Reviving waters: a conference on stream restoration

- Conference Abstracts

Introduction

What's so special about the Vindel River?

Christer Nilsson, Department of Ecology and environmental science, Umeå university

Abstract: The Vindel River system is a protected Swedish river and one of the few free-flowing large rivers in Europe. It is 450 km long and originates in the Scandes mountains on the border between Norway and Sweden and joins the heavily regulated Ume River about 40 km upstream of the Gulf of Bothnia. The river and its tributaries have numerous rapids, slow-flowing stretches and lakes. The channels are characterized by large seasonal variations in water flow and heterogeneous environments with a species-rich flora and fauna and productive riparian meadows. When the young Linnaeus made his trip to northern Sweden his plans to visit the Vindel River were dashed and he had to return to the coast. In more recent years, however, numerous researchers have worked along the river and made it into one of Sweden's best studies river systems with respect to natural science. The river catchment has a long history of reindeer herding, a few hundred years ago farmers started to colonize the river valley, and from the mid 19th century and for more than a century the river was used for timber floating. Advanced plans to develop the river for hydropower production were rejected by the Parliament in 1970 and the river was protected. Later proposals to develop the river have also been turned down. Today, the tourist industry is growing, the formerly floated channels are being restored, and plans are developing to include the river in UNESCO's world network of biosphere reserves.

An overview of the Vindel River LIFE project

Johanna Gardeström, project leader

Abstract: Vindel River LIFE (LIFE08 NAT/S/000266) is a collaborative project involving Umeå University, Ume/Vindel River Fishery Advisory Board, the Swedish University of Agricultural Sciences and the Swedish Agency for Marine and Water Management. The project objective is to restore tributaries of the Vindel River which have been heavily affected by timber floating, in order to regain more variable aquatic habitats that are favourable to plants and animals. In all, 44 kilometres of rapids have been restored in the Natura 2000 sites of the Vindel River catchment.

The project period is from 2010 to 2014 and the budget is 2 675 000 EUR, half of which is provided by the EU LIFE nature fund and the rest by the County Administrative Board of Västerbotten, the municipalities of Umeå, Vännäs, Vindeln, Lycksele, Sorsele and Arjeplog, and the four project partners stated above.

When restoring the tributaries, the Project works with two types of river restoration practices: one in which restoration is more advanced, where methods of a demonstrative character are used and is hence called “Demonstration Restoration;” and one which has a more traditional restoration approach, i.e., where “Best Practice” methods are used that have previously been tested and applied in other restoration projects in the Vindel River. The Demonstration Restoration was applied in stretches within 10 tributaries where large boulders, large wood, and gravel from uplands were placed into the channel. To evaluate the ecological response of the new Demonstration Restoration methods, these sites have been compared with reference sites upstream, that were restored by Best Practice methods in the 1990s to early 2000s

Information and communication is of critical importance to the Project. The Project has been involved in many information events ranging from local consultation meetings with Fishing Management Organizations, landowners, and Sami (the indigenous people) villages, to international conferences. A large number of project information materials, such as information leaf-lets, interpretative signs, brochures, and a website have been produced. The Project has also been actively involved in The Nature School (Naturskolan) in Umeå, conducting a school information project to work on raising awareness and knowledge about the river and its typical habitats and species, as well as awareness and knowledge about the restoration work and the expected outcomes. The Project’s work with The Nature School has also involved educational visits for 5th graders in the municipalities of the various rivers and environmental education with the teachers.

Practical restoration methods in the Vindel River LIFE project

Daniel Holmqvist, Ume/Vindel River Fishery Advisory Board

Abstract: Antropogenic activities such as floatway constructions have significantly affected wild fish populations in Sweden. Rivers has been cleared from major boulders, channelled and cut off to facilitate log transport during 1850-1970. After ending the river log transport era several restoration projects has been initiated.

Modern Swedish river restoration is aiming to give the rivers a natural impression; in other words restore the rivers to a pre-floatway impression. All floatway constructions are documented before restoration: measures, boulder sizes, water depth etc. Photo documentation is fundamental. Electro fishing is done before and after restoration, reference stretches are also identified and fished. Old aerial photographs give guidance how some of the riverstretches looked in the past.

Excavators are used in practical restoration, numbers depending on the boulder volumes for each object. A supervisor leads work and all excavator operators are certified in river restoration including biology, work safety and environment. Environment adapted oils and gasoline are used. All work is done during low-water periods. Practical restoration methodology aims to reinforce the rivers natural structures. Existing river rapids, points, pools and shallow areas are reinforced with material from the floatway constructions and cut offs are opened. All boulder sizes are spread even in the river width and some large boulders are placed down in the river substrate. Broken rocks are placed under the water surface for an esthetical reason. It's important to focus both on shallow and deeper sections of the river to provide a natural mosaic structure. Floatway objects with high social-history values are left undestroyed in educational purposes and as culture-history monuments for future generations. Another aspect is restoration of spawning areas for trout (*Salmo trutta L.*). Large amounts of spawning areas have been destroyed, in particular for trout, due to floatway channels. Spawning area restoration is done by hand with especially designed tools and it often takes place simultaneously with the excavation work. Riverbed areas with suitable gravel fractions and water velocity are restored by raking together the existing and remaining gravel in front of two rocks, which works as stream concentrators. Expected results of river restorations are broader rivers, more varied shoreline, bottom topography and wider areas for fish (salmonids), aquatic insects and plants. The restoration work described above is also in line with the EU-directive of water.

Remibar – Remediation of Migratory Barriers in Nordic/Fennoscandinavian Watercourses.

Sofia Perä, Länsstyrelsen Norrbotten and Ida Schönfeldt, Trafikverket

Abstract: Many animals and plants that live in streams are dependent on migration during certain stages of their lives, to spread and to reproduce. For fish, migration is vital in order to move between spawning grounds, nursery grounds and feeding grounds.

The overall aim of the project Remibar is to minimize migratory barriers in five larger water systems in the northern part of Sweden. The work is conducted within the network of Natura 2000, and the goal is to improve the conditions for the target species salmon, freshwater pearl mussel, bullhead and otter, along with their habitats. The project represents one of the largest freshwater initiative in Sweden. A total of 300 migratory barriers, both culverts and remains from the log driving period, will be addressed.

In Sweden there is a road crossing approximately every second kilometer of a stream and of these at least 30% are barriers to fish and other aquatic species. There are also dams, remaining from the log-driving period, which are no longer in use but still makes barriers. Through removing barriers we create connectivity within the streams.

What are the problems?

Culverts can cause different kinds of migration barriers. Some of the most significant are:

- Water velocity is high.
- Lack of resting places for fish.
- Low water level within the culvert.
- Perched crossings – that is, the culverts level is above the stream bottom at the outlet.

Bridges or culverts lacks natural shores, and can be a barrier to terrestrial animals.

Left figure: A culvert that is perched creates a fall at the outlet. The culvert's dimension is too small which results in high water velocity. Right figure: A good solution to make connectivity in streams, a bridge with a natural riverbed, creates resting places for fish and lower water velocity.

