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Individual Internship report

4th year

Habitat assessment and habitat suitability of the Wien River for nase (*Chondrostoma nasus*) and barbel (*Barbus barbus*)

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1. Introduction

1.1 Presentation of the host institution

The host institution is the University of Natural Resources and Life Sciences in Vienna, Austria. The university was originally a small agricultural university founded in 1872. Nowadays 15 departments conduct research in a broad range of fields from agricultural and forestry sciences to biotechnology and civil engineering. The internship was carried out at the Institute of Hydrobiology and Aquatic Ecosystem Management (IHG) of the department of Water – Atmosphere – Environment (WAU). Key areas of research and teaching at the institute are functions, processes and structures of freshwater ecosystems and their environments. IHG aims to foster the sustainable management of freshwater ecosystems including conservation, restoration, and biodiversity aspects as well as the provision of ecosystem services in the light of man-made pressures and global change in order to contribute towards the development and implementation of sustainable policies at the national, EU-wide and global level. The IHG is composed of many working groups. The IMMA (Integrative Modelling and Management of Aquatic Ecosystems) and the FISH (Freshwater Fish Ecology, Sustainable Fisheries and Aquaculture) groups were involved in this internship project.

1.2 Presentation of the project and the mission

The internship project is part of the "WienFlussFisch" research project which aims to evaluate the suitability of the Wien River for barbel (*Barbus barbus*) and nase (*Chondrostoma nasus*) by translocation of the fish into the river and according to surveillance of the habitat use and movement patterns of the fish using the radio telemetry method. Although, the seasonal water temperature pattern of this river, resembles that of barbel-region rivers, barbel and nase are not found in the Wien River. One explanation is the presence of migration barriers along the river that are among the reasons for not meeting the objectives of the EU Water Framework Directive. Suitable habitat is defined as the part of a river that fish and their life stages prefer for a successful survival and reproduction (Melcher, Hauer and Zeiringer, 2018). The internship objective within this project is to assess the aquatic habitats in the area near the flood control basins (Auhof) area in order to describe the habitat suitability of the Wien River for the reintroduction of nase and barbel. Suitable habitats must be present in the quantity or quality necessary for all life stages at the release site to ensure the success and persistence of translocated populations (George *et al.*, 2009; Carpenter-Bundhoo *et al.*, 2020).

Figure 1: Artificial and heavily modified section of the Wien River with some of the migration barriers (concrete steps) at the Kennedybrücke station

1.3 Historical background of the investigated area

In the 18th and 19th centuries, the Wien River was gradually regulated by stabilising the banks through planting or paving, and by deepening, straightening, and limiting the width of the river. Moreover, flood protection measures were implemented between 1895 and 1902, and 7 retention basins were constructed on the outskirts of the city (Bauer, 1992). In total 1.16 million m^3 of water from the Wien River and 150,000 m^3 from the Mauer Brook (a tributary of the Wien River) can be retained. The seven flood control basins of the Vienna River are arranged one behind the other and separated from each other by concrete walls that can be overflowed. In order to protection, movable weirs have been built into these concrete walls. (Fischer and Chovanec, 2019). In the 1990s, the Wien River was redesigned close to nature in the area of the flood control basins over a total length of about 1.5 kilometres. In addition, another 300 metres of naturally designed river course and bank were added downstream of the basin in 2014, increasing the available habitat for amphibian and aquatic species (Fischer and Chovanec, 2019).

Figure 2: Flood control basin n°2 at the Auhof area

1.4 Translocation and telemetry

Translocation is defined as the human managed movement of living organisms from one area for free release in another (Kock, Woodford and Rossiter, 2010). One of the central questions of the "WienFlussFisch" project is whether barbel and nase find spawning sites in the Wien River. The fish were therefore collected at the time of the spawning migration (Mai for the nase and June for the barbel) using electrofishing sampling methods. Unfortunately, no nase were collected during their spawning period and another species, the ide (*Leuciscus idus*) was translocated. The barbel was collected in one boat electrofishing session on random stretches along the bank of the Danube canal and two wading electrofishing sessions in an artificial sidearm of the Danube along the hydropowerplant Freudenau. After the collection, the fish were anaesthetised in ambient water of the Danube containing 2-phenoxyethanol (Sigma ‐ Aldrich) and weighed (g) and measured (mm). Nano radio telemetry transmitter tags and wire antenna were then surgically implemented by an incision through the body wall of the fish to access the peritoneal cavity (Carpenter-Bundhoo *et al.*, 2020). The fish were only tagged if the tag weight was not exceeding 2% of the body weight. Fish were then stocked into an oxygenated tank to recover from the surgery and to be transported to the translocation site. In total 15 ides and 25 barbels were released in the second basin of the Auhof area. After translocation, radio telemetry was used to track the fish movement using a mobile Lotek SRX 800 receiver (carried by a person walking along the river) and two land-based receivers (one at Auhof, at the exit of the flood control basins and one downstream of the Wien River, where it discharges into the Danube canal). Radio telemetry is preferred in shallow, freshwater environments, where radio signals are capable of traveling greater distances than acoustic signals (DeCelles and Zemeckis, 2014). The radio transmitter and wire antenna that trails behind the fish emits the radio signal. The radio signal travels through the shallow water and into the air, where it can be detected by the receivers. Radio transmitters are differentiated from one another by operating at unique frequencies (DeCelles and Zemeckis, 2014).

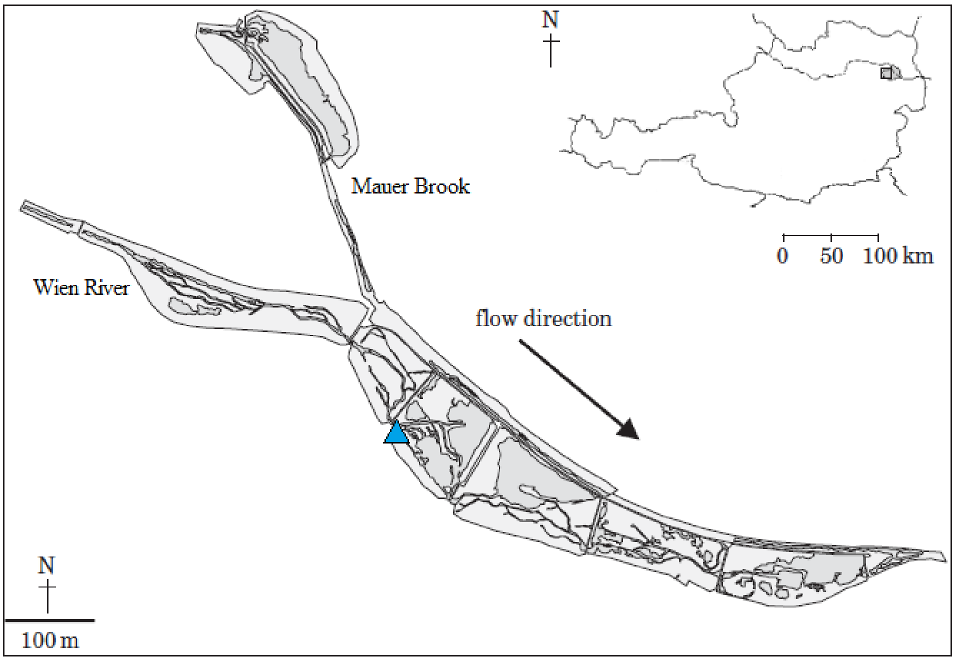

FIG. 1. Study site in the flood control basins of the River Wien (□, wetlands). Inset: Austria (□, Vienna region).

