«Mapping potential spawning habitats of brown trout in the river Schwechat»

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1. Introduction

Freshwater ecosystems cover only 1% of earth's surface. However, according to *Strayer u. Dudgeon (2010)* they harbour around ten percent of the whole world's species and around one third of worlds vertebrate species. With that in mind, special attention has to be paid to the fact that 83 percent of the freshwater vertebrate populations have declined since 1970 (WWF, 2018: 7.).

Wetland ecosystems and therefor also freshwater and river ecosystems provide a variety of benbefits to humans. First of all, water itself is critical for survival of humans and any other species. Wetland ecosystems also play a vital role in the global water cycle and in regulating local water availability. Furthermore, they contribute to general water quality by contributing to water purification in form of denitrification, detoxification, and nutrient cycling. Freshwater ecosystems also significantly contribute to sediment transfer and nutrient retention. While water itself is, as mentioned, a provisioning ecosystem service it, is also necessary for several other provisioning ecosystem services like food production or cultural ecosystem services (Russi et al., 2013: 8).

River ecosystems in particular provide several ecosystem services, like the provision of food, clean water, fuel, flood and drought regulation, reduction of nutrients, provision of highly biodiverse habitats, cultural identification and cultural assets like hiking, natural experience and (sport-)fishing. This is due to their highly variable hydrological conditions, the high rates of sediment and biomass transport and turnover, and their high productivity, in addition to the general properties of wetlands mentioned above (Becker et al., 2022: 1-ff.).

Rivers connect landscapes. They transport sediments and organic matter, but also nutrients and pollutants between different parts of their catchments. They are connected to surrounding ecosystems in longitudinal (along the stream), lateral (between the stream and riparian and upland areas) and vertical (between the channel and the hyporheic zone) ways. This connectivity is important for the functioning of river ecosystems and especially to a lot of organisms. Different parts of the stream are of great importance for many species to grow, reproduce and survive threatening conditions (Jansson et al., 2007: 2-ff.). The majority of Middle European rheophilic fish use gravel as their preferred substrate to create their spawning habitats (Pulg, 2009: 1).

Brown trout (*Salmo Trutta*) require specific conditions to build their spawning nests. After analysing existing literature, *Louhi et al. (2008)* specified preferred habitat conditions for brown trouts with flow velocities between 20 and 55 cm/s, water depths between 15 and 45 cm and a grain size distribution between 16 and 64 mm size.

Finer sediments reduce oxygen content and thereby egg survival while coarser gravels might be too heavy to be moved by the trout in order to create their spawning nests. Regarding this, damming and regulation, especially shoreline stabilisation, greatly reduce gravel transport and in severe cases might even prevent it completely. On the other hand, erosive land use, such as several agricultural practices (i.e. maize farming) transport lots of fine sediments into rivers, which end up clogging potential spawning habitats. Furthermore, river regulation might reduce or increase water depth and water speed to an extent in which former spawning habitats might not be suitable anymore. Migration barriers remove the possibility of migratory fish species to move to more suitable spawning grounds and force many individuals to breed and spawn on an area that is much too small for this amount of nests, leading to higher mortality and overall worse health of fish (Pulg et al., 2011).

Water temperature is another factor that greatly influences the health and reproduction rates of water inhabiting species. It controls biochemical turnover rates, photosynthesis, and respiration of aquatic species. Nearly every aquatic species has specific temperature ranges in which they thrive and sudden temperature changes impact their production and development and might even lead to death. Damming and river regulation influence the thermic dynamics of streams and rivers in two ways: Firstly, the dam itself changes the thermic properties both in the reservoir and downstream, as well as the thermal interaction between water and the atmosphere. Secondly, damming and riverbed regulation influence the heat exchange by water entering and leaving the main channel. Studies have shown that dam building and river flow regulation increases overall water temperature throughout the year, with the biggest increase being in Autumn. (Yang et al., 2022: 1-ff.) Brown trout gametes have a relatively high tolerance to rising temperatures, ranging from three to fifteen °C. However, brown trout embryos exposed to temperatures above eleven °C showed reduced percentages of hatched larvae and increased percentages of malformed larvae, according to a study by *Lahnsteiner (2011)*.