During the project time (2011-2016) 300 barriers will be removed in the County of Norrbotten and Västerbotten. The project budget is 8 million € and EU's LIFE nature-fund contributes with half the sum. Through cooperation we get more nature value of our actions. All barriers within the catchment areas are removed. Remibar is a cooperation project between the Swedish Transport Administration, The County Administrative Board of Norrbotten and Västerbotten, the Swedish Forestry Agency, The Swedish Agency for Marine and Water Management, Sveaskog, Holmen and SCA.

Bending rivers by mussels

Ivan Olsson[1], Martin Österling[2] Lea Schneider[2] and Vibeke Lirås[1]

Presenting author: Dr Ivan Olsson, Project manager UC4LIFE, CAB Skåne[1], Karlstad University[2], Sweden.

Abstract: The Fyleån Creek in southern Sweden has been subjected to floodplain restoration, focusing on in-river habitat enhancement, water quality improvements and hydrological restoration. The major objective is to recreate conditions suitable for the threatened thick shelled river mussel (*Unio crassus*), the flagship species targeted by this European LIFE-project.

By re-meandering the former channelized *ditch* in 2013, the *creek* is one kilometer longer today, and the habitats more heterogeneous compared to pre-restoration conditions. By rising the ground water level in the valley (70 ha), flooding now occurs more frequently at a larger scale, resulting in a more dynamic and nature-like floodplain hydrology compared to pre-restoration conditions. In addition, nine wetlands and five tributaries have been restored, enhancing the Valley with additional habitat types, favoring a more diverse flora and fauna.

The flagship species *Unio crassus* has a complex lifecycle, including a parasitic larval stage on fish. Freshwater mussels are generally sensitive to environmental disturbances, such as habitat degradation and changes in water quality. Just as in numerous European rivers, *Unio crassus* became extinct in the Fyleån Creek during the past two centuries. At present, *Unio crassus* belongs to the most threatened freshwater mussel species in Europe.

Here, we present novel results from the restoration, including the outcome of the Fyleån Creek re-introduction program of *Unio crassus*. In parallel with the restoration work, we have mapped and identified the host-fish species used by *Unio crassus* during its parasitic stage. As a result, we have been able to farm and breed *Unio crassus* successfully, for the first time ever in Scandinavia.

By applying an integrated multi-disciplinary approach, this LIFE-project clearly demonstrates that we are able to restore depressed aquatic habitats, identify and recreate conditions suitable for highly threatened organisms such as *Unio crassus* during a relatively short time window.

Experiences of river restoration in Finland

Anssi Eloranta, Centre for Economic Development, Transport and the Environment of Central Finland, Jyväskylä, Finland

Abstract: Almost all rivers and tributaries in Central and Southern Finland have been influenced in many ways by forestry, agriculture, water power, peat industry and transportation. For example about 20 000 km of natural river channels have been dredged and straightened for timber floating in the period of 1850-1960. After this heavy exploitation there were thousands of low-producing and ecologically spoilt riverine ecosystems in Finland.

The history of the Finnish river restoration is quite recent. In the 1950s and 1960s some small-scale trials of in-stream improvements were carried out by volunteers, but the river restorations of modern style became more common through the country in the 1980s. The development and funding of the Finnish river restoration have been under the state´s guidance probably more than anywhere in Europe. The typical targets of these projects are usually ecological, conservational, recreational and scenic. The main types of restoration in Finland are obligation, mandate and voluntary brook restoration. Mandate restoration projects are fishery-based, budget-funded and directed to nationally most important rivers. Their monetary benefit can also be high. Until now, usually the fisheries authorities have commissioned, supervised and funded the restoration projects while the environmental authorities planned and restored them.

The implementation of restoration measures is one of the most critical phases in the restoration procedure. It is possible to design a great restoration plan that can, however, fail under poor control in the field during implementation. Hence, the rationale behind the restoration has to be emphasized. The Finnish actors have tried to follow certain ”golden rules”: (1) aim to attain the original nature of the river type, (2) improve the whole ecosystem, not only the life-conditions of a few fish species, (3) help the ecosystem to heal itself by initiating beneficial processes of changes, (4) do only the most necessary measures for faster re-colonization, (5) use all-year-round solutions, and (6) monitor the influences of the restoration, write the self-evaluation of project and modify the course of action accordingly.

Because of the global financial situation the future of the Finnish river restoration is now under strong changes and challenges. The Ministry of the Environment and the Ministry of Agriculture and Forestry are drawing the outlines of the restoration policy. Their frame gives the Strategy for Restoration of Waters 2013 and the National Strategy of Fish ways 2012. These strategies are also integrated to the targets of the EU Water and Flood Directives. As examples from the problems of the Finnish river restoration can be mentioned expansion of the financing base, monitoring, assessment of the effectiveness of restoration activities, strengthening of cooperation networks and partnerships, and specialization and outsourcing of the restoration actors.

Restoring natural geomorphic process to river environments influenced by practical design constraints

Dr Hamish Moir, cbec eco-engineering UK Ltd

Abstract: The process restoration philosophy promotes the reinstatement of natural process (particularly the continuum of sediment transport processes) at the catchment scale. Associated with this approach is the concept that river biological communities, having evolved under natural/ un-impacted conditions, will respond positively to the reinstatement of natural physical function. The application of this 'let-the-river-do-the-work' approach is regarded as providing a sustainable alternative to traditional more 'hard engineering' approaches. However, often the reality is that full restoration of the controlling physical processes at the catchment scale is not feasible due to a variety of constraints (e.g. altered geomorphic regime, agriculture, infrastructure/ services, urban development, costs, etc.) and less ambitious objectives have to be set. Thus, under these typical constrained circumstances, can process restoration still be applied and, given the fundamental assumption of biophysical linkage, can ecology still be expected to respond positively? To elucidate these issues, we present four case studies from Scotland which represent the spectrum of process restoration application relating to almost no design constraints to very significant limitations (culvert daylighting within a housing development). We highlight that, despite significant constraints, physical river processes can (and should) always be considered in restoration design. The case studies demonstrate that natural physical processes (evidenced through indicators of sediment transport) quickly reinstate following construction; this was despite significant local constraints but reliant on physical/ geomorphic process being explicitly incorporated into to the design approach. Furthermore, evidence of associated improvements to the ecological/ habitat/ biotic condition of the restored sections of river were observed.

LIFE Triple Lakes – Catchment restoration and preventive action for aquatic habitats in a climate change perspective

Ingemar Näslund, Länsstyrelsen Jämtland

Abstract: The overall objective of the project is to develop a model for adaptive catchment management for high conservation valued aquatic ecosystems in a climate change perspective. This is to be done by implementing catchment measures to improve aquatic Natura 2000 ecosystem status and resilience. The objectives are (1) to eliminate and/or reduce the current negative ecosystem impact of man-induced changes and threats to morphology, hydrology and water quality in two Natura 2000 sites. Focus will be on three big Natura 2000 lakes and their tributaries – Locknesjön, Revsundssjön and Näckten. (2) to increase the capacity of the aquatic habitats to maintain favorable conditions and to contribute to good ecological status according to the EU Water Framework Directive, (3) to increase the ecosystem resilience with respect to actual/expected effects of climate change, (4) to develop the stakeholder process including capacity building, demonstration and training to establish a more sustainable use of land and water resources, and (5) to develop an adaptive model for future catchment management.