Figure 3: Scheme of the flood control basins of the River Wien and location of the fish translocation site (blue triangle) modified from Bartl and Keckeis (2004)

Figure 4: Pictures taken during the tagging surgery and release of the barbels

2. Ecology of barbel and nase

Nase *Chondrostoma nasus* (L.) and barbel *Barbus barbus* (L.) are the two dominating and co-existing cyprinid species in the barbel zone of Austrian rivers (Melcher and Schmutz, 2010). Due to their life-history patterns and habitat requirements they are indicator species for habitat quality in the lower rhithral and upper potamal zones of European river systems (Keckeis, Frankiewicz and Schiemer, 1996; Melcher and Schmutz, 2010). Both species are rheophilic (fast-water habitats) and patomodromous (migrating within the river system). In spring, they migrate upstream and/or into tributaries of larger streams to spawn on open gravel (lithophilic spawners). Nase larvae and early juveniles inhabit tributaries as well as the shallow inshore areas of large rivers, feeding mainly on zooplankton and detritus (Bartl and Keckeis, 2004). Older juveniles and adults graze on the river bottom with a hardened lower lip and feed on algae and invertebrates (Rauch, 2014). Barbel feeds mainly on benthic invertebrates. Adult barbel and nase use deep habitats with high flow velocities in the summer months. Juveniles also require fairly strong flow with shallower habitats than adults. The 0+ stages (fish younger than age 1) of barbel and nase use shallow and slow flowing habitats mainly sandy and fine-grained substrate. Structure types also represent an important habitat factor for juvenile and adult barbel and nase. Especially for the barbel, structures such as submerged vegetation, in the form of deadwood accumulation, but also overhanging vegetation are of great importance (Schmutz et al., 1999; Melcher, 2000; Schöberl et al., 2014a, 2014b).

Figure 5: Adult barbel (left) and nase (right) with the hardened lower lip

3. Case study reach

The Wien River is the largest tributary of the Viennese Danube with a length of 34 kilometres, 16 kilometres of which flow through the city of Vienna. It rises in the Vienna Woods (Wienerwald) at an altitude of about 520 meters a.s.l. and discharges into the Danube canal (Donaukanal), at 155 m a.s.l., in the centre of Vienna (Pollack *et al.*, 2016; Fischer and Chovanec, 2019). The Vienna Woods are drained by natural streams, while the urban area is drained by the sewage system. The catchment covers a total area of 224km^2. The impermeability of the soil in the upper catchment (Miocene and Flysch sandstone) determines the torrential flow character of the Wien River leading to quick runoff of surface waters into the river in case of heavy rain (Pollack et al., 2016). The low flow of the river in Vienna is 0.20 m^3/s and the mean flow is 0.84 m^3/s. (Fischer and Chovanec, 2019). The 10-year return flood delivers 140 m^3/s and the 100-year return flood delivers 200 m^3/s (BMLFUW, 2011). Figure 6 and Figure 7 present the ecological status and the ecological potential of the Wien River.

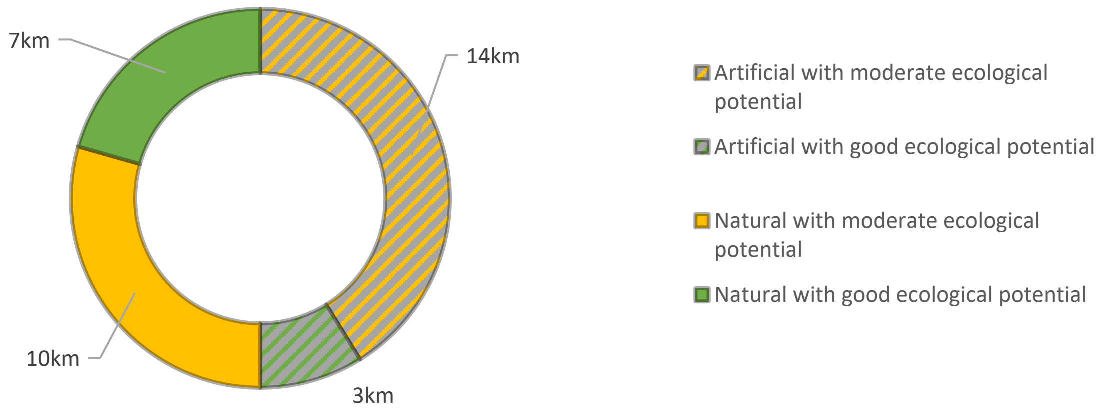

Figure 6: Ecological status and ecological potential of the Wien River

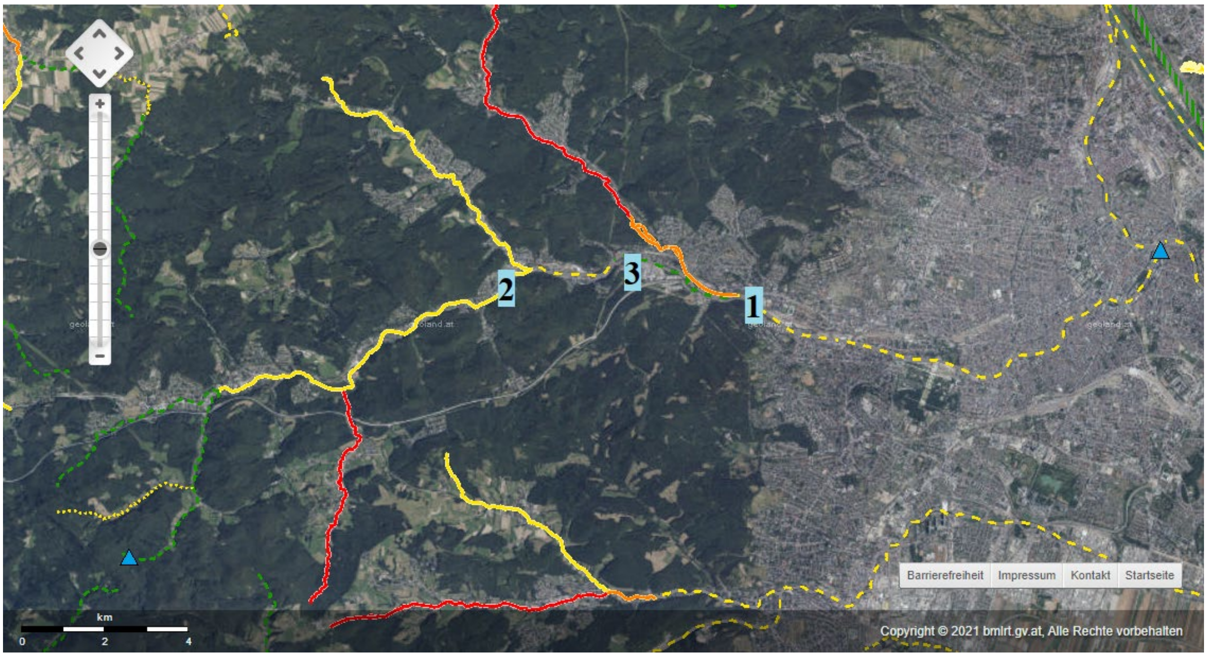

Figure 7: The Wien River (the blue triangles indicate the spring and the end of the Wien River – the numbers indicate the location of the surveyed stretches)

For a detailed investigation of the habitat suitability of the Wien River for nase and barbel, three reaches with different hydro morphological characteristics were selected, a floodplain reach (in the flood control basins), a restored channel reach running beneath and a heavily modified uniform reach. A detailed assessment of a river stretch was carried out in each of these reaches. The localisation of each stretch was chosen based on telemetry measurements (coordinate points where the fish have been detected). The floodplain stretch (stretch 3) was selected based on barbels coordinates, while the restored channel stretch (stretch 1) was selected based on ides coordinates. The heavily modified stretch (stretch 2) was selected arbitrarily. The official fish bioregion of stretch 2 and 3 corresponds to the lower trout region. However, due to climate change, a shift in fish region is observed, as water temperature is more important. Therefore, the seasonal water temperature pattern of these two stretches, resembles that of barbel-region rivers.