The vast majority of fish spawning on gravel is endangered or even extinct in Central Europe, and populations seem to continue decreasing. The brown trout especially suffers a lot from the aforementioned problems. (Pulg, 2009) Although the brown trout is listed as “least concern” in the IUCN (2010) list of endangered species, this might not be true for all of Europe, as natural brown trout populations decrease in Austria and especially Lower Austria. This is indicated by the election of the brown trout as “Fish of the Year 2020” in Austria, an “award” that is, aimed at raising awareness, granted to endangered fish species every year. (Naturschutzbund, 2020)

The aim of this case study is to map potential brown trout spawning habitats in a section of the river Schwechat, located in Lower Austria. The research question for this project is: Do natural, heavily degraded and moderately degraded sections of the river Schwechat differ in their potential as spawning ground for the brown trout (*Salmo Trutta*)?

The hypotheses are:
HQ1: Natural and moderately degraded sections are more suitable as spawning habitats than heavily degraded sections.

HQ2: There is no difference between the sections.

2. Study site

The river Schwechat is a river of second order that has its well in the hills of the Vienna Forest. It flows through the so called “Helenental”, makes its way through the Vienna Basin and discharges into the Danube at the cite of the same name Schwechat. It has a length of 62 kilometres and falls off 588 meters over the distance. The average discharge is 2 m^3/s, the lowest average discharge every year is 0,38 m^2/s. Yearly floods (HQ1) have a discharge of 50 m^3/s, ten-year flood events (HQ10) discharge 210 m^3/s, thirty-year flood events (HQ30) 255 m^3/s and 100-year flood events (HQ100) 290 m^3/s. The yearly mean temperature of the river is 12,9 °C with peaks up to 22,9°C and a minimum of 2,1 °C for the duration of 2019 to 2023. (Wasserstandsnachrichten und Hochwasserprognosen, NOEL.gv.at)

Like most rivers in Lower Austria, the Schwechat is severely degraded. There are several big dams and smaller weirs, which hinder many fish species from migrating upstream. Furthermore, the riverbed is straightened on most of the river's length. River straightening ranges from stones placed on the riverbank to prevent sideward erosion, to concrete banks, such as in the city are of Baden. The studied area of this river is characterized by concrete banks in the city of Baden and river regulation by big boulders on the rest of the stretch. There are two parts of the whole river Schwechat that still flow naturally. Those account for only around 7% of the river's length. One of them is called “Traiskirchner Au”, which is part of the studied area. Several renaturation projects were started and finished in the last years, one of them located in the observed area. The first renaturation project consisted of removing the stones on the side of the bank, as well as redirecting the river and installing natural obstacles like logs and boulders in order to establish sidewards bank erosion and allow the river to meander again.

2.1 The brown trout in the river Schwechat

No scientific studies could be found about the state of the brown trout in the catchment of the river Schwechat. However, indicators can be found in forums and media reports. While the brown trout population in the river were considered as good or sufficient in the decade of 2000-2010, the brown trout stock started to decline in the middle of the last decade. This might have several causes. First of all, climate change increased the overall average water temperature of the catchment, leading to worse conditions for the brown trout. The second cause might be the introduction of bigger rainbow trout populations to the catchment. The rainbow trout is better suited for higher temperatures and shows higher resistances to diseases than the brown trout. Furthermore, the rainbow trout competes for habitats and spawning grounds, according to the fishing association of Baden. The third cause for depleting brown trout populations is a wrong approach at stocking. In former times the river was stocked with fish of sizes about 30cm. This is the minimal size for sports fisherman to take brown trout out of the river for human consumption. This was done to provide lots of legally killable trout for fishermen and to offer attractive sports fishing. However, this has a few disadvantages. Firstly, fish raised in artificial sanctuaries are not used to the conditions in wildlife, that being water temperature, flow velocity and the gathering of wild food. This itself makes them vulnerable to diseases and starvation. Another disadvantage of this approach is that fish raised in the safety of protected waters is that the fish are not adapted to predation. Possible predators for trout this size are birds like the Kingfisher, the Cormoran or the Grey Heron, as well as the fish otter. This leads to the fish being unequipped to being hunted, which then leads to better hunting outcomes for the predators and rising populations of such. This, together with the (regulated) decimation of stocks by humans through sport fishing led to rapidly declining brown trout populations.