The project has an integrated, overall ecosystem (catchment) approach and will include habitat restoration of streams and lake habitats, reintroduction of species, elimination of migratory barriers, elimination of macrophytes, inventor of sewage treatment systems, establishment of demonstration areas and dialogue/education processes to establish a more sustainable forestry, agriculture and fisheries.

Stakeholders are forestry companies, farmers, private land owners, fishery managers, a hydropower company, and the public, and also local, regional and national authorities.

The project started in July 2014 and will end in June 2019 and is financed by EU, Swedish Agency for Water and Marine Management, and several associated beneficiaries.

Potential to enhance fish populations in the fragmented river system Motala ström – A feasibility study of fishpass installations and habitat improvements at multiple sites.

Peter Rivinoja, Dag Cederborg, Mattias Jender & Martin Stenqvist.
Sweco Environment AB & Sweco Energuide AB.

Abstract: The potential to recover migration routes and reproduction areas for various fish species in the regulated and fragmented river system Motala ström was investigated. The potential passage probabilities of each obstruction were estimated by considering site-specific environmental conditions in relation to fish species preferences for migrations and reproductions. The evaluations included fish biological criteria, hydrological regimes, surrounding environmental conditions and dam security issues. At most sites various fishpass solutions for both up- and downstream migrations were initially considered, yet only a few constructions were judged to be both effective and practically realisable. Based on GIS and visual mapping of habitats, focusing on hydrological patterns and bottom substrates in the river main stem the amount of potential fish reproduction areas were defined. By applying river-bed restoration and environmental flow adaptations at some of the sections the extent of these areas could be enhanced. Due to the great number of dams, high success rates are needed at the proposed fishpasses to recover the historical migrations of diadromous fish in the river system, nevertheless other migratory species could be favoured by rehabilitation of migration routes and river habitats.

The Ångerman river project Part 3 (2014-2015)

Sara Friberg, Micke Strömberg och Lennart Norström, Älvräddarna

Abstract: In the third Ångermanriver-project we focus on the river stretch from Vilhelmina in the county of Västerbotten downstream to Näsåker in the county of Västernorrland. Three hydropower companies operate the nine Hydro-power dams and stations along the 160 km river stretch: Vogsjöfors, Hällby, Gulsele, Degerforsen, Edensforsen, Långbjörn, Lasele, Kilforsen (in the mouth of Fjällsjö river) and Nämforsen. The aim is to map the biological status of primarily fish both before the regulation - which started in the 1940'ies - and of today. For biological status of today we use the biotope mapping method (Biotopkarteringen) approved by the Environmental Protection Agency (2003) and a quantitative electrofishing method approved by the former Board of Fisheries. Working downstream power plants is dangerous why we always apply for work permission in dialogue with the hydropower company. When it comes to historical and recent data on fishing, we use a qualitative interview method following a protocol and search for information in different historical archives. The data will be processed in public where we invite the hydropower plant companies, municipial officials and politicians as well as NGO's, private business and inhabitants along the river to participate. The basic data and the result of the discussions in public will be used along with GIS-data to present possible remedial measures focusing on achieving as good ecological status as possible within the legal framework. In the next phase of the project we will merge data from all the three Ångerman river projects to propose the best potential measures of enhancing the biodiversity locally and regionally along the whole main river, with focus on salmonid fishes.

The project is sponsored by WWF Sweden and Telge Energi.

Longer-term performance of bottom ramps to mitigate gravel habitat bottlenecks in a regulated lowland river

Brandon Goeller, (independent researcher)

Dr. Christian Wolter; Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin

Abstract: The longer-term performance of measures to restore in-stream habitat in gravel bed rivers is uncertain in the presence of continued land use pressure and fine sediment inputs. The goal of this study was to evaluate the longer-term performance of five bottom ramps designed to facilitate fish passage and to provide compensatory gravel riverbed habitat for benthic invertebrates and fish in a regulated lowland river. A significant decrease in the relative abundances of coarse substrate-preferring benthic invertebrates corresponding to project construction age was found, but there were no significant differences in the CPUE of rheophilic or lithophilic fish species among sites. The age of bottom ramps did not significantly influence the habitat conditions, as evidenced by a lack of correlations with the percentage of fine sediment less than 2mm, the organic content of the substrate, and the years since construction. Even if an exponential decrease in habitat suitability cannot be excluded due to possible threshold effects of fine sediment deposition, there is substantial evidence that similarly-constructed bottom ramps in comparable environmental settings efficiently provided habitat for benthic invertebrates and fish for over 12 years. Bottom ramps are recommended as efficient measures to enhance longitudinal connectivity, fish passage, and gravel habitat provision in regulated lowland rivers.

The steps in stewardship: Spring fens as the origin, source of inspiration and commencement for any reviving. Practical experiencies from the central part of Moldanubic plateau

Pavel Pokorný, Czech Union for Nature Conservation

Abstract: The experience, lessons and skills with non-invasive management about valuable spring fens. Scattered around the Bohemian-Moravian highlands (Vysočina): V hatích, Nad Svitákem, Ve Sklenářích, Na Oklice, Jankovský potok nature sanctuaries. Can these patterns of the unique habitat withstand a distinct deterioration in qualities of a surrounding landscape, at least in the mid-term perspective? Is such a small-scale restoration work beneficial in situ?

Adapted forestry is needed after stream restoration

Lennart Henrikson, Natur och Människa

Abstract: Most of the restored streams in Sweden are found in the forest landscape. Almost all Swedish forests are managed. Forestry affect the streams, e.g. by sediment input and damages on the riparian zone. If the restored streams are expected to recover, we need considerations within forestry. During the last decades the water protection issues within forestry have got increased interests. There have been improvements in practice, although not enough.

We need a scientific base to take the most effective forestry measures/protection. We have to include water protection issues in the forestry planning systems and develop the technique. We have to apply the legislation. However the Swedish Forestry Act is rather week. But, I think, the most important is to involve the stakeholders. This means the forest owners, who are the key players as they decide in practice the consideration to streams.
I am going to share my experiences of meetings with forest owners, how to support them with ecological facts

Brown trout spawning bed restoration: how complicated is it?