Table 1: Ecological status and potential of the surveyed stretches

	Stretch 1	**Stretch 2**	**Stretch 3**
Ecological status	Artificial and heavily modified	Natural	Artificial and heavily modified
Ecological potential	Moderate or poorer	Moderate	Good or better
Fish bioregion	Epipotamal (barbel region)	Metarhithral (lower trout region)	Metarhithral (lower trout region)

Figure 8: Pictures (from left to right) of stretch 1, stretch 2 and stretch 3

4. Methods and Materials

3.1 Physical spatial measurements

Topographic survey

Topographic survey was carried out by cross sectional measurements using a total station Leica TS02ultra-7 and a reflector stick. Additional points were sampled between the transects especially for particular structures such as rocky structures, rocky steps or tree trunks. The variability in transect length and number of points per transect within a stretch is explained by the difficulty of accessing the bank due to the high density of the vegetation.

Table 2: Description of the topographic survey point cloud for each stretch

	Stretch 1	Stretch 2	Stretch 3
Length	120m	100m	80m
Number of transects	7	8	11
Mean transect length	20.6m	10.5m	8.7m
Mean number of points per transect	12pts/transect	10pts/transect	12pts/transect
Total number of points	212 pts	186 pts	241 pts
Point density	0.09pt/m²	0.18pt/m²	0.35pt/m²

Rocky step Tree trunk

Figure 9: Structures in the riverbed of stretch 1

Figure 10: Topographic survey material. 1- Reflector stick. 2- Total station. 3-Measuring tape. 4- Walkie-talkie. 5- Tripod

Flow velocity measurement and flow rate calculation

To calibrate bed roughness for the hydraulic modelling, flow rate calculations were carried out for tree different water levels. Water levels were measured using iron sticks driven into the riverbed. To calculate flow rates, flow velocity (v) was measured at the water surface (v100) and in 40 % of water depth (v40) at different points along a transect using an inductive flow meter (Flo-Mate®).

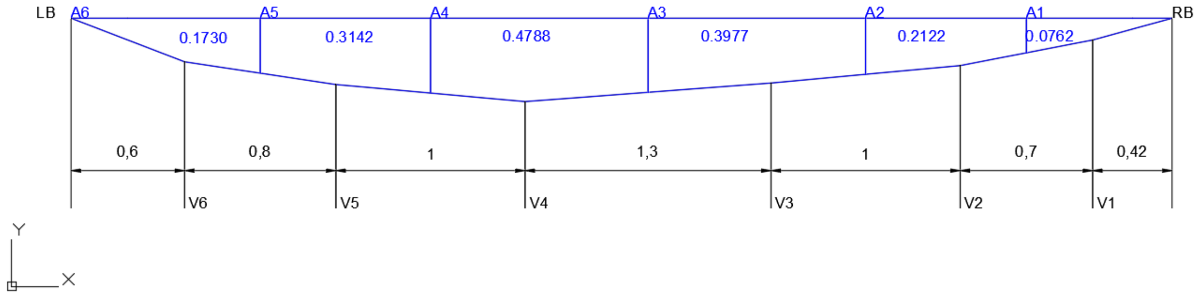

Figure 11 : Cross-section transect of the Wien River for flow rate calculation. LB (Left Bank) – RB (Right bank)

Equation 1. Calculation of mean flow velocity (m.s⁻¹) at the point i according to the two-point method from Krebs

$$Vi = 0.31 * V100i + 0.634 * V40i$$

Equation 2. Calculation of the cross-sectional area Ai (m²)

$$Ai = \frac{L_{i+1} - L_{i-1}}{2} * t$$

Where:
Li is the distance (m) of the i-th flow velocity measurement point from the starting point of the transect
t is the water depth

Equation 3. Calculation of the total discharge Q ($m^3.s^{-1}$)

$$Q = \sum_{i=1}^{n} Ai * Vi$$

GPS coordinates survey

In order to include the surrounding area of each stretch (outside the topographic survey area) in the hydraulic models, the digital terrain model of each stretch was merged with a laser scan of the city of Vienna. Therefore, GPS coordinates were measured at certain points of each stretch using a GPS Leica Zeno 20 and a S050 antenna. The GPS accuracy was determined by comparing the coordinates measured with the Leica Zeno 20 GPS at selected official points of the Austrian cadastral survey with the official coordinates given by the Austrian Federal Office of Metrology and Surveying.

Substrate assessment

Substrate assessment was carried out using an aerial mapping method at the micro-habitat scale (between 0.5-20m²). Micro-habitat is defined as an area with homogeneous water depth and flow conditions. The two dominant grain sizes were determined visually while standing in the river. The turbidity was high on the day of the assessment and visibility was therefore low. Thus, substrate composition sometimes had to be estimated or extrapolated based on the areas where the substrate was visible and by the "feeling under feet". This led to a loss of accuracy in mapping with homogenous areas of up to 100m². Substrate mapping in the riverbed area of each stretch was drawn using GIS and imported into the River2D_Bed program to allocate a substrate attribute to each node of the mesh and create a channel index file used as input of the habitat model (Figure 18, Figure 19, Figure 20).

Table 3: Substrate for instream microhabitat

Substrate composition	Substrate name	Grain size(mm)
1	Megalithal – Blocks	>400
2	Macrolithal – Blocks	<400
3	Mesolithal – Cobbles	<200
4	Microlithal – Gravel	<63
5	Akal – Fine gravel	<20
6	Psammal – Sand	<2
7	Argyllal – Loam	<0.063

3.2 Hydraulic modelling

In order to describe the hydrology of the Wien River in the investigated area, a sub-catchment area was delimited. The area of the sub-catchment is 110km² and its outlet is the monitoring station Hadersdorf-Weidlingau (Figure 14). This station was chosen because it is located upstream of the confluence of the Wien River and the Mauer Brook (a tributary of the Wien River). The characteristic flows (Table 3) were interpolated from daily mean flow data recorded at the Kennedybrücke monitoring station (Figure 14) from 1 January 1976 to 31 December 2018. The Kennedybrücke station is located approximately 4 kilometres downstream of the first investigated stretch and the size of the catchment is 199.4km². Characteristic flow rates for the investigated area were calculated using the Myer Equation (Equation 4).

The processing of the topographic survey data was done using the Surface-water Modeling System (SMS) program developed by AQUAVEO™, to generate 2D mesh file. One mesh was created for each stretch and imported into the River2D model, a two-dimensional depth averaged finite element hydrodynamic model that has been customized for fish habitat evaluation studies. The calibration of the bed roughness was done according to our flow rate calculations for different water levels. River2D was then used to simulate distributions of water depth and flow velocity for different discharge scenarios. Discharge scenarios were chosen according to characteristic flow rates for the investigated area (Table 4) and an intermediary flow rate of $5m^3/s$ was also simulated.

