	not used
Maps (scale)	not used

9 **Personnel**

Fish team (sampling unit) total number on boat	3
Total crew involved per site (incl. landbased)	5
Number of cars	2
Number of trailers	1
Number of boats	1

2.6.10 Romania

The equipment of the Romanian team was basically state of the art, but they could not provide a boom construction to their boats because of legal restrictions (licence). Although the boats were big and stable and thus good for bridging the sometimes large distances at speed, their strong engines proved useless for navigating slowly along the banks as it is necessary for electrofishing. Thus, fishing was usually done rowing which worked sufficiently well with low-current conditions. The provided dip-nets used were comparable to standard recreational angling support tools and not very suitable for electrofishing purposes.

Although the team was also able to measure and record their catch in situ on the boat, their practise of measuring and weighing the fish deviated considerably from the repeatedly requested strategy. The separation of fish by species in advance to the measuring and weighing procedure was time consuming and the gathered weight data proved unreliable.

Thus, the combination of time consuming handheld fishing as well as fish counting, measuring and weighing limited the amount of sampled strips per day considerably. This reduces the statistical value of the data for further analysis, even if the number of recorded fish and species is comparable to other sites and teams. Species determination in the field was usually done correctly, although uncertainties existed with juvenile specimen and between the species *Abramis brama / Blicca bjoerkna* and *Gymnocephalus baloni / G. cernuus*. All protocol work was done in situ on the boat or nearby on land.

Independent of technical or logistical limitations it must be noted, that the Romanian team was responsible for the longest river section. They had to collect more samples than any other team besides bridging sometimes large distances on land and thus spent the longest time “on the go”, except the core team.

Electro fishing with handheld anode (left) and spotlight and torches used for night sampling (right)

Electric generator and cable roll (left) used for electro fishing by wading with handheld anode (right)

Small tanks for separating fish species (left) and plastic bags for group weighing of fish (right)

DESCRIPTIVE FORM FOR TECHNICAL EQUIPMENT USED

1 **Team**

Nationality: ..... JDS2 Natioanal Team Romania
Team leader: ..... Serban Iliescu
Contact email: ..... serban.iliescu@rowater.ro
Contact phone: 0040723632807;0040746270524

2 **Fishing boat**

Fabric / type ..... CONERO Drifting
Material ..... fiber glass
Length (m) 6
Width (m) 2
Weight (kg) empty / fully equipped ..... 600 Kg

Engine (PS/kW, 2- or 4-stroke) ..... outboard motor, SelvaPortofino 80 PS, 2 stroke
Action radius of the boat (km) ..... ~50

3 **Electrofishing generator**

Fabric / type ..... Hans Grassl, EL 64II GI
Current type ..... DC
Power (kW, maximum A, V) 7,5kW, 25A, 250-450V
Voltage and amperage during fishing ..... 200-250 V
Amperage during fishing ..... 12-15 A
Type of current used (direct, pulsing) ..... direct

4 **Electric devices - anodes**

Anode (boom): materials ..... -
Anode (boom): number ..... -
Anode (boom): configuration of anodes ..... -

Anode (handheld): materials ..... glass fiber stick, metal ring with net
Anode (handheld): number 1
Anode (handheld): diameter (cm) 30
Anode (handheld): net/no net, mesh size ..... net, mesh size 5mm
Anode (handheld): cable length (m) 6
Anode (handheld): stick length (m) 2

Cathode: materials: ..... copper braided
Cathode: number 1
Cathode: length ..... 4 m
Cathode: configuration ..... water submerged braided cable

Security device (dead-man switch) ..... hand held switch

5 **Dip-nets**

Material ..... steel frame with net sack, aluminium or wood stick
Number 2
Net opening (diameter or height x width) 50x50cm
Depth of net-sack (cm) 50
Mesh width (mm) 5
Stick length (m) 2

6 **fish tanks on boat**

Material ..... polyethilene
Number 2
Size/volume ..... 20 l each
Permanent freshwater supply ..... no
Oxygen supply ..... not used

7 **Additional night fishing equipment**

Type of spotlights ..... halogen boat spotlight
Lamp power (W) ..... 50 (per spotlight)?
Number 1
Position ..... middle on 2 m high master
Power supply (battery, generator) ..... 12V car battery

8 **Other equipment**

GPS-type / fabric ..... handheld / Garmin, E-trex
Sonar type / fabric ..... no
Maps (scale) 1:100.000

9 **Personnel** (numbers in brackets are for tributary sampling)

Fish team (sampling unit) total number on boat 5 (2)
Total crew involved per site (incl. landbased) 8 (4)
Number of cars 2 (1)
Number of trailers 2 (1)
Number of boats 2 (1)

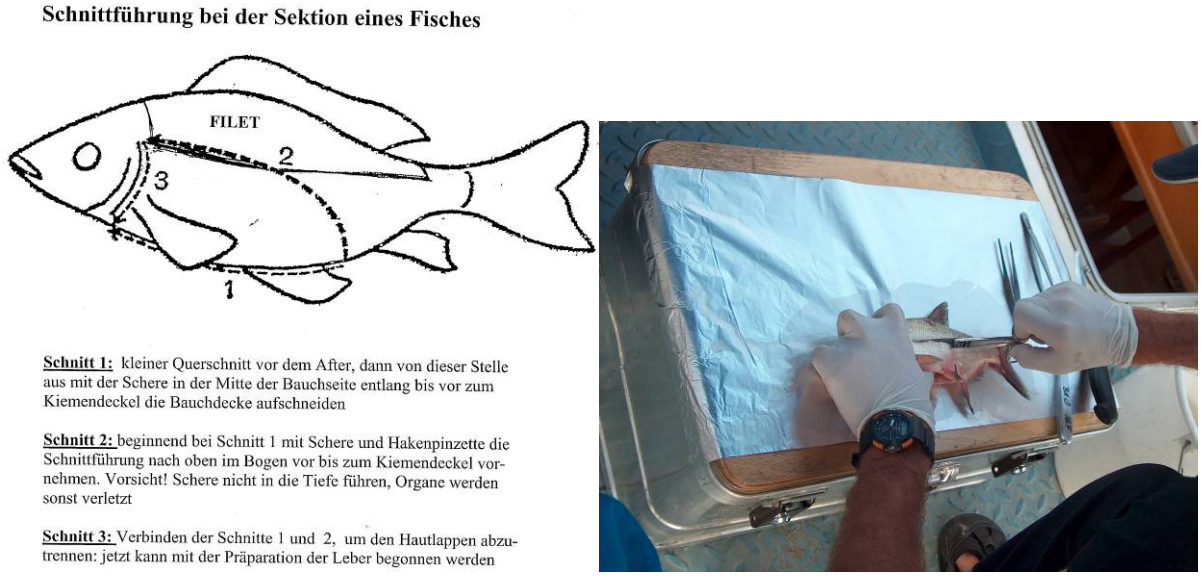
2.7 Fish tissue sampling

At selected sites (see table below) tissue samples (liver & muscle) were taken from 2-3 adult bream (*Abramis brama*) to be analysed for heavy metals and organic pollutants.

Fish were killed by a strong blow to the head. Body cavity was opened as shown in the Figure below. Liver tissue was dissected from the gut and collected in aluminium foil. Epaxonic muscle tissue was dissected from left and right body side, skin detached. The same tissues (liver, left and right muscle) were pooled from 2 to 3 fish. Each of these samples was equally divided into 2 subsamples – each one to be analysed at Bayerisches Landesamt für Umwelt, Referat 78 in Bavaria and JRC, Ispra.

The samples were packed in aluminium foil, labelled and fresh frozen packed in plastic bags.

For analyses of intestine parasite (Acanthocephala) accumulation of toxicants up to 10 specimens of medium sized barbels (Barbus barbus) from a few sites (JDS13, 16, 26 and 32) were collected, killed and frozen whole.



Scheme for fish tissue sampling as provided by Manfred Sengel (left) and real life action (right)

Individual tissues were divided for two laboratories (left) and usually this work was done late at night (right).

It was not possible to catch enough bream to prepare samples from all sites, so tissue samples were provided from the following JDS-sites: 2,7,13,16,26,32,40,77,91,94,95,96.

Labelling (left) and storing of samples in a freezer on Szechenyi (right)

2.8 Strategic remarks

The sampling procedure was carefully planned as seen from the SOP above, and equipment was prepared to ensure successful sampling. However, planning can never foresee the problems that arise when such an ambitious sampling schedule, involving many people, is carried out. The sampling crew experienced many types of problems, including: Bad weather conditions, breakdown of equipment, misunderstanding/lacking communication between core-team and national teams and delays due to border-crossing procedures. The main problem was, however the fact that the cruise speed of the core-team boat (Vienna 115) was much lower than foreseen. In the planning, it was expected that travelling downstream from one site to another would be done during night and only take 3-4 hours. In reality all travelling took place during day and at a much slower pace. This meant that there was much less time available for sampling than planned. Due to the time constrain, the core-team could not participate as actively as planned in the samplings done by the national teams and at many sites, the driftnet-sampling in the middle river could not be carried out as planned. The driftnet sampling required not only time, but also a very detailed local knowledge about the structure of the river bottom, to select suitable places for netting.

Therefore, whenever possible (weather conditions, location), “Vienna 115” was allowed to proceed for approximately 10-30 km downstream the actual sampling site and await our arrival “on the cruise”. Usually it meant that after finishing sampling, the core team had to drive at speed with the zodiac and catch up with “Vienna 115”. In this way up to 2 hours of time could be gained per day. However, under stormy weather conditions, which occurred rather often in the second half of the survey, this was not possible with the zodiac.

Whenever a common place for spending the night with the other ships was possible, the exact timing of arrival and location had to be arranged by phone call with the expedition leader, Bela Csanyi, the national coordinators or Jaroslav Slobodnik. Only in rare cases did a direct communication between the ships also provide the essential information. However, the regular need of spending the night together with the other ships (supply of fuel, electric power, water, washing machine, communication opportunities, data exchange) also limited our night fishing activities to those days, where the sampling site was nearby the night location.

3 Results

3.1 Explanatory notes

3.1.1 Taxonomic issues and species name abbreviations

The taxonomy relevant for the species list is in accordance with Kottelat & Freyhof (2007). However, for database conventions, some names were kept in the traditional way (e.g. *Abramis ballerus*). These species are marked with an asterix (*) in the table.

Throughout the survey, species names were discussed with national team members to assure a homogenous treatment and thus avoid inconsistencies or misunderstandings. Corresponding synonyms or, in exceptional cases (*), the current name in Kottelat & Freyhof (2007) are listed in the right column of the table below. The following equivalents (synonyms) were used by national teams. For easier labelling of figures, the following abbreviations are used:

Actual name (Kottelat & Freyhof, 2007)	abbreviation	English name	synonyms
Abramis ballerus *	ABR-BAL	Blue bream	Ballerus ballerus *
Abramis brama	ABR-BRA	Bream	
Abramis sapa *	ABR-SAP	Danube bream	Ballerus sapa *
Acipenser ruthenus	ACI-RUT	Sterlet	
Acipenser stellatus	ACI-STE	Starry sturgeon	
Alburnoides bipunctatus	ALB-BIP	Spirlin	
Alburnus alburnus	ALB-ALB	Bleak	
Ameiurus melas	AME-MEL	Black bullhead	Ictalurus melas
Ameiurus nebulosus	AME-NEB	Brown bullhead	Ictalurus nebulosus
Anguilla anguilla	ANG-ANG	Eel	
Aspius aspius	ASP-ASP	Asp	
Barbatula barbatula	BAR-BUL	Stone loach	
Barbus barbus	BAR-BAR	Barbel	
Barbus peloponnesius *	BAR-PEL	Romanian barbel	Barbus petenyi *
Benthophiloides brauneri	BEN-BRA	Beardless tadpole goby	
Benthophilus nudus	BEN-NUD	Black Sea tadpole-goby	Benthophilus stellatus
Blicca bjoerkna	ABR-BJO	White bream	Abramis bjoerkna
Carassius carassius	CAR-CAR	Crucian carp	
Carassius gibelio	CAR-GIB	Prussian carp	Carassius auratus
Chondrostoma nasus	CHO-NAS	Nase	
Cobitis elongatoides	COB-ELO	Spined loach	Cobitis taenia
Cottus gobio	COT-GOB	Bullhead	
Ctenopharyngodon idella	CTE-IDE	Grass carp	
Cyprinus carpio	CYP-CAR	Carp	
Esox lucius	ESO-LUC	Pike	
Eudontomyzon mariae	EUD-MAR	Ukrainian lamprey	
Gasterosteus aculeatus *	GAS-ACU	Threespine stickleback	Gasterosteus gymnurus *
Gobio gobio	GOB-GOB	Gudgeon	
Gymnocephalus baloni	GYM-BAL	Danube ruffe	
Gymnocephalus cernuus	GYM-CER	Ruffe	
Gymnocephalus schraetser	GYM-SCH	Schraetser	
Hucho hucho	HUC-HUC	Danube salmon	
Hypophthalmichthys molitrix	HYP-MOL	Silver carp	
Lampetra planeri	LAM-PLA	Brook lamprey	
Lepomis gibbosus	LEP-GIB	Pumkinseed	
Leuciscus idus	LEU-IDU	Ide	
Leuciscus leuciscus	LEU-LEU	Dace	
Lota lota	LOT-LOT	Burbot	
Misgurnus fossilis	MIS-FOS	Weatherfish	
Mugil cephalus	MUG-CEP	Striped Mullet	

Neogobius eurycephalus	NEO-EUR	Mushroom goby	
Neogobius fluviatilis	NEO-FLU	Monkey goby	
Neogobius gymnotrachelus	NEO-GYM	Racer goby	
Neogobius kessleri	NEO-KES	Bighead goby	
Neogobius melanostomus	NEO-MEL	Round goby	
Oncorhynchus mykiss	ONC-MYK	Rainbow trout	
Pelecus cultratus	PEL-CUL	Sabre carp	
Perca fluviatilis	PER-FLU	Perch	
Perccottus glenii	PER-GLE	Chinese sleeper	
Phoxinus phoxinus	PHO-PHO	Minnow	
Proterorhinus semilunaris	PRO-SEM	Tubenose goby	Proterorhinus marmoratus
Pseudorasbora parva	PSE-PAR	Stone moroko	
Rhodeus amarus	RHO-SER	Bitterling	Rhodeus sericeus
Romanogobio kesslerii	ROM-KES	Kessler's gudgeon	Gobio kesslerii
Romanogobio uranoscopus	ROM-URA	Danubian gudgeon	Gobio uranoscopus
Romanogobio vladykovi	ROM-VLA	White-finned gudgeon	Gobio albipinnatus
Rutilus pigus *	RUT-PIG	Danube roach	Rutilus virgo *
Rutilus rutilus	RUT-RUT	Roach	
Sabanejewia balcanica	SAB-BAL	Balcan loach	
Salmo trutta fario	SAL-TFF	Brown trout	
Sander lucioperca	SAN-LUC	Pikeperch	
Sander volgensis	SAN-VOL	Volga pikeperch	
Scardinius erythrophthalmus	SCA-ERY	Rudd	
Silurus glanis	SIL-GLA	Wels catfish	
Squalius cephalus	SQU-CEP	Chub	Leuciscus cephalus
Syngnathus abaster	SYN-ABA	Black-striped pipefish	
Thymallus thymallus	THY-THY	Grayling	
Tinca tinca	TIN-TIN	Tench	
Vimba vimba	VIM-VIM	Vimba bream	
Zingel streber	ZIN-STR	Streber	
Zingel zingel	ZIN-ZIN	Zingel	

3.1.2 Explanation on sampling sites included in data set

The final data set includes 45 Danube sites and 21 tributary sites. Of the Danube sites, 40 were sampled throughout the survey by the core team and national teams. Additional 5 sites (JDS9, 16a, 17a, 18a, 18b) were contributed by the national teams after the survey's completion but – due to reduced sampling effort and comparability – only one site (JDS9) can be used for all analysis. The other sites will be used only for species occurrence and relative abundance.

For some sampling sites the site-number was altered (JDS39a, JDS91a and JDS93a) to better reflect the distance from the nearest original JDS site.

3.2 Time table and diary

As sampling effort was often limited because of other tasks (e.g. navigation time), a time table indicating roughly the position and tasks of our support vessel (Vienna 115) and sampling activities (day / night) of the Core Team and the national teams is provided. As it is considered to be of informative and reference value and not tale-telling, a descriptive diary is not provided. However, some background information on the events during the survey can be found at the webpage (http://www.icpdr.org/jds/diary).