Daniel Palm, Department of Wildlife, Fish and Environmental Studies,
Swedish University of Agricultural Sciences

Abstract: As floatway operations have caused erosion and loss of brown trout spawning substrate in tributaries to Vindelriver, restoration of spawning habitat have been an area of focus during the EU project VindelriverLIFE. To gain more knowledge about the function and effects of spawning beds an ambiguous survey program have been conducted at c.80 individual spawning in 11 different tributaries. Due to monthly and annual monitoring of flow dynamics and erosion two different erosion models, acting at different scales, could be evaluated. The best model to predict erosion (93%) requires data on substrate size and water velocity from each individual spawning bed. The downstream movement of individually PIT-tagged spawning substrate was carefully monitored and showed that artificial constructed spawning beds can last c. 20 years given that erosion due to high water velocities are minimal. Monitoring of spawning habitat preference revealed that distance to shore and content of fines are the most important factors influencing where brown trout choose to spawn. Survival assays on brown trout embryos, from fertilization to swim up, showed that survival in the study tributary was generally high (60-80%) and that the persisting levels of sand and fines (0-6 percentage of mass) accumulated within the substrate was too low to influence survival. We conclude that spawning habitat restoration within Vindelriver tributaries result in higher abundance of juvenile brown during significant time periods trout given that spawning beds are constructed at sufficient sites, with enough gravel department and are utilized by spawners.

Germination after restoration of flow regimes

Judith M. Sarneel[1], E.S. Bakker[2], C. Nilsson[1].

1.Department. of Ecology and environmental science, Umeå university
2.Department of Aquatic Ecology, Netherlands Institute of Ecology

Abstract: After restoration, many ecosystems face changed water regimes. As water level fluctuations (WLF) affect the spatial deposition of seeds, habitat conditions under which seeds are deposited and the timing of seed arrival, changed WLF can induce changes in vegetation composition. However, we know little about the processes that can induce such vegetation changes. We studied how germination was affected by the flooding regime, and focused on the importance of timing of flooding.
We found that WLF determine seed input and establishment and restoration of WLF increases recruitment. In a greenhouse study we showed that seeds arriving early after restoration had higher establishment on soils with a low moisture content, while establishment of early and late arriving seeds was comparable high on wet soils. This shows that especially on dryer locations the seed deposition events that occur shortly after restoration can have a deterministic effect on vegetation composition.

ECOLOGICAL MONITORING OF RIVER RESTORATIONS IN FINLAND

Pauliina Louhi, Department of Biology, University of Oulu

Abstract: The new Strategy for Restoration of Waters was launched by Finnish Ministry of Environment in 2013. The strategy presents the measures and means for promoting restoration of waters in improving ecological and chemical status of waters, strengthening of cooperation networks and the capacity of the central government to promote restoration activities, expansion of the financial base for restoration projects, assessment of the effectiveness of restoration activities and systematic collection of information. The strategy also clarifies the principles of state support for restoration projects, and recommends the development of the Finnish know-how in water restoration work as an export product for international marketing.

According the Strategy, restoration measures are seen as a way to contribute to the achievement of a good status for water bodies required by WFD. In practice, however, restorations typically aim to improve habitat for salmonids and other biota is rarely considered. Restoration measures are typically instream structures; for example, boulders from the stream banks are replaced back to the channel to construct deflectors and boulder dams. Often also spawning gravel is added and side channels are re-opened.

Restorations have been carried out for the past 30 years, but evaluation of their outcome is still at its infancy. Monitoring of restoration projects, if any, is very sporadic without proper replication through time and space. If monitoring is conducted, data are rarely available for public or research purposes, or published in reports or journals. Thus, it is often impossible to conclude if restoration was successful or not and, in the latter case, what could be improved.

Finnish Game and Fisheries Institute and University of Oulu have been carrying out long-term scientific monitoring of six differently restored north boreal forest streams. The design is based on three treatments: (i) boulder additions; (ii) boulders + large wood; (ii) unmodified controls, each in a separate section of a stream. To date annual fish monitoring has been conducted for 3 yrs. before and 13 yrs. after restoration. Benthic macroinvertebrates have also been sampled from the same reaches but less regularly. The in-stream restoration measures used increased stream habitat diversity, and landlocked brown trout populations in the restored sections seemed to recover more rapidly from a severe drought following the restoration. However, population densities of trout are still low after 13 yrs. post-restoration, and restoration did not enhance benthic biodiversity.

The lack of funding for biological monitoring is a major challenge in Finland. With the reduction in state and municipal resources, the importance of restoration work undertaken by the private sector and citizens will increase. There is no certainty how this will affect restoration intensity or monitoring; there are no proper guidelines for these sections on how to carry out biological monitoring. There is thus a real risk that all ecological monitoring in the context of Finnish stream restoration projects will cease in the near future. As the biggest challenge, however, I see the lack of cooperation among management, scientists, private sector and other organizations involved. There is little interaction between the key groups on how to improve the planning, implementation and monitoring of future restoration projects.

Good controls, time, adaptive management, and scale: factors affecting the scope and interpretation of stream restoration research in northern Sweden

Eliza Maher Hasselquist, Department of Ecology and Environmental Science, Umeå University

Abstract: Many researchers have been criticized for focusing on one aspect of restoration and not taking a holistic approach. I tried to take a holistic approach and studied the instream and riparian plant communities, nitrogen cycling, and carbon sequestration of over 20 stream reaches in northern Sweden. Various problems that affected the scope of my research and the ability for me to interpret results included a lack of good controls, varying times after restoration, sites being restored multiple times, and the scale of restoration. Regarding controls, earlier studies in this region had paired channelized and restored reaches on the same stream, but most channelized reaches have now been restored. There is a paradox, because more streams being restored is good, but we cannot truly understand the effect of restoration if we do not have useful controls. Time after restoration has been the foundation of my research as well as has undermined my work. I used a chronosequence of time after restoration to understand the recovery times of various communities and ecosystem processes. But, I have taken data in reaches with just one to two years after restoration and have not used it for publication because it is too soon after restoration to be evaluated. Furthermore, many of the streams in northern Sweden have undergone multiple restorations due to perceived lack of success and subsequent "adaptive management." When assembling the chronosequence of restored stream reaches, it was difficult to find older sites because many have been restored again since the initial restoration. Finally, I found that the scale of restoration was often too small to monitor some instream processes, which require reaches to be much longer than 150 meters. Practitioners could help researchers to study the effects of restoration by consulting with many researchers from different disciplines about the problems I outlined above before undertaking restoration work.

Restoration and monitoring work in the river Drava

Tilen Basle, DOPPS – BirdLife Slovenia

Abstract: Drava River is the second largest river in Slovenia. The natural dynamics of the Drava River has been heavily altered after the building of hydro-power plants, as most of the water (ca. 95%) was diverted into the inlet channel. Discharges and bedload transport in the old riverbed were reduced drastically causing overgrowing of the riverbed and gravel bars by woody vegetation. Extensive network of river branches gradually diminished and at present majority of them remain unconnected to the main river for the most of the year. These caused lack of suitable breeding sites and/or foraging areas of many endangered species. Larger restoration works were not carried out on Slovene rivers so far. Maintenance "flood protection" water-engineering practices that include installation or reconstruction of existing lateral embankments, removal or inappropriate modification of gravel bars, consolidation of outflow sections of smaller tributaries etc., often accompanied by removal of patches of floodplain forest, still take place. However, we carried out a detailed study analysing and modelling the effects of different maintenance work on indicator bird species, especially Little Ringed Plover *Charadrius dubius*. Study aimed to recognize and quantify the appropriate maintenance techniques both from flood-protection and nature-conservation point of view. Lowering of high gravel bars and reduction of bare gravel surface turned to have most negative effects on the species' population. Following the results, conservation actions in the river bed were prepared under LIFE11 NAT/SI/882 project. For the first time restoration of 3 river branches over a total length of 1,550 m will be carried out together with removal of lateral embankment. Additionally, removals of woody vegetation at gravel bars to restore Little Ringed Plover habitat, were carried out.