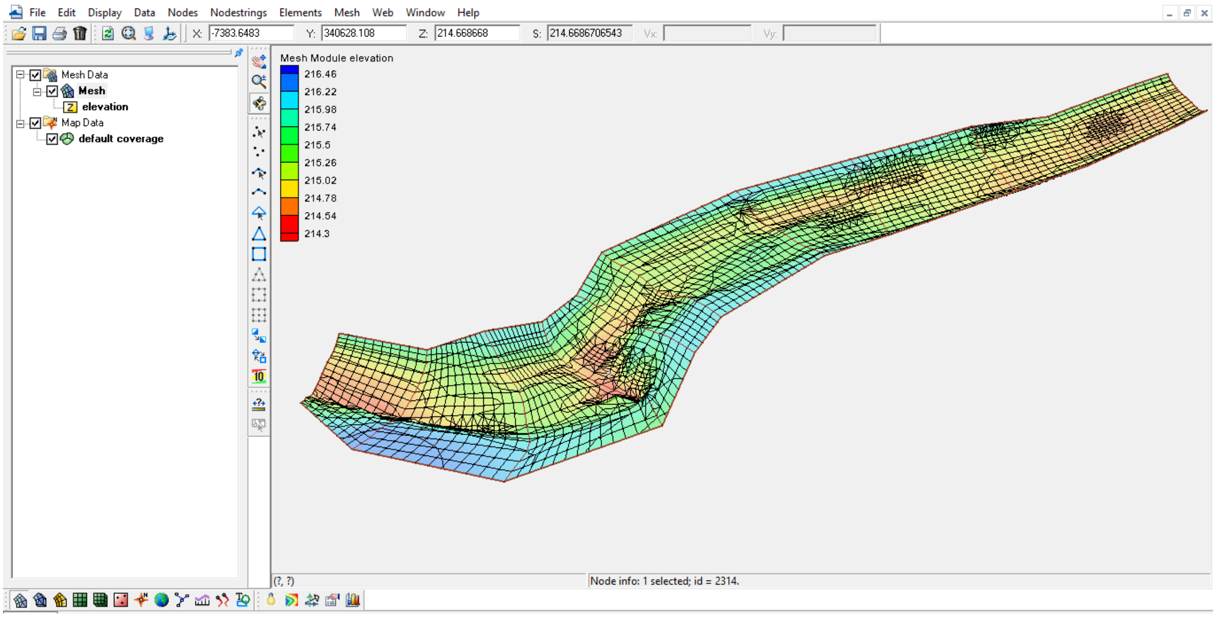

Figure 12: 2D mesh of stretch 1 in the SMS program interface

Equation 4: Myer Equation

$$Q_{Hadersdorf} = Q_{Kennedy} \times \left(\frac{A_{Hadersdorf}}{A_{Kennedy}}\right)^{\alpha}$$

Where:

α coefficient : 1.2 at low flow ; 1 at mean flow ; 0.8 at high flow

Q: Flow rate (m^3/s)

$A_{Kennedy}$: Catchment size at the Kennedy station (km²)

$A_{Hadersdorf}$: Subcatchment size at Hadersdorf-Weidlingau (km²)

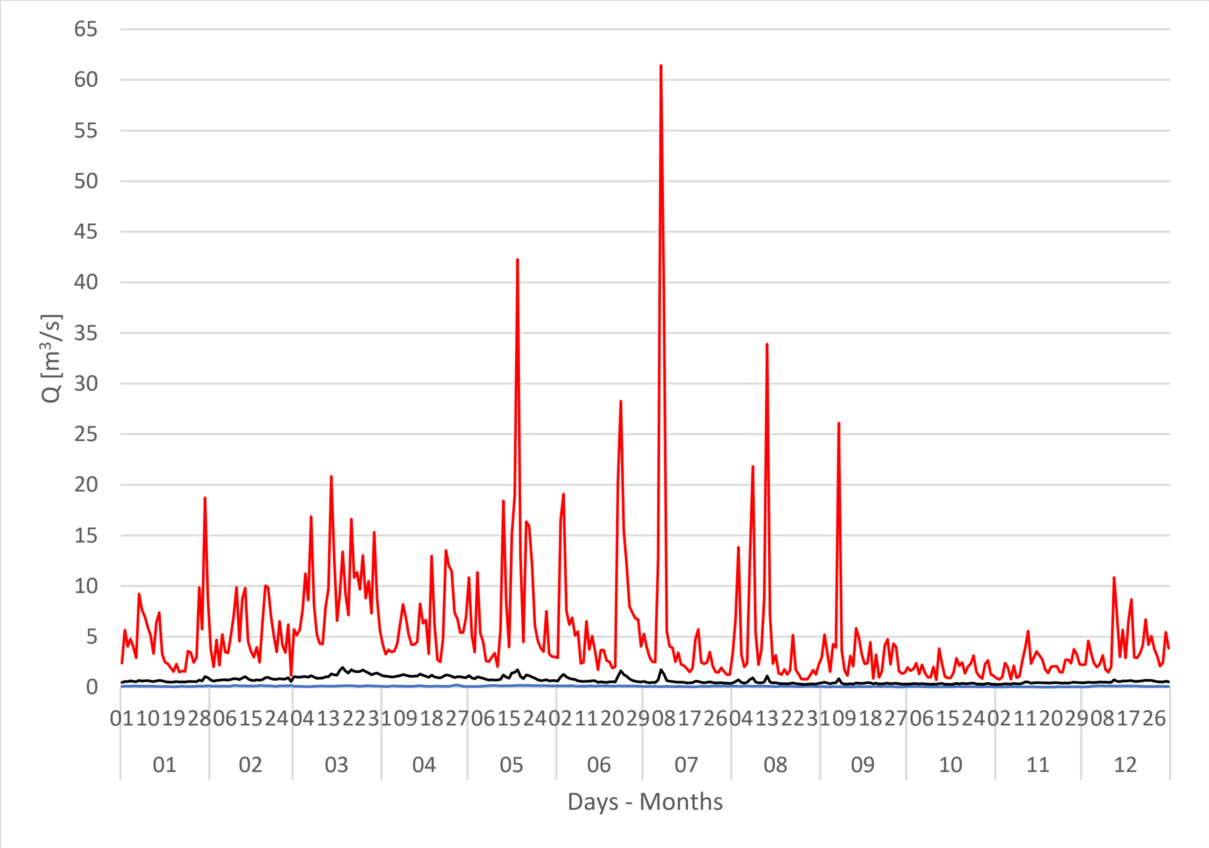

Figure 13: Wien River daily mean flows at the Hadersdorf-Weidlingau station for the period 01.01.1976 – 31.12.2018. Red line – highest daily mean flow. Black line – daily mean flow. Blue line – lowest daily mean flow.

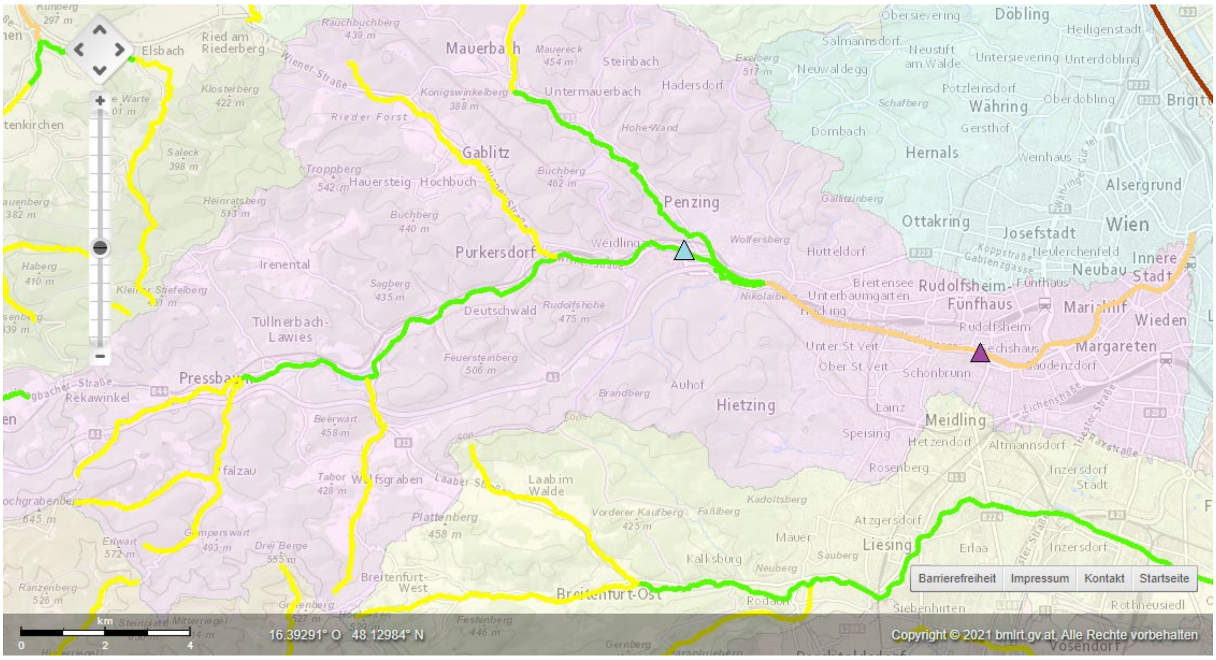

Figure 14: Catchment area of the Wien River (light purple). Blue triangle - Hadersdorf-Weidlingau station. Purple triangle – Kennedybrücke station. The coloured lines indicate the Strahler stream order – Yellow <4/ Green= 4/Light orange=5