After realising the approach of restocking the brown trout population was not optimal, the method of the fishing association was changed. Now, matured trout get caught upstream and from other rivers and their eggs and milt get gathered. After that, the eggs get fertilized and kept in safe sanctuaries until they hatch afterwhich they get released into the wild. This helps with some of the aforementioned issues, because the juvenile fish are accustomed to the characteristics of the river system and get introduced to predation at a young age. It might also have positive effects on the susceptibility of fish to human predation as they might get caught several times before they reach the size limit and thereby are used to the baits that anglers use. This change of approach led to slow recovery of the brown trout population. However, the recovery takes time and is much slower than the decline that the river suffered in the previous years, which means that the brown trout in the catchment of the Schwechat is still critically endangered.

3. Methods

Louhi et al. (2008) defined the optimal characteristics for spawning habitats of brown trout with flow velocities of 20-55 cm/s, depths between 15 and 45 cm and grain size distribution of bed material between 16 and 64 mm. While flow velocity and depth were easily measurable in the course of this small project, this was not the case for grain size distribution, because this would have needed measurement of several samples in order to get an idea of how spawning habitats look. Due to this, a meeting with a representative of the fishing association of Baden was organized. The purpose of the meeting was to find actual spawning nests of brown trout in a different part of the river. When a spawning nest was found, the surrounding sediments were used as visual and sensitive examples for the upcoming mapping.

Mapping was done by creating GPS markers on a mobile device whenever a potential spawning habitat was found. For the first few spots, flow velocity was measured using a float connected to a rope of defined length and depth was measured using a measuring tape. Sediment size was evaluated by comparing to photographs of the above mentioned gathered samples of actual spawning nests. After several potential spawning habitats were mapped this way, the following spots were evaluated on the experience gained from the previous habitats.

For mapping and analyzing the results, the river was divided in the following different sections regarding its level of degradation:

- Severely degraded, concrete banks
- Severely degraded
- Moderately degraded
- Renaturated
- Semi-natural
- natural

Severely degraded sections show little to no signs or characteristics of naturally flowing rivers. They are characterized by a straightened channel, no meandering whatsoever, little to no bends in the rivers reach, a lot of anthropogenic obstacles like weirs and groynes and thereby drastically changed hydromorphological patterns and characteristics, like flow velocity, water depth or sediment size. This category was split in two sub-categories because the composition of the river bank might have influence on erodibility of the banks and sediment load of the river.

Moderately degraded parts of the river show some signs of natural flow characteristics, like a slightly bent river channel, more natural composition of the riverbed and overall less anthropogenic influences than in severely degraded sections.

Renaturated sections are sections of the river where it has been severely or moderately degraded in the past, but efforts have been made to undo this degradation. They are often characterized by more natural river characteristics, with riffles, pools, erosion and deposition areas or the beginning of meandering. However, depending on the age of the renaturation project and the made efforts, these characteristics might not have fully developed yet and renatured sites might still look quite degraded.

Semi-natural sections of the river are sections that show primarily natural characteristics, but anthropogenic influences are still clearly visible. These influences could be man-made obstacles such as small groynes but could also be structures limiting the area in which the river can meander and erode.

Natural sections are, in contrast to the first category, parts of the river that show little to no signs of anthropogenic influence. They are characterized by a meandering river and a high variety of habitats, resulting from their natural state and natural flow. Pools and riffles, side-channels, as well as erosion and deposition zones can be found in abundance.

As mentioned earlier, lateral obstacles play a significant role in influencing flow regimes as well as sediment transport and other major characteristics of rivers. Therefore, lateral obstacles were also mapped in the observed area. A critical differentiation of lateral obstacles is whether they are passable by fish or not. The following categories have been chosen to map obstacles:

- weir, impassable
- weir, passable
- groyne, passable
- small groyne
- riffle

Most of the obstacles found on the course of the river were labelled as “groyne, passable”. There are two impassable weirs in the studied area, as well as some riffles, small groynes, and passable weirs.

