LAND
OBERÖSTERREICH

BOOK OF ABSTRACTS

Nov. 13th – 14th, 2013

INTERNATIONAL MEETING ON

IMPROVING THE ENVIRONMENT FOR THE FRESHWATER PEARL MUSSEL

WEINBERG CASTLE, KEFERMARKT, AUSTRIA

LAND
NATUR IM LAND
OBERÖSTERREICH

INTERNATIONAL MEETING ON IMPROVING THE ENVIRONMENT FOR THE FRESHWATER PEARL MUSSEL

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Amt der Oberösterreichischen Landesregierung, Austria

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Birgit Lerchegger, Christian Scheder & Clemens Gumpinger

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Abteilung Naturschutz, Direktion für Landesplanung, wirtschaftliche und ländliche Entwicklung,
Linz, Austria
November 2013

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Birgit Lerchegger
Christian Scheder

CONFERENCE PROGRAM

WEDNESDAY, NOVEMBER 13TH

Host: Clemens Gumpinger – Consultants in Aquatic Ecology and Engineering (blattfisch), Wels, Austria

12.00 **Welcome coffee**

13.00 **Opening**
Dkfm. Carl-Friedrich Wentzel – Castle owner
Dr. Gottfried Schindlbauer – Head of the Department of Spatial Planning, Economic and Rural Development – Government of Upper Austria

THE CURRENT SITUATION OF THE FRESHWATER PEARL MUSSEL IN EUROPE. THREATS, CONSERVATION STRATEGIES, MONITORING AND STATUS ASSESSMENT

13.15 **From captive breeding to catchment management - the Austrian freshwater pearl mussel project approach**
Gumpinger Clemens – Consultants in Aquatic Ecology and Engineering (blattfisch), Wels, Austria

13.45 **The freshwater pearl mussel: Threats and conservation**
Geist Jürgen – Aquatic Systems Biology Unit, Department of Ecology and Ecosystem Management, Technische Universität München, Germany

14.15 **The freshwater pearl mussel in Sweden - methods for monitoring and status assessment**
Bergengren Jakob – County Administrative Board of Jönköping, Sweden

14.45 **The freshwater pearl mussel in Sweden - status, trends, and action plans**
Söderberg Håkan – County Administrative Board of Västernorrland, Sweden

15.15 **BREAK**

15.45 **The freshwater pearl mussel in Norway - status and conservation strategies**
Larsen Bjørn Mejdell – Norwegian Institute for Nature Research, Trondheim, Norway

16.15 **Status of species, population structure and survival capabilities of freshwater pearl mussel *Margaritifera margaritifera* (Linnaeus 1758) in Latvia**
Rudzite Maris – Latvian University, Museum of Zoology, Latvia

16.45 **Environment of the freshwater pearl mussel - role of host fish species**
Taskinen Jouni – Department of Biological and Environmental Sciences, University of Jyväskylä, Finland

17.15 **Biological monitoring in combination with water and detritus analysis in potential freshwater pearl mussel habitats in Upper Austria**
Lerchegger Birgit – Consultants in Aquatic Ecology and Engineering (blattfisch), Wels, Austria

17.45 **Shortcoming analyses of watercourses and their catchments with regard to their applicability for the re-establishment of freshwater pearl mussel populations in Upper Austria**
Scheder Christian – Consultants in Aquatic Ecology and Engineering (blattfisch), Wels, Austria

18.15 **END**

19.00 **BEER RECEPTION (with locally brewed specialty beer)**

THURSDAY, NOVEMBER 14TH

Host: Clemens Gumpinger / Christian Scheder – Consultants in Aquatic Ecology and Engineering (blattfisch), Wels, Austria

8.30 **Introduction**

PRACTICAL EXPERIENCE IN CATCHMENT MANAGEMENT AND RESTORATION - CASE STUDIES FROM VARIOUS EUROPEAN COUNTRIES

8.45 **Reduction of unnaturally high loading of silt and sand in running waters. A successful species protection measure for the freshwater pearl mussel in Lower Saxony, Northwest Germany**
Altmüller Reinhard – Lachendorf, Germany

9.15 **Sediment management on a river basin scale to preserve and/or restore freshwater pearl mussels habitat**
Hauer Christoph – Christian Doppler-Laboratory for Advanced Methods in River Monitoring, Modelling and Engineering, University of Natural Resources and Life Sciences Vienna, Austria

9.45 **Catchment management of freshwater pearl mussel rivers in Bavaria and Saxonia, Germany: Survey of pressures and mitigation measures.**
Schmidt Christine – Schmidt & Partner GbR, Goldkronach, Germany

10.15 **BREAK**

10.45 **Qualitity of pearl mussel habitats: Critical Examination of Indicators for Siltation and Chemical Conditions in the Sediment.**
Vandré Robert – Schmidt & Partner GbR, Goldkronach, Germany

11.15 **Evidence based approach to the restoration of *Margaritifera margaritifera* habitats in the Czech Republic**
Douda Karel – Department of Zoology and Fisheries, Czech University of Life Sciences Prague, Czech Republic

11.45 **Brook renovation in boreal forest area - new actions and experiences about headwaters and freshwater pearl mussels**
Luhta Pirkko-Liisa – Metsähallitus, Natural Heritage Services, Pohjanmaa, Finland

12.00 **River restoration, trout and pearl mussel - river Siika-Juujoki case, Lapland**
Kangas Marko – Center for Economic Development, Transport and Environment of Lapland, Rovaniemi, Finland

12.15 **LUNCH BREAK**

14.00 **Habitat restoration measures for the freshwater pearl mussel *(Margaritifera margaritifera)* in the low mountain range of the Ardennes in Luxembourg**
Thielen Frankie – Natur & Umwelt, Project Life Nature freshwater pearl mussel, Heinerscheid, Luxembourg

14.30 **Strategic improvement of freshwater pearl mussel environment through catchment management: Part 1 - Assessment of key issues in freshwater pearl mussel populations**
Killeen Ian – Malacological Services, Dublin, Ireland

15.00 **Strategic improvement of freshwater pearl mussel environment through catchment management: Part 2 - Conservation and rehabilitation effort as a response to freshwater pearl mussel needs**
Moorkens Evelyn – Evelyn Moorkens and Associates, Dublin, Ireland

15.30 **BREAK**

16.00 **Life Project Conservation of habitats of Pearl Mussels in Belgium**
Stephanie Terren - Centre de Recherche de la Nature, des Forêts et du Bois, Gembloux, Belgium

16.30 **The impact of some major anthropogenic threats to the freshwater pearl mussel: life cycle studies and different scales**
Martin Österling - Department of Biology, Karlstad University, SE 651 88 Karlstad, Sweden

17.00 **The freshwater pearl mussel in Sweden - conservation at catchment level**
Henrikson Lennart – Nature och Man Ltd., Hyssna, Sweden

17.30 **Measures for improving habitat for FWPM in the Armorican Massif**
Dury Pierrick – Fédération de pêche du Finistère, France

18.00 **END**

VENUE

The International Meeting will take place at the auditorium in Weinberg castle.

