Report

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812388 Environmental Impacts on Riverine Ecosystems II

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Abstract

Most European rivers are impacted by various anthropogenic pressures and in need for action in order to reach a good ecological status as required by the EU Water Framework Directive. Since benthic invertebrates are good bio-indicators, they are often used to monitor rivers and to assess organic pollution, habitat availability and overall degradation. For this study the multi-habitat sampling approach was carried out in the unimpacted river Ois and in the channelized Maiergraben in order to assess differences in benthic invertebrate communities. At the unimpacted river different mineral habitats, biotic cover and flow velocities are present, whereas the impacted site is very homogenous. Furthermore, a higher number of taxa, EPT-Taxa and sensitive taxa occur at the Ois, which is a result of high habitat heterogeneity. The Maiergraben on the other hand shows low taxa diversity and very high abundances of generalists such as chironomids. In order to reach a good ecological status at the Maiergraben the need for action should not be ignored but appropriate measures should be implemented to restore the rivers biodiversity.[1]

[1] Data not available from EUWWR.

Contents

1 Introduction

Limited access to clean water has become an increasingly alarming concern around the world. This is not the current situation in Austria, where most of the rivers have low levels of organic pollution. However, through the pursuit of hydropower production and flood protection, Austrias water bodies face other anthropogenic pressures such as channelization, impoundment and hydropeaking (Muhar et al., 2000). The EU Water Framework Directive 2000/60/EC (WFD) established the legal obligation of member countries to maintain healthy water resources and mitigate damages inflicted upon their water bodies. The WFD describes a water bodys status by both abiotic and biotic criteria. Biological quality elements are subdivided into assessment of benthic invertebrates, fish, algae and aquatic flora. The ecological status of a water body is defined by comparing the biological community composition present with the near-natural reference conditions. The ecological status is calculated from the residual between the observed condition and the reference condition (Fürhacker, 2008).

Benthic invertebrate organisms live in a diverse range of habitats representing a wide variety of aquatic ecosystems. Community structure of Macrozoobenthos (MZB) responds to environmental disturbances in a rather predictable way. This makes them an excellent candidate for monitoring changes in environmental conditions (Li et al., 2010). MZBs are able to reflect different anthropogenic pressures through changes in structure or function of the assemblages. These changes allow for an overall assessment of streams. Aside from organic pollution, MZB can detect habitat loss and overall stream degradation (Hering et al., 2004; Hering et al., 2006). According to Marzin et al. (2012), macroinvertebrate metrics appear to be more sensitive to the degradation of the overall condition of the river than fish metrics. This could be explained by the localized nature of MZB. The insect order trichoptera are particularly well suited as a bioindicators for describing habitat degradation (Schmidt-Kloiber et al., 2017).

Many benthic invertebrate species have adapted to specific habitat parameters by way of flow velocity preference, structural needs, feeding strategies and tolerance to pollution (Stoll et al., 2016). It has been shown that substrate size is one of the best predictors of benthic invertebrate distribution within a river by Jowett (2003) and Schröder et al. (2013); while Dohet et al. (2015) described the influence that thermal regime and land use has on MZB inhabiting headwater streams. A study of species diversity and functional feeding groups of benthic invertebrates in Austrian rivers, which was carried out by Yoshimura et al. (2006), showed that MZB communities are dependent on their environmental conditions. Studies in Poland have shown that benthic communities have significantly reduced taxonomic richness in constrained channels (Wyżga et al., 2014).

This report focuses on the benthic invertebrate communities sampled from two Alpine rivers near Lunz-am-see. We collected and assessed a sample of the benthic community

Figure 1. Reference sample location on Ois River.

from a near-natural site of the Ois River (Fig. 1). This was to be used as a reference site when compared to a sample which was collected from a heavily impacted site of the Maiergraben. By comparing the collected samples from the Ois and Maiergraben, we aim to answer the following questions:

1. Does habitat availability differ between the unimpacted Ois River and the impacted Maiergraben?
2. Is there a relation between choriotope and sensitive screening taxa?
3. What influence do microhabitats have on benthic communities within a river?
4. Is there a difference in taxa composition, diversity and abundance between the unimpacted Ois and impacted Maiergraben?
5. Does the benthic community represent the observed impacts at the Maiergraben?