It is important to note that the categories for both degradation of the river and obstacle mapping were entirely chosen by the author and are in fact not underlying any scientific evaluation, as it was not the topic of this research paper. These classifications and mappings only served to simplify analysis and to provide the reader with a visualization of how the studied area looks like. Mapping of obstacles was done on the base of orthophotos, while the classification of degradation was done while mapping potential spawning habitats, as well as out of experience and local expertise of the author.

Data collection was followed by GIS-mapping using QGIS (v 3.34). The mapped GPS-markers were imported as a vector layer. As mentioned above, not all mapped points are based on measurement, but on educated assumptions made by the author. In the created map, points that were mapped based on measurements of flow velocity and water depth, and points that were mapped by estimating those parameters on the basis of experience, are displayed differently. A map of the researched area and the degradation of the river can be seen in figure 1.

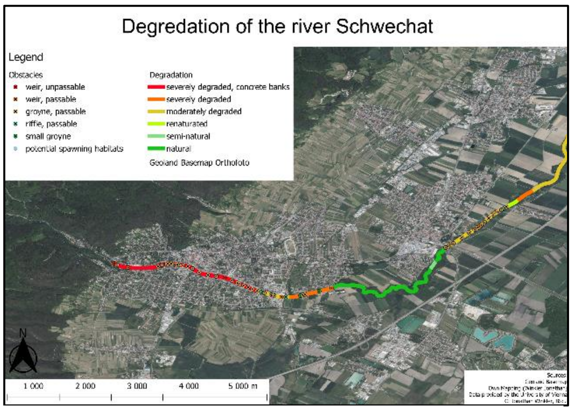

Figure 1 Degradation of the river Schhwechat

4. Results

The results of the mapping process can be seen in figure 2. Because this map is to small scaled to observe exact patterns, separate maps for every subsection of the mapped area were created. Those can be seen in the following figures. To describe and discuss the results they will be split into two parts, general patterns and local patterns. General patterns are findings that apply to the research area as a whole. Local patterns describe findings that apply on distinct sections of the river or even very small scale plots in between a section. The results of mapping can be seen in figures 2-7.

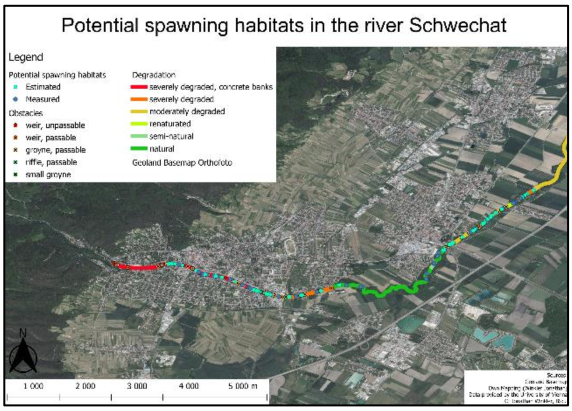

Figure 2 Potential spawning habitats in the river Schwechat

4.1 General patterns

A total number of 117 potential spawning habitats were observed. During mapping, one definite spawning nest was found in the “severely degraded, concrete banks” section.

Against expectation, the natural sections of the river do not offer the right conditions for potential spawning habitats. Only nine potential spawning habitats can be found in these parts of the river - the lowest number of all river sections. It might also seem surprising that the worst degraded parts of the river (“severely degraded, concrete banks”) contain the highest amount of potential spawning habitats with a number of forty. The potential spawning habitats in these parts of the river are quite evenly distributed. This is not the case for the “severely degraded” sections, where the absolute number of potential spawning habitats (twentyone potential spawning habitats) is lower than in “moderately degraded” and “severely degraded, concrete banks” sections, but distinct spatial patterns can be observed. Moderately degraded sections of the river show an absolute number of potential spawning habitats of thirtyfive, renatured sections offer five potential spawning habitats and semi-natural sections two. It seems that suitability of the riverbed as spawning habitat generally decreases downstream, as potential spawning habitats get rarer.