Table 4. Characteristic flow rates of the Wien River at the Hadersdorf-Weidlingau station in m^3/s (in blue, the different flow rate used to simulate the hydraulics)

	Flow rate (m^3/s)
Lowest flow (1976-2018)	0.015
Mean low flow (1976-2018)	0.125
Q40 (1978-2018)	0.681
Q30 (1988-2018)	0.697
Q20 (1998-2018)	0.734
Q10 (2008-2018)	0.765
Q5 (2013-2018)	0.726
Q2 (2016-2018)	0.625
Mean high flow (1976-2018)	13.441
Highest flow (1976-2018)	61.428

3.3. Univariate preference curves

Univariate preference curves are used to determine the suitability of habitats for a given species and age stage based on a single abiotic parameter (Hauer *et al.*, 2008). The abiotic parameters used to describe the habitat suitability are water depth (hw), flow velocity (v) and substrate composition (choriotop). Univariate preference curves are produced on a given river section (a reference river) by determining the ratio of used habitat to available habitat. Used habitat are observed habitat occupation under given condition. Different methods can be used to describe used habitat like snorkeling-diving, electrofishing, or visual description. Measurement of flow velocity, water depth and substrate composition are made for used and available habitat. Empirical frequency distributions are derived from used habitat data for a single abiotic parameter. They are standardized based on the most strongly occupied class. The class with the largest frequency receives a value of 1. All further classes are weighted after it. The unused classes have the suitability index (SI) 0 (Hauer *et al.*, 2008). The univariate preference curves used for habitat modelling of the Wien River are based on previous studies on the new section of a Danube tributary, the Traisen River (Schmutz et al., 1999; Melcher, 2000; Holzer, 2011; Schöberl et al., 2014a, 2014b). A new meandering river and wetland habitat was created over a distance of 10 kilometres between the former Traisen canal and the Danube. This section of the river is characterised as natural with a good ecological potential and belongs to the epipotamal barbel fish bioregion. The river presents an existing fish population of nase and barbel. Figure 15, Figure 16 and Figure 17 show the univariate preference curves for each abiotic parameter, species and life stage as well as for spawning habitat. The gray area corresponds to the range of available suitability functions for water bodies comparable to the new Traisen section. The red dotted line shows the preference of adult barbel for deeper habitats.

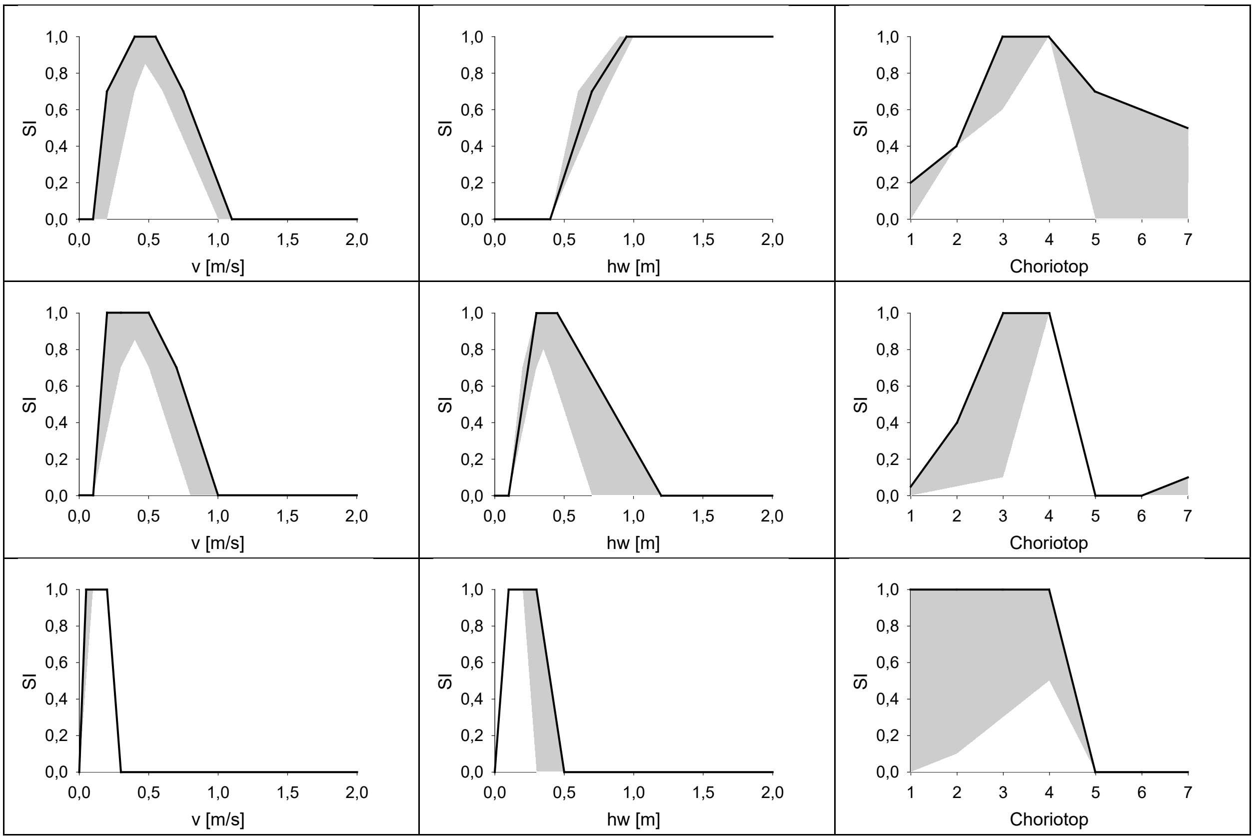

Figure 15: Univariate preference curves of nase in summer (adult top, juvenile middle, 0+ [fish younger than age 1] bottom) for flow velocity (left), water depth (middle) and substrate composition (right).