Habitat complexity and competition between yearclasses in salmonids; implications for stream management

Johan Höjesjö, Department of Biological and Environmental Sciences, University of Gothenburg

Abstract: In this talk, I will present data from several experiments examining the competition between year classes of salmonids and on the effects of added structural complexity on the growth of juvenile brown trout. Our results show that age-classes of stream-living salmonids compete for limited resources in the stream habitat and that density-reductions of older cohorts in field increased the growth of young-of-the-year trout. In addition, the spatial pattern previous reported, with young-of-the-year individuals using shallow, low-velocity, habitats close to the spawning area and older cohorts in deep, high-velocity, areas were instead demonstrated to be an effect of habitat exclusion rather than size-dependent habitat preference.

In a second field experiment we examined the effects of structural complexity on growth and abundance of juvenile brown trout (*Salmo trutta*). Just after emergence, the added complexity had a positive effect on the density, biomass and condition factor of young-of-the-year (0+) brown trout. This difference in density was not present six weeks later. In contrast, both young of the year and older brown trout generally tended to be larger in the simple habitat. Hence, our data suggests that increased complexity initially is beneficial for young of the year individuals probably due to lower risk of predation and increased densities of prey. However, as density increases in the complex environment it may induce negative density dependent effects, here reflected in smaller sized fish in the complex environment. This might force fish to redistribute to habitats with lower densities of conspecifics as they grow larger.

The findings suggest that for salmonids, marginal stream habitats may be essential during the first months after emergence by acting as refuges from inter-cohort competition, thus emphasizing the importance of maintaining and restoring these habitats. In addition, habitat complexity can probably increase survival of yearlings in early phases and thereby also affect the overall population structure of brown trout in natural streams. Hence our findings highlight the importance of taking age-class interactions and habitat complexity into account during habitat management of salmonid streams where both marginal stream habitats and a variable degree of complexity needs to be maintained.

Modeling erosion and longevity of artificial Brown trout (Salmo trutta) spawning beds caused by spawning activity

Gustav Hellström[1, 2], Daniel Palm[1], Viktor Tylstedt [1], Annika Holmgren[1] and Hans Lundquist[1]

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Abstract: We evaluated erosion of artificial spawning beds attributable to spawning activities by female brown trout by deploying PIT-tag marked pebbles over spawning beds in a tributary to River Vindelälven in northern Sweden. Data was used to develop a model describing the erosion process. The results suggests that there is a spatial heterogeneity in erosion probabilities over a spawning bed. Erosion differed in magnitude between central-, downstream- and upstream sections. A longevity model, based only on the bed erosion caused by female digging activity, suggests that a artificial spawning bed have a lifespan in the range of 13 to 35 years, depending on gravel department. The erosion prediction tool developed in this study can offer guidance for fisheries managers when constructing and maintaining spawning beds and significantly improve and facilitate restoration efforts, provided the user of the models understand its limitations.

Habitat compensation in nature-like fishways

Stina Gustafsson, Olle Calles, Martin Österling, Karlstad University

Abstract: Stream restoration efforts are increasing world-wide, and in areas where important habitats have been degraded or destroyed by human activities, new habitats can be created to compensate for these losses. One restoration measure which simultaneously provides faunal habitat and maintains connectivity in fragmented streams is the construction of nature-like fishways. Due to their limited size they will never be able to fully compensate for all habitat lost due to impoundments in the main river. Nevertheless, nature-like fishways is the most common fishway type in Sweden and such artificial stream habitats are likely to become increasingly important as river rehabilitation and connectivity issues are addressed. To date, however, the potential for habitat rehabilitation in nature-like fishways has not been fully realized. To develop the concept of how to design a nature-like fishway, a 500-meter long nature-like fishway, termed the biocanal, was constructed at the Eldforsen hydroelectric facility, Sweden. It included four habitat types: riffle, pool, floodplain and braided (i.e. with islands), each replicated three times. Thus the biocanal had a more varied in-stream environment than those of conventional nature-like fishways. Studies of the colonization of macroinvertebrates in the biocanal showed that the construction of this more diverse type of nature-like fishway possesses the potential for high biodiversity. Further efforts to improve the habitat function in the biocanal will be focused on the freshwater pearl mussel (Margaritifera margaritifera) and its host fish, the brown trout (Salmo trutta).

Evidence of recruitment failure in all life stages of Margaritifera margaritifera: non-destructive methods to better assess population status

Martin Österling, Karlstad University

Abstract: Freshwater unionoid mussels are one of the most threatened groups of organisms on earth. Many factors have been suggested to be the cause of the dramatic decline of these mussel species. Determining the cause of the decline of a species is not simply a question of which factor is threatening the species' existence, but also which life stage is being affected. This may be particularly problematic for a species with a complex life cycle that includes a parasitic stage on a host because there is also a need to examine the ecology of the host population. Unionoid mussels have an obligate parasitic stage on one or more host fish species. The mussels are sensitive to environmental changes, which can also change the distribution and abundance of their hosts. The threatened freshwater pearl mussel (M. margaritifera) is considered to be an umbrella species in European rivers. The main threats to the mussel are habitat degradation and fragmentation, which result in non-recruiting populations lacking juvenile mussels. We showed that all life cycle stages are related to recruitment failure of M. margaritifera. As mussels and host fish are often threatened, non-destructive methods have been developed to investigate the life cycle stages. Therefore, it may now be possible to investigate every life stage of unionoid mussels without using harmful methods at all.

RIVER ICE PROCESSES IN CHANNELIZED AND RESTORED STREAMS

LOVISA LIND and CHRISTER NILSSON, Landscape Ecology Group, Department of Ecology and Environmental Science, Umeå University

Abstract: Ice is an important component of high-altitude and high-latitude streams and rivers, affecting many ecological processes, directly or indirectly through effects on hydrology. The ecological effects of river ice on vegetation are however little studied. In high-latitude and high-altitude regions, humans have altered riparian and aquatic habitats with, for example, impoundments, flow regulation and channelization. In several European countries and parts of North America and Asia, streams and rivers were intensively used for timber floating from the mid 19th to the mid 20th centuries. Streams and rivers were regulated by splash dams and channels were modified and straightened by removing large sediment and wood. Channelization changed the conditions for ice formation and altered the environment for many organisms. Efforts have been placed on restoring these systems by replacing boulders and large wood. Such components reduce flow velocity, which may decrease the formation of anchor ice and favour a stable ice cover. Ice dams often form in areas with large emergent boulders and in areas where flow accelerates. Therefore, addition of boulders in large channels is less efficient since the boulders seldom emerge above the water surface. Addition of large objects in small channels can result in further jamming of ice and subsequent flooding of the riparian zone, restoring the natural disturbance regime. However, our data indicate that the response of ice formation to restoration of streams and rivers is site specific. Streams close to lake outlets may get less dynamic ice formation after addition of boulders and consequently reduced flow. In contrast, steep streams or streams far away from a lake may produce massive amounts of anchor ice after addition of large objects. Changes in ice formation should therefore be considered in planning and execution of restoration efforts.