TIME SCHEDULE			TASKS	LOCATION / TRIP of Vienna 115						SAMPLING ACTIVITIES						REMARKS
Day	Date	Time	Core team (CT), National teams (NT), Vienna 115 (V115)	Country	Daily destination	Start-km	End-km	Distance (km)		JDS-site	Site name	River-km	National teams (NT)	NT	CT	Remarks
0	*Aug 03*		*Deliverance of fully equipped zodiac for upstream voyage with V115*	*D*	*Vienna*											
1	Aug 12		Arrival of Nikolaus Schotzko **(NS)** and Christian Wiesner **(CW)** in Regensburg; preparing accomodation on V115, first check of available equipment and information	D	Regensburg, Westhafen	2376	2376	0	0							
2	Aug 13		Completion, installation and check of equipment, arranging details of sampling procedures, first meeting with German national team	D	Regensburg, Westhafen	2376	2376	0	0							
3	Aug 14	Morning	CT meets NT-D, trip to JDS2	D	Regensburg, Westhafen	2376	2376	0	0							all trips by car
		Day	CT observes sampling of NT-D at JDS2													all trips by car; CT observes NT-D but had no sampling permission in Germany
		Afternoon	CW returns to Regensburg for "Launch ceremony"							**2**	Kelheim	2421-2417	D	yes	no *	
		Evening	NS returns and Jaroslav Cerny **(JC)** arrives to Regensburg												no	all trips by car
		Night	Night sampling by national team only													
4	Aug 15		Trip from Regensburg to Deggendorf; picking up and adapting drift nets for first use in Austria	D	Deggendorf, Schutzhafen	2376	2284	92	92							no sampling possible because of holiday
5	Aug 16	Morning	CT meets NT-D, trip to JDS5	D	Niederalteich	2284	2275	9	76							
		Day	CT observes sampling of NT-D at JDS5			2275	2275	0								
		Afternoon	JC stays with NT-D for night fishing at JDS5, others continue voyage to Kasten	A	Kasten, Jachthafen	2275	2208	67		**5**	Niederalteich	2277-2273	D	yes	no *	* CT observes NT-D but had no sampling permission in Germany
			NT-D with JC do night fishing at JDS5													
		Night	V115 stays in Kasten, NS+CW join NT-A1 for night fishing at JDS7			2208	2208	0		**7**	Jochenstein	2215-2204	A1	yes	no *	* for security reasons, CT only observes NT-A1 but did not start with own equipment at night
6	Aug 17	Morning	NT-D and JC arrive in Obernzell	A	Jochenstein	2208	2204	4	73	**7**	Jochenstein	2215-2204	D, A1	yes	yes *	* only drift net sampling
		Day	NT-D with JC, CW joins NT-A1, NS starts drift net fishing supported by NT-A1 members, V115 waits in Jochenstein													
		Afternoon	CT continues voyage to Linz		Linz	2204	2135	69					D	yes	no	
		Night	NT-D does night fishing at JDS7													
			NT-A1 does night fishing at JDS8			2135	2135	0		**8**	Enghagen	2118-2110	A	yes	no	due to the late arrival at Linz, only CW joined the local meeting briefly
7	Aug 18	Morning	Trip from Linz to Enghagen, adaptation of the drift net for next use	A	Enghagen	2135	2118	17	98							
		Day	Sampling at JDS8, JC joins NT-A1, V115 waits in Mauthausen		Mauthausen	2118	2111	7		**8**	Enghagen	2118-2110	A1	yes	yes	
		Afternoon	CT continues voyage to Melk		Melk, Hafen Luberegg	2111	2037	74								
		Night	CT stays at Melk, NT-A1 does night fishing at JDS10			2037	2037	0		**10**	Oberloiben	2010-2006	A1	yes	no	
8	Aug 19	Morning	Trip from Melk to JDS10 Oberloiben	A	Oberloiben	2037	2012	25	108							
		Day	CT samples with NT-A1 at JDS10, V115 waits in Krems		Krems	2012	1999	13		**10**	Oberloiben	2010-2006	A1	yes	yes	last parallel sampling of NT-A1
		Afternoon	CT continues voyage to Vienna		Vienna	1999	1929	70								
		Night	CW leaves V115 to organize equipment and administrative tasks, others stay on V115			1929	1929	0								
9	Aug 20		Press event in Vienna, maintenance of equipment, arrangments for next day's interviews, data input, reports	A	Vienna	1929	1929	0	0							
10	Aug 21	Morning	Trip from Vienna to Bad Deutsch-Altenburg, CT meets with NT-A2 at JDS13	A	Bad Deutsch-Altenburg	1929	1887	42	64							
		Day	Interviews, show sampling, sampling at JDS13, Vienna115 waits in Hainburg		Hainburg	1887	1883	4							yes	
		Evening	CT continues voyage to Bratislava, CW stays with NT-A2 for night fishing	A / SK	Bratislava, Yacht harbor	1883	1865	18		**13**	Wildungs-mauer	1893-1882	A2	yes	no *	* only one CT member observes NT-A2
		Night	CW observes NT-A2 during night fishing at JDS13 and returns to CT late at night to CT, CT stay with V115 at Bratislava	SK												
11	Aug 22	Day	JC joins press meetings, in the afternoon CT goes by zodiac to JDS16, maintainance of V115	SK	Bratislava, Yacht harbor	1865	1865	0	0	**16**	Bratislava	1873-1871	SK *	no*	yes	* NT-SK present, but has no own equipment
		Night	night sampling at JDS16, observed by NT-SK													
12	Aug 23	Day	Continued day sampling at JDS16, in the afternon departure to Cunovo and sampling at JDS17	SK	Bratislava, Yacht harbor	1865	1865	0	13	**16**	Bratislava	1873-1871	SK *	no*	yes	* NT-SK present, but has no own equipment
		Afternoon			Cunovo	1865	1852	13		**17**	Cunovo	1857-1851				
		Night	Night fishing was cancelled because of thunderstorm			1852	1852	0						no	no	* NT-SK present, but has no own equipment
13	Aug 24	Day	Continued day sampling at JDS17	SK / HU	Cunovo	1852	1852	0	0	**17**	Cunovo	1857-1851	SK *	no*	yes	* NT-SK present, but has no own equipment
		Afternoon	CT continues voyage to Medvedov		Medvedov	1852	1805	47								
		Evening	"land trip" for buying petrol, first meeting with NT HU			1805	1805	0								
		Night	No night fishing at JDS18 possible as NT-HU was not familiar with site			1805	1805	0								
14	Aug 25	Day	Sampling at JDS18, V115 waits in Györ	HU	Györ	1805	1794	11	61	**18**	Medvedov	1806-1797	HU	yes	yes	CT-sampling only by electrofishing gear as priority was put on comparison of equipment
		Afternoon	CW joins NT-HU for night fishing, CT continues trip to Mocs		Mocs	1794	1744	50								
		Night	CW stays NT-HU but night fishing postponed until next day, CT stays in Mocs			1744	1744	0								
15	Aug 26	Morning	Trip from Mocs to Szob, including shopping stop at Sturovo	HU	Szob, Pilismarot harbour	1744	1705	39	39							
		Day	Sampling at JDS26			1705	1705	0		**26**	Szob	1706-1700	HU	yes	yes	CT uses drift nets and electro fishing
		Night														
16	Aug 27	Morning	Trip from Szob to Budapest	HU	Budapest, Ujpest harbour	1705	1653	52	52							
		Day	Shopping, preparations for next samplings, check and arrangement of furhter time schedule			1653	1653	0								
		Afternoon	Trip with zodiac to JDS30, sampling							**30**	Szentendre side arm	1664-1659 *	HU	yes	yes	* Drift net used as beach seine upstream of electrofishing site
		Night	CT meeting													

TIME SCHEDULE			TASKS	LOCATION / TRIP of Vienna 115						SAMPLING ACTIVITIES						REMARKS
Day	Date	Time	Core team (CT), National teams (NT), Vienna 115 (V115)	Country	Daily destination	Start-km	End-km	Distance (km)		JDS-site	Site name	River-km	National teams (NT)	NT	CT	Remarks
17	Aug 28	Day	Local trips with ships for press & public events, discussion with Tibor Kiss, Igor Liska and Jaroslav Slobodnik about abortion or continuation of fish survey	HU	Budapest, Ujpest harbour	1653	1653	0	0	30	Szentendre side arm	1664-1659	HU	yes	no	night fishing was done in the later evening
		Night								32	Budapest downstream	1634-1628	HU	yes	no	
18	Aug 29	Morning	Trip to JDS32, V115 stays in petrol harbour during sampling	HU	Budapest, petrol harbour	1653	1639	14	14							
		Day	Sampling at JDS32		downstr. Budapest	1639	1639	0	0	32	Budapest downstream	1634-1628	HU	yes	yes	
		Afternoon	CT continues voyage to Dunajvaros		Dunajvaros	1639	1578	61	61							
		Night	CT stays at Dunajvaros			1578	1578	0	0							
19	Aug 30	Day	Trip to Baja	HU	Baja	1578	1479	99	130							
		Afternoon	Short meeting with NT-HU to dsicuss problems with sampling, CT continues voyage to Mohacs		Mohacs	1479	1448	31								NT-HU could not find a proper place for bringing their boat to water around Baja
		Night	Night fishing at JDS39a			1448	1448	0		39a *	Mohacs	1457-1449	HU	yes	yes	* originally labelled JDS38
20	Aug 31	Day	Sampling at JDS39a	HU	Mohacs	1448	1448	0	0	39a *	Mohacs	1457-1449	HU	yes	yes	* originally labelled JDS38
		Afternoon	Waiting for Argus and Szechenyi													
		Night	CT stays in Mohacs for border crossing next morning													
21	Sep 1	Morning	border crossing delayed	HU / HR	Mohacs	1448	1448	0	68							
		Day	new CT member Grigore Davideanu **(GD)** arrives, border exit procedures further delayed													
		Afternoon	CT continues voyage to Batina but has to wait for other ships to do the final border passing procedures		Batina	1448	1430	18		40 *	Batina	1429-1423	HR	yes	no	* originally labelled JDS39
		Night	CW joins NT-HR for sampling at JDS40, CT moves on to Aljmas	HR	Almjas	1430	1380	50							no **	** only CW observes NT-HR
22	Sep 2	Day	Sampling at JDS41	HR	Aljmas	1380	1380	0	0	41	Aljmas	1383-1380	HR	yes	yes	
		Afternoon	JC and NS leave the CT and Gabor Guti **(GT)** joins the CT													
		Evening	CT continues until Vukovar		Vukovar	1380	1333	47	47							
		Night	NT-HR does night fishing at JDS41			1333	1333	0	0						no	
23	Sep 3	Morning	CT continues until Ilok	HR / RS	Ilok	1333	1303	30	30							
		Day	Sampling at JDS45			1303	1303	0								
		Evening	Border crossing into Serbia		Backa-Palanka	1303	1303	0		45	Ilok	1303-1299	HR	yes	yes	
		Night	Sampling at JDS45 on Croatian side, V115 stays on Serbian bank											no		
24	Sep 4	Morning	Trp to Novi Sad	RS	Novi Sad	1303	1255	48	48							
		Day	Sampling at JDS47			1255	1255	0		47	Novi Sad	1254-1251	RS	yes	yes	
		Night	Night fishing cancelled because of thunderstorm													
25	Sep 5	Morning	Trip to Belegish	RS	Belegish	1255	1202	53	85							
		Day	Sampling			1202	1202	0							yes	
		Afternoon	CT continues until Belgrade		Belgrade, mouth of Sava river	1202	1170	32		50	Belegish	1201-1197	RS	yes	no	
		Night	CT stays in Belgrade, NT-RS does night fishing at JDS50			1170	1170	0								
26	Sep 6		Press meeting and public event in Belgrade, shopping, reporting and maintainance activities	RS	Belgrade, mouth of Sava river	1170	1170	0	0							
27	Sep 7	Day	Trip with zodiac to JDS52, sampling, V115 stays in Belgrade	RS	Pancevo	1170	1170	0	54						yes	
		Afternoon	V115 continues trip to Smederevo and picks up CT		Smederevo	1170	1116	54		52	Pancevo	1164-1159	RS	yes	no	
		Night	CT stays in Smederevo, NT-RS does night fishing at JDS52			1116	1116	0								
28	Sep 8	Day	Trip with zodiac to JDS54, sampling, V115 stays in Smederevo	RS	Smederevo	1116	1116	0	21						yes	
		Afternoon	V115 continues trip to Kostolac and picks up CT		Kostolac	1116	1095	21		54	Grocka	1136-1130	RS	yes	no	
		Night	NT-RS does night fishing at JDS54													
		Night	CT does night fishing at JDS57			1095	1095	0		57	Velika Morava	1097-1094	RS	no	yes	night fishing was limited to 1 strip because of empty battery
29	Sep 9	Day	Sampling at JDS57	RS	Velika Morava	1095	1095	0	36	57	Velika Morava	1097-1094	RS	yes	yes	
		Afternoon	CT continues trip to Veliki Gradiste as captain of Argus refused further cruise at nightfall		Veliki Gradiste	1095	1059	36								
		Evening	Assissting in delivering samples from Szechenyi			1059	1059	0								
		Night	All ships stay overnight in Veliki Gradiste													
30	Sep 10	Morning	Border passage into Romania, GD left V115 to join NT-RO	RO	Moldova Veche	1059	1047	12	105							
		Day	CT except GD continues trip to Orsova, GD observes sampling of NT-RO at JDS60		Orsova	1047	954	93		60	Golubak Koronin	1046-1044	RO	yes	no *	* only one CT member observes NT-RO
		Night	CT stays in Orsova, NT-RO does night fishing at JDS60			954	954	0								
31	Sep 11	Morning	V115 continues trip through Iron Gate I unto Turnu Severin, CT proceeds to JDS63 by zodiac	RO	Turnu Severin	954	931	23	23							
		Day	Sampling at JDS63			931	931	0		63	Vrbica/ Simijan	928-923	RO	yes	yes	
		Night	Night sampling at JDS63													
32	Sep 12		Press meeting and public event in Turnu Severin, museum visit, reporting and maintainance activities, dinner and party	RO	Turnu Severin	931	931	0	0							
33	Sep 13	Day	GD & GG join NT-RO for sampling, CW stays on V115 and starts trip to Iron Gate II	RO	Iron Gate II	931	863	68	78							
		Afternoon	V115 continues trip to #, NT-RO samples at JDS64		Radujevac	863	853	10		64	Upstream Iron Gate II	883-881 *	RO	yes	no **	* 14 km upstream of actual JDS-point; ** two CT members observe NT-RO
		Night	V115 stays overnight in Radujevac, NT-RO does night fishing at JDS64			853	853	0								
34	Sep 14	Day	Early start from Radujevac, trip to Lom, NT-RO samples at JDS65 but could not be observed this time by CT	RO / BG	Lom	853	742	111	111	65	near Timok / Pristol	847-844	RO	yes	no	
		Evening	Meeting with Stojan Mihov from Bulgaria			742	742	0								
		Night	CT stays in Lom													

TIME SCHEDULE			TASKS	LOCATION / TRIP of Vienna 115						SAMPLING ACTIVITIES						REMARKS
Day	Date	Time	Core team (CT), National teams (NT), Vienna 115 (V115)	Country	Daily destination	Start-km	End-km	Distance (km)		JDS-site	Site name	River-km	National teams (NT)	NT	CT	Remarks
35	Sep 15	Morning	Trip to Kozloduy, CT detaches during the voyage and proceeds ahead by zodiac	RO / BG	Kozloduy	742	700	42	116							
		Day	NT-RO samples at JDS68 without CT participation							68	Calafat	791-798	RO	yes	no	only 2 strips in side channel sampled
			CT samples at JDS69, accompanied by Stojan Mihov representing Bulgaria, V115 continues until Oriahovo		Oriahovo	700	679	21		69	Kozloduy downstream	683-681	BG	no*	yes	* NT-BG only represented by Stojan Mihov, no own equipment
		Afternoon	CT continues trip to Corabia		Corabia (Baloiu island)	679	626	53								
		Night	V115 stays near Corabia, CT does night sampling at JDS72			626	626	0		72	Iskar downstream	628-626	BG	no*	yes	* NT-BG only represented by Stojan Mihov, no own equipment
			NT-RO does night sampling at JDS68							68	Calafat	791-798	RO	yes	no	only 1 strip in side channel sampled
36	Sep 16	Day	Day sampling at JDS72 until breakdown of equipment	RO / BG	Corabia (Baloiu island)	626	626	0	28	72	Iskar downstream	628-626	BG	no*	yes	* NT-BG only represented by Stojan Mihov, no own equipment
		Afternoon	Repair and maintanance of equiment while continuing the trip unto Turnu Magruele		Turnu Magurele	626	598	28								NT-RO did not sample that day
		Night	CT stays at Turnu Magruele, no night sampling possible for CT and NT			598	598	0								
37	Sep 17	Day	Sampling at JDS75	RO / BG	Turnu Magurele	598	598	0	46	75 *	Olt river	609-601	RO	yes	yes	* originally labelled JDS74
		Afternoon	CT continues trip until Svistov		Svistov	598	552	46							no	
		Night	V115 stays in Svistov, CT does night sampling on right bank at JDS77			552	552	0		77	Zimnicea/ Svishtov downstream	562-556	BG	no*	yes	* NT-BG only represented by Stojan Mihov, no own equipment
38	Sep 18	Day	CT samples right bank at JDS77	RO / BG	Svistov	552	552	0	57	77	Zimnicea/ Svishtov downstream	562-556	BG	no*	yes	* NT-BG only represented by Stojan Mihov, no own equipment
			NT-RO samples left bank at JDS77										RO	yes	no	
		Afternoon	CT continues trip until Ruse		Ruse	552	495	57								
		Night	CT stays in Ruse			495	495	0								
39	Sep 19		Press meeting and public event in Turnu Severin, shopping and repair of equipment, excursion	BG	Ruse	495	495	0	0							
40	Sep 20	Day	Sampling at JDS82	RO / BG	Ruse	495	495	0	63	82 *	Ruse/Giurgiu downstream	490-488	RO	yes	yes	* originally labelled JDS80
		Day	CT continues trip until Oltanita		Oltanita	495	432	63								
		Evening	Zodiac lifted onto Szechenyi for repair												no	
		Night	NT-RO does night sampling at JDS82, CT stays in Oltenita			432	432	0								
41	Sep 21	Day	Repair of zodiac on Szechenyi, maintainance of equipment, reporting	RO / BG	Oltanita	432	432	0	57							
		Afternoon	All ships continue trip until Silistra		Silistra	432	375	57		83	Arges upstream	434-432	RO	yes	no	
		Night	Ships stay in Silistra			375	375	0								
42	Sep 22	Morning	Zodiac put back to water	RO / BG	Silistra	375	375	0	77							
		Day	Sampling at JDS86							86	Chiciu/ Silistra	380-378	BG	no*	yes	* NT-BG only represented by Stojan Mihov, no own equipment
			NT-RO samples at JDS87							87	Cernavoda upstream	296-295	RO	yes	no	
		Afternoon	CT continues trip to Cernavoda	RO	Cernavoda	375	298	77								
		Night	CT stays at Cernavoda			298	298	0								
43	Sep 23	Day	CT travels until Galati, NT-RO samples at JDS89	RO	Galati	298	150	148	148	89	Braila downstream	163-162	RO	yes	no	Distance upstream of Galati measured in km, downstream in miles, km 150 = mile 81
		Evening	Arrival of CT in Galati, short visit to museum			150	150	0								
		Night	NT-RO does night sampling at JDS89													
44	Sep 24	Day	Check out procedure, GD leaves V115 to join NT-RO but does not meet them until the evening, NT-RO meanwhile samples at JDS91a; all ships start their voyage into Ukraine including check in	RO / UA	Reni	150	124	26	175	91a	Reni	137-128	RO	yes	no *	Distance upstream of Galati measured in km, downstream in miles, km 150 = mile 81 * only one CT member observes NT-RO ** Chilia arm & Bystroe canal have different km-range (0-116 km) than Sulina arm (0-80 km = 0-43 miles); branching at Sulina (mile 43 = km 80) / Chilia (km 116); difference = 36 km
		Noon	CW leaves V115 and continues trip on Szechenyi using time and space for report writing and organizing the final days including trip to Ukraine, V115 gets attached to Argus for making speed and night trip		Bystroe canal	124	11 **	149 **								
		Night	Ships arrive and stay over night near Bystroe canal in Ukraine; NT-RO does night sampling in JDS91a	UA		11 **	11 **	0 **								
45	Sep 25	Day	Trip with zodiac to JDS94, meeting with Ukrainian team, brief sampling with drift nets and bottom trawl (NT-UA), brief demonstration of electrofishing (CT), V115 follows other ships back to Vilkovo	UA	Vilkovo	11 **	20 **	9 **	114	94	Bystroe canal	5-6 **	UA	no *	yes	* NT-UA without electrofishing gear, using additional sampling methods, ** see previous day
		Afternoon	Prolonged and troublesome check out procedure			20 **	20 **	0 **								
		Evening	Return trip to Tulcea, V115 again attached to Argus	RO / UA	Tulcea	20 **	71	105 **								** see previous day
		Night	All ships stay in Tulcea	RO		71	71	0								
46	Sep 26	Morning	CT and NT-RO separate: CW joins NT-RO for sampling at JDS95, GD & GG take part of CT equipment and join NT-RO for sampling at JDS96; V115 remains in Tulcea	RO	Tulcea	71	71	0	0							All km values are derived from miles (see remarks above) * see description of tasks ** St.Gheorghe Arm has different km-range (0-108 km) than Sulina Arm and branches off at Sulina mile 34 = km 63
		Day	Sampling at JDS95							95	Sulina Arm	km 39 = mile 21	RO	yes *	no *	
			Sampling at JDS96							96	St. Gheorghe Arm	83-63 **	RO	no *	yes *	
		Evening	CW returns to Tulcea, as his NT-RO cannot sample at night at JDS95 because of troubles with outboard engine													
		Night	GD&GG with NT-RO do night sampling at JDS96, all ships stay in Tulcea													
47	Sep 27		Press meeting, dinner, excursion, CW & GG visit Danube Delta Institute and museum, shopping, preparation of return journey, farewell party	RO	Tulcea	71	71	0	0							
48	Sep 28	Day	NT-RO samples at JDS93a	RO	Tulcea	71	71	0	0	93a	Chilia Arm-Valcov	75-73	RO	yes	no	Chilia arm & Bystroe canal have different km-range (0-116 km) than Sulina arm (0-80 km = 0-43 miles); branching at Sulina (mile 43 = km 80) / Chilia (km 116)
			Packing of equipment, delivering samples, last meeting of JDS2 participants													
		Night	All ships stay in Tulcea													
49	Sep 29		Return journey		Vienna											
-	*Oct*		*Return of equipment*		*Vienna*											

