



Project LIFE 14/NAT/IT/000809



The management of
cross-border water bodies:
comparing experiences



Friday 16th November 9.00 a.m.
Cinema-Theater of Tolmin



Project LIFE 14/NAT/IT/000809
Founded by the European LIFE programme



CONFERENCE PROGRAM

The management of cross-border water bodies: comparing experiences

- 9.00 a.m. Registration of participants
- 9.30 a.m. Greetings
- MORNING SESSION**
- 9.45 a.m. “The SillFFE Project - The concrete actions”
(*Dr. Marco Zanetti - Bioprogramm s.c.*)
- 10.15 a.m. “The Fluvial Functionality Index (FFI) and the Fluvial Protection Areas (FPA)”
(*Dr. Maurizio Siligardi - River Ecologist*)
- 10.45 a.m. “Restocking with native fish fauna and fight against alien species”
(*Dr. Barbara Grava Vanin - Treviso District*)
- 11.00 a.m. “Agricultural sector: key role to management and conservation biodiversity”
(*Dr. Lisa Causin - Veneto Region*)
- 11.15 a.m. Coffee break**
- 11.45 a.m. “C2 and C3 actions: environmental redevelopment interventions along the river Sile”
(*Dr. Davide Malavasi - Naturalist and Agronomist*)
- 12.00 p.m. “Ecological situation of the water bodies of Slovenia”
(*Dr. Klavdij Bajc - Institute of the Republic of Slovenia for Nature Conservation*)
- 12.20 p.m. “Economic and social aspects linked to repopulation of endemic fish species in upper Soča”
(*Dr. Miro Kristan - Head of Environment, spatial planning and rural development department at Soča valley development centre and the President of Soča river foundation*)
- 12.40 p.m. “Fisheries management in Slovenia”
(*Dr. Blaž Zidarič - Fisheries research institute of Slovenia - Head of the aquaculture department*)

1.00 p.m.

Lunch time

ARTERNOON SESSION

2.30 p.m.

“PROJECT Life for Lasca: Urgent measure to conserve nearly extinct species *Protochondrostoma genei*”
(*Dr. Marko Rajkovič, Fishery Expert*)

2.50 p.m.

“PROJECT VIPava: Measures for the conservation and improvement of the status of endangered animal species and habitats in the Vipava valley”
(*Dr. Nino Kirbiš, Expert Associate*)

3.10 p.m.

“PROJECT Life Stržen LIFE16 NAT/SI/000708: Improvement of Natura 2000 statuses with renaturation of Stržen’s riverbed on intermittent Cerknica Lake, agricultural management and fisheries management of Cerknica Lake”
(*Dr. Ana Gabrejna - Project coordinator LIFE STRŽEN and Dr. Dejvid Tratnik - Project coordinator KRAS.RE.VITA*)

3.30 p.m.

“The AQUALIFE Project”
(*Dr. Tiziana Di Lorenzo - Research Institute on Terrestrial Ecosystems of the CNR*)

3.50 p.m.

“Integrated hydraulic-environmental restoration of the reclamation channels” - The LIFERINASCE Project (LIFE+13 ENV/IT/000169)”
(*Dr. Aronne Ruffini - Reclamation Consortia of Central Emilia and Eng. Marco Monaci - Marco Monaci srl*)

4.10 p.m.

“Conservation of Adriatic grayling (*Thymallus thymallus aeliani*) in the Soča river catchment”.
(*Dr. Dusan Jensensek - Fish Specialist*)

4.30 p.m.

Coffee break

5.00 p.m.

Panel discussion - “Environmental protection and anthropic activities”
(*Chairman: Dr. Paolo Turin*)

6.00 p.m.

Conference closing

The SILIFFe Project - The concrete actions

Dr. Marco Zanetti

Bioprogramm s.c.

The SILIFFe LIFE 14 / NAT / IT / 000809 project is divided into three phases: “ex ante”, “in itinere” and “ex post”.

The “ex ante” actions provided the programmatic basis for evaluating the subsequent actions of the project. The functionality, the biological quality (A1 and A2 Actions) and the composition of the fish fauna (Action A3) were monitored in 25 stations, distributed on the River Sile and at the confluence of its most important tributaries.

The “in itinere” actions involved the native aquatic fauna (C4 Action), focusing mainly on the reproduction in the natural environment of the lamprey (*Lampetra zanandreae*), the bulhead (*Cottus gobio*) and the italian spring goby (*Knipowitschia punctatissima*). To facilitate the natural reproduction of bullhead and italian spring goby, artificial structures have been placed in the riverbed. The results of the three years of experimentation were flattering: 153 egg masses of *C. gobio* and 231 of *K. punctatissima*. The observation of the lamprey allowed to understand the reproductive strategy and to locate the reproduction area, in order to protect them. Also within C4, a stretch of about 300 meters (about 150 meters for each bank) of the Taglio del Sile, in the area of the Sile river, in the municipality of Vedelago (Treviso) was renatured.

The “ex post” monitoring action (D1 Action), always focused on functionality, biological quality and fishes, allowed to evaluate the actual results of the individual project actions. The purpose of monitoring was to verify the success of the interventions, increasing the knowledge of habitats and native species, with particular attention to those considered to be priority or of conservation interest.