Venue: Schloss Weinberg, Weinberg 1,
4292 Kefermarkt, Austria

GPS (WGS84): E 14,53925 / N 48,44851

INTERNET AND COMPUTER ACCESS

Internet will be available on specially marked hot spots in the Weinberg castle.

FOOD AND REFRESHMENTS

A „Welcome Coffee" will be served at the beginning of the meeting on 13th November 2013 in the Weinberg castle.

Dinner will be serverd near the venue at the taverne of the castle brewery Weinberg on the 13th November 2013 (address: Erste oberösterreichische Gasthausbrauerei Schlossbrauerei Weinberg, Weinberg 2, 4292 Kefermarkt).

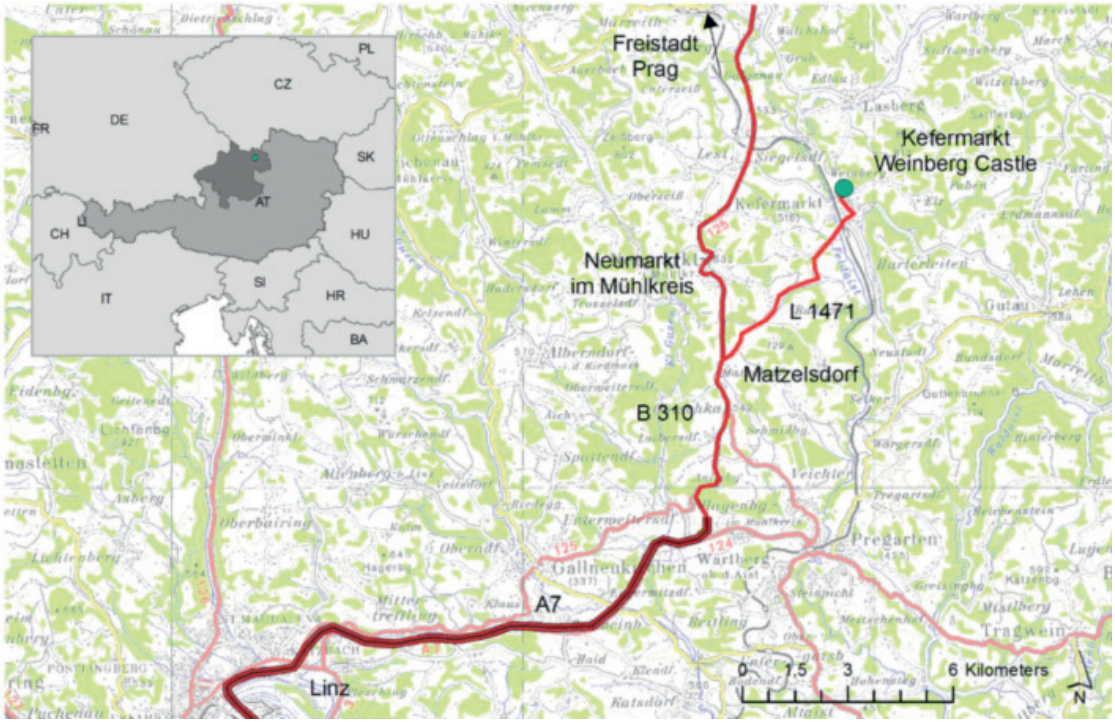
Breakfast will be served individually at your accomodation.

For the lunch on 14th November you will get detailed information from the organizing team on the previous day.

During all breaks coffee and cakes will be served in the Weinberg castle.

MAPS

General map



Local map of Kefermarkt

ABSTRACTS

ORAL PRESENTATIONS

FROM CAPTIVE BREEDING TO CATCHMENT MANAGEMENT – THE AUSTRIAN FRESHWATER PEARL MUSSEL *(MARGARITIFERA MARGARITIFERA)* PROJECT APPROACH

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Since the year 2011 a project for the conservation of *Margaritifera margaritifera*, called "Vision Flussperlmuschel" is conducted in two Upper Austrian river systems, the Aist and the Naarn.

The aim of the project is the establishment of reproductive freshwater-pearl-mussel-populations in these both river systems, respectively in one tributary of each of them.

It was decided to reach these overall goal in using two more or less succeeding strategies. First we had to learn to "produce" mussels by captive breeding. As a result we should be able to reproduce as much mussels, as we need. In a first step some hundred individuals should be enough – just to be able to do some biomonitoring with buddensiek-cages. This aim should be considered as reached even in the first years.

The second strategy concentrates on the mussel-environment. As there are (nearly) no river-systems left in Upper Austria, that provide appropriate habitats in a sufficient quantity to establish a pearl mussel population in a sustainable way, we will have to restore habitats.

Meanwhile, in some tributaries in the catchment systems of the Rivers Aist and Naarn abiotic and biotic factors are collected and analysed on the basis of the requirements of *M. margaritifera*. Thereupon we have to draft measures to sanify some catchment areas and we have to transfer these measures into action. As this will need some long time, we also have to think about changing the medium term strategy. For example, constructing an artificial "mussel river", based on habitat-modelling and equipped with hydraulic features to minimize sediment loads and all structures needed to provide living environment for the mussel.

The overall project is financed by the Office of the State Government of Upper Austria, Section for Environmental Protection, the Environmental Councilor, Dr. Manfred Haimbuchner and the European Union.

