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Comparative fish stock assessment at the Johnsbach brook and the Enns River within the course of the EU LIFE-project "Conservation strategies for woodlands and rivers in the Gesäuse Mountains“

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Abstract

In the course of the EU LIFE-Project “Conservation strategies for woodlands and rivers in the Gesäuse Mountains“ (2005-2009) revitalization programs were implemented at the Enns River and the Johnsbach brook. Fish stocks before and after the implementation of the project were compared to investigate the program´s efficiency for fish in biomass, density and species assemblage. Despite the realized revitalization program, fish stocks of the Johnsbach brook declined slightly between 2005 and 2009 whereas at the Enns River stocks stayed constant.

In addition, migration obstacles in the Johnsbach brook were investigated to assess the barriers’ potential for successful fish passage. Measurements at the obstacles were compared to previously published data on jumping and swimming capacity of different fish species. Our results show that fish passage, especially for bullheads and juvenile salmonids, is still problematic in every part of the Johnsbach brook containing such obstacles.

Keywords

Nationalpark Gesäuse, EU LIFE-Project, river restauration, Enns, Johnsbach, fish migration

Introduction

This LIFE project (LIFE05NAT/A/78) was conducted from 2005 to 2009. The project aimed to open the connection between the rivers Enns and Palten and thereby establish highly dynamic areas where changes of flow directions depending on water levels became possible. Furthermore, the LIFE project involved the reconnection of a silted back water (Lettmair-Au), and the adaptation of existing obstacles in the Johnsbach brook. The studied stretch of the river Enns ranges from the estuary of the river Palten in Selzthal into the centre of the National Park Gesäuse where the Johnsbach brook discharges into it on the right bank. For the current study the river Enns has been further divided into two sections, i.e. (i) upstream Gesäuse and (ii) Gesäuse.

Materials & Methods

Fish stock assessment

In order to assess the fish ecological state 2009 fish stocks in the study areas were collected by electro-fishing whereby different forms of this method were used depending on the size of the water body. Results of the 2009 operations were compared to results of operations conducted prior to the LIFE implementations.

Assessment of the fish ecological status

The current ecological status of a water body is, in addition to chemical and physical components, determined by the composition of the biocoenoses within it, whereby fish biomass, density and species assemblage are playing a significant role. Based on these data, a deficit analysis is created. This shows to what extent the current state of a river deviates from the river-type specific model which corresponds to the "high ecological status" thereby determining in what way implementations need to be set in terms of water quality, morphology, hydrology and water continuum. In the current study, the nomenclature of HAUNSCHMID et al. (2006b) was used to calculate the current status based on a data matrix resulting in five classes from 1 to 5. A fish ecological status of 1 (class limits 1.0 to <1.5) represents the reference state and therefore the "high ecological status" regarding fish biocoenoses. Class 2 (class limits 1.5 to <2.5) thus corresponds to the "good ecological status". Results worse than class 2 (class limits from 2.5 and above) imply an insufficient state and thus demand action from an ecological perspective.

By applying this method, four components are assessed to characterize fish resources. These are (i) fish biomass (kg / ha), (ii) species composition (number of river-type-specific species, ecological guilds), (iii) the fish area index (distribution of river-type specific fish species) and (iv) the population structure with special emphasis on the abundance of juvenile individuals.

Obstacle assessment at the Johnsbach brook

In the course of fieldwork in September 2009, an assessment of 27 obstacles in the Johnsbach brook was carried out by measuring the flow velocities and drop heights from water level on the obstacle to water level underneath

(Δh). The aim was to evaluate possibilities of successful fish passage by comparing the obtained physical characteristics of obstacles to previously published data on the swimming and jumping capacity of the most abundant fish species in the area, i.e. bullheads, adult brown trout and grayling as well as their juvenile stadiums.

In order to examine the conditions of flow velocities and drop heights at a low water level, and to include the evaluation of further conducted implementations (carried out October 2009) further assessments of obstacles were conducted in December 2009.