3.3 Basic results

Effort

The fishing/sampling effort can be viewed as number of strips sampled or more correctly as fished area. When we compare samples from different sites, where different effort has been used, it is essential that the effort is not having impact on the evaluation of each site. Thus, if we assume that all samplings were done by equal efficiency, we have a basic comparable catch per unit effort, here as catch per m^2 fished. However, it is not possible to attain equal efficiency due to varying conditions, so for each sampling (strip) the team was estimating an efficiency (in %) for each species. With this additional information, it is possible to calculate the abundance of species and compare from site to site.

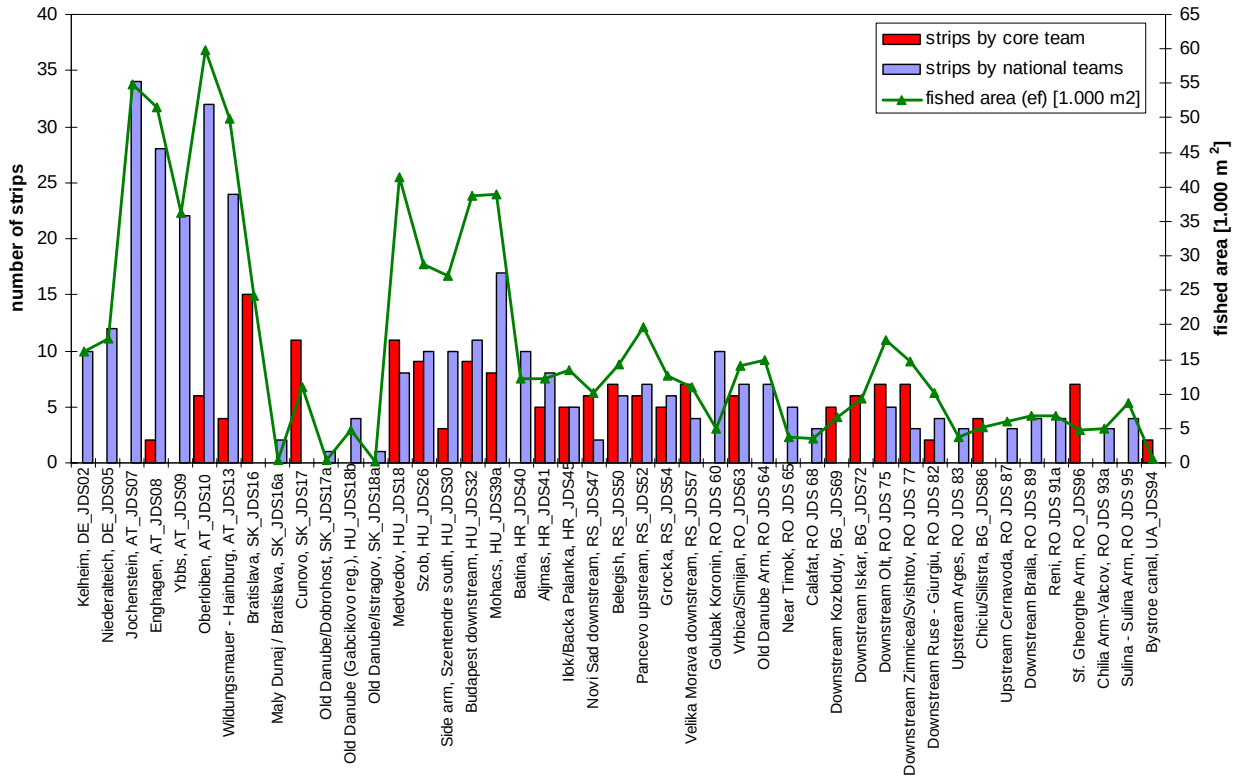


Fig. 1: Sampling effort (electro-fishing only) on the different (main river) sites in terms of strips and area fished.

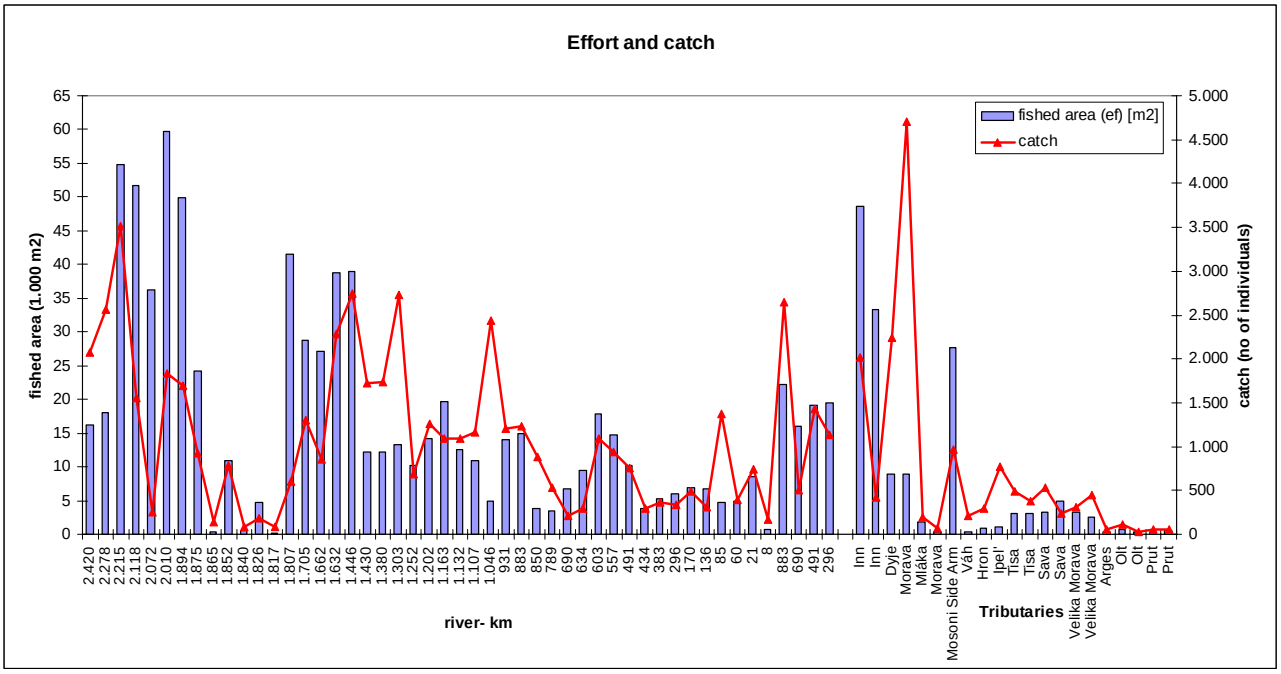


Fig. 2: Sampling effort and number of individual fish caught at each site by electro-fishing (including tributary sites).

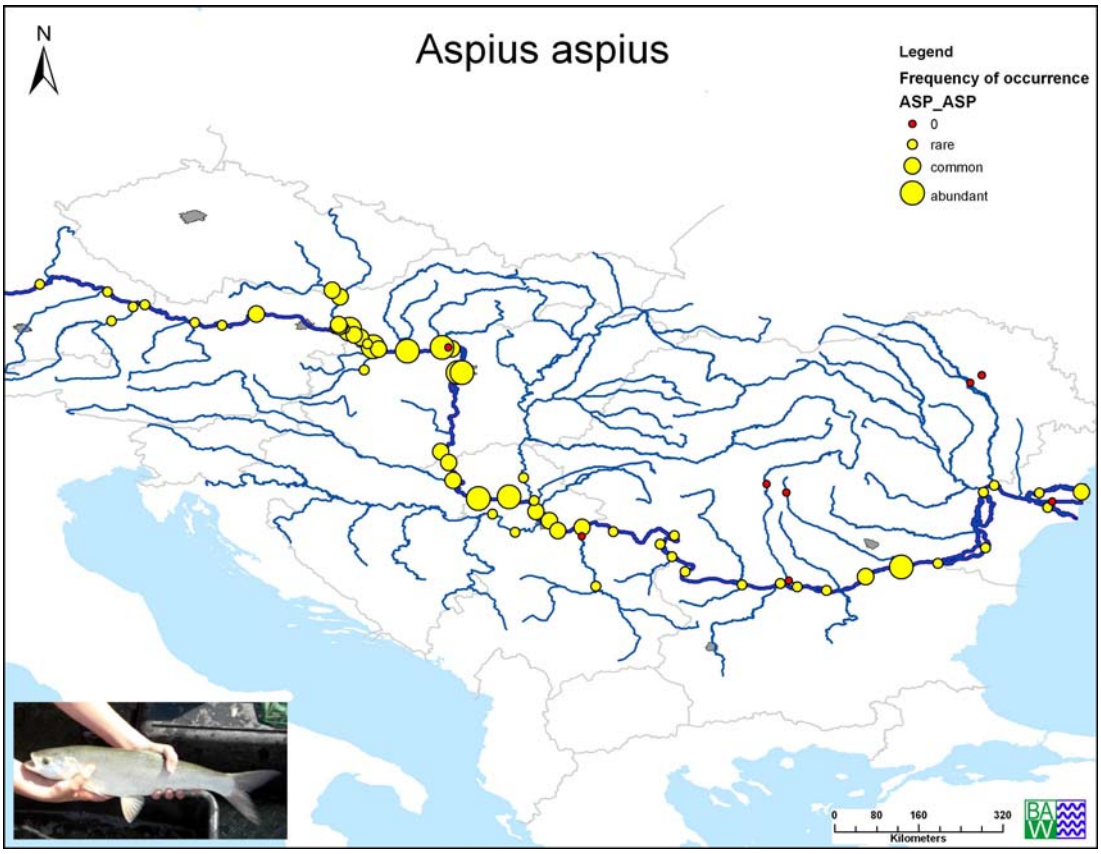
As can be seen from Figure 1 & 2, there was a great variation in sampling effort, even when the drift-netting is not considered. Including the results from netting is not practical due to very large areas fished, with very low number of individuals caught. The variation is mainly caused by the very intense sampling program, carried out by the Austrian national teams, where 25-35 strips were fished, compared to the 5 -20 strips per site fished in the rest of the river.

Within all 45 Danube- and 21 tributary sites a rather impressing number of 71 different fish species was caught. A total of 49,039 fish of 66 species were sampled in the Danube and 14,564 fish of 58 species were sampled in the tributaries. This shows a very high species diversity for any river and probably Danube still remains the European River with most fish species (e.g. the Rhine has in total about 60 species), despite the disappearance of several native species. As can be seen from Table III, bleak (*Alburnus alburnus*) was by far the most abundant fish in the catch and made up almost 50% of the number of fish captured. Bleak was abundant throughout the whole river.

Only very few sick, deformed, injured or parasite infested fish were caught, so in general the fish population seems healthy. In contrast, it is common to encounter a high proportion of deformed/damaged/diseased fish in many (Mediterranean) reservoirs.

In addition to the identification to species level and the examination for injuries/diseases, most individuals were also measured (total length). This means that for each site there is a size distribution available for all fish caught in substantial numbers. The histograms with length-frequency data from each site can be found in appendix 4.

In appendix 3, the distribution of each species is shown along with the length-frequency of the 20 most caught species (pooled site data).



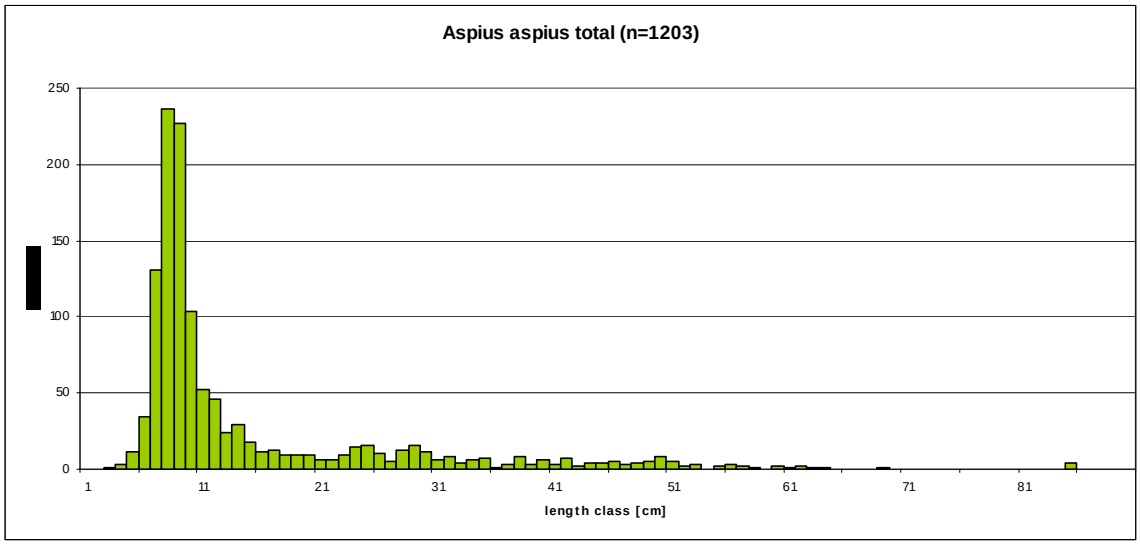


Fig. 3: Example of the information in Appendix 3, spatial- and size distribution of *Aspius aspius* in the samplings.

Migratory species

Migratory species like shad and sturgeon were not encountered at all or only rarely in the samples. The only migratory species that was caught in good numbers were eel. As the eels were only caught in the very upper river and are considered non-native in the Danube basin it must be concluded that these are exclusively results of stocking of juvenile eel, mainly done in the German part of the basin.

Neogobius and Burbot

Burbot (*Lota lota*) and several goby species (*Neogobius* spp.) were found in high or even dominating abundances along the rip-rap protected and regulated banks, an artificial habitat common along the upper and middle course of the Danube, that is not used by other species to a similar extent. In contrast to that, downstream of the Iron Gate, where the hydro-morphological impact on the river – not considering the dams and impoundments of the Iron Gate – is much lower, their abundance is low.