We hypothesized that the hydro-morphologically dynamic Ois River will contain more diverse habitat than the constrained Maiergraben. We predicted that some screening taxon are associated with specific choriotopes. We also hypothesized that habitat heterogeneity will result in more taxon richness and abundance, with an increase in specialized taxa. We predicted that the taxa composition, diversity and abundance would differ between the two sites, with the Ois River having a higher diversity and abundance than the Maiergraben. We assumed that the benthic community of the Maiergraben will be comprised of taxon associated with heavily impacted and channelized rivers.

2 Materials and Methods

2.1 Study area-GIS

Table 1. River length distribution among the bioregions above 1200m in Austria.

Bioregion	All rivers	Res. flow	Non-glacial rivers	Non-glacial res. flow	Glacier fed rivers	Glacier fed res. flow
	meters					
Glaciated Central Alps	542,425	236,798	-	-	542,425	236,798
Unglaciated Central Alps	2,420,882	570,002	2,204,664	533,641	216,218	36,361
Ridge landscape and foothills of the Central Alps	260,746	14,551	260,746	14,551	-	-
Flysch	19,769	-	19,769	-	-	-
Limestone Alps	43,108	350	43,108	350	-	-
Northern lime high Alps	453,930	18,730	453,360	18,730	570	-
Southern Alps	146,517	4913	146,517	4913	-	-
Helvetic	15,611	-	15,611	-	-	-
Unknown[a]	105,125	7428	105,125	7428	-	-
Total	3,992,501	852,772	3233,289	579,613	759,213	273,159

[a]Data not available from EUWWR.

2.2 Study area

The benthic macro-invertebrate samples were taken at two sites near lake Lunz (Mostviertel, lower Ausrtria). For reference conditions the Ois River in Lunz am See was sampled (Fig. 1). This small, natural, alpine river represents the headwaters of the Ybbs River and subsequently flows into the Danube river. The second sampling site was the so called Maiergraben, a small, concreted, channelized creek flowing through a forested area into lake Lunz (Fig. 2a).[2]

2.3 Methods

2.3.1 Multi-Habitat Sampling (MHS)

For this approach the examined river reach was partitioned into 20 subunits. These sampling units were representing different habitat types (choriotopes) and their proportional areal coverage within the reach. Sampling units were characterized by both mineral (Table 2) and biotic (Table 3) habitats.

[2]Data not available from EUWWR.

(a) Heavy regulation present at impacted site. **(b)** Sample collection from impacted area.

Figure 2. Impacted site located on Maiergraben.

Table 2. Mineral choriotopes.

Nomenclature	Grain size	Description of choriotope
megalithal	>40 cm	upper sides of boulders, large cobbles and blocks, bedrock
macrolithal	>20 cm to 40 cm	coarse blocks, head-sized cobbles, variable percentages of cobbles, gravel and sand
mesolithal	>6.3 cm to 20 cm	fist to hand-sized cobbles and pebbles with a variable percentage of gravel and sand
microlithal	>2 cm to 6.3 cm	pebbles, coarse gravel with percentages of medium to fine gravel
akal	>0.2 cm to 2 cm	fine to medium-sized gravel
psammal	0.063 mm to 2 mm	sand
pelal	<0.063 mm	mud and sludge
argillal		silt, loam and clay

First the share of mineral habitat classes was defined, secondly the biotic habitats within the mineral habitats were classified. This was done by a visual estimation of the area. For every 5% of a certain choriotope (combination of mineral and biotic habitat) one sampling unit was chosen. The shares and subunits of each choriotope were then put in a field-protocol (see Appendix A).

Sampling units also had to be distributed accordingly between the mesohabitats (river bottom/bank, lentic/lotic, riffles/pools). As the sampling area should not be disturbed beforehand, the sampling started downstream and then proceeded upstream.

Table 3. Biotic choriotopes.