Table 1: Classification of obstacles in the Johnsbach brook as surmountable (green, +), potentially surmountable (yellow, (+)) or not surmountable (red, -) for all native species. In December 2009 the obstacles 1.1c to 1.1k were not measured due to weather conditions.

		September 2009				December 2009			
Section	Obstacle	bullhead	juvenile salmonids	adult grayling	adult browntrout	bullhead	juvenile salmonids	adult grayling	adult browntrout
1	1a	-	(+)	(+)	(+)	+	+	+	+
1	1b	+	+	+	+	-	(+)	+	+
1	1c	+	+	+	+	-	-	(+)	(+)
1	1d	+	+	+	+	-	+	+	+
Mouthregion		-	(+)	(+)	(+)	-	-	(+)	(+)
1	1e	(+)	(+)	+	+	+	+	+	+
1	1f	-	(+)	+	+	-	-	+	+
1	1g	+	+	+	+	-	-	+	+
Section 1 total		-	(+)	+	+	-	-	(+)	(+)
1.1	1.1a	-	-	-	-	+	+	+	+
1.1	1.1b	-	-	+	+	-	-	+	+
1.1	1.1c	-	-	+	+				
1.1	1.1d	-	-	-	(+)				
1.1	1.1e	-	+	+	+				
1.1	1.1f	+	+	+	+				
1.1	1.1g	-	-	+	+				
1.1	1.1h	(+)	(+)	+	+				
1.1	1.1i	-	+	+	+				
1.1	1.1j	-	+	+	+				
1.1	1.1k	+	+	+	+				
Section 1.1 total		-	-	-	-	-	-	+	+
2.1	2.1a	(+)	(+)	+	+	-	-	+	+
2.1	2.1b	-	+	+	+	-	-	+	+
2.1	2.1c	-	+	+	+	-	(+)	+	+
2.1	2.1d	-	(+)	+	+	-	-	(+)	+
2.1	2.1e	-	+	+	+	-	-	+	+
2.1	2.1f	-	+	+	+	-	-	+	+
2.1	2.1g	-	-	+	+	-	-	+	+
2.1	2.1h	-	-	+	+	-	-	(+)	(+)
2.1	2.1i	-	-	+	+	-	-	+	+
Section 2.1 total		-	-	+	+	-	-	(+)	(+)

Results & Discussion

Johnsbach brook - fish stock

Across the entire study area, a total of 189 fish, representing five different species, were caught in the Johnsbach brook. These were 163 brown trout - *Salmo trutta* (86.2%), 14 bullheads - *Cottus gobio* (7.4%), 5 rainbow trout - *Oncorhynchus mykiss* (2.6%), 4 sparctic char - *Salvelinus fontinalis x umbla* (2.1 %) and 3 grayling - *Thymallus thymallus* (1.6%). Bullheads were caught exclusively in the mouth region of Johnsbach brook (Section 1A). Overall, a distance of 1971 m was fished with an average width of 9.1 m. The average of all sections results in an abundance of 10.31 Ind./100 m or 112.37 Ind./ha, and a biomass of 0.67 kg/100 m or 7.26 kg/ha.

The majority of the captured brown trout range within the size class 151-200 mm. The second most abundant size class is 101-151 mm, followed by the classes 201-250 mm and 51-100 mm. The classes 0-51 mm and >250 mm are present only sporadically.

Johnsbach brook - Evaluation of fish ecological status

The required "good ecological status" according to the EU WFD was achieved in five of the six sections within the Johnsbach brook. These five sections (1, 1.1, 2, 2.1, 3) are all classified as strongly bedload carrying, so that the minimum target of fish biomass of 50kg/ha does not apply. Only in Section 4 ("upper tunnel"), the "knock-out criterion" biomass does apply, since in this area the sediment transport is no longer dominant, therefore leading to an insufficient result concerning the fish ecological status in this section. In all sections except section 1 a further adaptation to the reference condition was applied by changing the status of *C. gobio* from dominant species to rare species.