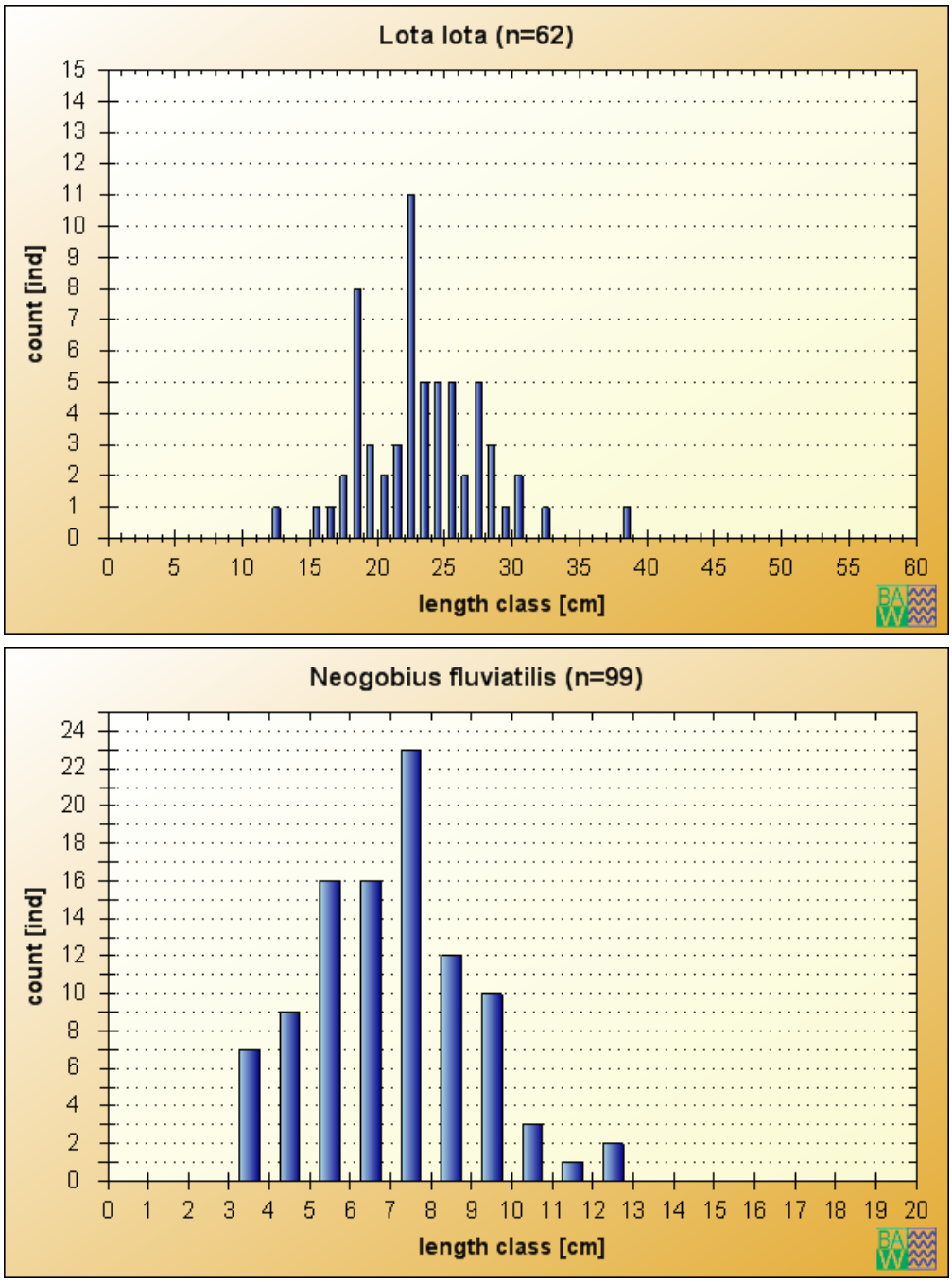


Fig. 4: Examples of size distribution of Burbot and Neogobius at JDS-41(Aljmas, HR).

Exotic species

Several non-native fish species have established populations in the Danube basin, mainly due to human activities, like stocking, angling and a general movement of fish. During the JDS-2 some of these were even abundant and widely distributed.

For a better understanding of the human impacts on the fish community, species numbers will repeatedly be referred to as native and non-native. However, the native range of a fish species may sometimes include only parts of a river catchment or river basin. Apart from migration processes that extent this native range in a natural way, translocation (intentional or unintentional) by human activities may also lead to occurrences outside a former and thus acknowledged "native range".

In case of the Danube, some Ponto-Caspian species, originating from the lowest section (downstream Iron Gate) and/or the Danube delta as well as the coastal areas of the Black Sea, are meanwhile found further upstream than historically known. Included are the species *Neogobius fluviatilis, N. gymnotrachelus, N. kesslerii, N. melanostomus, Proterorhinus semilunaris* and *Syngnathus abaster*. Wiesner (2005) showed clear evidence, that *Neogobius* spp. was translocated by freight vessels to the Upper Danube and at least 2 species have meanwhile become established there. Ladiges & Vogt (1979) and Kottelat & Freyhof (2007) describe native occurrences of *Proterorhinus* up to Austria, but a critical treatment of available data may also restrict the historical native range of this species to downstream of the Iron Gate, as it is followed here. Although a species-specific treatment would represent the natural conditions better, for practical reasons, all these species are treated as native in the section downstream of Iron Gate dam 2 and non-native upstream of this dam.

Table I: Danube fish species that are considered native in the lower river and non-native in the upper.

Species name	Ladiges & Vogt (1979)	Kottelat & Freyhof (2008)	JDS-Sites Upstream IG JDS2-64	JDS-Sites Downstream IG JDS65-96
Syngnathus spp.	upstream as far as "Kleine Walachei" = Oltenia, km 600	native in Black Sea and Danube Delta, invasive close up to Hungary	non-native	native
Neogobius spp.	Danube until Olt / "Kleine Walachei" (km 600)	native in lower Danube, first record of *N. fluviatilis* in Lake Balaton around 1970	non-native	native
Proterorhinus sp.	Donau bis March (km 1880)	native up to Vienna, invasive since 1970ies	non-native	native

Generally, 57 species are considered native at least in parts of the Danube catchment and 9 remain as entirely non-native (*Ameiurus melas, A. nebulosus, Anguilla anguilla, Ctenopharyngodon idella, Gasterosteus aculeatus, Hypophthalmichthys molitrix, Lepomis gibbosus, Oncorhynchus mykiss, Perccottus glenii*). As data for reference fish communities in tributaries are usually scarce, their sites are not considered here. The higher numbers of non-native fish upstream of Iron Gate 2 (Fig. 5) are a result of up to 5 goby species being considered non-native there.

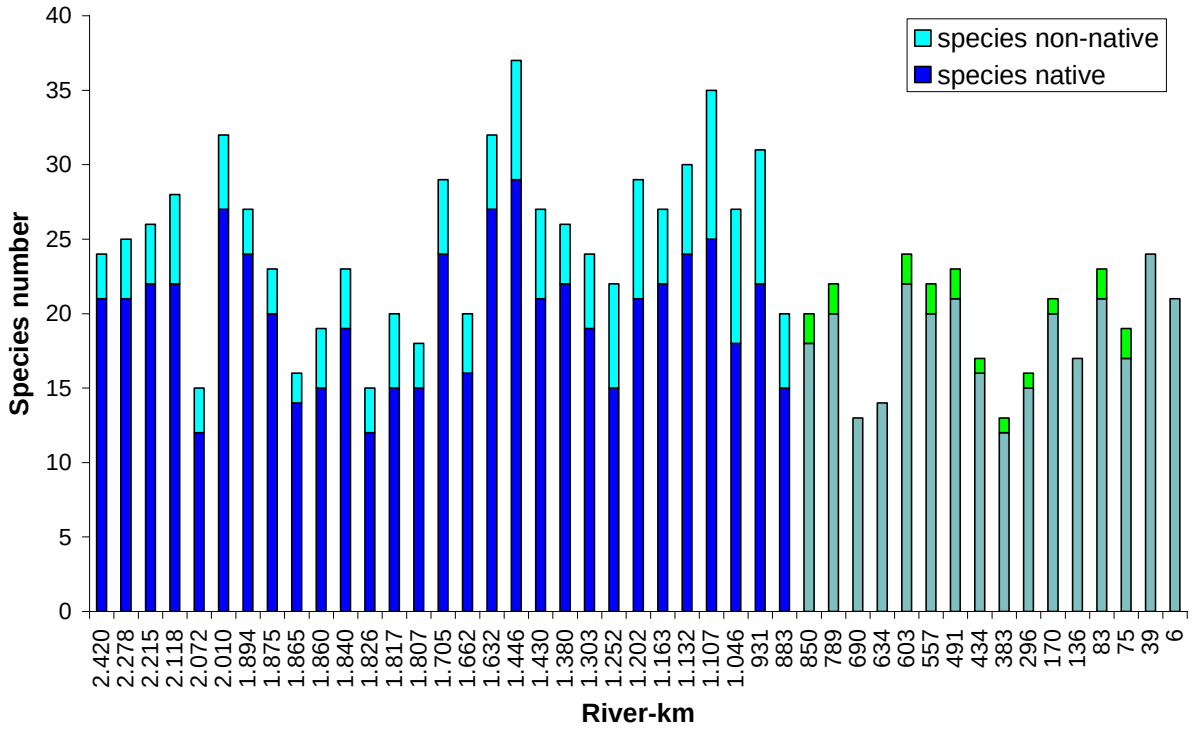


Fig. 5: Native and non-native species along the Danube (blue bars = upstream Iron Gate 2, green bars = downstream Iron Gate 2)

As can be seen from table II, most of the area was sampled during day with electro-fishing, but also results from night fishing and netting are incorporated in the database!

Table II. Overview of sampling effort

Location	Number of strips	Length of strips (m)	Total fished area (m^2)	Number of species	
Danube	504	182362	1378732	66	
Tributaries	150	43848	297261	58	
total	654	226210	1675993	71	
Location	Number of strips	Length of strips (M)	Total fished area (M^2)	Method	day / night
Danube	86	28047	139903	electrofishing	night
Danube	405	134465	615679	electrofishing	day
Danube	12	19800	623000	driftnet	day
Danube	1	50	150	beach seine	day
Danube total	***504***	***182362***	***1378732***		
Tributaries	12	4000	15680	electrofishing	night
Tributaries	131	35056	138921	electrofishing	day
Tributaries	5	3502	140080	driftnet	day
Tributaries	2	1290	2580	bottom trawl	day
Tributaries total	***150***	***43848***	***297261***		

Table III. The 20 most common species in the samplings

Scientific name	Number caught	Percentage of catch	Common name
Alburnus alburnus	23943	48.8	Bleak
Carassius gibelio	4344	8.9	Prussian carp
Neogobius melanostomus	4088	8.3	Round goby
Rutilus rutilus	2407	4.9	Roach
Neogobius kessleri	1533	3.1	Bighead goby
Aspius aspius	1233	2.5	Asp
Blicca bjoerkna	1201	2.4	White bream
Leuciscus idus	984	2.0	Ide
Perca fluviatilis	846	1.7	Perch
Abramis brama	807	1.6	Bream
Lota lota	761	1.6	Burbot
Chondrostoma nasus	683	1.4	Nase
Neogobius fluviatilis	634	1.3	Monkey goby
Sander lucioperca	514	1.0	Pikeperch
Squalius cephalus	462	0.9	Chub
Rhodeus amarus	457	0.9	Bitterling
Romanogobio vladykovi	426	0.9	White-finned gudgeon
Barbus barbus	414	0.8	Barbel
Lepomis gibbosus	386	0.8	Pumkinseed
Esox lucius	290	0.6	Pike

Danube sites

Figure 6 shows the relative abundance of the most important species (except bleak) on basis of river-km. Figure 7 show the habitat guild distribution and includes all species.

From both figures it becomes clear, that the upper part (up to river-km 1132), except the most upstream site JDS2 Kelheim, is heavily infested by the non-native goby-species. Further downstream, even in their native range (km 850-6), their importance is drastically lower and only slowly increases towards the delta, where *Neogobius eurycephalus* contributes mainly to their abundance.

In the German sampling sites JDS2 and 5 the non-native eel (*Anguilla anguilla*), a catadromous species, is abundant due to stocking but soon vanishes from the catches throughout the Austrian section. On the opposite end, the record of *Acipenser stellatus* (anadromous native species) can faintly be seen at km 6.

In the upper part, until km 1303, rheophil-A species are represented primarily by barbel (*Barbus barbus*) and nase (*Chondrostoma nasus*), whereas downstream of Iron Gate 2 this guild is mainly comprised by *Romanogobio vladykovi* and *Gymnocephalus schraetser*.

The rhithral guild, quite abundant in the Slovakian/Hungarian section is mainly represented by burbot (*Lota lota*) and thus, like the gobies, closely related to rip-rap bank protection.

The stagnophilous guild is represented primarily by Bitterling (*Rhodeus amarus*) but also by the non-native pumpkinseed (*Lepomis gibbosus*).

Indifferent species are present throughout the entire river course but their relative proportion is higher in the lower half of the river, especially because of increased abundance of Prussian carp (*Carassius gibelio*).

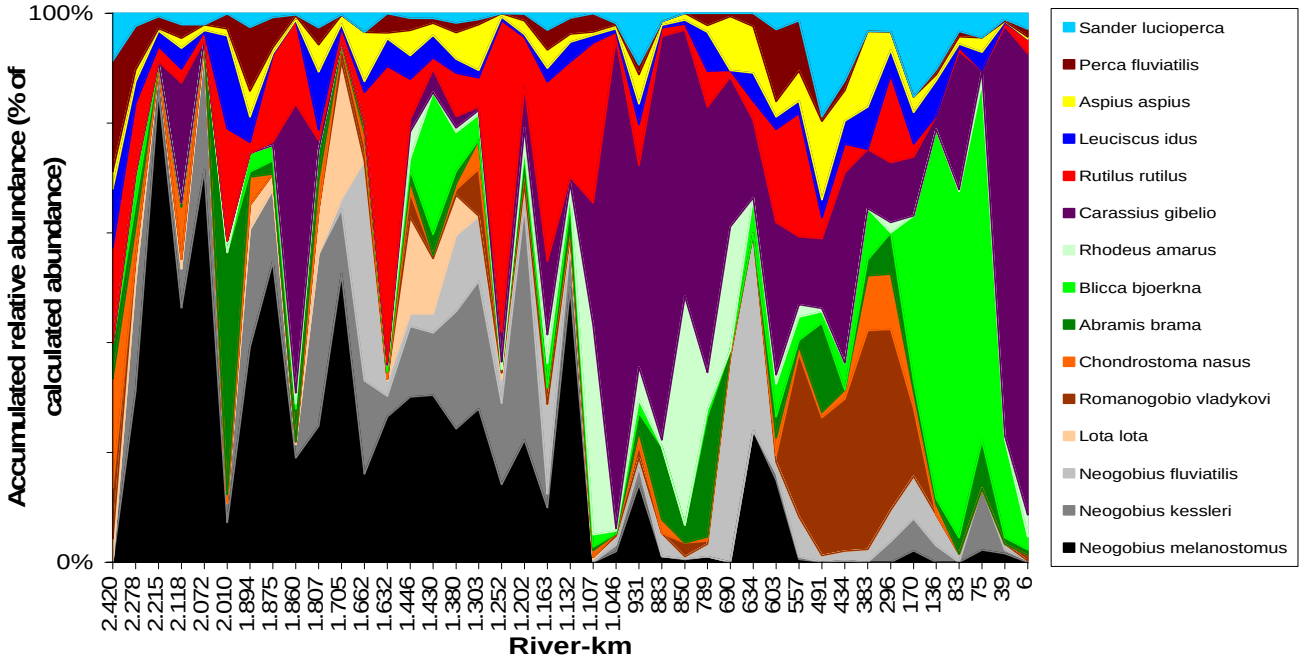


Fig. 6: Relative abundance of the most frequent species along the river course (based on calculated abundance; Bleak (*Alburnus alburnus*) is excluded, JDS16a, 17a, 18a, 18b excluded).

As can be seen from figure 7 and figure 8, fish belonging to the eurotypic guild are the most dominating. The higher proportion of eurytopics in the lower Danube River (fig. 7) reflects the flatter slope and moderate flow conditions (river character).

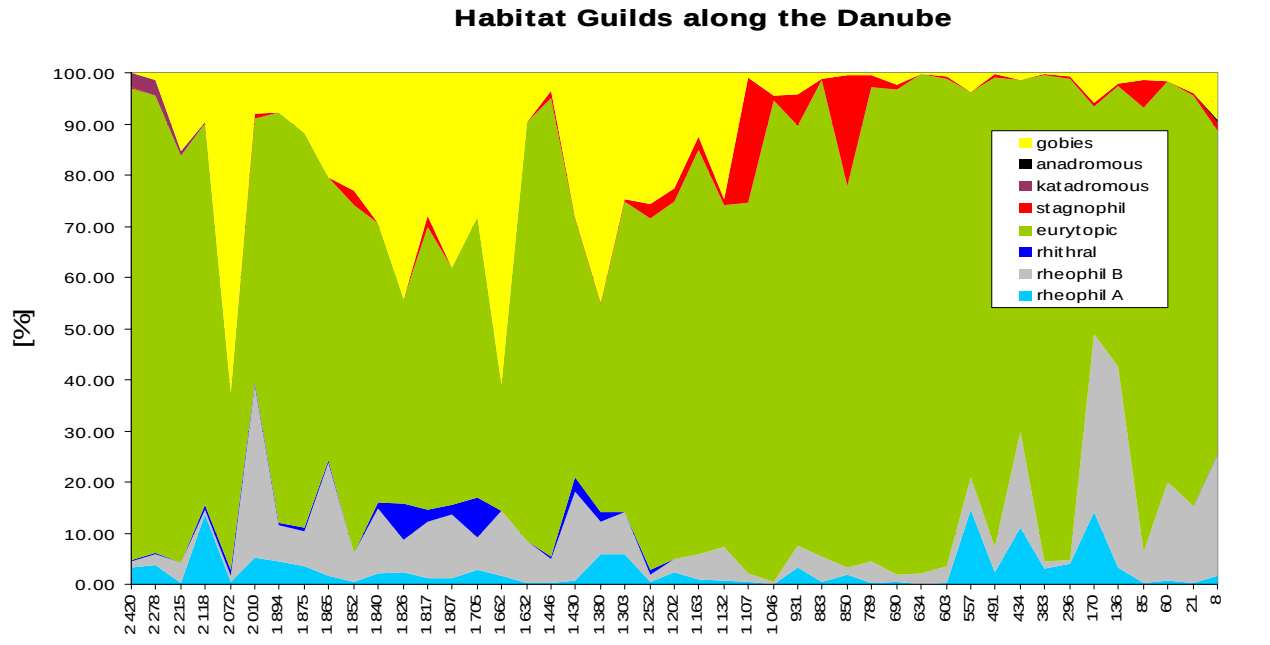


Fig. 7: Relative abundance of the ecological guilds along the river course (based on calculated abundance; JDS16a, 17a, 18a, 18b excluded).