THE FRESHWATER PEARL MUSSEL: THREATS AND CONSERVATION

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Freshwater pearl mussels *(Margaritifera margaritifera)* are declining throughout Europe, with many populations now being at the brink of extinction. This contribution (i) gives an overview of the critical stages and bottlenecks in the pearl mussel life cycle in relation to habitat change, and (ii) suggests strategies for conservation based on ecological and genetic data from European pearl mussel populations.

Most of the extant pearl mussel populations still have a great reproductive potential, irrespective of their current population size. At the same time, the genetic diversity and differentiation is well understood, facilitating the selection of priority populations and units of conservation. Host suitability testing and comparative data on host fish density and biomass indicate that this stage of the life cycle is not limiting in the majority of sites. The core problem for successful recruitment is the early post-parasitic phase when juvenile pearl mussels live buried in the interstitial zone of the stream bed. Structural habitat change and flow modifications, along with excessive introduction of fines from the catchments, were identified to result in low redox potentials and poor oxygen supply for the juveniles, ultimately increasing their mortality. The high rates of fine sediment depositions measured in several study streams, along with experimental trials of stream substratum restoration indicate the limited use of some of the most commonly applied stream bed restoration techniques and suggest the necessity of considering the entire catchment in freshwater pearl mussel conservation. Since habitat restoration is time-consuming and expensive, captive breeding has become very popular, but it must not replace restoration of functional habitats and the overall objective of arriving at naturally recruiting populations in the wild.

Restoration of habitats in priority populations and captive breeding to retain the genetic and evolutionary potential of the species should be used in combination. Generally, all efforts require detailed documentation and evaluation which is essential for adaptive management in the long run.

THE FRESHWATER PEARL MUSSEL IN SWEDEN – METHODS FOR MONITORING AND STATUS ASSESSMENT

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In Sweden, there is a national standard method for monitoring of the Freshwater Pearl Mussel (FPM) *Margaritifera margaritifera*. The stream is stratified into three strata and at least 5 sections are randomly chosen within the strata. All mussels, visible with a bathyscope without digging, in the sections are counted and the smallest mussel found is measured. Outside each section the length of 15 randomly chosen mussels are measured.

The conservation value of a FPM population is assessed by six criteria – population size, mean density, distribution range, smallest mussel found, percentage mussels < 20 mm, and percentage mussels < 50 mm – and placed in three classes.

A simple system for classification of FPM population status is based on length measurements of the first 100 mussels found.

THE FRESHWATER PEARL MUSSEL IN SWEDEN – STATUS, TRENDS, AND ACTION PLANS

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The Freshwater Pearl Mussel (FPM) *Margaritifera margaritifera* is widely spread all over Sweden with the most populations in the northern part. It is present in around 600 streams, which means that Sweden holds one third of all European FPM populations.

Half of the streams do not show any evidence of recruitment during the last 20 years, i.e. no mussels <50 mm are found. Just 13 % of the streams have recent recruitment (mussels <20 mm, approx. 10 years old). Moreover at least 78 populations have gone extinct, mainly in southern Sweden.

However, the conservation value assessments show that Sweden still has a number of healthy FPM populations – 98 populations have high or very high conservation values. During the last decade there are changes indicating lowered viability, increased length of smallest mussel found, and decreased number of streams with mussels <50 mm. However, in streams limed to counteract acidification there were no changes indicating that liming is an important conservation measure.

The first national action plan for FPM was adopted in 1991, the second in 2005 and now the third one is developed. It will be focused on conservation priority, legal protection, and stream habitat restoration. The responsible national authority is the Swedish Agency for Marine and Water Management.

THE FRESHWATER PEARL MUSSEL *MARGARITIFERA MARGARITIFERA* IN NORWAY – STATUS AND CONSERVATION STRATEGIES

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The goal for the management of the freshwater pearl mussel is presence of healthy populations all over Norway within the normal living area of the species. All present natural populations should be maintained or improved.

We have information about 527 streams or localities with freshwater pearl mussels in Norway, and the mussel is still found all over the country. The total number of streams includes 114 localities (about 22 %) where the mussels are believed to be extinct. Streams with pearl mussels are most frequent (50 % of all streams) in the central parts of Norway, and we find most of the extinct populations in the south-eastern and southern parts of the country. Based on length distribution and recruitment in 74 streams, recruitment was described as good (mussels less than 20 mm) in 35 % of the streams investigated. This indicates that Norway have a relatively high percentage of the sustainable populations of pearl mussels in Europe.

The freshwater pearl mussel is on the Norwegian red list of threatened species ("vulnerable"), and designated as a "responsibility species" for Norway. Consequently, an Action plan for the freshwater pearl mussel was published in 2006 by the Norwegian Directorate for Nature Management. The County Governor in Nord-Trøndelag has a central role in implementing the action plan. Among the measures proposed in the action plan were monitoring, public information, habitat improvement, and improvement of management routines according to acts and regulations relevant for the freshwater pearl mussel. Additional mapping and extended work to establish a database with information on the distribution and status of the freshwater pearl mussel was also proposed.

A monitoring programme was started in 2000, and the baseline registrations including water chemistry, host fish population and freshwater pearl mussel in the 16 selected rivers were finished during 2006. The watercourses are planned to be monitored in cycles of 5–6 years.

Actions – some examples will be given: stocking of fish with or without mussel larvae on the gills, liming in acidified areas, improving substrate for fish and mussels, and management plans for selected river basins. A captive breeding programme was established in 2011 to rear juvenile mussels with the goal of reintroducing them back into their native catchments.

It is an offence to harvest pearl mussels in Norway (from 1993), and in 2009 we got The Norwegian Nature Diversity Act which has management objectives for habitat types and species. The freshwater pearl mussel is suggested as a "priority species", i.e. active measures shall be taken if this is necessary in order to ensure the conservation of the species. The most important pressures on Norway's river systems are runoff from agriculture, hydropower developments and long-range transboundary pollution. Integrated, eco¬system-based management and planning is the most effective way of improving the situation. The EU Water Framework Directive can be an important tool to achieve this, and generally greater vigilance and awareness in rivers with freshwater pearl mussel give hope for the future.