The Fluvial Functionality Index (FFI) and the Fluvial Protection Areas (FPA)

Dr. Maurizio Siligardi

River Ecologist

The riparian zones of the rivers are structural elements recognized as essential in the ecological-functional activity of a river such as a buffer function of nutrients, shading control, sediment trap. The delimitation of suburban areas intended as fluvial protection areas can make a significant contribution to the planning of the territory and represent an important management tool to guarantee the naturalistic and landscape functions of the Sile river basin.

Identification of the Fluvial Protection Areas (FPA)

The definition of the FPA is based on the analysis of the FFI* method (Fluvial Functionality Index) which provides for the drafting of a data sheet with the collection of data concerning vegetation, morphology, habitat and biota. The FFI data are, then, used in the methodology developed in the province of Trento**, that, before applying it, has been calibrated for the territory falling within the boundaries of the Sile Park. The identification and definition of the river protection areas were mainly carried out in three phases:

- a) attribution of the value of the ecological river environment on the basis of the river functionality requirements (FFI);
- b) definition of the amplitude;
- c) graphical representation of ecological river areas

For each river stretch, first of all, it was verified the presence of urbanized areas in the territory surrounding the watercourse, that can prevent any form of intervention on the riparian zone of the watercourse: in this case, is assigned a low ecological river score. If instead, despite the presence of a urbanized area, it is believed that there is the possibility of maintaining and/or restoring a river protection area, then the value of the area may be evaluated as mediocre or high based on the FFI values.

Definition of the FPA river protection areas

Once it has been determined the high value of the riparian zone it is necessary to define the amplitude of this area expressed in meters, adding up different values referring to the distance from the source, slope of the river and of the banks, river width, flood capacity. Once the values to be assigned to the individual parameters have been defined, the amplitude of the high ecological zone is defined; while for the FPA of mediocre value the amplitude is set at 30 meters, and for the low value no amplitude is foreseen.

The examination of these widths for the Sile river, that amount to 327 ha as high, 128 ha as mediocre and 23 km as low, has let us estimate the nutrients buffered by riparian vegetation to be equal to 172.8 tons/year of nitrogen and 6.8 tons/year of phosphorus.

Restocking with native fish fauna and fight against alien species

Dr. Barbara Grava Vanin

Treviso District

The Province of Treviso during the LIFE SIlIFFe project, has carried out actions aimed at the reintroduction of two salmonid species which had disappeared for a long time from the River Sile: the marble trout and the grayling.

Then Province of Treviso carried out activities to control some alien species that represent an increasingly serious threat to this environment, such as the cat-fish (*Silurus glanis*) and the Louisiana crayfish (*Procambarus clarkii*), which have often replaced the original fauna, strongly threatening biodiversity.

Restockings with native salmonids

Action C.4 is aimed at restoring biodiversity and reintroducing native salmonids.

In the period 2016-2018, the restockings of the river Sile and its tributaries were carried out annually with n° 20.000 specimens of marble trout from the Piave stock (Lt. 4-6 cm) and n° 6.000 specimens of grayling from the Adriatic stock (Lt. 9-12 cm). In a renaturalized stretch of the river Sile, artificial spawning areas were created, consisting of coarse substrates and current deflectors, in order to recreate the characteristics suitable to host these two salmonid species.

Control of alien species: sheat-fish and Louisiana crayfish

Actions C.5 and C.6 are aimed at one of the most important environmental problems of recent years, the spread of invasive alien species. The activities were addressed to the monitoring and control of two species considered to be among the most invasive for our waters, *Silurus glanis* and *Procambarus clarkii*, also called “killer crayfish”.

Control of the *Silurus glanis*

The containment and eradication activities of *Silurus glanis* were carried out with electrofishing and with trammel nets and in the low course of the river Sile and some of its tributaries. The cat-fish is present with structured and reproducing populations. The tributaries represent nursery areas, while the main course of the Sile is a habitat for large specimens. The interventions led to the capture of n. 1217 specimens in the 2016-2018 period. The captured animals have been ethically suppressed.

Control of the Louisiana crayfish

In the last years, numerous discoveries of alien crayfish species have been recorded in Italian inland waters (NICS - Non Indigenous Crayfish Species), this represents a threat to native crayfish species. The intervention on N.I.C.S. species was carried out through net-traps and electrofishing. The investigations were carried out in late spring and early autumn, in the period 2016 - 2018 and have highlighted the total absence of the native species, *A. pallipes*, and the consistent presence of a single alien species, *Procambarus clarkii*, around 9,303 specimens were captured.

Agricultural sector: key role to management and conservation biodiversity

Dr. Lisa Causin

Veneto Region

From the analysis of the studies carried out by the Sile River Regional Park in the organization of the management plans of the Natura 2000 areas and then used for the definition of the Conservation Measures for the Special Areas of Conservation (SACs), it is noted that agricultural activity has a direct influence: in the western part of Treviso for an area of approximately 77.3% of the total, reduced to 17.8% in the eastern part.