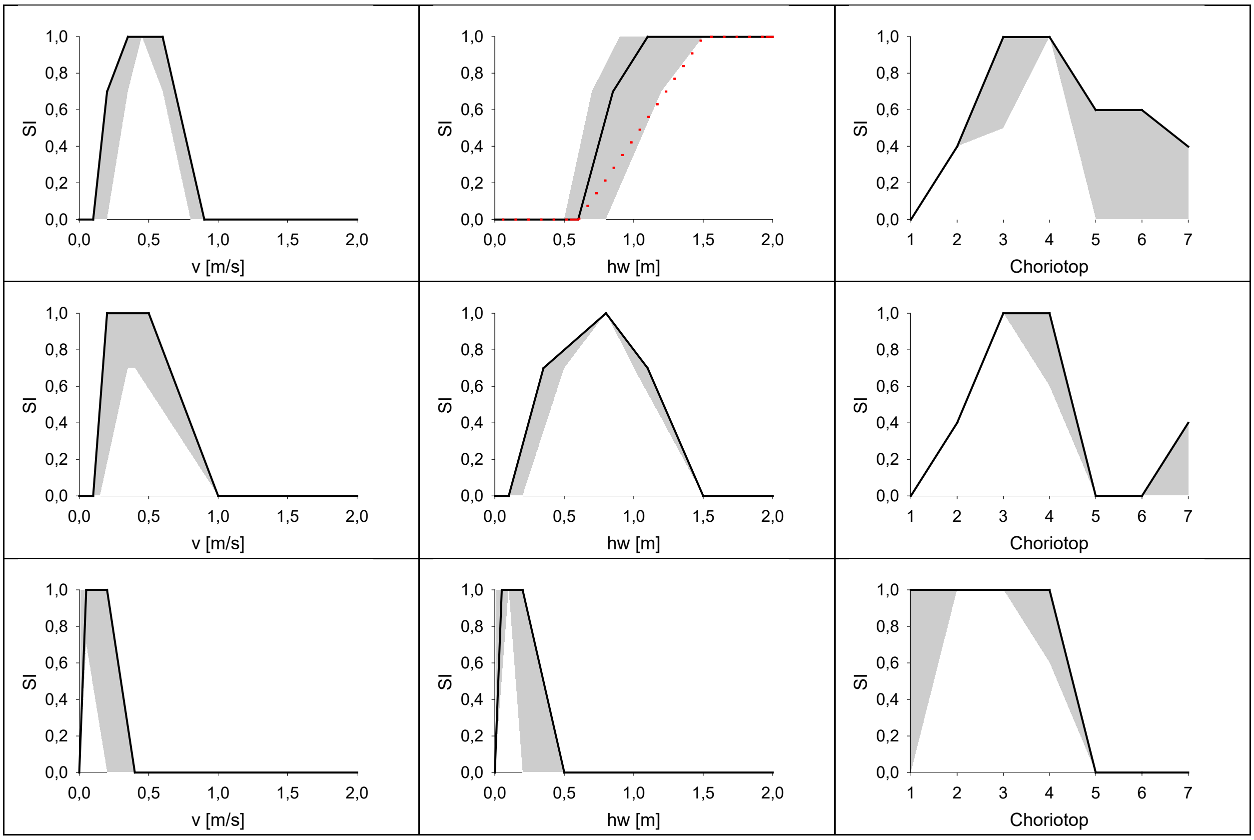

Figure 16: Univariate preference curves of barbel in summer (adult top, juvenile middle, 0+ [fish younger than age 1] bottom) for flow velocity (left), water depth (middle) and substrate composition (right).

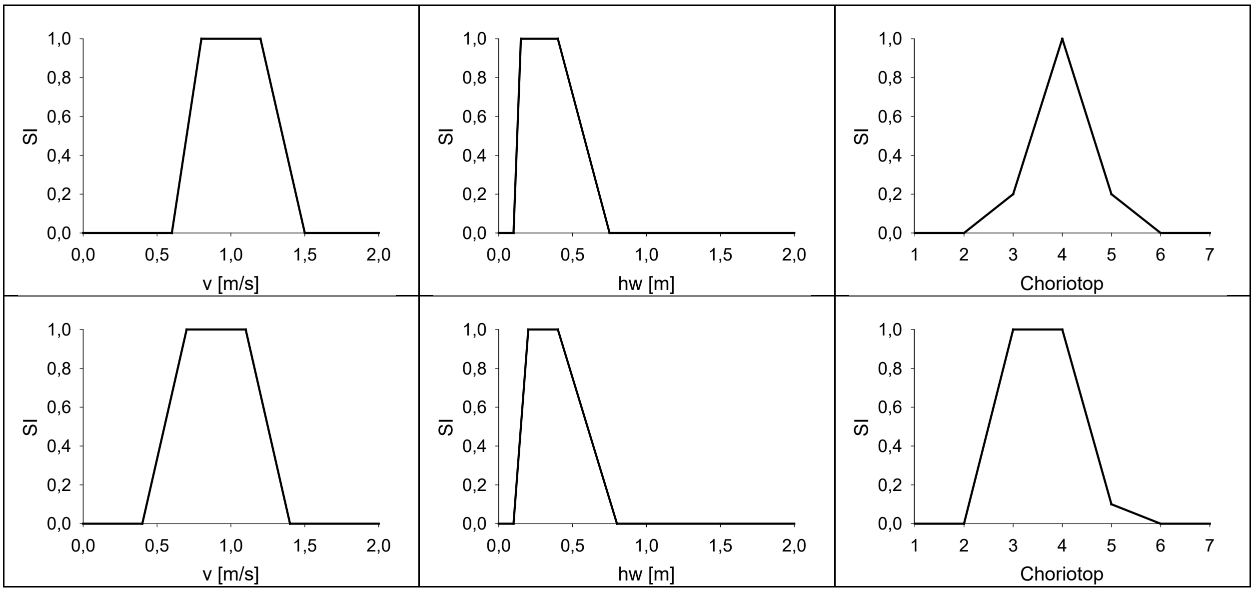

Figure 17: Univariate preference curves for spawning site in summer for nase (top) and barbel (bottom)

3.4 Habitat modelling: The PHABSIM approach

Aquatic habitat models are based on covariation between environmental variables and habitat preference in the wild for selected target species or life stages (K. Pinter, B. Zeiringer, A. Melcher, 2021, *Lecture and exercises: Aquatic Habitat modelling*, lecture notes, BOKU, delivered 21 June 2021). Habitat modelling was performed using the PHABSIM weighted usable area (Physical habitat simulation system - WUA) approach based on hydraulic parameters and habitat preference curves as input. It is a microhabitat predictive model that predicts habitat associations at a fine spatial scale. The River2D© software was used to generate WUA values for every single fish species, age stage and discharge.

Habitat suitability Index (SI) is calculated separately for each parameter (flow velocity, depth and substrate composition) and for each node i. A Composite Suitability Index (CSI) is then calculated for each node (Equation 5). WUA values are finally generated for each node and for a given discharge Q (Equation 6). The stretch total WUA is equal to the sum of WUA values of each node. Due to the variability in study stretch length, Hydraulic Habitat Suitability Index (HHS) were calculated to allow a comparison between stretch habitat modelling results (Equation 7).

Equation 5: Calculation of the Composite Suitability Index for each node i

$$CSI(i) = SI(v) * SI(d) * SI(s)$$

Where:
SI(v) is the Suitability Index for flow velocity
SI(d) is the Suitability Index for total depth
SI(s) is the Suitability Index for substrate

Equation 6: Calculation of the Weighted Usable Area

$$WUA(Q) = \sum_{i=1}^{n} CSI(i) * A(i)$$

Where:
WUA(Q): weighted usable area for the discharge Q
A(i,Q): wetted area of a node i for the discharge Q

Equation 7: Calculation of the Hydraulic Habitat Suitability Index

$$HHS = \frac{WUA}{Wetted\ Area}$$

Significant computational difficulties are encountered when the depth is very shallow or when there is no water at all over a part of the modelled area. The River2D model handles these occurrences by changing the surface flow equations to groundwater flow equations in these areas. A continuous free surface with positive (above ground) and negative (below ground) depths is calculated (Waddle and Steffler, 2002). By saving Note Attribute File and filtering the wetted area with a depth superior or equal to 0 in Excel, the total wetted area can be calculated.

5. Results

The results will include WUA and HHS values for each species, age stage and flow rate. Hydraulic rating curves can then be plotted to visualize habitat suitability at different flows. The regression equation for the hydraulic rating curve can be combined to a flow time series to plot a WUA time series and a WUA duration curve.