Effectiveness of stream restoration for riparian vegetation and habitat

Lenka Kuglerová and Roland Jansson, Landscape Ecology Group, Department of Ecology and Environmental Science, Umeå university

Abstract: Constituting the boundary between aquatic and terrestrial habitats, riparian zones are predominantly structured by the hydrological regime of adjacent streams and rivers. In northern Sweden most river channels were transformed to facilitate timber floating which heavily affected both aquatic and riparian habitats. Stream restoration practices in the Vindel River catchment (northern Sweden) entailed placing boulders and tree logs back into the channel, removing stone walls, blocking backwaters and side channels and restructuring the aquatic and riparian habitat. It is believed that such restoration should enhance aquatic and riparian habitat heterogeneity presumably approaching pre-channelization conditions.

The main objective of this project is to estimate whether ecological restoration of streams can be an effective way to improve the status of riparian plant communities. Due to the strong link between riparian vegetation, riparian habitat and fluvial processes we aim to described the differences between channelized and restored stream reaches by investigating riparian vegetation patterns (richness and composition), riparian habitat (edaphic properties) and fluvial regimes (magnitude, duration and frequency of flooding). Three set of restoration statuses are used in this project, “channelized”, “best practise” (restored at least 8 years ago) and “demonstration” (re-restored in 2010 according the state-of-art method) restored reaches.

The preliminary results show that restoration has an effect on riparian plant species richness. While there is small difference in species richness between “best practise” and “demonstration” reaches, the channelized segments have lower species richness, less diverse plant communities and lower vegetation cover than either of the restored types of streams. This is especially significant in areas closest to the stream channels. In contrast to this, channelized reaches have soils of higher quality with higher pH and higher organic and nitrogen contents. Such conditions should be beneficial to plant communities, however the total amount of soil along channelized reaches is much less than along restored streams due to extensive boulder cover. In conclusion, despite the more favourable soils along channelized reaches (probably due to longer time since major disturbance) the small amount of such soils cannot compensate the habitat available along restored reaches which is thus reflected in more species growing along restored stream segments. The lack of differences between the two restoration statuses (“best practise” and “demonstration”) is most likely due to lack of time for the plant communities to re-establish after the restoration disturbance in 2010 when the “demonstration” restoration was implemented.

Red Listed species on Swedish freshwater shores

Ulf Bjelke, ArtDatabanken (Swedish Species Information Centre), SLU, Uppsala

Abstract: Conservation of Swedish freshwaters is often focused on species and habitats within the water and more rarely on the terrestrial biota connected to freshwater shores. However, in an average Swedish freshwater habitat, the likelihood of finding threatened species is often greater on the shore than in the water body.

Approximately 270 species on the Swedish IUCN Red List are terrestrial but connected to the freshwater/land zone. These species are represented mainly by vascular plants, bryophytes, lichens, birds, amphibians and a number of invertebrate groups.

These species are often poor competitors and are dependent on the disturbance caused by natural, seasonal changes in water levels and on grazing and mowing. Regulation of water levels and reduced grazing both often lead to overgrowth by opportunistic plant species. This is the main threat for terrestrial species adapted to the land – freshwater interface. Another threat is forestry, which is harmful for a number of species, mainly lichens and bryophytes. Invasive alien species is an increasing issue. The most problematic species are American mink, Canada goose and a handful of garden plants; Himalayan balsam, Giant hogweed and Japanese knotweed. These plants may out-compete the natural flora, but so far invasive plants are mainly a local, but increasing, problem in Sweden.

Presently, increased housing along freshwaters due to legislative changes and practices, may lead to a reduced acceptance for natural water level fluctuations and a risk for spread of invasive alien garden plants.

However, there are several good examples where conservation efforts, such as restored natural water level regimes and re-introduced grazing and mowing, have led to substantial population increase among threatened species in these habitats.

Session 3. Wrapping up

Restore LIFE+ project – Building the knowledge base and sharing river restoration good practice

Toni Scarr, Department of Energy and Climate Change, UK

Abstract: One of the potential barriers to successful river basin management and improving the environment for our rivers is the lack of accessible evidence. As part of addressing this gap RESTORE LIFE+ project developed an online 'RiverWiki' repository of case-studies highlighting lessons learnt and best practice examples. We also worked with planners and architects to write 'River by Design' which is aimed at the planning and development sector. We need to communicate the benefits of a quality water environment to more sectors than just the water industry and environmental NGOs. As part of this we need to share evidence and knowledge to help member states successfully deliver European Directives. Better valuation of ecosystem services that water provides would help us to communicate the benefits of a quality water environment and support management of the whole river catchment from source to sea.

MulkearLIFE's Community Engagement in River Restoration and Catchment Management on the lower River Shannon Special Area of Conservation

Ruairí Ó Conchúir, MulkearLIFE, Inland Fisheries Ireland, Limerick, Ireland

Abstract: MulkearLIFE (www.mulkearlife.com) is an important, partnership based, integrated catchment management project based on the Lower Shannon SAC. It is a five-year EU LIFE+ project involving Inland Fisheries Ireland, Office of Public Works and Limerick County Council. The catchment covers some 650 km². The main project objective is to restore degraded habitats on the Mulkear River and its principal tributaries for Atlantic Salmon, Sea Lamprey and Otter. The work has benefited a wide range of other fish species, invertebrates, birds and mammals.

Degradation and loss of habitat, as a result of past drainage dating back to 1874 has impacted negatively on target rivers preventing natural recovery. Consequently, habitat rehabilitation measures are required. MulkearLIFE's instream work has included the installation of rubble mats, stone weirs, bank protection work and the strategic placement of random boulders on over 35 km of river channel. The measures have greatly assisted in creating habitat complexity, enhancing the abundance of macro-invertebrates and fish. The work has broken up uniform habitat and reduced sediment input.

Considerable success has also been achieved with sea lamprey including the installation of the first ever substrate designed specifically for the easement of sea lamprey passage on barriers in Ireland. Passage has been achieved over various weirs since 2011. In 2013, a major barrier to passage was addressed with the removal of Ballyclogh weir, opening up an additional 180km of habitat for sea lamprey. The success of this work was confirmed in July 2014 with the most significant distribution of sea lamprey ever recorded in the upper catchment.

Community engagement and involvement has been of critical importance. It has included treatment of over 260 km of riparian zone for non-native invasive plant species, including the manual removal by volunteers of Himalayan balsam. The engagement included the establishment of the Mulkear Conservation Volunteers as the first catchment based conservation volunteer corp in Ireland. In 75 local schools, a highly successful environmental education programme has been delivered to over 1,900 schoolchildren and their teachers.

MulkearLIFE has also worked closely with local farmers to address local water quality concerns and develop alternative solutions to cattle drinks. Community involvement in the project's work with otter has allowed it to undertake five extensive catchment wide otter surveys. This has informed the direction of MulkearLIFE's work with otter which has included significant habitat restoration work and the installation of artificial otter holts throughout the catchment.