Ecological guilds basically characterize fish species in terms of their ecological requirements. The classification used here describes their affiliation with flow velocity and thus riverine habitats. Rhithral species require cold and oxygen-rich headwaters at least for spawning.
Rheophil A and B species live in riverine habitats and use this environment (A) throughout their life circle or (B) make seasonal habitat shifts between the river and adjacent backwaters. On the contrary, stagnophil species inhabit stagnant water bodies and very often disconnected backwaters. Eurytopic species show no clear preference. More or less exceptions from this classification are the long distant migrating species that migrate upriver for spawning (anadromous) like sturgeons, or migrate seaward like eel (catadromous). Also gobies have been assigned to a separate guild, as they inhabit rivers, lakes and coastal areas in crevices of rocky substrate. Usually they are labelled ”speleophil“ (i.e. affiliated with cavities, especially for spawning) but to distinguish between them and similar species (e.g. *Cottus gobio*, here in the rhithral guild), thus highlighting their role in the Danube fish fauna, we decided to assign them to an individual class.
Thus the proportions of these guilds describe the fish community and river morphology and help detecting impacts on the river and its fish.

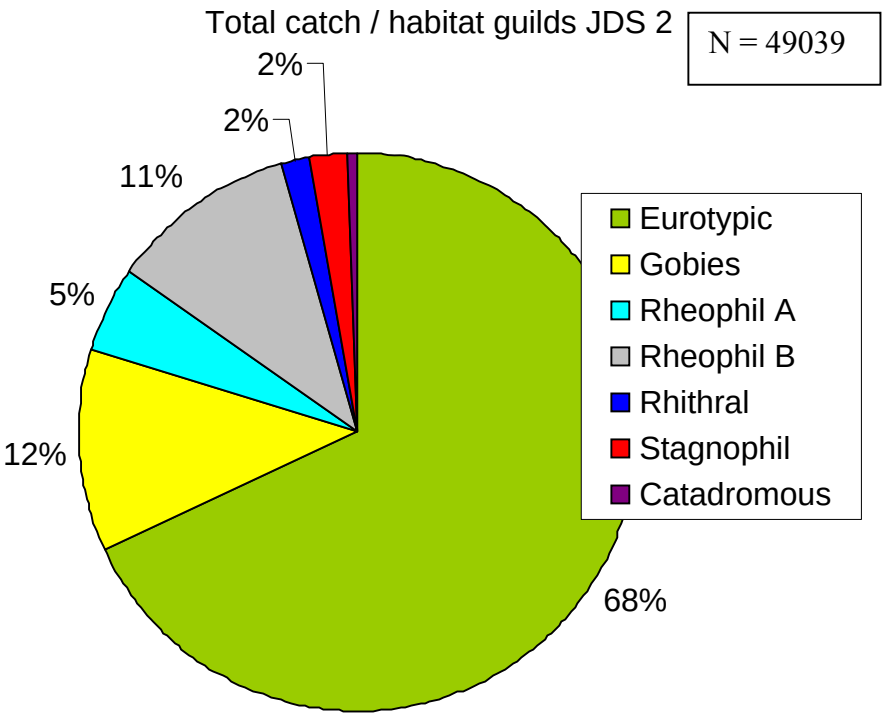


Fig. 8: Overall ecological guild representation from all the Danube sites.

Tributaries

In the 21 sites in the tributaries a total of 15,564 fish of 58 species were sampled by the national teams. The catches from the tributary sites varied even more than in the main river. This was not unexpected, but it makes it hard to make general statements about the status of the tributaries. According to the EFI (and FIA) scores, the tributaries seem to be in conditions from good to bad. The Morova at Lanzhot has the best score on the FIA of all sites and seem to have some of the least impacted fish fauna found in the Danube and lower tributaries.

Below (figure 9) are two examples of the guild distribution of catches in different tributaries. Information from each tributary can be seen in Appendix 2.

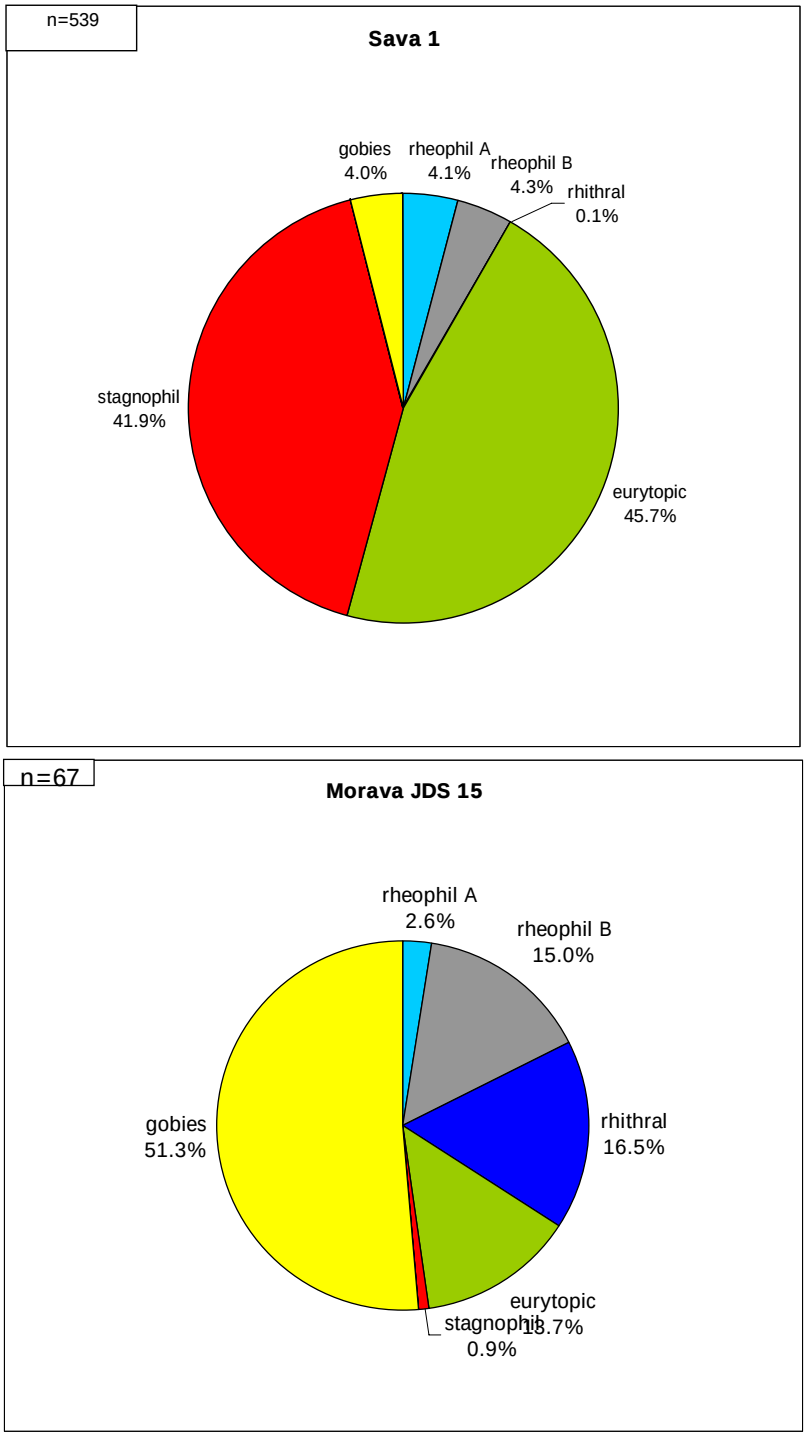


Figure 9. Ecological guilds from two tributaries, reflecting the large variation in fish composition.

3.4 Results per sampling site

In appendix 1, the basic results from all Danube sites are presented in table and graphic form, like the example below. In appendix 2, the same information is given for the tributary sites! NOTE that for the first 3 sites, abundance data are not shown because of a German agreement with local commercial fishers to not publish such data. Table IV and Figure 10 provide examples of that content. This is also the reason for lack of length frequency data for the German sites in Appendix 4.

Table IV. Example of site specific results in Appendix I and II, here from JDS30 (Appendix I).

JDS30	**section**	**5**	**site length**	**river width**	**date**	**27/08/07**
Szentendre	**r-km**	**1 662**	**5 000 m**	**230 m**		
HU						

	Electrofishing effort along the banks					
	handheld day	boom day	handh., night	boom, night	**beach seine**	**total**
strip number	2	8		2	1	13
total length [m]	230	3 480		860	50	4 620
fished area [m^2]	1 150	20 880		5 160	150	27 340

				Total Length [cm]			
Scientific Name	English Name	abundance [ind/ha]	biomass [kg/ha]	min	mean	max	n
Abramis brama	Bream	1.93	0.8	32.5	33.3	35.0	3
Abramis sapa	Danube bream	0.64	0.0	8.0	8.0	8.0	1
Alburnus alburnus	Bleak	641.90	8.0	3.5	10.1	17.0	498
Aspius aspius	Asp	334.63	8.0	5.5	15.2	63.0	99
Barbus barbus	Barbel	2.75	5.0	53.0	58.7	67.0	5
Chondrostoma nasus	Nase	21.20	0.1	5.0	8.8	19.5	17
Esox lucius	Pike	0.64	1.0	60.0	60.0	60.0	1
Eudontomyzon mariae	Ukrainian lamprey	2.18	0.0	9.0	13.0	16.0	5
Gymnocephalus schraetser	Schraetser	3.17	0.0	8.5	10.2	11.0	3
Leuciscus idus	Ide	35.88	0.9	7.5	19.5	30.0	7
Neogobius fluviatilis	Monkey goby	955.77	3.5	4.0	7.1	12.5	70
Neogobius gymnotrachelus	Racer goby	0.44	0.0	5.5	5.5	5.5	1
Neogobius kessleri	Bighead goby	354.25	3.2	5.0	8.2	14.0	26
Neogobius melanostomus	Round goby	507.02	1.7	4.0	8.3	13.5	39
Romanogobio vladykovi	White-finned gudgeon	11.19	0.1	8.0	9.1	12.5	17
Rutilus pigus	Danube roach	5.82	0.2	7.5	12.9	19.5	9
Rutilus rutilus	Roach	88.00	0.9	4.5	8.8	31.5	29
Sander lucioperca	Pikeperch	9.02	1.2	12.5	20.5	49.0	14
Squalius cephalus	Chub	1.92	0.4	22.0	25.5	28.0	4
Vimba vimba	Vimba bream	2.58	0.1	13.0	13.3	13.5	4
20 species	**total**	2 981	35			total number caught	**852**

INDEX	score	status
EFI	0.49	**Good**
fibs		
FIA	4.00	**Poor**

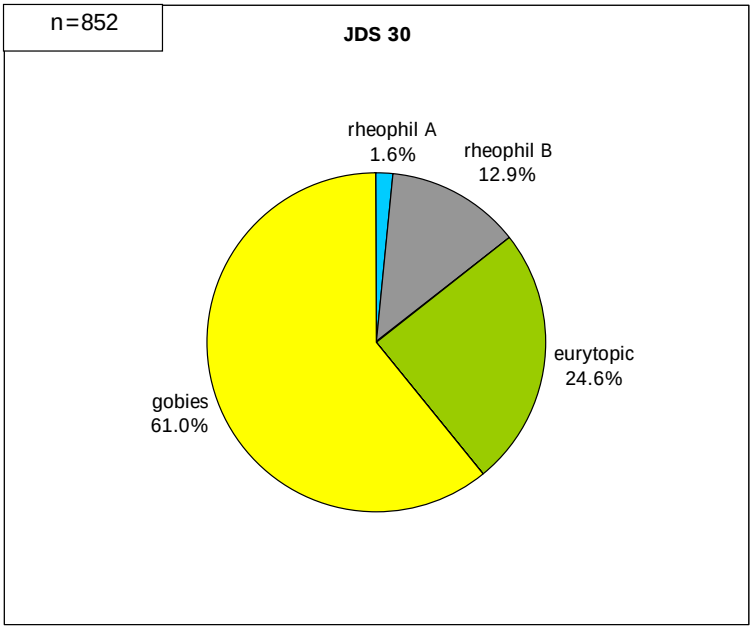


Figure 10. Example of site specific guild distribution in Appendix I and II, here from JDS30 (Appendix I).

Ecological classification - FISH INDEX

According to the requirements of the Water Framework Directive, all EU-member states must establish monitoring network and assessment methods for all 4 quality elements (phytoplankton, invertebrates, macrophytes & fish) in all natural waterbodies. Despite these clear requirements and much effort by most member states, it has proven difficult to develop solid, pressure sensitive indicators (metrics) based on the fish communities. Thus, the current status is that there are 8-9 officially approved national methods for assessing the ecological quality of *small and medium sized rivers* based on electrofishing sampling of the fish fauna. None of these national methods have yet been intercallibrated and accepted as tools for setting boundaries between ecological quality classes. So in the case of the Danube, we have the problem that no method has been developed for large rivers and from the Danube countries, only Germany and Austria have developed a national method. So, to use the fish results from the JDS-2 to evaluate the ecological quality along the Danube is challenging. We choose to calculate the scores from the Austrian Fish Index (FIA) and from the European Fish Index (EFI) that was developed by the EU-supported FAME project. The EFI has been developed by testing a long row of candidate metrics on a large pan-European fish database and testing their reaction to various pressures. The final EFI constitutes of 10 metrics that together produces a score between 0 and 1 which is then directly translated into EQ-class. In the process of testing and intercalibration it appeared that the EFI (as expected) had several shortcomings and limitations. We know that the EFI is sensitive to water quality pressures, but not very good in showing hydromorphological pressures like canalization and presence of obstacles (dams). In contrast the FIA (with 9 metrics) was developed to be able to detect hydromorphological pressures in Austria and thus, the two indices will show significant differences in scores at each site. Bearing this in mind, the assessment presented in Table VI, is at best a qualified guess of the “true state” of each site.
The missing FIA values are due to insufficient effort per site to allow calculation. FIA is a system of comparison between actual fish community and reference fish assemblage. To obtain a reliable score for all metrics used, it is necessary to have an adequate sample. In smaller streams this is achieved by removal methods (Moran-Zippin, DeLury), in medium sized river by strip-fishing method (Schmutz et al 2001) and for large rivers a minimum set of methods and effort was established, consisting of 5.000 m electrofishing strips (50 % of site length) during day and 2.000 m (20%) electrofishing at night. At Austrian sites that lead to a mean of 20 strips per site in the main channel during our national monitoring program; including backwaters a mean of 25 strips. Samples of additional methods (longlines, gillnets, driftnets, ...) did deliver some additional rare species, but did not change the index significantly (Schotzko et al in prep.).

The present results are currently being used for testing a revised and improved version of EFI, the EFI+ index, which has been adjusted to also cover the Danube species.

Table V: The 10 metrics used by the EFI and their response to human pressures (↓ = decrease; ↑ = increase of metric)

Metrics	Response to human pressures	
Trophic level		
1. Density of insectivorous species	↓	
2. Density of omnivorous species		↑
Reproduction strategy		
3. Density of phytophilic species		↑
4. Relative abundance of lithophilic species	↓	
Physical habitat		
5. Number of benthic species	↓	
6. Number of rheophilic species	↓	
General tolerance		
7. Relative number of intolerant species	↓	
8. Relative number of tolerant species		↑
Migratory behaviour		
9. Number of species migrating over long distances	↓	
10. Number of potamodromous species	↓	

Table VI: Indications of the ecological classification of sites by EFI and FIA (* insufficient data)**.**

River	Sitename	r-km	EFI	StatusEFI	FIA	Status FIA
Danube	Kelheim, DE_JDS02	2 420	0.52	Good	2.21	Good
Danube	Niederalteich, DE_JDS05	2 278	0.49	Good	2.26	Good
Danube	Jochenstein, AT_JDS07	2 215	0.50	Good	4.00	Poor
Danube	Enghagen, AT_JDS08	2 118	0.65	Good	4.00	Poor
Danube	Ybbs, AT_JDS09	2 072	0.35	Moderate	5.00	Bad
Danube	Oberloiben, AT_JDS10	2 010	0.49	Good	4.00	Poor
Danube	Wildungsmauer - Hainburg, AT_JDS13	1 894	0.45	Good	2.33	Good
Danube	Bratislava, SK_JDS16	1 875	0.40	Moderate	3.04	Moderate
Danube	Maly Dunaj / Bratislava, SK_JDS16a	1 865	0.43	Moderate	3.07	Moderate
Danube	Cunovo, SK_JDS17	1 852	0.20	Poor	5.00	Bad
Danube	Old Danube/Dobrohost, SK_JDS17a	1 840	0.35	Moderate		*
Danube	Old Danube (Gabcikovo region), HU_JDS18b	1 826	0.50	Good		*
Danube	Old Danube/Istragov, SK_JDS18a	1 817	0.38	Moderate		*