Observing general patterns in the research area shows that big lateral obstacles like weirs influence the potential of the riverbed as potential spawning habitat. In both cases of the two big unpassable weirs located in the research area, the river downstream is not quite suitable as spawning ground for brown trout. While in the case of the big weir at the start of the observation area, the length of the river section that is not suitable for reproduction of brown trout is quite long, this is not the case for the second big weir. However, the impact is still noticeable, as potential spawning habitats start appearing several hundreds of meters downstream.

Another pattern applicable for the whole research area is the influence of mid-sized lateral obstacles like groynes, riffles, or small weirs on the hydromorphological characteristics of streams and thereby their suitabability as spawning grounds for brown trout. While there were some exceptions in the studied area, in mid-sized lateral obstacles seem to generally have a positive influence on the suitability of the river as spawning habitat. While it seems that such objects decrease suitability immediately downstream of the obstacle, they do, on the other hand, increase suitability again a few meters further downstream. However, this is not always the case, as there are some observed obstacles where suitability did in fact not increase downstream. It also seems important to consider the distance between separate obstacles. Apparently, small distances between two or more structures in the river lead to a decline in suitability. Long distances between structures and/or obstacles also seem to have a negative influence on habitat suitability for spawning.

4.2 Local patterns

There are little to no potential spawning habitats for brown trout in the “severely degraded” section. However, there are two small spots highly suitable for building spawning nests. Both of those are related directly to small structures, like small groynes. These structures are missing for a long part of this stretch. This indicates that small structures can improve habitat suitability significantly.

As mentioned before, the naturally flowing stretches of the river offer little value as spawning habitats. The only potential spawning grounds were found at the start and the end of the section, where human impact on this untouched part of the river was clearly visible. It seems that the parts of this section that were still slightly straightened show slightly better characteristics for spawning habitats than the entirely natural sections.

The one mapped renaturation site showed major improvements in comparison to the upstream adjacent “moderately degraded” section. This is especially true for the upstream part of the renaturation site, where water velocity is quite fast and the river sediment has the right size. However, in the downstream part of the renaturation site, where the river starts turning more towards its supposedly natural state, the amount of potential spawning habitats declines again.

5. Discussion

5.1 General patterns

The high number of potential spawning grounds in the “severely degraded, concrete banks” part of the river can be explained by the high abundance of rather big groynes. Groyne size and shape can have a significant influence on how groynes change flow patterns and erosion and deposition rates. (Dianguang et al., 2022: 1-ff.) Groynes offer a variety of advantages that help create habitats suitable for brown trout spawning in the river. They disrupt the stream flow initially, creating pools with deep water depths and slow flow velocities. Those pools also trap suspended fine sediments inside them, removing them from the water column and depositing them at the bottom of the pools. However, at the same time groynes speed up water velocities downstream of the pools, leading to shallower, faster moving and oxygen rich water bodies. (Choi et al., 2013: 1-ff.) This, together with bigger grain size distribution and less fine sediments resulting from those getting trapped in the pools built up by the groynes, creates ideal conditions for spawning habitats. This explains why potential spawning habitats tend to cluster up downstream of groynes. Differences in the distance between groynes and spawning habitats cluster can be explained by groyne size and form. It appears that as a general rule it can be assumed that the bigger the groyne is, the bigger the distance between groyne and spawning habitat cluster. However, if groynes are too small, the searched-for benefits in regards to forming potential spawning habitats might not be given. The aforementioned characteristics of groynes and their influence on flow attributes, sediment transport and riverbed composition also explain why the distance between groynes is important for potential spawning habitats. While water flow tends to speed up downstream of groynes, if they are not far enough apart the distance between the groynes might not be enough for the water to reach this state. Therefore, it seems that a minimum distance between two groynes has to be given in order to create spawning grounds for brown trout.

Rivers carry finer sediments the further downstream they go and the closer to their outlet they are. (Heitlmuller and Hutson, 2009: 3) As mentioned earlier, fine sediments clog the spawning nests, resulting in mortality of the eggs. Suitability of the river as spawning habitat for brown trout seems to decline downstream, as mapped potential spawning habitats also decline in the course of the river. This might, on one hand, be due to a finer sediment load and higher deposition rates of the river, threatening spawning nests. On the other hand, groynes and other lateral obstacles get rarer downstream. This again indicates the importance of groynes and obstacles in degraded river systems.