Nomenclature	Description of choriotope
algal periphyton	areal stone cover
filamentous algae	tufts or floating mats
mosses	-
macrophytes	submerged plants
living wood	roots, branches (with leaves),tree trunks
deadwood	branches and tree trunks
CPOM	course particulate matter
FPOM	fine particulate organic matter
sapropel	decaying sludge
bacteria & fungi	lawns and tufts

2.3.2 Sampling Method

Table 4. Choriotope description of the sampling units at the Ois River.

Sample	Mineral Habitat	Biotic Habitat	Velocity [m/s]	Velocity Class	Water Depth [cm]	Distance to Shore [m]
1_2	mesolithal	micro_algae	0.9	high	10	2
3_4	macrolithal	micro_algae_moss	1.3	very_high	25	6
5_6	megalithal	moss	1.3	very_high	5	8
7_8	mesolithal	micro_algae	0.5	medium	20	4
9_10	megalithal	micro_algae	0.5	medium	10	8
11_12	mesolithal	periphyton	0.2	slow	30	5
13_14	akal	none	0.2	slow	25	2
15_16	mesolithal	CPOM	0	no_flow	20	0.5-1
17_18	macrolithal	micro_algae	0	no_flow	10	0.5
19_20	mesolithal	CPOM	0.2	slow	20	0.5

Sample collection at each sampling unit was performed with a stationary rectangular net (Mesh size: 500 µm EU standard) and by disturbing a quadratic area upstream of the net (25x25cm). For the Ois River we chose 10 sampling locations where we took 2 samples each, for a total of 20 units (Table 4).

Since the Maiergraben had a very homogenous structure we chose only four sampling locations three in the creek and one under a small bridge. We collected 5 samples from each location for a total of 20 sampling units. (Table 5 and Fig. 2b)

Table 5. Choriotope description of the sampling units at the Maiergraben.

Sample	Mineral Habitat	Biotic Habitat	Velocity [m/s]	Velocity Class	Water Depth [cm]	Distance to Shore [m]
1-5	technomega	micro_macro_algae	0.22-0.32	medium	4.8	0.5
6-10	technomega	micro_macro_algae	0.24-0.34	medium	2.8	0.5
11-15	technomega	micro_macro_algae	0.22-0.32	medium	4.5	0.5
16-20	technomega	bare	0.30-0.40	medium	4.2	0.5

Samples taken from organic habitats, always had to include the underlying mineral substrates. The different mineral habitats needed to be sampled accordingly.

Megalithal: Boulders were sampled from all sides by sweeping the surface with a brush and flushing the animals into the net.

Macro- and Mesolithal: Surface dwelling animals were flushed in the net by gently sweeping the cobbles or stones by hand. Next clingers and sessile animals were scratched off with a brush. Finally, the underlying substrate (within 15 to 20 cm depth) was churned by foot.

Microlithal and Akal: Coarse gravel and sandy substrate was sampled by disturbing the sediment by kicking it downstream the net.

After sampling each unit, the content of the net was transferred first into a tray and then into a closable bucket, which was filled with ethanol, in order to kill the animals.

2.3.3 Sorting Techniques

To sort the animals by size classes the buckets contents were later put through a sieve tower with different mesh sizes (10 mm down to 500 µm). The different fractions were then placed in trays (Fig. 3), so animals could be sorted, counted and determined to screening taxa level with the help of binoculars (Fig. 4). Only whole animals, so no single body parts, empty shells, exuvies or headless animals were taken into account. In trays with large amounts of animals (usually the smaller fractions) rare or single-occurring animals were taken out, and the rest was subsampled. This was done by transferring the animals in another tray that consisted of a grid, separating the tray into 16 or 8 cells. The organisms of usually two representing subsamples were determined and counted. The number of animals then had to be multiplied accordingly. A taxa list was created with MS Excel and further analysis were made with the programs MS Excel and EcoProf (version 4.0.0).

2.4 Equipment

Nets	Sieve tower
Brushes	Sorting trays (Fig. 3)
Trays	Subsampling trays
Buckets (closeable)	Tweezers
Ethanol	Binoculars

Figure 3. Sorting tray used for taxa identification.

Figure 4. Identifying taxa within the samples using binoculars.

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