STATUS OF SPECIES, POPULATION STRUCTURE AND SURVIVAL CAPABILITIES OF FRESHWATER PEARL MUSSEL *MARGARITIFERA MARGARITIFERA* (LINNAEUS 1758) IN LATVIA

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Species approaching extinction, now in a critical condition; decreasing populations not only in Latvia but throughout its range. Main goal: to halt the decline of the freshwater pearl mussel population; establish conditions for its normal regeneration by improving and stabilizing appropriate habitats in oligotrophic river ecosystems. During the time span between 1999 and 2007 altogether 163 rivers have been surveyed (totally 610 km) (Rudzite 2001, 2004, 2005), but in 2008 and 2009 more than 95 watercourses (more than 100 km) were specially examined. As a result 8 Freshwater pearl mussel locations have been recognized, while empty shells are found in seven rivers. Total number of Freshwater pearl mussels is about 25 000 and the extension of the population area is 40 km (Rudzite 2005). In the year 1999 and 2000 the age structure of pearl mussel populations has been studied and compared with the data of 1977; all the populations are found to be in the ageing stage (Rudzite 2001).

The cycle of development of the Freshwater pearl mussel has been studied: the eggs, glochidia, parasitic cyst stages, host fish populations. In the year 2000 and 2001 the salmonid fish smolt gills from 8 pearl rivers were examined, and they were invaded with glochidia cysts. In the year 2005 egg development and glochidia on the female mussel gills were studied, with harmless methods. The normal development of eggs and hatching is observed. On control fishing, all the swift river fishes were recognized, but natural resurgence of salmonid fish was found insufficient. From the year 2004 to 2007 in the Freshwater pearl mussel rivers several thousand brown trout Salmo trutta m. fario (L.) smolts were released.

The beavers are recognized in all the freshwater pearl mussel rivers, they destroy large territories – the habitat of pearl mussels and salmon fish – by building dams. In the 2005 nine hunting cooperatives were involved to control the number of beaver in the freshwater pearl mussel locations and to establish the habitats (Rudzite 2005, Rudzite; Znotiia 2006). From 2005 to 2008 the 215 beavers have been hunted and 181 dams destroyed in the protected areas. In the 2006, the complex investigations of the ecological system in the Rauza river basin were carried out and hydrobiological and hydrochemical analyzes in 20 points showed impact of pollution sources and nitrogen content unfavourable to mussels.

To determine the importance of the river basin for the surviving of mussels, the territories with different land usage were studied and verified with correlation and regression analysis. The basins with alive pearl mussels are associated with forests and wetlands, but less with agricultural lands. The regression analysis gives us possibility to estimate eventual Freshwater pearlmussel *Margaritifera margaritifera* rivers in the North Vidzeme Biosphere reserve. Pearlmussels were not found, but another rare mussel species living in the swift rivers and vulnerable to pollution – Thick Shelled River Mussel Unio crassus – was found.

Latvian Pearl rivers, according to the Swedish valuing system (Erikson et al. 1998), correspond to the Class I ("Site of nature conservation value") and Class II ("High nature conservation value"), but none of them corresponds to the Class III ("Very high nature conservation value"). The condition of two populations corresponding to the Class II, may be valued as good, they have the chance to survive. In the 2007, in the Rauza river 14 Freshwater Pearlmussels were found, at the age of 7 to 9 years, having shell size 40–50 mm, which are the youngest individuals of this species known for Latvia since such investigations are carried out. But in nature reserve Melturu sils the results of monitoring in 2008 showed that population is near extinction (Rudzite M., Rudzitis M. 2011). The pearl fishing in 18–19 century had an important role in the Freshwater Pearlmussel decline in Latvia (Rudzitis, Rudzite 2012; Rudzite, Rudzitis 2012).

ENVIRONMENT OF THE FRESHWATER PEARL MUSSEL – ROLE OF HOST FISH SPECIES

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As larvae of the freshwater pearl mussel, *Margaritifera margaritifera*, are parasitic on fish, one important aspect of the environment of pearl mussels is the availability of suitable hosts. The fish hosts of *M. margaritifera* in Europe are Atlantic salmon Salmo salar and brown trout S. trutta. In addition, the North American populations of *M. margaritifera* are suggested to use the brook trout, Salvelinus fontinalis, as their fish host. Traditionally it has been thought that salmon and trout both are equally suitable hosts for the European pearl mussels. However, for conservation of the remaining European *Margaritifera* populations, it is of great importance to know whether Atlantic salmon or brown trout (or the local salmon/trout stock) is preferred by a given pearl mussel population. In addition, it is also important to evaluate suitability of the invasive species, brook trout, as a fish host for European *M. margaritifera*, which has faced severe declines throughout Europe.

We studied these questions by laboratory and field experiments in River Iijoki water system having sea-migrating salmon, sea-migrating brown trout, as well as resident brown trout. It appeared that if pearl mussels originated from River Livojoki – a (former) salmon tributary of River Iijoki – they infected and developed better in salmon than in trout. On contrary, pearl mussels originating from (former) trout rivers performed better in trout than in salmon. There was no consistent pattern with respect to local adaptation. In one cross infection experiment the local trout was better host than non-local, but results of another experiment indicated opposite. The results indicated a clear, previously unknown host specificity with respect to Atlantic salmon and brown trout in the freshwater pearl mussel. It is worth to mention that in the (former) salmon river where mussels infected better salmon than trout, no salmon has been available for the pearl mussels for 50 years since the building of hydroelectric power plant which stopped salmon migration from/to the Baltic Sea.

Thus, our results urge actions to restore the sea-migrating Atlantic salmon of River Iijoki to improve the 'host environment' for the threatened freshwater pearl mussel in that river system. When tested with glochidia from different pearl mussel populations of River Iijoki system, it turned out that brook trout is a very poor host for *Margaritifera*. Therefore, extermination or control of this invasive salmonid would improve the host environment of the freshwater pearl mussel.