5.2 Local patterns

5.2.1 Severely degraded, concrete banks

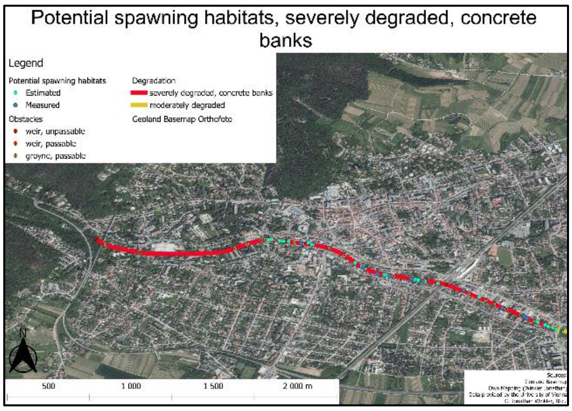

Figure 3 Potential spawning habitats in "severely degraded, concrete banks"

"Severely degraded, concrete banks" is the worst classification used to describe degradation of the river in the studied area. However, as results show, these parts of the river, found especially in the city area of the city Baden, host the highest amount of potential spawning habitats of all mapped sections. This might have several reasons. First of all, there's a high abundance of groynes, it appears that the right size to create ideal spawning habitat characteristics. Secondly, the river in this area is mostly embedded in concrete and if not in concrete there's big boulders on the side of the river channel. This, together with the highly straightened channel, reduces sidewards erosion to a minimal degree. This, together with the high density of groynes, leads to little to no fine sediments in the water. This makes excessive deposition impossible and leads to a relatively coarse sediment - perfectly fitting for spawning nests of brown trout. Additionally, the pools create habitats for mature fish to live in.

Both of the unpassable weirs are located in this river stretch and after both of them the potential of the river as spawning grounds is much lower than in the rest of this section. The riverbed downstream of both big weirs is characterized by sediments the size of gravel rather than the needed pebble sized stones. This might be because of finer as well as coarser sediments being trapped upstream of the weir and in the pool after the weir. Big weirs also disrupt river connectivity and water flow, slowing down water velocity and often creating pools. They greatly impact sediment transport and sediment characteristics and thereby also influence habitats of wildlife (Chong et al., 2021:1).

5.2.2 Severely degraded

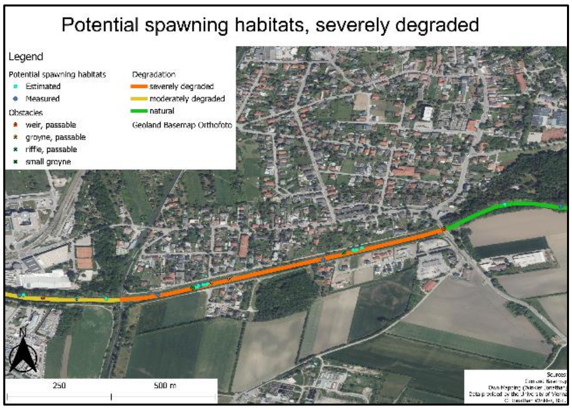

Figure 5 Potential spawning habitats in "severely degraded"

As visible in the maps, "severely degraded" sections contain much less potential spawning habitats than "severely degraded, concrete banks" sections. A major reason for this might be the abundance, form, and size of lateral obstacles in this part of the river. Not only are obstacles much rarer than in the section with concrete banks, they are also a lot smaller and often fully submerged under the water surface. This leads to a much smaller impact of the structures on river characteristics than in the other section upstream. Fine sediments are not trapped, there are no created pools and water velocity is not sped up or changed drastically. Therefore, the river is too shallow and too fast flowing in this section. However, there are two locations where structures in the form of boulders forming a barrier in a roughly 90° angle was added to the riverbed. A photo can be seen in figure 4. This structure sped up flow velocity on one side of the riverbed, giving it more energy to transport larger stones downstream of the structure. At the same time, on the other side of the bed, behind the structure, a deep pool with a slow eddy is created by slowing down the current, creating a diverse habitat for fish to both spawn and live in.