ÅNGERMANÄLVSPROJEKTET

Sara Friberg, Micke Strömberg och Lennart Norström, Älvräddarna

Abstract: The River Ångermanälven is the third largest river in Sweden and generates 17% of the national hydropower. The hydropower development was mainly carried out during the 1940s-1960s, with no environmental consideration. Fish ladders were deemed unnecessary and the wild salmon (Salmo salar), with annual catches well above 50 tonnes, was replaced with stocking of reared smolts at the lowermost dam. The loss of eel (Anguilla anguilla) and river lamprey (Lampetra fluviatilis), both locally important for the river fishery, was not mitigated or economically compensated. Local populations of the red-listed freshwater river pearl mussel (Margaritifera margaritifera) were isolated from the abundant populations of the host species for the mussel larvae - trout (Salmo trutta).

Starting in 2009, 2011 and 2014, respectively, three projects have been launched aiming at planning of remedial measures in connection with hydropower operations. The first plan dealt with the upper part of the river, the next plan with the lower reaches and the ongoing plan focuses on the middle reaches.

Along with improved fish passage, up- and downstream, also required changes in water regulation, minimum flows and restoration of river beds have been suggested. Further the old water court decisions and the legal process leading up to them have been documented in order to describe the biodiversity lost and why no mitigation plans were established.

The conclusions of the first two projects is that up-stream fish passages can be built at most dams, generally as natural fish passages, in some cases combined with short technical regular fish-ways. At some dams several different alternatives are given. Down-stream passage of smolts and kelts are also discussed and found feasible. These fish passages with required alterations of water regulation, increased minimum flows and river bed restoration could generate an annual production of 21 000 salmon smolts and 12 000 sea trout smolts at expected fish passage efficiencies. Along with this are increased habitats for several other species, including river lamprey and eel. Improved abundance of young trout would also be beneficial for the reproduction of the red-listed freshwater pearl mussel.

The ongoing third project focuses on dry river beds below the power plant dams, quantifying historical and present biodiversity, and suggesting remedial measures.

Water: connecting people. Building up a Life integrated project proposal for freshwaters.

Jari Ilmonen, Metsähallitus Natural Heritage Services

Abstract: Finland is preparing two applications for the first call of the new Life funding instrument, Life integrated projects. The process and outline of the application dealing with freshwater and coastal habitat management in Natura 2000 areas is described in this presentation. Preparation of the application was initialized by the Finnish Ministry of Environment in October 2013. After outlining the main themes and actions for the freshwater habitat project into a logical framework, regional authorities and other actors were asked for proposals, which are currently being wrapped up into a coherent project plan. Combining top-down and bottom-up approaches in the planning phase has yielded both challenges and advantages. Aims of the project are to improve the conservation status of selected freshwater and coastal water habitats and species by improving co-operation between different actors implementing different directives related to water, and by restoring aquatic habitats and their catchments in selected pilot areas.

The River Restoration Centre: encouraging river restoration in the UK and Europe

Ulrika Åberg, UK River Restoration Centre

Abstract: The UK River Restoration Centre (RRC) was founded in 1994 following a successful bid from EU's LIFE fund to demonstrate best practice in urban and rural river restoration and encourage river restoration in Europe. Shortly thereafter, in 1995, the European Centre for River Restoration (ECRR) was established. Both centres exist to promote, facilitate and support best practice in river, watercourse and floodplain management across the UK and Europe. This presentation will provide an overview of the work that RRC and ECRR carries out and give examples of some of the manuals and guidance documents we have produced.

With the Water Framework Directive as a major driver, river restoration practices are growing in Europe. However, research showed a lack of access to shared experiences and knowledge, which restricted effective means of carrying out best practice river restoration. To address this issue the LIFE funded RESTORE partnership was set up to encourage ecological river restoration in Europe by increasing the communication, dissemination and education in best practice river restoration.

The second part of this presentation will focus on the outcomes of the RESTORE partnership, and especially the online RiverWiki database. This was one of the key achievements of the RESTORE partnership to address the gap in accessible information. The RiverWiki contains about 500 European case-studies and is an interactive resource for sharing best practice river restoration and lessons learnt. The RRC is now managing the RiverWiki on behalf of the ECRR, and some examples of how to use this tool will be given.

Poster Abstracts

The Vindel River as a future UNESCO Biosphere

Kajsa Berggren, Länsstyrelsen Västerbotten

Abstract: Launched in 1971, UNESCO's Man and the Biosphere Programme (MAB) is an Intergovernmental Scientific Programme that aims to establish a scientific basis for the improvement of relationships between people and their environments. It proposes interdisciplinary research, demonstration and training in natural resources management. The MAB Programme develops the basis for rational and sustainable use and conservation of the resources of the biosphere and for the improvement of the overall relationship between people and their environment. It predicts the consequences of today's actions on tomorrow's world and thereby increases people's ability to efficiently manage natural resources for the well-being of both human populations and the environment.

Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science. As places that seek to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature, they are ideal to test and demonstrate innovative approaches to sustainable development from local to international scales.

Today there are 631 biospheres in 119 countries, of which 5 are located in Sweden. We argue that the Vindel River watershed could be a valuable addition to the world network of Biosphere reserves. The Vindel River is a free flowing treasure ranging about 500 km from the Scandinavian mountain range and down to the Ume River, which the run to the Baltic Sea. With head waters in Northern Europe's largest nature reserve (Vindelfjällen), and itself protected against hydropower exploitation the Vindel River is one of 4 Swedish so called National rivers. The Vindel River Valley has high landscape values in a wide range of areas, cultural, social, ecological, geological etc. In Umeå we have two of Sweden's larger Universities and the capacity for building knowledge. There is a strong engagement for sustainable development in the valley. People living along the river are the ones who once struggled to keep the river free flowing, and won. A grass root movement that spread to become a national movement. This is a good ground for a future Biosphere reserve!

There are many challenges ahead, but also visions and creative people with ideas.

LIFE TO AD(D)MIRE; MIRERESTORATIONS IN SWEDEN

Lisa Tenning[1], A. Lundgren[2], F. Lundin[3], J. Rova[4], S. Lamme, K[5]. Lindström[6] and T. Hansson[7]

The County Administration boards of 1) Jämtland, 2) Östergötland, 3) Dalarna, 4) Jönköping, 5) Kronoberg, 6) Västernorrland and 7) Skåne

Abstract: The Life to ad(d)mire project will restore 35 Natura2000 sites from the North to the South of Sweden. The project aims at stopping the decrease of habitats and species at these sites through hydrological restoration and vegetation measures.
The project is funded by Life and the Swedish Environmental Protection Agency. Life is EU 's financial instrument supporting Nature and Environmental conservation projects, the main goal is a decreasing loss of biodiversity within Europe. Life Nature supports projects within Natura 2000-sites. Natura 2000 is a network established for EU 's most threatened species and habitats. Life Nature supports projects that contribute to the implementation of the EU's Birds and Habitats Directives.