Danube	Medvedov, HU_JDS18	1 807	0.47	Good	5.00	Bad
Danube	Szob, HU_JDS26	1 705	0.47	Good	2.52	Moderate
Danube	Szentendre south, side arm, HU_JDS30	1 662	0.49	Good	4.00	Poor
Danube	Budapest downstream, HU_JDS32	1 632	0.48	Good	2.10	Good
Danube	Mohacs, HU_JDS39a	1 446	0.51	Good	1.96	Good
Danube	Batina, HR_JDS40	1 430	0.48	Good	2.45	Moderate
Danube	Aljmas, HR_JDS41	1 380	0.43	Moderate	2.56	Moderate
Danube	Ilok/Backa Palanka, HR_JDS45	1 303	0.37	Moderate	2.61	Moderate
Danube	Novi Sad downstream, RS_JDS47	1 252	0.44	Moderate	3.34	Moderate
Danube	Belegish, RS_JDS50	1 202	0.32	Moderate	2.67	Moderate
Danube	Pancevo upstream, RS_JDS52	1 163	0.34	Moderate	2.81	Moderate
Danube	Grocka, RS_JDS54	1 132	0.36	Moderate	2.62	Moderate
Danube	Velika Morava downstream, RS_JDS57	1 107	0.31	Moderate	2.42	Good
Danube	Golubak Koronin, RO JDS60	1 046	0.15	Bad	2.89	Moderate
Danube	Vrbica/Simijan, RO_JDS63	931	0.31	Moderate	2.20	Good
Danube	Old Danube Arm, RO JDS64	883	0.24	Poor		*
Danube	Near Timok, RO JDS65	850	0.29	Moderate		*
Danube	Calafat, RO JDS68	789	0.26	Poor		*
Danube	Downstream Kozloduy, BG_JDS69	690	0.23	Poor		*
Danube	Downstream Iskar, BG_JDS72	634	0.21	Poor		*
Danube	Downstream Olt, RO JDS75 (+ Olt river confl)	603	0.30	Moderate	4.00	Poor
Danube	Downstream Zimnicea/Svishtov, RO JDS77	557	0.27	Poor	5.00	Bad
Danube	Downstream Ruse - Giurgiu, RO JDS82	491	0.29	Moderate		*
Danube	Upstream Arges, RO JDS83	434	0.21	Poor		*
Danube	Chiciu/Silistra, BG_JDS86	383	0.25	Poor		*
Danube	Upstream Cernavoda, RO JDS87	296	0.35	Moderate		*
Danube	Downstream Braila, RO JDS89	170	0.32	Moderate		*
Danube	Reni, RO JDS91a	136	0.29	Moderate		*
Danube	Sf. Gheorghe Arm, RO_JDS96	85	0.26	Poor		*
Danube	Chilia Arm-Valcov, RO JDS93a	60	0.29	Moderate		*
Danube	Sulina - Sulina Arm, RO JDS95	21	0.37	Moderate		*
Danube	Bystroe canal, UA_JDS94	8	0.60	Good		*
Danube	JDS64, 65, 68 (pooled sites)	883-789	0.30	Moderate	1.98	Good
Danube	JDS69, 72 (pooled sites)	690-634	0.24	Poor	3.15	Moderate
Danube	JDS82, 83, 86 (pooled sites)	491-383	0.31	Moderate	2.12	Good
Danube	JDS87, 89, 91a (pooled sites)	296-136	0.34	Moderate	2	Good
TRIBUTARIES						
Inn	Inn, Braunau	49	0.61	Good	4.00	Poor
Inn	Inn, Ingling, AT_JDS06a	5	0.41	Moderate	5.00	Bad
Dyje	Dyje, Pohansko	22	0.51	Good	2.08	Good
Morava	Morava, Lanzhot	79	0.54	Good	1.79	Good
Mláka	Mlaka mouth	0	0.33	Moderate	2.58	Moderate
Morava	Morava mouth, SK_JDS_15		0.45	Good		
Mosoni Side	Raab, Mosoni side arm, HU_JDS19	6	0.45	Moderate		

Arm						
Váh	Vah, Kamenicna, SK_JDS21	1	0.46	Good		
Hron	Hron, Kamenica nad Hronom, SK_JDS_24	1	0.57	Good		
Ipel'	Ipel' mouth, SK_JDS25	1	0.44	Moderate		
Tisa	Tisa, Titel		0.35	Moderate		
Tisa	Tisa, Novi Becej		0.40	Moderate		
Sava	Sava, Upstream Kupinovo		0.36	Moderate		
Sava	Sava, Stremska Mitrovica		0.32	Moderate		
Velika Morava	Velika Morava, Varvarin		0.44	Moderate		
Velika Morava	Velika Morava, Ljubicevski most		0.37	Moderate		
Arges	RO Arges river, Capataneni, RO_1_Arges		0.40	Moderate		
Olt	RO, Olt river, Caineni, RO_2_Olt_1		0.30	Moderate		
Olt	RO Olt river Izbiceni, RO_3_Olt_2		0.26	Poor		
Prut	RO Prut river, Ungheni, RO_4_Prut_1		0.53	Good		
Prut	RO Prut river, Bumbata, RO_5_Prut_2		0.36	Moderate		

In the main river there are 14 sites with good status, 21 with moderate, 9 with poor and 1 site with bad status. For the tributaries there are 7 good sites, 13 moderate sites and 1 poor site. The mean EFI-score for the Danube sites are 0.37, and for the sites in the Tributaries: 0.42. This means that if a mean of the site EFI values should be used for a final BQE-classification for the whole river, it would be classified as having moderate status.

As stated earlier, the EFI and FIA are NOT final tools for assessing the EQ of a river like Danube. Calculation of EFI includes many variables and there are several examples of EFI scores that do not reflect the real situation in the field. One such example is the case of the River Mlaka, a tributary of the River Morava situated few kilometres from the confluence with the Danube. Although the national team found a high diversity of fish species (26) in this small river, its EFI score is low (0.33). It is even lower than EFI for the Rivers Hron (0.57; 22 species) and Vah (0.46; 18 species). Moreover, the lower section of the River Mlaka has a natural character with no regulation, high diversity of microhabitats, etc. In other words, one would expect a much higher EFI score for Mlaka than for Hron and Vah.

How much sampling effort is necessary to make an assessment of EQ of a large river based on the fish community? This is an important question and the experience from this survey indicates that at least the EFI is not very dependant on effort. As can be seen from figure 10, even the sites with little sampling effort may score high and vice versa. It is very important that an index is insensitive to differences in sampling effort and thus, only 6 of the 10 EFI metrics are related to species diversity. However, there is off course a minimum level of sampling effort that is needed to give a comparable picture of a fish community and it should be noted that even at the JDS-2 sites with least effort, several km of river were electrofished. With equipment like it was used during JDS-2, it is possible for a team of 3-4 persons to make a decent sample in one day.

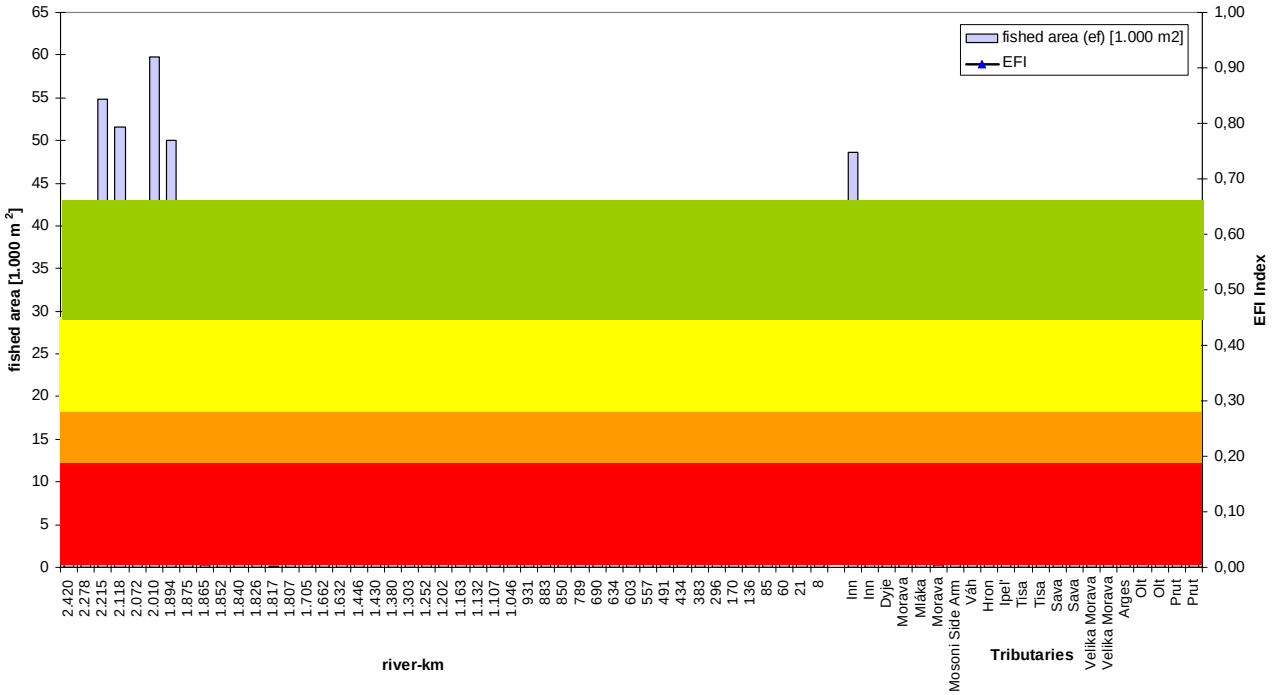


Fig. 11: Sampling effort and EFI-score (values on Y-axis is 1.000 of m^2).

3.5 Comparison of sampling methods

Clearly, electro-fishing has its limitations in sampling large, deep rivers. In this respect large rivers are comparable to lakes, where you can only sample the part of the fish community that are associated with the littoral zone. Even powerful generators and large cathode/anodes can only efficiently sample fish in water depth less than 2 meters. Thus, fish species that spend most of their lives at the deeper parts or in the main channel will not be represented in the catches. This may not be a problem, as it is not necessary (nor possible) to sample all species to get a picture of the status, but generally it is considered important to be able to catch most of the available species. To achieve this, drift net fishing and night electro-fishing was used. The drift-netting in the main channel would allow for capture of the benthic species inhabiting the open, deep areas of the main channel. The night fishing utilise the fact that several species of fish inhabiting the open waters, do enter the littoral area during dark and thus become available for electro-fishing. Unfortunately, the lack of compliance with the planned minimum effort regarding net-fishing and night electro-fishing makes it impossible to perform any valid comparisons of the methods. Only 41 individuals of 10 species were caught by drift-netting. However, as it appears from Fig. 15, there seems NOT to be a clear correlation between effort and the number of species caught. The number of species caught per site range from 15 to 35, and is not clearly related to effort. Thus, a very important result is that it seems to be sufficient to use a simple littoral electro-fishing approach to actually sample a representative number of individuals and species in order to use the sample results to evaluate the ecological status of a given site! This is off course depending on the assessment method and it is clear that if the aim is to collect a high proportion of all available species in such a large river, and maybe even need different size/age classes, then a high fishing effort is needed. One must consider that at most sites a range of 50-60 native species and about a dozen non-native species should be expected. Recording the majority of these requires seasonal sampling efforts, especially earlier in summer, when juvenile stages can be captured along the banks more easily than at the time of the survey. However, a minimal e-fishing effort seems to be enough to get at least an overview of the composition of the most abundant species and as such is suitable for indicating ecological status.

From the data it is also apparent that electro-fishing during night can be more efficient than during day. Between 0 and 7 additional species per site were caught during night fishing. Thus, in large rivers, the most time-efficient way to sample a sufficient number of species and individuals is to electro-fish during night. This is generally not recommended (CEN) due to safety consideration, but with good equipment, experienced crew and a good light system, it should not be more risky than day-fishing. A direct comparison of the used methods in terms of caught individuals per area, show that standard electrofishing with a handheld anode during daytime can be very efficient in a large river.

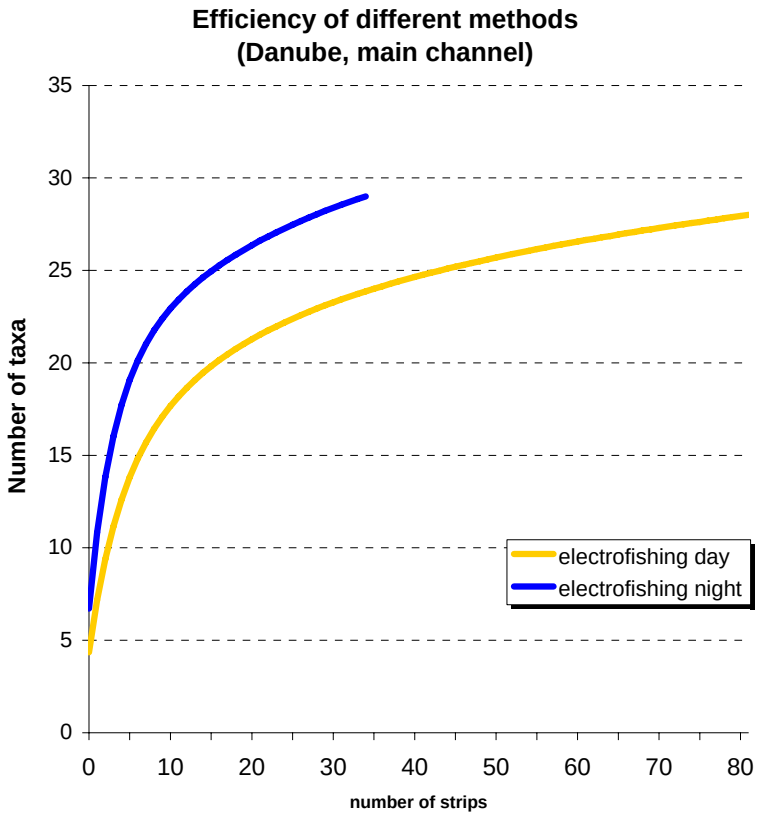


Fig. 12: Cumulative species number related to fishing effort during day and night electro fishing.

However, our results do not justify any conclusions about the "best method" because the different methods were used in different areas. From Figure 13 it can be seen that boom fishing were used in the upper river, where there are fewer species and probably lower densities of fish, whereas hand-held was used in the lower river, where there are more species and more fish, so if the methods had been applied equally, we would have had a good basis for comparison.

3.5.1 Electrofishing

Electrofishing was the method that caught almost all of the fish during this survey. As mentioned before there were some variation in the method and equipment used and this may also have influenced the results of the samplings. E-fishing was done in 4 major ways: During day and night, with a handheld anode or with a fixed boom anode (or "spider anodes" in HU). Below (table VII and Fig. 13) can be seen that equal effort was used by hand-held and boom anode and it appear that the handheld

anode is more efficient in catching fish. However, when considering time use, they may be fairly equal because it is easier and faster to sample using a fixed boom anode.

Table VII: Overview of the electrofishing and netting performed during JDS-2

Method	TOTAL
Electrofishing - hand held	
strip number	487
total length [m]	124097
fished area [m^2]	404822
no of ind.	39933
no of species	66
Electrofishing - boom	
strip number	454
total length [m]	179889
fished area [m^2]	965457
no of ind.	14652
no of species	50
total no of ind. day	54585
total species day	69
Night electrofishing - hand held	
strip number	78
total length [m]	18036
fished area [m^2]	62330
no of ind.	4679
no of species	44
Night electrofishing - boom	
strip number	106
total length [m]	42058
fished area [m^2]	233156
no of ind.	4277
no of species	40
Electrofishing - total	
strip number	1125
total length [m]	364080
fished area [m^2]	1665765
no of ind.	63541
no of species	70
Driftnetfishing	
strip number	29
total length [m]	43102
fished area [m^2]	1386080
no of ind.	41
no of species	10

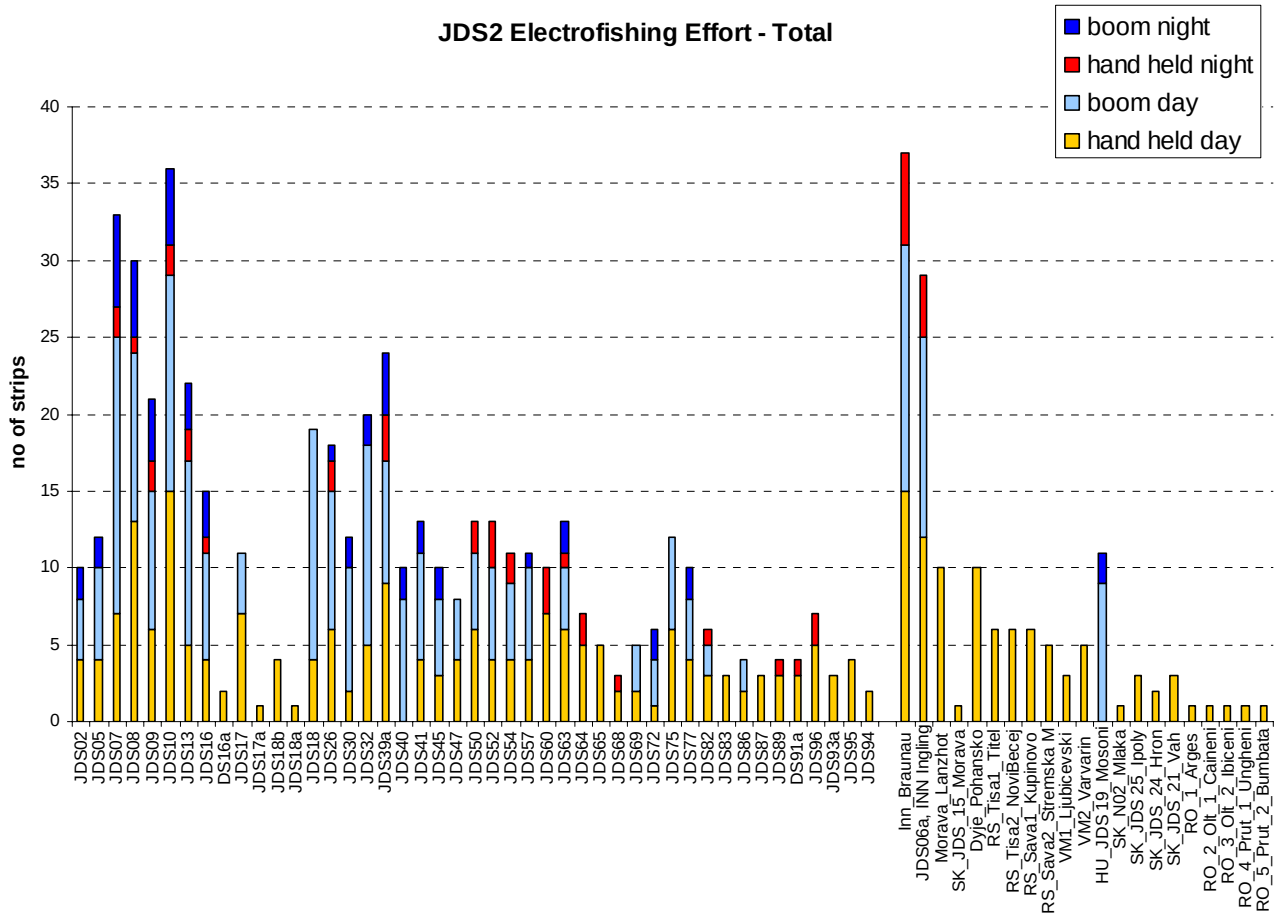


Fig. 13: Graphical presentation of the electrofishing effort at all sites.