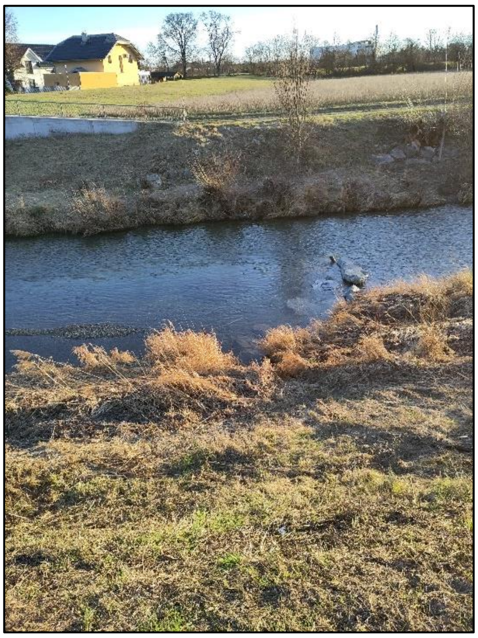

Figure 4 Small structure creating diverse habitats

5.2.3 Moderately degraded

In the moderately degraded sections of the river, potential spawning habitats seem to be more clustered up than in other river segments. This is because moderately degraded river segments show signs of both the severely degraded rivers and semi natural rivers. While, as mentioned earlier, severely degraded sections benefit from many bigger structures that create favourable conditions for trout to create their nests in, semi-natural segments often do not have those and thereby lack the benefits they provide. However, if there are some obstacles, natural or anthropogenic, it appears that moderately degraded sections also can act as suitable spawning grounds.

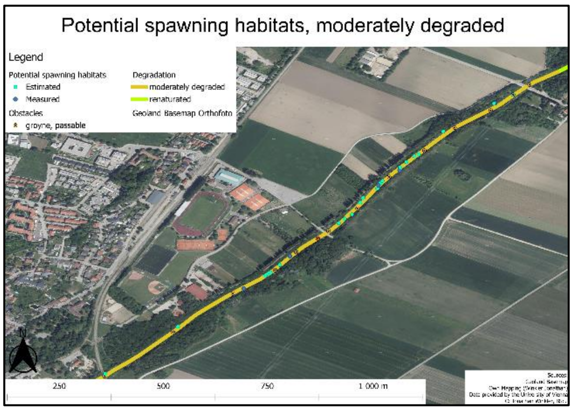

Figure 6 Potential spawning habitats in "moderately degraded"

5.2.4 Renaturated

One renaturated section was mapped in the course of this project. It shows that renaturating rivers might contribute not only to several ecological benefits, but also create diverse living habitats for adult fish and possible spawning grounds for natural reproduction by altering flow characteristics and giving the river a head start in going back towards its natural state. (Wohl et al., 2015: 1-ff) While it seems that a few potential spawning habitats were built up after renaturation in this case, they are not many. The reason for this is that with the river is slowly returning to its natural state and the suspended and deposited sediments become finer again. Additionally, although a diverse habitat landscape with pools and riffles is formed, characteristics needed for spawning habitats are seldomly found. This is mainly because water velocity is often not right, or bedrock sediments are too fine. It is important to note that although river restoration projects might not add many valuable spawning habitats for brown trout, they provide very valuable habitats for fish to live in.

5.2.5 Semi-natural and natural

As mentioned above, sediments in these sections are rather small sized, resulting from sediment trapping in the various pools as well as slower water velocity in the meandering parts of the river. This, together with the mentioned overall slower water velocity leads to nearly no potential as spawning grounds in this part of the system. The area is dominated by pools and riffles and the state in between, needed for brown trout to reproduce, is very rare. Some locations with potential as spawning grounds can be found at the beginning and the end of the sections. This is due to the last bits of human influence and the effect of weirs or groynes at the start of the natural section. That being said, just as restored parts of the river, semi-natural and natural segments offer great value as living habitats. Natural and semi-natural sections are characterized by a variety of features, such as deep pools, fast flowing riffles, gravel banks, sedimentation and erosion areas or side channels. This creates a diversity of habitats for the fish to hide, hunt and live in, allowing them to grow to bigger sizes and being able to produce more eggs.