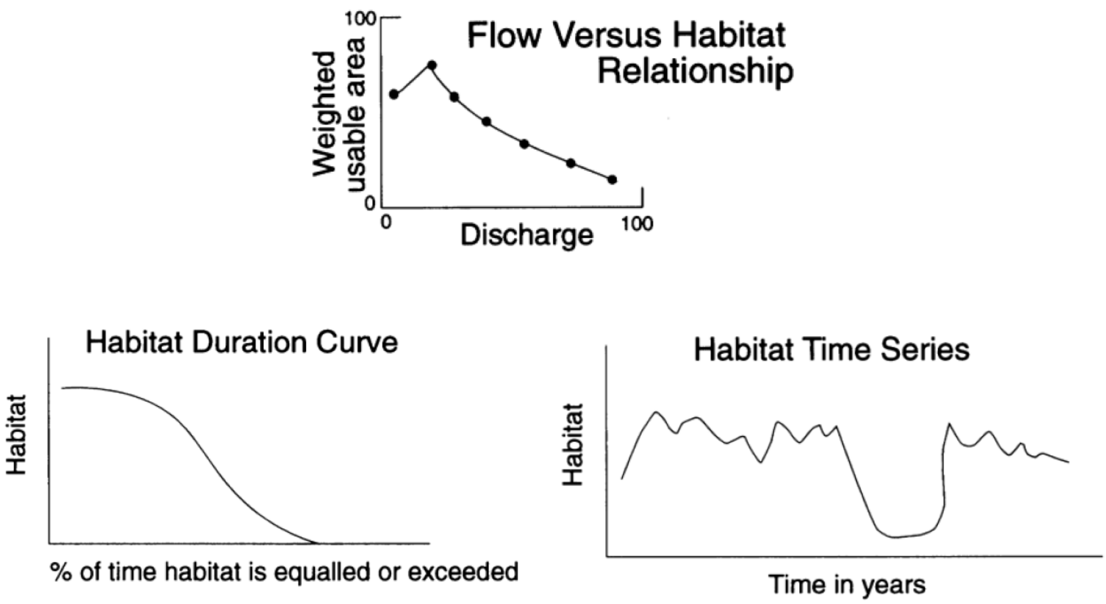

Figure 18: Expected results (from K. Pinter, B. Zeiringer, A. Melcher, 2021, Lecture and exercises: Aquatic Habitat modelling, lecture notes, BOKU, delivered 21 June 2021)

6. Discussion

Due to its typical hydrological regime with low flows that can increase dramatically in case of heavy rainfall event, the Wien River has been gradually regulated since the 18th century. Today, 50% of its length is classified as artificial and heavily modified and 71% has a moderate ecological potential (the remaining 21% has a good ecological potential). The Water Framework Directive however requires all European countries to achieve a “good ecological status” for all surface waters by 2027. The aim of this internship project is to use the PHABSIM habitat modelling approach to determine the habitat suitability of the Wien River for nase and barbel, two indicator fish species of habitat quality. The objectives of the discussion will include relating the results of the hydraulic simulation and habitat modelling with the current hydrological and ecological characteristics of the Wien River. The results of the hydraulic simulation and the habitat modelling are not yet complete, but a discussion can already be initiated regarding the modelling approach and methodology.

The PHABSIM habitat modelling is a univariate approach, i.e. habitat suitability is determined in relation to a single influencing parameter. Individual suitability indexes are combined to form an overall value and the interaction between individual physical parameters is not considered. Moreover, physical habitat models are limited to the description of the habitat on the basis of physical and morphological parameters and other factors such as food availability, competition, predation or water temperature are neglected.

Another important parameter is the cover type. “As most European rivers are affected by both morphological and hydrological pressures river restoration strategies have to strive for an integrated approach covering both traditional hydro morphological and additional essential habitat features” (Melcher and Schmutz, 2010). Indeed, shading, screen protection and flow protection may vary according to the cover type and therefore influence the habitat suitability of a particular stretch. When considering over hanging vegetation, stretch 1 and 2 have a tree layer dominated by willow for stretch 1 and elm and alder for stretch 2. Stretch 3 has no tree layer but a shrub layer dominated by Japanese knotweed and Himalayan balsam. These neophytes were however very dense, sometimes exceeding 4 meters in height, leading to significant shading. Considering the submerged vegetation, heavy rainfall events also lead to an increase in the woody debris load in the river, mainly for stretches 1 and 3. Moreover, the banks of stretch 1 and 2 are partially stabilized with rip rap and stretch 1 and 3have occasional undercut banks. Thus, each stretch has particularities regarding cover type that are not included in the habitat modelling but that could strongly influence their habitat suitability.

Moreover, the high turbidity and associated low visibility on the day of the substrate mapping led to the mapping of large homogenous areas. As a consequence, some grain sizes may have been overestimated which could impact the suitability results. Stretch 3, for example, has 48% of grain size category 3 (<200mm) which is very suitable (SI=1) for all species and age stages, with the exception of nase spawning habitat. These could lead to an underestimation of the suitability of stretch 3 for nase spawing habitat and an overestimation for all other age stages. However, only the dominant substrate is considered for modelling and it could be that the second dominant substrate has a different suitability than the dominant one, thus balancing the suitability results.

In addition, the results of the habitat modelling could also be influenced by the results and the accuracy of the topographic survey and the processing of the point cloud to create the mesh. The point density of stretch 3 is almost 4 times greater than stretch 2 and almost 2 times greater than stretch 1. The point density could have been improved by increasing the number of transects but this raises the question of the field workload. Moreover, the survey is also influenced by the surveyor judgement when considering the location of points to describe the structures between transects. As these structures are drawn manually (triangles), the creation of the mesh is also influenced by the surveyor's ability to remember and draw this structure with the SMS software.

Thus, if the Wien River has suitable habitats for two indicators species of habitat quality in the lower rhithral and upper potamal zones of European river systems, a further research project could focus on opening migratory routes from the Danube canal to suitable spawning habitats in the Auhof area. However, if the results show that the Wien River does not have suitable habitats, attention should be given to habitat restoration.

7. Feedback on the experience

Doing an internship at the Institute of Hydrobiology and Aquatic Ecosystem Management (IHG) of the University of Natural Resources and Life Sciences Vienna was for me the opportunity to put into practice the skills I had acquired in the Urban and territorial planning and environment department (DAE) of Polytech Tours but also during my Erasmus semester in Vienna. Indeed, during my seventh semester, I followed some courses of the master Applied Limnology of the IHG and acquired knowledges in river habitat and landscape assessment or in fish sampling and monitoring that I actively applied during my internship. These knowledges, more focused on alpine and small rivers are complementary to the knowledges on large lowland rivers and wetland restoration acquired at the DAE. This project was also an opportunity to work on the particular case of an urban river, with various hydro-morphological characteristics and a typical hydrological regime.

The first step of the internship subject development was already an interesting process for me as I was fully involved into the design of my project by my internship supervisor before the internship started. My end of study project (PFE) at the DAE is related to habitat mapping in fluviatile systems. Particularly interested by the subject, I was willing to develop my skills in aquatic habitat modelling and suggested my participation in the Wien River project. By reading literature and with the help of my supervisor I was able to design the objectives and main steps of the methodology for the habitat assessment of the Wien River for nase and barbel. This approach allowed me to think about what I wanted to work on, what skills I wanted to acquire and how to apply them in the context of the Wien River project.

Thus, this internship was an opportunity to acquire new skills in aquatic habitat modelling and to use new tools. First, I used different equipment for the physical spatial measurements. Spending long hours in the field to carry out a detailed assessment at the micro-habitat scale allows to get familiar with the study site and to understand the challenges of data acquisition for the following processing steps of the modelling. It was interesting to apply a different method (topographic survey), at a smaller scale compared to the methods I was reading about for the literature review of my project of end of study (PFE). Indeed, my PFE is more related to the acquisition of high resolution topographic and bathymetric data by an airborne LIDAR (Light Detection and Ranging) method. Although this method allows for the rapid acquisition of data over several hundred kilometres of river, it does not really allow to get familiar with the study site and raises the importance of the pre- and post-processing of the data.

I also participated in an aquatic habitat modelling field trip in Lunz am See, Lower Austria where we snorkelled to determine the habitat use and habitat availability of brown trout in the Ois River. We then developed univariate preference curves for different age stages of brown trout. It was interesting to work on the development of preference curves to understand how the biotic data used as input to habitat modelling are produced. Then, I also learned how to use new software such as the SMS program or the River2D model and how to analyse the model output. It was also the occasion to apply the PHABSIM approach and to understand its strengths and weaknesses.