BIOLOGICAL MONITORING IN COMBINATION WITH WATER AND DETRITUS ANALYSIS IN POTENTIAL FRESH WATER PEARL MUSSEL *(MARGARITIFERA MARGARITIFERA)* HABITATS IN UPPER AUSTRIA

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In Austria, the freshwater pearl mussel *(Margaritifera margaritifera)* is heavily endangered – as it is all over its distribution area. The Upper Austrian government decided to launch an extensive conservation project titled "Vision Flussperlmuschel" in 2011. The overall aim of this project is the establishment of reproductive *M. margaritifera* populations in fully restored habitats that grant for their survival. Therefore four tributaries in the catchment areas of the Rivers Naarn and Aist were scrutinized with regard to their suitability as potential mussel habitats. In these tributaries chemical parameters of the surface water and the interstitial water were examined during the 2012 growing season. Furthermore, redox potential, temperature regime, habitat suitability and detritus chemistry were analyzed.

The River Waldaist and the Gießenbach brook were chosen as reference streams with well known mussel populations. Finally, juvenile mussels were used for bio-monitoring in order to find out the most appropriate habitats by determining growth and mortality rates as well as correlating the results with the chemical water and detritus parameters.

Strong negative correlations between growth rates of the juvenile mussels and potassium (R^2=0.9), water hardness (R^2=0.8), calcium (R^2=0.7), sulphur (R^2=0.6), magnesium (R^2=0.5) and electrical conductivity (R^2=0.5) were detected. Positive correlations were shown between growth rates and nitrate (R^2=0.6). Mortality rates correlated positively with magnesium concentrations (R^2=0.6). After a 70-day-bio-monitoring the River Weiße Aist showed the highest survival rates (95 %), whereas the highest growth rates (30.5 %) were achieved in the River Harbe Aist. The importance of detritus as a basic food resource for juvenile mussels is shown by the positive correlation between the organic part of the detritus and mussel growth rates (R^2=0.5).

In 2013 the bio-monitoring program was resumed with mussels of different age classes in order to increase the predictive significance. A cross-border stream that connects Upper and Lower Austria and had turned out to be a promising candidate for the re-establishment of freshwater pearl mussel populations was added to the survey.

SHORTCOMING ANALYSES OF WATER-COURSES AND THEIR CATCHMENTS WITH REGARD TO THEIR APPLICABILITY FOR THE RE-ESTABLISHMENT OF FRESHWATER PEARL MUSSEL *(MARGARITIFERA MARGARITIFERA)* POPULATIONS IN UPPER AUSTRIA

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The government of Upper Austria has launched an extensive conservation project entitled "Vision Flussperlmuschel". The overall aim of this project is the establishment of reproductive *M. margaritifera* populations in fully restored habitats. At this stage, appropriate habitats are sparse or even lacking in virtually all potential mussel brooks, due to a variety of negative influence factors, including amongst others the intensive agricultural land use in the catchment areas, land drainages, allochthonous riverine vegetation or stream regulation measures. In the course of a multistage preselection process five promising tributaries to the River Aist and the River Naarn (two important refugia for the last remaining Upper Austrian freshwater pearl mussel populations) were selected for further examination. Comprehensive physicochemical analyses were carried out, accompanying a two-year biomonitoring with juvenile pearl mussels (Lerchegger et al. in prep.) in order to find out the most suitable watercourse for the re-establishment of captive bred mussels.

In a next step a shortcoming analysis was conducted in the five tributaries and their catchment areas: A total distance of 34 km was mapped by pacing out the watercourses from the respective area of planned re-establishment upstream unto the source. The streams were divided into adjoining 250-m-sections; for each section 22 parameters were assessed, including hydromorphological aspects like water depth, flow velocity, slope or substrate composition as well as potential threats like increased fine sediment depositions, adverse land use or drainages. The results were then evaluated and correlated with the biomonitoring results. This correlation does not only help to decide on the most appropriate site for the future re-establishment, but is also the basis for the development of detailed management plans that will help creating and keeping up adequate living conditions for the freshwater pearl mussel.

REDUCTION OF UNNATURALLY HIGH LOADING OF SILT AND SAND IN RUNNING WATERS. A SUCCESSFUL SPECIES PROTECTION MEASURE FOR THE FRESHWATER PEARL MUSSEL IN LOWER SAXONY, NORTHWEST GERMANY

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The freshwater pearl mussel (FPM) once lived in five big catchments in Lower Saxony in the north of the Federal Republic of Germany (TAUBE 1766). As early as the 1930s there was only one catchment left in which the FPM had survived with about 50,000 specimens, in the River Lachte and its tributary the River Lutter. (WELLMANN 1938) At the beginning of the 1980s only about 3000 adult mussels were left (DETTMER 1982).

Extensive conservation efforts have been made by artificial attachment of glochidia on to brown trout, both hatchery reared (BISCHOFF & UTERMARK 1976) and also with wild brown trout caught by electrofishing (ALTMÜLLER & DETTMER unpubl.). All these efforts were without success, no young mussels could be found.

Large amounts of mobile sand were suggested as the main reason for the lack of young mussels. The sand was drifting like sand dunes on the bottom of the rivers. These mobile sand masses were observed in changing thickness since 1985 during the annual electrofishing efforts in the River Lutter to catch wild brown trout for the attachment with FPM glochidia. Our assumption was confirmed by the work of BUDDENSIEK (1991).

The conservation efforts for the FPM got an important extension by the Lutterproject in the years 1989–2006 (ABENDROTH 1993, SCHERFOSE et al. 1996). The amount of drifting sand masses could be substantially reduced in the context of this project (ALTMÜLLER & DETTMER 2006). The first shells of young FPM were found in 1997 as a result of these measures (ALTMÜLLER & DETTMER 2000).

The population recovery of the FPM in the River Lutter has been annually monitored by snorkeling since 2000. In 2012 the total estimate of individuals was more than 12,000. Since 2002 no artificial attachment of glochidia onto brown trout were carried out. The glochidia now attach naturally onto the gills of the trout.

The successful reduction of the amount of drifting sand masses was not the end of the nature conservation efforts in the catchment of the River Lutter. Long stretches of the River Lutter were destroyed by excavation in the 1960s and 1970s. Now large quantities of gravel have been reintegrated into the bottom of the river to reconstruct riffles and pools as a basis for rehabilitating the typical biocoenosis of the river. The population density of different fish species rose immediately. This is relatively simple to monitor. The results of the monitoring of the mussel response will take a number of years, as it is carried out without the destruction if the river bed habitat.