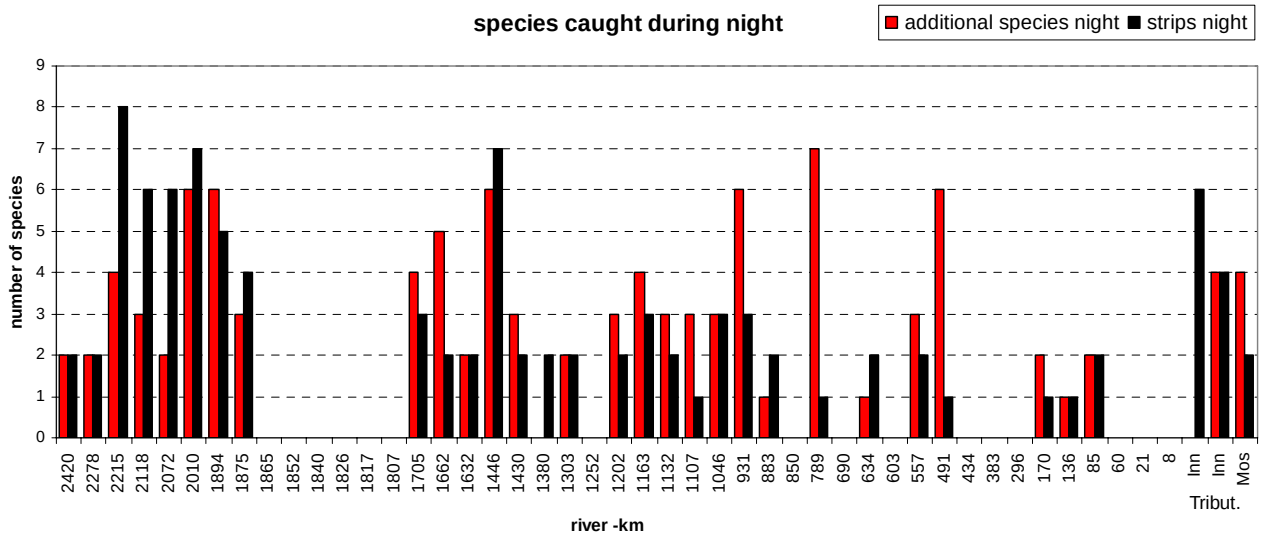


Fig. 14: Results from sites, where both day- and night electrofishing was done, showing the additional species that were caught during night.

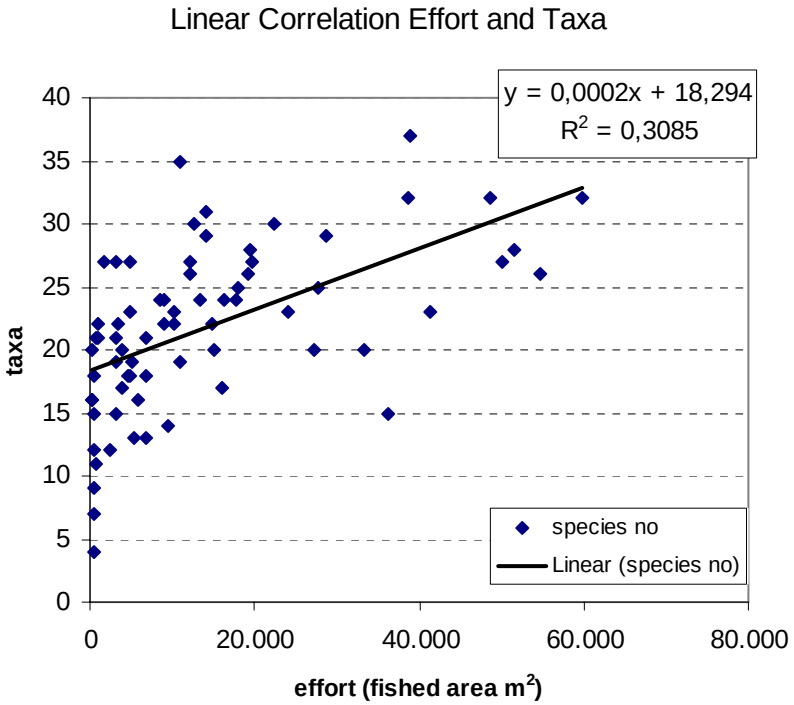


Fig. 15: Relationship between sampling effort and the number of species found. It should be noted that all the high effort sites were in the upper Danube, where there are fewer species.

Navigation

There seems to be an effect of navigation in the upper river. The passing of ships introduce large waves, which can negatively impact the juvenile fish, living in the very shallow littoral habitats. Thus, there is some effect on reproductive success (population structure) especially of sentinel species like barbel and nase, for example there are clear differences between the population structure of barbel and nase at Kelheim (JDS2) without navigation and Jochenstein (JDS7) with a narrow channel and navigation. In contrast, the newly build structures like sheltered side arms (eupotamon) in Enghagen (JDS8) and Oberloiben (JDS10) are the habitats, where we caught the young of the year of these species. Further down these effects seem less clear, probably due to the Danube getting wider. As there is always a combination of pressures on such a large river, a quick "survey" will not deliver clear results. However other studies have demonstrated this effect. One of the latest was conducted in Weltenburg, upstream Kelheim by Zauner et al. (2007), where a vessel was going at different speeds in a reach of the Danube without commercial navigation and both larval drift and beaching of fingerlings was shown.

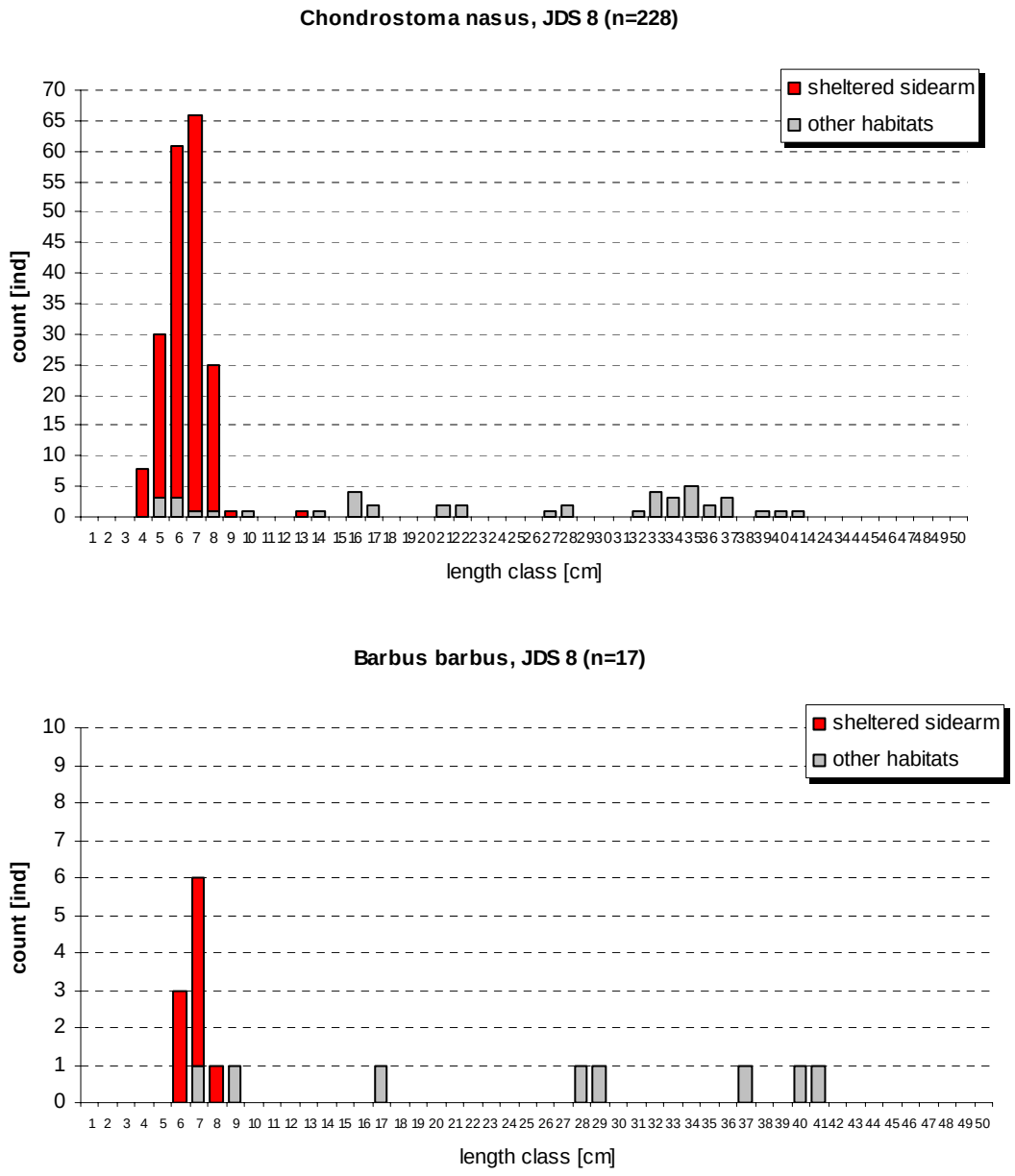


Fig. 16: Sizes of Barbel and Nase sampled in a sidearm (without the wave effects of navigation) and sampled on more exposed area from the same sampling site (JDS8, Enghagen).

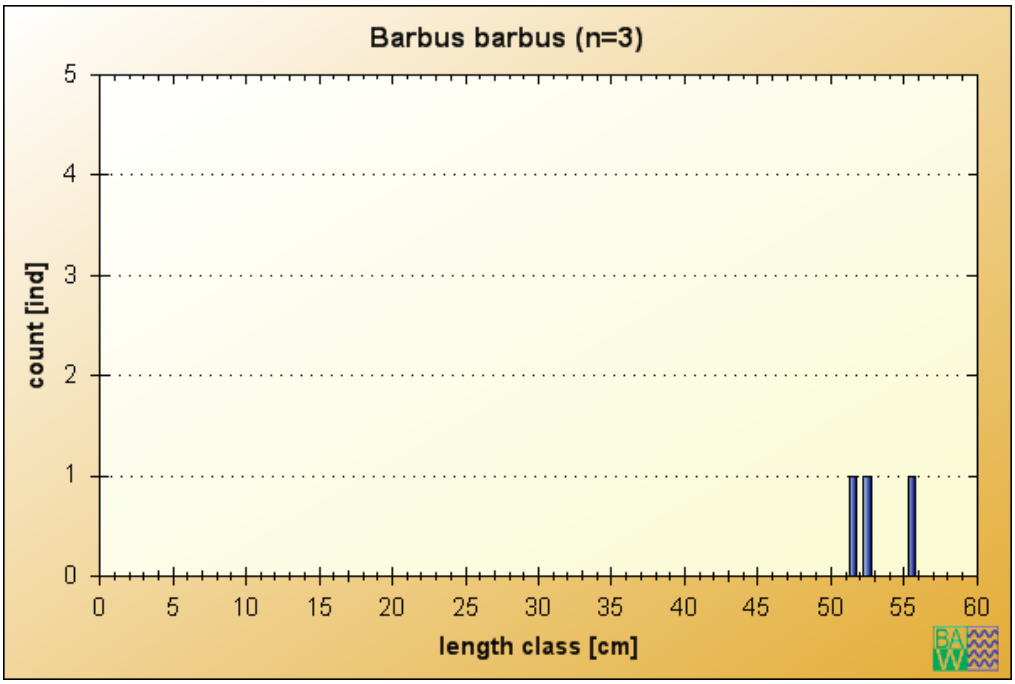


Fig. 17: Barbel sizes at JDS6 (Jochenstein), with navigation.

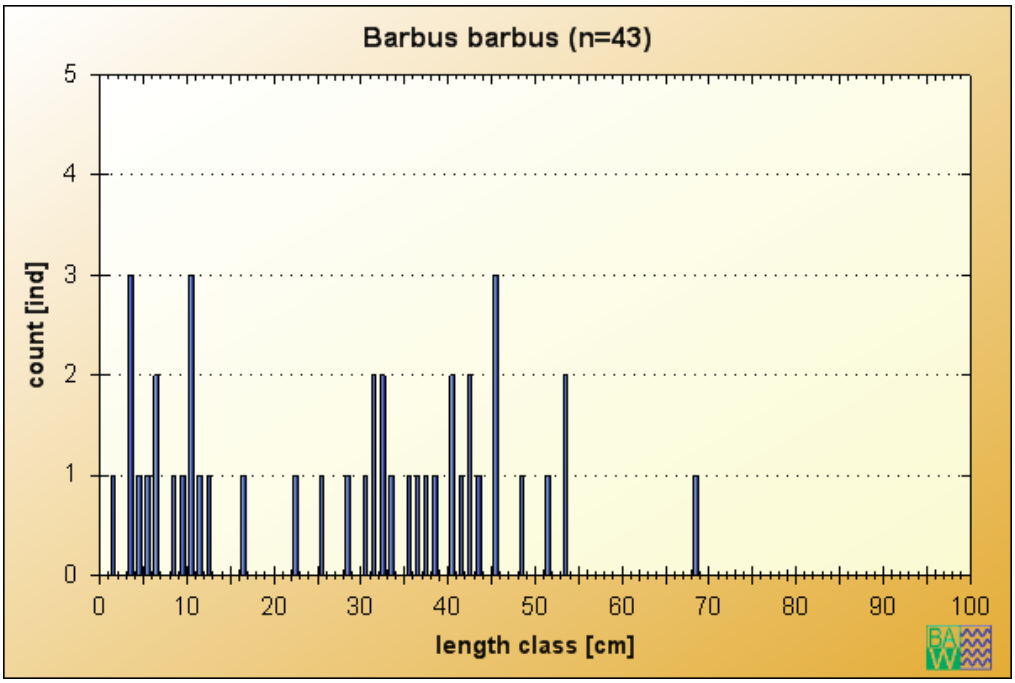


Fig. 18: Barbel sizes at JDS2 (Kelheim), without navigation.

4 Conclusions

In conclusion it can be stated that considering the available resources and the harsh field conditions, the fish sampling went very well. We did not fulfil the planned sampling schedule and subsequently the database is slightly smaller than planned. It can be concluded that sampling fish in a comparable way in a large river is far from easy and even during perfect conditions, with perfect planning and much experience; there will be a high degree of variation in the sampling efficiency.

Having said that, the results from the JDS-2, gives cause for some optimism regarding the possibilities for sampling fish in large rivers for evaluation of ecological status. It seems clear that with a standardised sampling program, based on electrofishing in the shallow (littoral) areas, it is possible to gather detailed information about the fish community in a cost efficient and manageable way. With frequent samplings at sites in the tributaries and Main River, it is possible to collect sufficient information to make meaningful assessment of the ecological quality of the whole basin in compliance with the water framework directive.

4.1 Results

- In total, over 64,000 fish of 71 species were sampled.
- The results indicate that even a large river like the Danube can be sufficiently sampled by using simple electrofishing from a boat. Additionally, it turned out that sampling during night in a large river is highly effective. Therefore, these results should be taken as cause to update the CEN-Standard for electrofishing.
- The composition of the fish fauna indicates the importance of different pressures. During the JDS-2, the results show that hydromorphological alterations is the main pressure in the upper section, water quality pressure in the middle section and the lower section. Navigation has a negative impact on fish populations especially in the upper part of the Danube River.
- The site-to-site variation in the fish fauna composition, expressed by the index scores, was very high and apparently the fish community shows a clear response to local conditions.
- Presence/absence of injured, diseased or deformed fish seems not to be a potential indicator for EQ in Danube because the vast majority of the fish caught, appeared healthy.
- The general lack of migratory species indicates a serious loss of connectivity, but the time of sampling as well as the limitations in sampling mid-river, makes this a more speculative conclusion.
- Several introduced/exotic fish species are present in Danube and the tributaries, and there is some indication that this has caused changes in the composition of the fish fauna.
- The indication of ecological status (by EFI) of the sampled sites in the Danube and the tributaries range from good to bad. In the upper Danube most sites were evaluated as good, but in the middle and lower part evaluations showed mainly moderate status. However, the limited amount of data only allows a rough indication and not a sound evaluation of the status.

4.2 Basic practical considerations

Organising a large river expedition, that not only has to travel through different countries but also fulfil the task of field sampling according to sophisticated and standardised methods that are still in a state of development, is a challenge anyway. Doing it for the first time and having a fixed and narrow time frame to fit it in, is pushing the limits towards the impossible. Thus, limitations and drawbacks

during this first fish survey did not come unexpectedly. However, many experiences gained throughout this first ever pan-Danube fish survey need to be considered for the next time. Several improvements, starting already in the pre-survey phase of organising, could be recommended.

How to improve the conditions for any further JDS fish expedition requires understanding of the circumstances under which that survey took place and what problems arose. The fish core team had to deal with several bottlenecks:

1) Accommodation on a small vessel used for storage, living, administration and even partially working platform (fish tissue sampling, maintenance of equipment, data input, report writing) with insufficient supply of space, electric power, comfort and social exchange.
2) Equipment purchased or/and adapted with a minimum budget and within a minimum time frame (partially <3 months).
3) Permanent need to stick to an overall time-schedule but limited communication possibilities.
4) Unforeseen last-minute drop-out of the team leader and thus reduced quality and completeness achieved in the pre-survey organisation phase.

4.2.1 Support vessel

After some initial discussions about using land-based (car with a boat on a trailer) core-team, it was decided that due to the distances and limitations in road access, it was necessary to use a boat as the base of the survey. It would have been ideal to be placed on the Argus like the other sampling teams, but there was no more room and due to the long time required for fish sampling in comparison to other Biological Quality Elements, it would hardly be possible to keep the planned schedule. The search for suited rental cruise boats was not easy and very few alternatives were found. To rent a larger boat with crew for a 7 weeks survey is expensive and well beyond the budget we had, so when we found the Vienna 115 with an apparently experienced captain, willing to participate for a very modest price, there were no alternatives.

As it turned out, “Vienna 115” was not the ideal support vessel for such a voyage. Apart from the narrow space, in which sometimes dirty and wet material had to be stored or worked upon and lived for 6 weeks, it was hardly possible to fulfil our sampling tasks and bridge the distances in time. Despite the fact that the captain was not capable of English language, because of the fortunate choice of core team members (nationalities), communication with the crew worked basically well.