Johnsbach brook - Comparison 2005 and 2009

In section 1 both biomass and abundance has dropped significantly from 12.9 kg/ha and 474.4 ind./ha in 2005 to 6.42 kg/ha and 220.16 ind./ha in 2009. The allochthonous species *O. mykiss* appeared absent from this section in 2009. In both years bullheads were detected only in the mouth region below the first obstacle.

Section 2 showed a biomass of 13.0 kg/ha in 2005, while during 2009 only 11.93 kg/ha. However, the number of species increased in this section from two to three species as an adult grayling with 390 mm was caught.

In section 3 a total biomass of 42.6 kg/ha was recorded in the year 2005 while in 2009 a biomass of only 6.59 kg/ha was observed. In both years, brown trout was the only species present in this section, which is characterized by particularly high flow rates. It is noteworthy that greatly increased flow rates were observed in this section at the time of the 2009 assessment.

Section 4 showed in both years good results compared to the sections downstream. In 2005 a higher biomass was detected (33.7 kg/ha) than in 2009 (19.83 kg/ha). This section of the Johnsbach brook shows good potential for fish stock as the slope and the sediment transport are lower. However, only brown trout could be recorded. Apparently the barriers in the lower sections seem to act as a major obstacle for all other fish species to access this area.

Johnsbach brook - Obstacle assessments

Results for individual obstacles and fish species are summarized in table 1. Bullhead and grayling are undoubtedly limited in their upstream migration. In the case of the brown trout, the effects are less crucial. However, the consequences of continuum interruptions should not be underestimated even for this species. GOSSET et al. (2006) studied the effects of barriers on migration and reproductive behaviour of brown trout and showed that due to barriers large parts of upper river sections were not used as reproduction sites. The authors stress that this situation may very possibly have a direct negative effect on the survival and the genetic variability of the population. Our results indicate that the current situation in the Johnsbach brook allows for migration of adult brown trout and thus potentially enables utilization of upstream regions as spawning habitat for this species.

Migration distances of brown trout during the spawning season may vary but as the minimum distance was 20km (ZITEK et al. 2007 and references therein) a migration to the upper part of the 13.5 km long Johnsbach brook seems to be quite likely. Even apart of the spawning season migration of brown trout up to 122 km were found in various studies (ZITEK at al. 2007 and references therein), showing that a continuum of all water stretches seems essential not only at the time of spawning migration .

Grayling require even more attention, since they don't show the same capacities in jumping and swimming compared to brown trout. Furthermore, grayling are less able to adapt to changes in spawning conditions and are thus especially susceptible to interference from obstacles that are passable only at certain conditions (OVIDIO et al. 2007). OVIDIO & PHILIPPART (2002) stress that fish that get to a transverse structure, usually immediately try to overcome this. Does this first attempt fail they often undertake a downstream drift by several meters to wait for better conditions (flow, temperature), sometimes for several weeks. Especially for grayling this behaviour often has serious consequences as the optimum conditions at the target spawning areas could be missed during these waiting periods. Repeated attempts to overcome an obstacle may result in an increased energy challenge and as a consequence the fitness of the individual fish may be reduced and the spawning success may be minimized. Also the risk of injury increases with the number of attempts to pass a barrier. (OVIDIO & PHILIPPART, 2002).

It is doubtful whether the Johnsbach brook can serve as a permanent habitat for grayling. However, the value of such water bodies as spawning habitats should not be underestimated. Grayling are known to cover distances of up to several kilometres (NYKÄNEN 2004, ZITEK et al. 2007 and references therein) during spawning migration. Optimal conditions for grayling reproduction were observed in the Johnsbach brook some 13 km upstream of the mouth and the continuum is therefore desirable especially in the light of the increasingly limited grayling spawning grounds in the Enns river.

Also the bullhead is a species that could find suitable habitats in the Johnsbach brook. The conditions may vary considerably depending on the annual amount of discharge and sediment transport but it seems reasonable to assume a good potential for stable bullhead populations in individual years. According to UTZINGER et al. (1998), *C. gobio* is a very well suited indicator organism for the amount of continuum interruptions within a water body. At the time of the fish stock assessment in September 2009 bullheads could only be found in the mouth region - a finding in agreement with the supposed discontinuity as suggested by the results of the assessment of the physical properties of the obstacles. Whether the additional implementations carried out in October 2009 will result in an improved situation for bullheads remains to be assessed.