SEDIMENT MANAGEMENT ON A RIVER BASIN SCALE TO PRESERVE AND/OR RESTORE FRESHWATER PEARL MUSSELS HABITAT

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Erosion, transport and deposition of sediments are essential for the long term non-linear evolution of river systems. Based on a given sediment continuum various channel patterns develop according to bed slope, discharge and sediment supply. For the amount of sediment supply the geomorphological boundaries are decisive, which has to be related to exposed geology and the weathering of rocks (physical / chemical). Freshwater Pearl mussels streams are only found in crystalline catchments with specific morphological and sedimentological characteristics. Freshwater Pearl mussels streams are frequently characterised by a plane bed morphology with a lack of gravel bars. Moreover, the grain size distribution of bed surface sediments features bi-modal characteristics.

On the one hand coarse bed material is dominating (cobbles), on the other hand finer sediments (sand) are frequently documented for the surface layer composition. Especially the rate of these finer sediments increased (artificially) over the last years causing severe problems in most of the Upper-Austrian river systems, which featured historically high numbers of freshwater pearl mussel stocks. The presented work is dealing with (a) the identification of the trigger processes, why the amount of these sandy materials increased over the last decades and (b) which mitigation measures are possible to preserve and restore the highly endangered freshwater water pearl mussel habitats. Based on hydrodynamic-numerical modelling (one-dimensional / two-dimensional sediment transport modelling) and in-situ studies, these two research questions are addressed. The results show, that especially at the mouth of tributaries the sediment dynamics (amount of transport) slow down in undisturbed systems, due to a partially deposition of the sandy sediments along the banks of brooks and/or small rivers. Moreover, structural features like the placement of boulders, exhibited sediment sorting (deposition of sand in the downstream of the obstructions) especially for high flows with high sediment transport capacity. For determining future river basin management aims, the application of numerical sediment transport modelling delivered high quality data to test various aspects for the restoration of the habitats, especially for issues of sediment composition and self-forming habitats.

CATCHMENT MANAGEMENT OF FRESHWATER PEARL MUSSEL RIVERS IN BAVARIA AND SAXONIA, GERMANY: SURVEYS OF PRESSURES AND MITIGATION MEASURES.

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The freshwater pearl mussel suffers from unfavourable conditions of its habitat all over Europe. Eutrophication, siltation, degraded water quality, impoundments and altered fluvial regimes are considered to be the main causes of the decline of mussel populations. Detrimental sediment and nutrient loading of the rivers is often closely linked with the land-cover and use within the catchment area.

Catchment studies of mussel rivers in Bavaria and Saxonia with the aim to identify hot spots of erosion and pathways of sediments, nutrients and pollutants show that the sources are often distant from the river and material is transported by ditches and channelings. To improve the mussel habitats in the river mitigation actions should to be taken as near to the sources as possible, whereas end-of-pipe measures such as mud collectors in tributaries adjacent to the river most often are of limited efficiency.

Despite the fact that all rivers in cultural landscape of Central Europe face the same detrimental impacts, the significance of the different impairments varies greatly (e.g. erosion from arable land, erosion from forest, sewage deposition). Therefore each restoration project has an individual agenda and it is mandatory to deal with measures in the whole catchment and accordingly with quite a number of stakeholders. Thus, projects need time, stamina and permanent staff.

QUALITITY OF PEARL MUSSEL HABITATS: CRITICAL EXAMINATION OF INDICATORS FOR SILTATION AND CHEMICAL CONDITIONS IN THE SEDIMENT

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Siltation of the sediments of pearl mussel streams and rivers has repeatedly been shown to be a major impairment of the habitat of juvenile pearl mussels. There is strong evidence that silt and sand reduce the exchange of water between the free water body and the sediment, causing oxygen depletion and the suffocation of the juvenile mussels in the sediment. Different methods are used to indicate siltation of the sediment and oxygen supply. In a bachelor thesis at the Department of Hydrology, University of Bayreuth (Braun 2010), the redox probe as used by Geist and Auerswald (2007), iron nails (rust indicator) as introduced by Schmidt and Vandré (2005) and sediment boxes were tested.

The methods were simultaneously on apparently good and unfavourable sites of three pearl mussel rivers. The redox conditions in the sediments were characterized by the chemical analysis of redox species (O_2, NO_3-, Fe_2+, SO_{42}-, CO_2, CH_4) in sediment pore water samples from two different depths in the sediments and compared with the indications by the probe and the nails. The accumulation of silt and sand in sediment boxes, that is boxes filled with cleaned gravel and installed for several weeks in the river bottom, was compared to silt accumulation in freshly cleaned river gravels at the same sites.

The chemical analysis as well as the indicators showed less oxygenated conditions at the unfavourable sites.

More anoxic conditions at greater sediment depths were correctly indicated by the redox probe. Iron nails showed rust formation also at greater depths at one site. The chemical analysis showed SO_{42}- reduction and CH_4 formation in anoxic sediments. The redox probe, however, did not indicate redox potentials typical of these processes. Sediment boxes collected much more silt than stream gravels. Thus, the tested methods for the indication of siltation and oxygen depletion were appropriate for the relative comparison of habitat conditions, but they showed limited value for the absolute prediction of sedimentation and the chemical conditions in the sediment.

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EVIDENCE BASED APPROACH TO THE RESTORATION OF *MARGARITIFERA MARGARITIFERA* HABITATS IN THE CZECH REPUBLIC

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Habitat degradations and land use changes are responsible for *Margaritifera margaritifera* population decline in many central European localities. Particularly the lack of natural recruitment as a result of decreased juvenile survival seems to be the most important process responsible for the population decline. In the Czech Republic, the unfavorable conservation status resulted in the adoption of restoration activities since the 80ies of 20th century.

Decades of *M. margaritifera* conservation produced many empirical findings and suggestions to the catchment management in order to improve juvenile survival, however, only few generalizations can be made regarding the prioritization of conservation actions. As a result, in-situ bioindication methods can be very effective in the preparation and the backward evaluation of conservation actions. This contribution presents the results of large scale bioindication project in Blanice and Vltava River basin (Czech Republic) during 2011 – 2012 that addressed the role of main environmental variables for juvenile growth of *M. margaritifera* and the effects of recent habitat restoration activities.