In addition, this internship was a chance to get an insight into the field of applied research and to understand how tools like models can be use as decision support in integrative watershed management. As a future engineer in the field of river and wetlands, I really appreciated working on a project whose results are directly linked to the challenges of the Water Framework Directives. It was also a chance to work in a European context and to learn about some of the Austrian watershed management tools. To conclude, in addition with the technical and scientific skills I applied and acquired during my internship, I learned more about teamwork and the importance of communication. I also developed skills such as autonomy and decision making, but also initiative and organisation that will be essential in my future career as a river and wetlands engineer. I got a more detailed insight into the field of aquatic habitat modelling, which confirmed my interest in the subject and in the study of aquatic ecosystems.

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10. Annexes

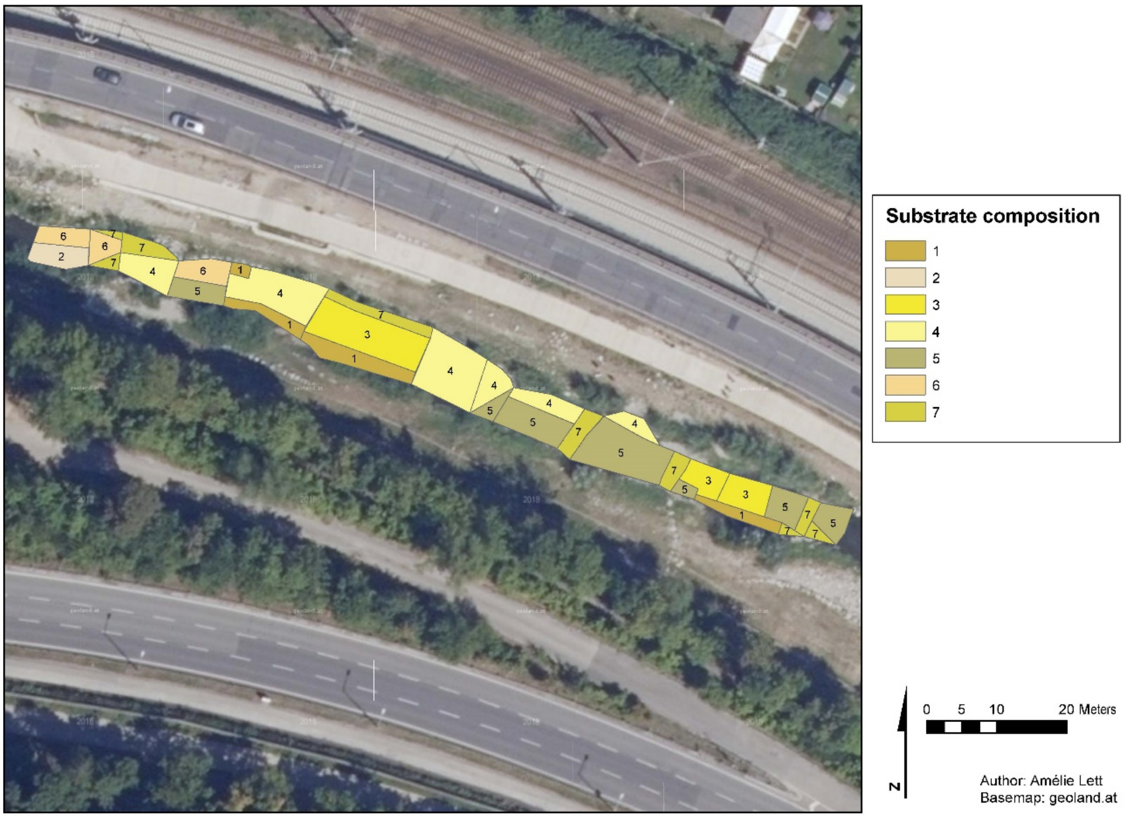

Figure 19: Aerial mapping of substrate composition for stretch 1

Figure 20: Aerial mapping of substrate composition for stretch 2

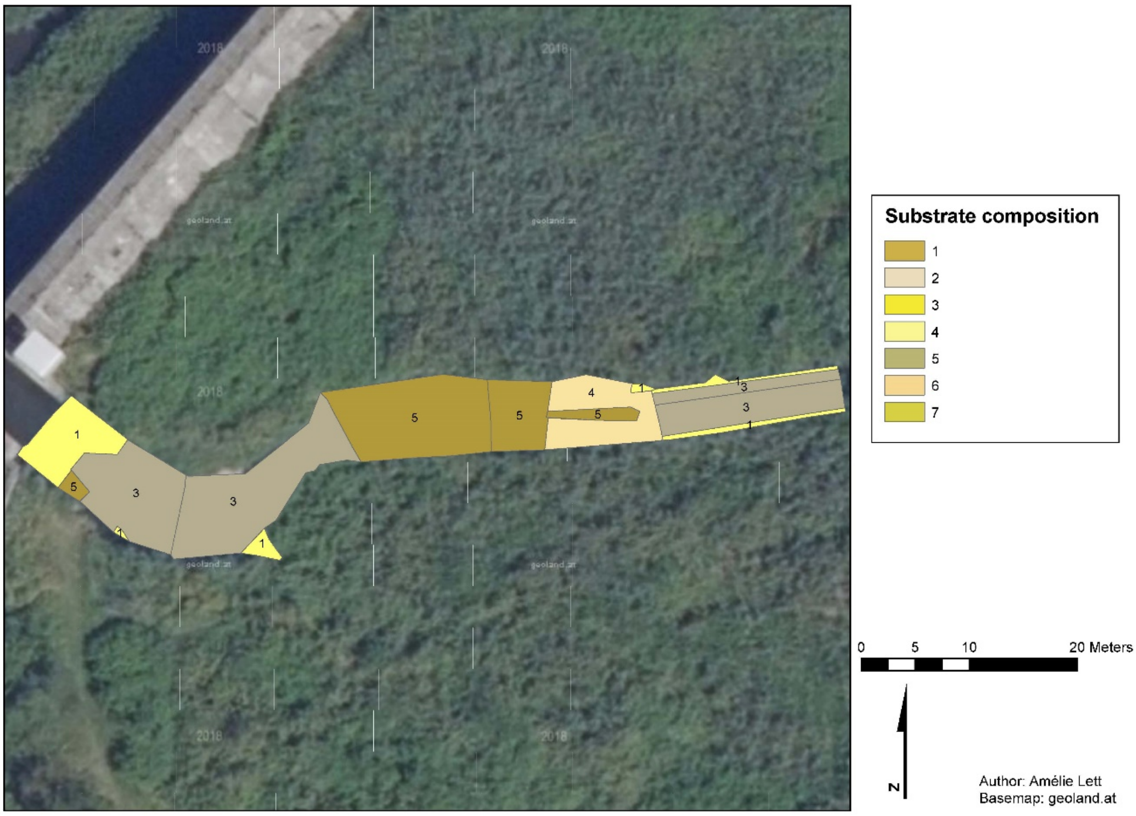

Figure 21: Aerial mapping of substrate composition for stretch 3

11. Figures

12. Tables

13. Equations

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Habitat assessment and habitat suitability of the Wien River for nase (*Chondostroma nasus*) and barbel (*Barbus barbus*)

Summary The Wien River is the largest tributary of the Viennese Danube. Due to its typical hydrological regime, the river has been gradually regulated since the 18th century. Today, 50% of its length is classified as artificial and heavily modified and 71% presents a moderate ecological potential. The Water Framework Directive however requires all European countries to achieve a "good ecological status" for all surface waters by 2027. The aim of this internship project is to use the PHABSIM habitat modelling approach to determine the habitat suitability of the Wien River for nase and barbel, two indicator fish species of habitat quality in the metarhithral and epipotamal zones of European river systems. If the Wien River presents suitable habitats, further research project could focus on opening of migratory routes from the Danube canal to the suitable spawning habitats in the Auhof area. However, if the results reveal that the Wien River does not present suitable habitats, attention should be given to habitat restoration.

Keywords habitat modelling, habitat assessment, *Chondrostoma nasus*, *Barbus barbus*, suitability curves

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