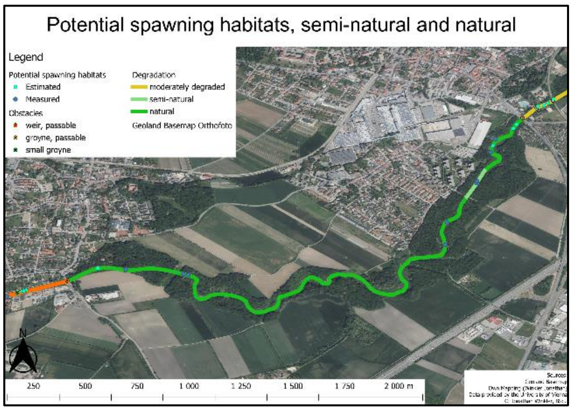

Figure 7 Potential spawning habitats in "semi-natural and natural"

6. Methodological critique and future research

Due to time and budget constraints, practical compromises had to be made to ensure project feasibility. While the first few mapped points of each field trip were mapped based on measured values of water depth and velocity, the following points were mapped based on estimations. Sediment particle size was estimated during the entire mapping process because measuring sediment particle size for every mapped point would have taken too much time. However, to maintain scientific integrity, before the mapping process started, a meeting with a member and expert of the fishing association of Baden was arranged. During this meeting, existing spawning nests of brown trout in another river segment were searched for and observed in regards to flow velocity, sediment particle size and flow velocity. This ensured that knowledge of the characteristics of brown trout spawning habitats is available. Nevertheless, such an approach is still prone to misinterpretations and false results. Another issue is that the accuracy of mobile device GPS marking is not very accurate. This results in some of the mapped points not being exactly where they were originally.

This project gave an insight into the problems brown trout face in Lower Austria. The goal was to assess the rivers suitability as spawning habitat in this area, as well as how human impact changed and influenced it regarding this suitability. It is necessary to emphasize that this project was about potential spawning habitats of brown trout rather than actual, observed spawning nests, so looking upon the difference between those two might be a topic worth investigating. Another possibility would be to investigate the impact of the implementation of obstacles and where to put those in severely degraded river sections, an example given in the chapters above, because this might be a cheap and effective way of creating new habitats without much effort. Furthermore, an assessment of how the found potential spawning habitats could be used to alter brown trout populations might be of high interest.

7. Conclusion

This project sheds light on declining brown trout populations and the issues they face in the river Schwechat. Apart from predation and climate change, a major reason for declining populations is the lack of reproduction. For this study the river was first divided into sections of degradation, ranging from “severely degraded, concrete banks” to “natural”. This was done to get a better understanding of the distribution of potential spawning habitats. Following this, potential spawning habitats were mapped using mobile devises with GPS tracking. Mapping showed that the worst degraded parts of the river, labelled as “severely degraded, concrete banks” show greatest potential as spawning grounds. The least potential spawning habitats were found in natural and semi-natural sections of the river. This is because in natural and semi-natural sections, water velocity is slow, and those segments are dominated by deep pools where a lot of sediment deposition happens. Apart from that, the deep pools and fast riffles in themselves are not suitable for spawning grounds as well. On the other hand, severely degraded sections are characterised by human impact in the form of channel straightening and especially lateral structures such as groynes and weirs. These structures trap sediments and, while slowing down water velocity initially, they speed up water velocity in the lower reach of the structures. Both processes lead to coarse riverbed sediments and optimal water depths and velocities. However, semi-natural, natural and renaturated sections offer highly valuable living habitats for brown trout and need to be protected.

It might be argued that, while natural sections represent the river in its natural state in this part of the river continuum, the severely degraded parts might represent a more upstream part of the river. These sections are characterized by groynes and weirs that artificially represent small waterfalls and other characteristics of more upstream rivers. The natural parts of the studied area are sections of the river that initially are not spawning habitats of brown trout anyway, but instead are habitats where adult trout live after spawning in a more upstream part of the river. Trout are migratory fish, meaning they live in a different part of the river than they spawn in. They migrate upstream again when about to mate. That being said it, might be of greater importance to restore lateral connectivity between the natural parts where adult trout have diverse habitats to live in, with the upstream, degraded sections of the river where a lot of potential spawning habitats can be found.

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