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BROOK RENOVATION IN BOREAL FOREST AREA – NEW ACTIONS AND EXPERIENCES ABOUT HEADWATERS AND FRESHWATER PEARL MUSSELS

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In Finland, peatland ditching and drainage to increase wood production has affected headwaters at the increasing rate since the 1960s. Nowadays 60–75 % of peatland is drained in for example in River Iijoki basin in northern Finland. Stream inventories in headwaters of River Iijoki with a single-visit method have been made since 1998. Every stream is divided to sections depending on the length and heterogeneity of the stream. Each section is ranked by using about 65 variables to describe channel morphology, hydrophysical habitat types, vegetation and human impact. Every section is evaluated and restoration measures are suggested if needed.

Only 1–2 % of brooks which have been inventored (n= 440) were in natural pristine. The biggest problem in boreal forest streams is sand erosion in dug ditches and sand drifting to the steams. Because of the accumulation of sand, spawning beds for the brown trout, young pearl mussels and wooden debris will get buried. In renovations of these silted up brooks have used wooden material, various deflectors and underminer structures, to collect sand and to allow the power of the flow to dig sand and pile it to advisable places. This way the old bottom, wooden materials and spawning gravel become visible again.

Old pearl mussels were moved to upper part of the brook for the restoring time and they were planted back to the restored area after the first spring flood. At least 20–40 % of the ditching of peatlands has been unprofitable by yielding to increase in wood production, but has – among other things – caused problems to the freshwater pearl mussel. It is necessary to restore these drained peatland areas and upgrade the level of the water protection in the drainage basin of River Iijoki, and other affected catchments.

RIVER RESTORATION, TROUT AND PEARL MUSSEL – RIVER SIIKA-JUUJOKI CASE, LAPLAND

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River Siika-Juujoki: 27 km of river, 144 km^2 of catchment.

Project: 2001 – 2004, restored sections total of 3570 m.

Problems: Clearing and straightening of the river for log floating, building of log floating channels and dams.

Aim: Restore the channel morphology and improve the ecological state. Changing forestry actions in the catchment.

Purpose: To increase trout density. To increase freshwater pearl mussel density.

Results: Trout densities in restored sections have increased markedly. Freshwater earl mussels have invaded the restored sections.

HABITAT RESTORATION MEASURES FOR THE FRESHWATER PEARL MUSSEL *(MARGARITIFERA MARGARITIFERA)* IN THE LOW MOUNTAIN RANGE OF THE ARDENNES IN LUXEMBOURG

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Freshwater mussels belong to the most imperiled animals worldwide. Particularly the long lived species, *Margaritifera margaritifera*; shows a dramatic decline within its distribution area. Many local populations have become extinct or are close to extinction.

Eutrophication and siltation of the river due to anthropogenic changes in the catchment area are the main factors responsible for the non functional populations of *Margaritifera margaritifera* showing little to no recruitment. Propagation programmes can help avoid the complete disappearance of local populations. The only sustainable way to protect a mussel population is to restore the habitat, although this process may last many years.

In order to protect the last existing Freshwater Pearl Mussel population in the river Our in northern Luxembourg (Europe) a LIFE NATURE project commenced in 2005 and finished in August 2011. The aim of theis project was to enhance the declining population by captive breeding and restoring its habitat.

The following habitat restoration measures have been completed within the project:

To reduce the amount of fine sediment entering the river 8 hectares of inappropriate spruce forest was removed. Four hectares of deciduous forest have been planted. To reduce the impact of cattle on the river banks, 2.5 km of fence, ten watering facilities and four cattle bridges were constructed. As the natural transport of gravel in the river system is still disturbed by 3 smaller dams, 500 m^3 of gravel has been added into the river during the past five years. To aid the host fish (brown trout) reaching their spawning grounds; twelve migration obstacles were removed in smaller creeks.

These restoration measures have surely a positive impact on the biota of the river Our and hopefully also on the freshwater pearl mussel population. However with monitoring methods (e.g. electric fishing, redox measurements, water analysis…) it is extremely different to see any obvious results on the short run in the main stream, which has a catchment of about 650 km^2 distributed over three countries. On the other side results of the removing of migration obstacles are fast visible.

Overall, continuous monitoring programs using adequate methods need to established, to demonstrate the effectiveness of different restoration measures.

STRATEGIC IMPROVEMENT OF FRESHWATER PEARL ENVIRONMENT THROUGH CATCHMENT MANAGEMENT: PART 1 ASSESSMENT OF KEY ISSUES IN FRESHWATER PEARL MUSSEL POPULATIONS

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For most rivers supporting populations of *Margaritifera*, the size of the catchment, the scale of the rehabilitation needed, and the cost of measures, mean that prioritization of restoration measures is often inevitable. Therefore, it is imperative to identify the issue(s) causing the greatest problem to a particular *Margaritifera* population so that a focused and most cost-effective rehabilitation strategy can be developed for the population. Whilst all restoration projects are intended to have a positive effect, there is little to be gained from putting all of the effort into silt-trapping, if the greatest problem is velocity and flow.

In Britain and Ireland, most rivers have had surveys to determine the gross distribution and numbers of mussels, subsets of rivers have had more detailed surveys to determine more precisely the small scale distribution and abundance. For some Natura 2000 rivers, information on population structure has been collected, and monitoring programmes have been instigated. However, whilst gathering all of the mussel data is necessary, for effective rehabilitation of *Margaritifera* populations, there is an increasing need to move the focus towards obtaining detailed data on the physical environment at mussel locations. In this paper we explore, using examples from England and Ireland, the information that is needed to identify the principal catchment problems, the means of collecting those data, and present some results of research on substrate condition, redox measurements and flow/velocity.

STRATEGIC IMPROVEMENT OF FRESHWATER PEARL ENVIRONMENT THROUGH CATCHMENT MANAGEMENT: PART 2 CONSERVATION AND REHABILITATION EFFORT AS A RESPONSE TO FRESHWATER PEARL MUSSEL NEEDS

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The decline of *Margaritifera* populations across their range has been severe, but progress has been made in linking the key issues in population decline with land use and catchment function. This presentation addresses how problems that have been highlighted through *Margaritifera* population monitoring can be addressed through a strategic approach to catchment management. Understanding whether loss of population function is due to sediment, flow, or nutrient problems is the first step to effective rehabilitation. A source – pathway – receptor approach is used to target particular problems.