The experience and suitability of the captain remained doubtful until the end but at least improved throughout the survey. The needs of the crew were not sufficiently communicated in advance and, in return, the crew made no concept of how to perform their task (e.g. tank stops, shopping and docking opportunities). Strangely enough, the crew did not request any details of the survey plan in advance and had thus no idea what would be going on, resulting in total misjudgement of timing, speed and logistic performance. As a result, the core team leader had to make these arrangements on a daily basis and communicate it between the crew and the teams. Furthermore, the crew of “Vienna 115” seemed incapable of crossing ship locks or national borders on their own. Thus, the assistance of the other ships’ crews and even the scientists on board was always required.

The lacking comfort was expected and acceptable considering the nature of the survey. However, with increasing time spent on the river, the value of meeting with other ships and crew members increased. The mood within the fish core team was always at least “satisfying” and mostly “good”, despite the many drawbacks. Nevertheless, the opportunity of social exchange with the other core team groups proved to be essential, as the contact with national teams was very limited and filled with scientific and logistic discussion.

The fact that our main equipment, the zodiac, could not be transported on our support vessel (like on Argus or Szechenyi) and had to be dragged behind, was also a disadvantage concerning speed and safety. It finally, through a storm at the Iron Gates, proved almost disastrous. The connecting ropes

were torn and the boat drifted off within minutes and the accident was only noticed and mended by fortune. The decision of the core team leader to remain on board of "Vienna 115" and not join the national team and the impossibility of doing anything except clinging on and looking through the window was the only reason why that accident was noticed and also that the boat could be re-captured and bound again. Furthermore, during our stop in Galati, we were reminded of the easy possibility of theft. Fortunately, nothing like that happened.

Another disadvantage was the weak and instable on-board electric supply. Several attempts to re-charge the car batteries for night fishing failed and even destroyed one battery beyond repair. Even mobile phones, laptops and camera batteries suffered from these conditions. Although these needs have been checked in advance, the provision was finally insufficient or unsuitable.

4.2.2 Core team equipment

The quality and quantity of the core team sampling depended on the suitability and operation of the equipment. Time and **budget limitations** finally resulted in a minimum supply, incompatible with the challenge of such a fish survey. Not only no reserve boat, outboard engine and electric generator was available but for both engines only the oldest available at BOKU could be donated for such a time span. It was thus not possible to test and optimize the arrangement and part of the equipment was old and not in best condition. The fact, that a decision on the sampling design was only achieved around mid April 2007 and a final confirmation on the budget for purchasing equipment (mainly zodiac) by mid May, severely limited the opportunities in fine-tuning and testing the equipment before deliverance (July 31st 2007). However, without funds for purchasing new and optimal equipment it was only possible to provide material that was already available and could be spared by the donators. As it turned out, most national teams had even worse restrictions considering purchase or construction of their equipment and thus could not help out with main parts of it. Nevertheless, all delegations did their best to support the core team when need arose, and only the personal engagement of all people involved made possible what was achieved within this survey!

4.2.3 Survey strategy

The restricted time frame and flexibility according to the time-schedule did not improve the already limited sampling opportunities. However, the need of press and public events and social contact between the JDS-2 participants requires regular meetings and thus a parallel activity. Because of the restricted on-board conditions on "Vienna 115" and the many drawbacks for the fish core team, the regular meetings proved essential for the completion of the survey.

Furthermore, an independent fully land-based core team would have faced major difficulties when accessing the sampling sites. Such limitations already affected the choice of sites by national teams severely this time and also reduced their available sampling time.

The sampling program was generally an achievable task, although some details need to be reconsidered (chapter 4.6). The basic conception of a core team, doing part of the sampling proved to be an essential aspect. Although the "standardised" methods are well known to scientists in different countries, their use – according to equipment and experience – is highly variable. A core team capable of sampling its own set of data is therefore needed for comparison and harmonisation of data quality.

However, a travelling core team that does most of the sampling within such a tight time frame is totally unrealistic, even if more speed, better timing and equipment can be arranged for the next cruise.

It turned out that no one, not even the captain of "Vienna 115" checked the travel distances. Thus, no one was aware of the problems that may arise for travelling and sampling. On some days distances less than 50 km had to be bridged, on others distances exceeding 100 km. A more homogenous approach, including a revised set of sampling sites is thus highly recommended. This would at least homogenize if not increase the core team sampling potential per site and also support the national teams which also have to cover the distances on land. Cross-border sampling was only performed twice (JDS07

Jochenstein and JDS77 Zimnicea/Svistov) and should be encouraged for scientific and political benefit.

Although alternative strategies were discussed during the survey, a final solution on the basic core team strategy can only be worked out in co-operation with national delegations. The following chapters' suggestions thus are restricted to the strategy as it was applied.

4.2.4 Core team and leadership

The fact that Niels Jepsen, the supposed team leader from JRC and main responsible person for the organisation of the fish survey, had to cancel his participation only two weeks before the survey's start, caused several problems. Many agreements and presumptions were not fully known to the other core team members and could thus not be demanded. Finally, nobody from the major funding institution JRC was present throughout the cruise and ICPDR delegates supported or moderated wherever possible to cover revealed gaps and inconveniences (e.g. higher expenses for fuel because of higher travel speed). However, issues concerning the contract with the ship owner or crew and written agreements could hardly be resolved.

The change in the leading person itself worked well, considering the fact, that no preparation time was possible, and many unexpected issues had to be solved throughout the survey, some from the very beginning (time plan, logistics).

4.3 Sampling design and methods

As mentioned above, the sampling design was an achievable task. However, inhomogeneous travel distances prevented the core team and the national teams from performing similar sampling efforts in each site. Thus, the minimum requirements could not be fulfilled. Further restrictions arose because of (1) technical breakdowns, (2) lacking equipment or experience of national teams, (3) teams not present or nearby the sampling sites during night, (4) insufficient knowledge of the local area by national teams and (5) unsuitable weather conditions. Especially night sampling was sometimes not possible, although its value became clear from the very beginning. However, limited sampling because of weather (heavy rainfall, storm) is an unavoidable risk that can only be compensated by additional time, allowing re-visiting individual sampling sites by the national teams. This could be somewhat mitigated by having a larger team, with persons who all possess practical and theoretical skills.

Net sampling was rarely performed in the first half of the survey and not only proved inefficient for catching fish but also difficult to perform. Without a full day's time in situ, this method cannot be recommended to be done by any team, unfamiliar with the site. These considerations and the lack of time resulted in the abandonment of this method for the second half of the survey.

4.3.1 Fish tissue sampling

Already throughout the survey's preparation phase concerns about the ability to sample distinct species and size classes at specified sampling sites were raised by the fish experts. Especially larger fish are not easily caught and may sometimes be totally absent from a sites catch. Material from different species or size-classes mixed, may result in incomparable data. Abundant species like bleak (*Alburnus alburnus*) – in fact the only species caught in all sampling sites – is not suitable for such kind of analysis and gobies are too small. However, it was decided to try and fulfil the task as good as possible.
Finally it turned out, that neither bream (*Abramis brama*) nor barbel (*Barbus barbus*) could be caught in sufficient numbers, even when ignoring the site as such. Even local fishermen that were sometimes asked for provision could not help out. Thus the number of sampled sites, compared with the request list, is small.
Such specified catches cannot be done within a day or – as it was usually the case – a few hours time.

Apart from the meagre catches, the dissection was usually done late at night outdoors, as suitable fish were often caught during night sampling, and free and clean space was not available inside the ship. Freezer capacity on board was also limited and thus usually required immediate deliverance of samples to Szechenyi. In this case it was fortunate, that only little material could be gained.

4.4 Teams and equipment

When comparing the equipment, performance and experience of teams (chapter 2.5 and 2.6) one must keep in mind, that the core team was used as reference and not as an "optimum". Each team had previous experience of different kind and some teams had not done field sampling on the Danube before. The fish-based assessment of the ecological status according to the WFD is a new concept and may even be unclear for some countries. Although differences in performance and effectiveness of teams were expected, the extent of variations was high. Financial limitations, other internal restrictions (e.g. no potential use of "large river sampling equipment" on other occasions) and sometimes difficulties in finding suppliers of suitable equipment finally led to the arrangements found.

Despite having a common understanding on the basic method of electrofishing and the presence of national delegates at the workshop in Göd, the final implementation of the agreed-upon set of methods and equipment was insufficient. Apart from countries unable to provide a team at all (Slovakia, Bulgaria), several teams (Hungary, Serbia, Romania) did not provide the full range of equipment (boom or handheld anode). These gaps could, in the case of some sites, not be compensated by core team samples. The usage of boats or wading equipment in shallow water was different. The reluctance to drive a boat into shallow areas and thus risk damage to the engine or propeller is understandable. However, the inability to sample shallow areas by wading and just pushing the boat along the bank was caused by lacking wading equipment or personal preferences.

The unfamiliarity with sampling sites is an avoidable issue and should have been solved by the national teams themselves in advance. The proper knowledge of a sampling area is an essential pre-requisite for choosing the right amount of typical habitats and for safety especially during night sampling and thus requires preparation, and in case of the JDS, also communication and fine tuning with the project leader. However, this process did not take place and site selection was thus not properly done within the narrow time frame available.

4.5 Fish results

Despite some practical problems and the subsequent flaws in the data-collection, the present results do provide a valuable picture of the condition of the fish population throughout the Danube River.

From the results it is clear that the Danube is still a suitable habitat for fish. The abundance of fish is rather high in all the sites, so there are no signs of river stretches so impacted that no fish can live there. However, the idea of using the fish as indicators for human impact is based on observed changes in fish community structure in response to different pressures and there are large differences in the number of species present at the different sites, but also on the ecological classification in terms of EFI-score. The scores ranged from bad to high ecological status, but most sites were classified as good or moderate.

The present results may not be sufficient to really give a clear judgement of the ecological status of each site, but nevertheless they are very important in terms of being a starting point in a time series of monitoring. Thus, future surveys as well as national monitoring results can be compared with the JDS-2 results to detect significant changes.

When the new European Fish Index (EFI+) has been developed, the present results will be used to calculate the EQ-score for each site again and probably the assessment will be more accurate and reliable because the index has been modified to accommodate the specific Danube species.

4.6 Scientific output

The results from this survey are very important, not the least due to methodological considerations. The database, which contains information of over 64,000 fish along with detailed information of sampling method and site characteristics, can be used to a multitude of analyses. Thus, it is possible to identify the most interesting results and publish in scientific journals. It is expected that at least 3 publications will be the direct result of the fish sampling.

Only few fish samples could be taken for reference collection throughout the survey, due to limited storage capacities and the need of sticking to the "non lethal method" agreement. However, a few essential specimen were taken and delivered to the Natural History Museum in Vienna, Austria.

NMW 95129: *Benthophiloides brauneri*, JDS95 Sulina Arm (MZB core team – airlift sample)

NMW 95130: *Benthophiloides brauneri*, JDS83 Upstream Arges River (MZB core team – airlift sample)

NMW 95131: *Benthophilus nudus*, JDS94 Bystroe Arm (Ukrainian fish team, bottom trawl sample)

NMW 95132: *Neogobius eurycephalus*, JDS94 Bystroe Arm (Fish core team electrofishing sample)

NMW 95133: *Neogobius eurycephalus*, JDS96 Bystroe Arm (Romanian fish team electrofishing sample)

NMW 95134: *Neogobius fluviatilis*, JDS30 Szentendre Side Arm (Fish core team electrofishing sample)

NMW 95135: *Romanogobio vladykovy*, JDS39a Mohacs (Fish core team electrofishing sample)

NMW 95136: *Syngnathus abaster*, JDS95 and JDS96 Sulina & St. Gheorghe Arm (Romanian fish team and fish core team electrofishing samples)

4.6 Recommendations for next survey and other WRRL related sampling activities

Based on the experiences throughout the survey, the following recommendations should be considered for the planning and running of the next fish survey. As mentioned above, an alternative strategy of how to run the fish survey (e.g. only land-based core team) is not considered here and should be discussed with national delegations at least two years before the next survey.

- Contracting issues concerning the crew members, core team equipment and the support vessel should start about two years in advance and should be settled at least one year in advance. Especially finding a proper support vessel (see below) may require some time.
- The support vessel should have a crane able to lift the sampling boat out of the water safely as a daily routine and carry it on a platform during cruise. Sufficient space for laboratory and administrative work as well as dry-keeping of sensitive electronic equipment and samples outside the sleeping rooms should be available.
- Supply of electric power, especially for recharging batteries (e.g. night sampling), and an on-board washing machine would allow more flexibility and independence of the fish team. Generally, a bigger ship would increase stability and thus safety during cruise and anchorage/docking.
- The contract with the support vessel's crew has to include logistic cruise preparation according to the ships requirement (fuel, water and food supply, border crossing options). The time-table (daily tasks, sampling site locations and travel distances) has to be worked out together with the scientific team.
- Nationality and language skills of the support vessel's crew have to be checked and matched with the language skills of the core team members on board.
- The possibility of navigation during night has to be checked thoroughly (e.g. noise level) as well as the crew's knowledge of distinct river sections (e.g. estimation of travel speed).

- All essential core team sampling equipment (boat, outboard engine, electrofishing generator and gear) should either be available in double or, alternatively, support of equivalent equipment has to be arranged with national teams in advance.
- National teams should be encouraged to supply a boom anode to increase the sample numbers per site and thus use the available time more efficiently.
- Small devices of the sampling gear (e.g. dip nets, handheld anodes, wading trousers) should be provided or offered by the organizers to the national teams, in case they cannot provide sufficiently comparable equipment in order to achieve comparable results. Similarly, replacements for damaged propellers should be offered to the national teams, in case they cannot risk or afford such expenses. Again, this would result in more comparative sampling designs.
- Site selection should be reconsidered and adjusted to fit the river typology better in the lower part of the Danube (Bulgaria, Romania).
- Available sampling time per site depends on the distances to be bridged by core and national teams. Thus, site selection and time-table need to be arranged in a way that allows at least 4-5 hours sampling time during daylight. If night fishing cannot be extended, 6-7 hours for daylight sampling are required.
- Night sampling has to be extended and daytime sampling can be reduced, at least to have equal efforts during day and night. For the core team, this requires night stops directly at the sampling site or no more than 5-10 km nearby. However, arrival at the sampling site well before nightfall is essential for a quick habitat survey of the location.
- Core team sampling priority must be put on efficient methods like electrofishing. Supplementary methods (usually do not provide the basis of data but just support them) should only be applied by national teams, as this can be done after the core team has left the area and thus has second priority.
- Press events (e.g. interview, show sampling) have to be pre-arranged and incorporated in the time schedule. Similarly, passage of critical borders (e.g. EU – non EU member states) should be considered.
- Because of the long travel distances in the Danube delta (trips into several arms including return trip to Tulcea), one or two additional days for sampling in the delta should be arranged for the fish team at the end of the survey. It is furthermore recommended to include the participation of the Romanian Danube Delta Institute, at least as additional national team in this part of the Danube. Thus, a higher sampling efficiency can be achieved with hardly any additional costs.
- Providing fish for tissue samples by the sampling teams cannot be recommended as a standard routine. Certainly, additional material gained throughout the sampling may be used but as a general strategy the requested fish (species, size) must be ordered weeks in advance by national delegates from local fishermen. They can catch the fish within a given time frame and keep them alive until the sampling teams arrive. Thus, fresh and suitable material could be obtained from most sites with only small additional costs.

REFERENCES

De Lury D.B. 1947. On the estimation of biological populations. Biometrics 3: 145–164.

Haunschmid R., Venier R. & Lindner R. 2003. ATFIBASE - Entwicklung und Etablierung eines Systems zur Erfassung und Analyse fischökologischer Zustandsparameter. Strobl J., Blaschke T. und Griesebner G. (eds). Angewandte geografische Informationsverarbeitung XV – Beiträge zum Agit Symposium 2003. Wichmann Verlag Heidelberg, 130-134.

Haunschmid R., Wolfram G., Spindler T., Honsig-Erlenburg W., Wimmer R., Jagsch A., Kainz E., Hehenwarter K., Wagner B., Konecny R., Riedmüller R., Ibel G., Sasano B. & Schotzko N. 2006. Erstellung einer fischbasierten Typologie österreichischer Fließgewässer sowie einer Bewertungsmethode des fischökologischen Zustandes gemäß EU-Wasserrahmenrichtlinie. Schriftenreihe des BAW Band 23, Wien; 104 pp.

Kottelat, M. & Freyhof, J. 2007. Handbook of European freshwater fishes. Kottelat, Cornol and Freyhof, Berlin, xiv + 646 pp. ISBN
978-2-8399-0298-4

Ladiges, W. & D. Vogt (1979): Die Süßwasserfische Europas. - 2. Aufl., Hamburg und Berlin, Paray-Verlag, 229pp.

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, 70–80.

Schiemer F., Guti G., Keckeis H. & Staras M. 2004. Ecological Status and Problems of the Danube River and its Fish Fauna: A Review. Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries; FAO, Welcomme R.L. & Petr T. Ed.; Volume 1, 273 – 299.

Schmutz S., Zauner G., Eberstaller J. & Jungwirth M. 2001. Die „Streifenbefischungsmethode“: eine Methode zur Quantifizierung von Fischbeständen mittelgroßer Fließgewässer. Österreichs Fischerei Jg. 54, Heft 1/2001: 14–27.

Seber G.A.F. & LeCren E. D. 1967. Estimating population parameters from the catches large relative to the population. J. Anim. Ecol. 36: 631-643.

Wiesner, C., 2005: New records of non-indigenous gobies (Neogobius sp.) in the Austrian Danube. J. Appl. Ichthyol. 21, 324 -327.

Zauner, G., Mühlbauer, M. & Ratschan, C. (2007): Einfluss des schifffahrtsbedingten Wellenschlags auf das Jungfischaufkommen in der Weltenburger Enge. Studie im Auftrag der Vereinigten Schifffahrtsunternehmen Kelheim, (VSK) Stadler, Steibl und Schweiger. 75 pp.

Appendices

Appendix 1: Detailed catch data from each main river sampling site, with a chart showing the fish distribution in the ecological guilds. NB. Abundance data for the German sites have been hidden.

Appendix 2: Detailed catch data from each tributary sampling site, with a chart showing the fish distribution in the ecological guilds.

Appendix 3: Maps showing the spatial distribution of the 70 fish species, caught during the JDS-2. For the 20 most numerous species, also the size distribution charts are shown.

Appendix 4: Length-frequency charts for each species for each site. The charts from the German sites are not available.