The small number of fish caught in September 2009 indicates that the existing barriers still have a strong impact on the fish fauna. However, it should be noted that in the course of this study no telemetry was carried out, therefore statements about the possibility to overcome obstacles are merely based on comparisons with values from the literature. Furthermore, it must be emphasized that the implementations carried out in the framework of this LIFE project took place only shortly before the current evaluation. Final steps were even implemented after the fish stock assessment 2009. Especially these adaptions achieved a significant improvement most notably in the mouth region (section 1, obstacle 1a) and at the webcam (section 1.1, obstacle 1.1a). Long term effects remain to be assessed but the implementations conducted during the LIFE project certainly lend hope for a development towards a further improved continuum in the Johnsbach brook.

Enns river - fish stock

In the Enns river a total of 1005 fish were caught in 2009 (549 individuals upstream Gesäuse and 456 individuals in the Gesäuse itself). *S. trutta* was the most abundant species in both sections, i.e. 45.9% in total, followed by *T. thymallus* with 22.9% and *C. gobio* with a total of 19.8%. The allochthonous *O. mykiss* accounted for 6% of the total catch.

In addition, the following native species were detected: chub (*Squalius cephalus*), Danube river lamprey (*Eundontomyzon vladykovi*), minnow (*Phoxinus phoxinus*), perch (*Perca fluviatilis*), Gibel carp (*Carassius*

gibelio), pike (*Esox lucius*), Danube salmon (*Hucho hucho*), nase (Chondrostoma nasus) and roach (Rutilus rutilus). All caught Danube salmon are most likely the result of recent restocking. Two further non-indigenous species were detected: brook trout (*Salvelinus fontinalis*) and sparctic char (*Salvelinus fontinalis x umbla*).

Enns river - Evaluation of fish ecological status

The assessment 2009 indicated an insufficient fish ecological status in both studied sections of the river Enns. The status of the section upstream Gesäuse was found to be class 4 (4.0), resulting mainly from a lack in biomass. By ignoring the biomass criterion and also adding all species reported by an additional structure assessment performed in 2007/2008 (WIESNER et al. 2010) a value of 3.22 could be achieved. Despite the failure of achieving a good ecological status in this stretch an increase in the detected species number needs to be positively emphasised. The assessment of the section Gesäuse likewise resulted in a bad fish ecological status, largely due to a substantial lack of biomass. Not taking into account the biomass, the required good ecological status could only just be reached with a value of 2.49.

Enns river - Comparison 2006 and 2009

Comparing the values of biomass and abundance of individuals in the Enns river between the year 2006 and 2009, no significant differences can be identified. In 2006 in the section upstream Gesäuse grayling accounted for the major part of biomass, whereas in 2009 it was brown trout. In 2009 *O. mykiss* was caught in lower numbers both in biomass and abundance compared to 2006. In the section Gesäuse the total numbers in biomass and abundance remained stable, but in 2009 the grayling accounts for a larger share than in the previous study and thus dominates now together with brown trout. Also, the proportion of rainbow trout has increased compared to 2006 in the section "Gesäuse".

Already in the course of the pre-monitoring in 2006, a severe deviation of the fish ecological status was determined in both studied sections of the Enns river, thus only reaching an insufficient condition according to the WFD (WIESNER et al. 2008). Although stocking of brown trout and Danube salmon took place between 2006 and 2009, only an insufficient fish ecological status was calculated at the post-monitoring due to low biomass and the incomplete composition of species. Taking into account additional data (fish stock assessments in specific structures, stocking actions of missing species) the potential for improvement may be recognized. However, a sustainable improvement can only be achieved by further habitat enhancement. Also for the recovery of populations of existing species, this step is a prerequisite. In the case of the Upper Drau river, which was similarly affected by regulation, a first success in terms of stock recovery became apparent only after 10 years of intensive restoration (personal communication G. UNFER and C. WIESNER, 2010).

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