Examples are presented on how rehabilitation efforts can be aided through catchment management plans, what strategies can be used for prioritising efforts, how land use conservation measures can be targeted to population needs, and how ecological targets along with mass loading information should be used instead of targets of water quality parameters.

LIFE PROJECT CONSERVATION OF HABITATS OF PEARL MUSSELS IN BELGIUM

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Life Nature B4-3200/02/8590: Conservation of habitats of Pearl Mussels in Belgium

Budget: 2.322.759 euros (EC co-financing 50 %)

Beneficiary:
Centre de Recherche de la Nature des Forêts et du Bois

Background and aims:
The project aims at the long-term conservation of the last Freshwater Pearl Mussel (FWPM) *Margaritifera margaritifera* populations and their associated habitats in Belgium (Wallonia). This demanding species and conflict species is protected under the Habitat Directive, the Bern Convention and is listed Endangered (IUCN).

Main threats are crushing of the mussels, water quality decline, river bed substratum clogging, host fish population alteration and, as a consequence, lack of young mussel since 50–80 years.

Chronological methodology used was organising workshop, raising awareness to stakeholders and authorities, precise mapping of threats and FWPM populations, studying water quality. Then GIS treatments of the data permitted to define priority to lead actions of habitats restoration and ecological studies.

Before the project, status of FWPM in Belgium was poorly known and there was no taking into account of FWPM presence in strategic decisions for land use management

Results:
First result was the discovery of a new population that was added to the project. Precise mussel population mapping permitted to propose specific measures for Natura 2000 and Water Frame Work Directive implementation.

Black points solving using dialogue, meeting, redacting administrative documents presenting mussels as an "umbrella species" with explanation of the scientific arguments permitted a more autonomous management of the threats by authorities. This also leads to take into account problematics inside and outside Natura 2000 perimeters.

Habitat restoration catalyzed complementary actions not funded by LIFE, like land buying outside Natura 2000 sites, large natural reserve creation, management of private land using contract, spruces clear cutting, installations for free fish circulation,…

Using complementary tools as Agri-Environmental Scheme, other Life/Interreg projects permitted to complete and connect area restored.

Exchanges with other Life/Interreg projects leaded to develop a new strategy to protect FWPM in Belgium.

Conclusions:
Life project was the only solution to start protecting FWPM populations in a very short time and permitted to catalyse restoration inside and outside the N2000 network. There is again a lot of work to do to reach the objectives but comparison between the situation before and after the Life project showed that if we want we can do it! Implementation of the After Life actions will be the key.

THE IMPACT OF SOME MAJOR ANTHROPOGENIC THREATS TO THE FRESHWATER PEARL MUSSEL: LIFE CYCLE STUDIES AND DIFFERENT SCALES

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The freshwater pearl mussel is declining all over its distribution, and in many of the streams where the mussel still exists there is a lack of recruitment of juvenile mussels. To be able to change this pattern, there is a need to understand the causes of the decline before restoration activities can be designed. Here, I summarize some of the reasons for the decline in Sweden from studies I have been involved in. These studies have been conducted to see how the mussels' life cycle stages are impacted by some major anthropogenic threat categories. The studies have been done at different scales, from large scale patterns all over Sweden to micro habitat scales.

THE FRESHWATER PEARL MUSSEL IN SWEDEN – CONSERVATION AT CATCHMENT LEVEL

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A catchment perspective is necessary for the conservation of the Freshwater Pearl Mussel (FPM) *Margaritifera margaritifera* as its stream habitat is three dimensional – longitudinal, lateral, and vertical – and changes all over the catchment may affect. Conservation actions at catchment level includes for example elimination of host fish migration barriers, elimination of sediment load, restoration of water quality (e.g. liming of acidified waters), and protection/r estoration of riparian zones. Of course, also in stream measures are needed, like replacing stones which have been removed from the stream channel or adding dead wood to restore the biotope heterogeneity and the internal dynamic.

LIFE+
MEASURES FOR IMPROVING HABITAT FOR FWPM IN THE ARMORICAN MASSIF

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The LIFE program «Conservation of the freshwater pearl mussel from the Massif armoricain» aims to contribute to the restoration of the freshwater pearl mussel *Margaritifera margaritifera* populations in the west of France. It includes six sites, classified as Special Areas of Conservation (SACs), that are known to be a refuge for the main freshwater pearl mussel populations.

Bretagne Vivante, works with the «Brittany fishing federation» (Fédération de pêche du Finistère) and the «CPIE des Collines normandes». We coordinate a series of initiatives through a LIFE program from 2010 to 2016 to try to save pearl mussels in these 6 rivers. The LIFE programme conducts 26 different actions which could be described in 3 categories.

First, recover a favourable environment is the priority. Many actions are already undertaken on all sites and the LIFE program can't substitute to them (so, these actions are extra-LIFE). We are trying to federate all these actions together and we are trying to yield new projects for habitat conservation or restoration: e.g. to set up fences, riverbank stabilization, control of farms, land acquisition, etc. Different tools can be used: Natura 2000 contracts, river contracts, etc.

Second, while guiding and federating project for restoration of habitat, the LIFE project provide some informations about environment quality for three objectives : first assess the environment in a long time period to characterize FWPM living areas, second to look for favourable habitats for reinforcement of populations and then in order to detect any problem. This survey is conducted in water but also in substrate. Global environment, fish population, black point list, etc. are also assessed and monitored all along the project.

Finally, even if restorations actions are conducted and are trying to solve black points, the mussel population situation in the west of France is considered as critical. That is why a rearing station was built thanks to the LIFE programme. The bred mussels will be re-introduced into their natural environment where and when the environment quality allows for it. In systems where the environment appropriate, we will re-introduce pearl mussel specimens to the natural environment. We will re-introduce pearl mussels from different age classes (from 0 to 4–5 years) by putting them either in contact with the gills of local host-fish or, in some sites, directly into the substrate.