Ditches draining the mires are filled to restore the hydrology; most of these restorations are done by excavators. Peat is used for filling the ditches and logs are used as plugs to stabilize the structure. In other parts of the mires the ditches are given a more natural appearance by meandering morphology.

Overgrown wetlands are being cleared and former haymaking mires are being prepared for mowing.

Monitoring is done before, during and after the restorations. Vegetation monitoring and bird monitoring are done with the national Natura 2000 mire methodology. Ground water pipes are placed inside and outside the sites. Arial photos are taken before the restorations started and will be taken the last year of the project.

GERMINATION IN RIPARIAN ZONES IN RESPONSE TO RESTORATION ACTIONS – A CASE STUDY OF VINDEL RIVER TRIBUTARIES IN SWEDEN

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1.CHRISTIAN-ALBRECHTS-UNIVERSITÄT ZU KIEL, GERMANY (CAU)
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Abstract: Stream flow regimes heavily regulate riparian vegetation, as water affects seed dispersal, germination, and establishment. Worldwide, riparian vegetation has been degraded due to regulation of flow regimes (e.g. damming and channelization). In recent decades, projects have attempted to restore riparian zones by reconstructing natural stream complexity and flow regimes. However in complex field situations, it is not well understood how flow regimes interact with seed dispersal, germination, and establishment to impact riparian vegetation. This study investigates how germination responds to flow regime changes after restoration, using restored tributaries of the Vindel River in Sweden. Historically, these tributaries were simplified to facilitate timber floating. Recent restoration has increased their structural complexity, with different methods creating different degrees of complexity. Demonstration reaches were restored by adding large boulders and woody debris to the stream, resulting in more variable flow regimes and higher riparian vegetation richness compared to reference reaches, which were restored with a simpler best practice method. Six native species were sowed at seven reaches of both restoration types to determine if germination rates were (1) different between reach types and (2) could be attributed to abiotic differences or (3) habitat heterogeneity. Total germination of all six species was not different between reach types. Individually, germination of three species differed between reach types, but only one germinated more in the reach type which also had more of that species in the vegetation community. Germination appeared to be species specific, responding to soil moisture and somewhat to canopy cover, and was not affected by habitat heterogeneity. In contrast to the germination of the sowed seeds, the number of native seedlings was higher at demonstration reaches, indicating the observed shift of vegetation is not due to differences in germination rates, but potentially to the trapping of a higher number of dispersed seeds.

The return of the thick-shelled river mussel (*Unio crassus*)

Martin Österling[1], Lea Schneider[1], Ivan Olsson[2], Vibeke Lirås[2], Marie Eriksson[2] Helena Herngren[3], Jacob Bergengren[4], Lars Gezelius[5] and Andreas Nilsson[6].

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Abstract: The thick-shelled river mussel (*Unio crassus*) used to be common in numerous catchments throughout Europe, but has decreased dramatically as a result of habitat destruction and degradation. Today, *U. crassus* is the most threatened freshwater mussel in Europe, with a few remaining populations in South Eastern Sweden. The lack of ecological knowledge has made it difficult to protect this mussel species.

A flagship species linking research and conservation

The overall objectives with the project are to increase the knowledge of the mussel's biology and habitat preferences, and to improve the environmental conditions and water quality in twelve rivers in south-eastern Sweden. In addition, the project aims to re-introduce *U. crassus* in the restored rivers.

The life cycle – can we solve the enigma?

One interesting characteristic of *U. crassus* is the complex life cycle, including a parasitic stage on several host fish species. So far, we have identified four host fish species: Bullhead, (*Cottus gobio)*, Minnow (*Phoxinus phoxinus*), Three-Spined Stickleback (*Gasterosteus aculeatus*) and Brown trout (*Salmo trutta*). Interestingly, preliminary results suggest that the host-parasite relationships are river specific, meaning that functional host fish species may not be the same in different rivers.

The comeback

The identified host fish species are used to produce juvenile mussels in our new breeding facility. This is done by the collection of gravid mussels in their native rivers in late spring. When the glochidia larvae release from the mussels, they infest the host fishes. After approximately one month, the juvenile mussels release from the host fish, and are collected in hatchery aquaria. So far, 30 000 juvenile mussels have been re-introduced into River Klingavälsån and Fyleån Creek.

Herbivores induce a sharp transition between water and land

Judith Sarneel, G.F Veen, J.P. Van Paassen , N. Huig, W. Rip, E.S. Bakker

Abstract: During succession in tranquile reaches or lentic systems, the riparian zone expands into the open water and gradually replaces aquatic macrophyte vegetation. This succession process is highly valued as it increases the diversity of freshwater systems and performs several important ecosystem functions. However, succession is easily halted or even reversed by multiple (sometimes obscure) factors. However, it is increasingly recognized that herbivory is a potential threat of successful restoration of macrophyte vegetation. Herbivory could minimize or interact with the effects of other restoration measures. Especially in the case of water level fluctuation, where lower water tables could make expanding shoots better accessible for foraging birds.

We therefore preformed an intensive exclosure study in ten nature area with altered water level management, in which we studied the effects of herbivory, water level fluctuations and macrophyte diversity. We followed the vegetation composition and succession in our grazed and ungrazed plots for two years. Already after one year, herbivory significantly reduced macrophyte cover and biomass and biodiversity. Further, the succession of helophytes into the open water was higher in the ungrazed plots compared to the grazed plots. We found significant interactions between macrophyte biomass and water departmenth, showing that water level management plays a crucial role. With increasing water departmenth, biomass decreased in the ungrazed plot but not in the grazed plot. The biomass of submerged macrophytes was only lowered in shallow grazed plots, not in water deeper than 75 cm.
This shows that it is very important to consider the effects of trophic interactions when restoration measures are applied.

Reintroduction of Freshwater Pearl mussel (*Margaritifera margaritifera*) in small restored streams

Niclas Wengström, Sveriges Sportfiske- och Fiskevårdsförbund

Abstract: The freshwater pearl mussel (FPM) is an endangered species throughout its distribution area and due to its limited ability to disperse it has gone extinct from several streams in Sweden. Once it has disappeared from a stream the probability to recolonize it is low. The mussel has an interesting and complex lifecycle which contains a larvae period as obligate ectoparasite on salmonids.

The infested fish can if they move longer distances allow and facilitate dispersal but the most frequently used host is found in the age class 0+ (young of the year fish) which usually are relative stationary. We've tested two different methods to reintroduce the freshwater pearl mussel to streams in the county of Västra Götaland. Moving pregnant female FPM from one stream to another resulted in an average infestation rate of 36 % with an average amount of glochidia on the infested fish of 235 (range: 3-1478). We've also put pregnant mussel and hostfish together in small flow through containers placed in the stream. Infestation rates were than close to 100 % with on average amount of glochidia on the fish of 154 (range: 1- 1238). The easy way of moving mussels between streams gives a lower infestation rate compared to the more demanding work of keeping animals together for a short while which gives a very high infestation rate. Both methods can however be used as tools for reintroduction of freshwater pearl mussel.