The surfaces involved in the agricultural activity are therefore about 1,100 hectares: it is mostly arable land, for the production of cereals and oleaginous crops, and horticultural vegetables such as asparagus, in the case of loose soil, and radicchio. In the Project area, precise impacts related to agricultural activity are easily detectable, such as:

- Extension of land tillage to the margins of wetlands with progressive burial of the existing spring waters;
- Modifications of hydraulic arrangements for the soil drainage and of small wetlands and besides spring waters;
- Elimination of buffer zones and hedges along the plots of land, along the river and the ditches;
- Disturbance of wildlife;
- Dispersion of chemical fertilizers and phytosanitary products.

The latter is a particularly critical point which, in the Project, was later confirmed by the biological analysis carried out, as already described in the chapter about the biological mapping. These elements and the possible impacts indicated above make it very clear how important and meaningful is a careful management of the agricultural activity and how much agriculture is and can become an important element for the preservation and enhancement of biodiversity. Therefore, within the SillFFe Project a dedicated action was identified, named action C9, in order to involve farmers and promote agri-environmental measures with in the Rural development programme (RDP) 2014-2020.

C2 and C3 actions: environmental redevelopment interventions along the river Sile

Dr. Davide Malavasi

Naturalist and Agronomist

C2 and C3 Actions deal with the restoration of the hydrogeological equilibrium and of riparian habitats in seven areas located along the river Sile: the project, therefore, concerns the restoration of some springs and the forest habitat restoration in some areas through the recreation of high conservation priority habitats: the project carried out shows a remarkable demonstrative value in the area of the Parco del Sile.

The project in the springs therefore concerned about the excavation of the ground, and the creation of a small drainage channel, while at Sant'Elena site some new wetlands have been created.

In five areas more than 5,000 seedlings of many tree and shrub species have been planted, in order to restore the 91E0* habitat "Alluvial forests of *Alnus glutinosa* and *Fraxinus excelsior*" (*Alno-Padion*, *Salicion albae*).

In order to increase saproxylic animals and microhabitat for biodiversity in some areas the project carried out digging new holes in dead and degraded wood.

Furthermore, in four areas, 30 bird nest boxes and 20 nest boxes for tree bats were installed.

Ecological situation of the water bodies of Slovenia

Dr. Klavdij Bajc

Institute of the Republic of Slovenia for Nature Conservation

The presentation presents the system of protection of the Soča river, with an emphasis on Natura 2000 areas, river habitats and fish species. The Soča river is considered one of the most beautiful alpine rivers and the most attractive river in Slovenia. Due to its geomorphological, hydrological, zoological and other characteristics, it is protected on many levels: as a natural monument, as a natural value, as an ecologically important area and as a Natura 2000 site.

Within the Natura 2000 site we are protecting many species in the Soča river. Some of them are fish species such as the *marble trout* (*Salmo marmoratus*), the *souffia* (*Leuciscus souffia*), the *Italian barbel* (*Barbus plebejus*) and the *European bullhead* (*Cottus gobio*), the *white-clawed crayfish* (*Austropotamobius pallipes*), and some alpine rivers habitats, for example Alpine rivers and woody vegetation with Eleagnus willow (*Salix eleagnos*) along their banks.

The protection objectives of the Natura 2000 site are defined in the Natura 2000 Site Management Program (2015-2020). The protection objectives of the protected area and the preservation of the protected features of the river are achieved primarily through the incorporation of nature conservation guidelines in the certification procedures for fishing and water management programs, through expert opinions in processes for acquiring nature protection consents and permits for interventions in the natural areas, on the level of expert opinions and through permanent communication with stakeholders, especially with representatives of local communities.

Economic and social aspects linked to repopulation of endemic fish species in upper Soča

Dr. Miro Kristan

Head of Environment, spatial planning and rural development department at Soca valley development centre and the President of Soca river foundation

From the ecological point of view repopulation of *Marble trout* and *Adriatic grayling* have been and are one of the main fish species related challenges within the upper part of the Soča catchment.

The same area is also a place of many other legitimate economic interests and potential conflicts linked to different water uses. In addition to the repopulation process there have been many initiatives to bring different stakeholders together for a contemporary Soča river with its tributaries.

Therefore it is very important to find balance and to face all possible scenarios in advance. One to mention is the process that led to the establishment of the Soča river foundation. Its main aim is to guarantee sustainable development by building of the participatory process linked to the river management. In addition the overall idea related to repopulation is also to find synergies with profit making and dependent subsectors such as aquaculture and tourism (angling) to sustain the process both for a better state of the ecosystems and positioning on the market or branding (Bridges project).

Fisheries management in Slovenia

Dr. Blaž Zidarič

Fisheries research institute of Slovenia - Head of the aquaculture department

The presentation presents the system of protection of the Soča river, with an emphasis on Natura 2000 areas, river habitats and fish species. The Soča river is considered one of the most beautiful alpine rivers and the most attractive river in Slovenia. Due to its geomorphological, hydrological, zoological and other characteristics, it is protected on many levels: as a natural monument, as a natural value, as an ecologically important area and as a Natura 2000 site.

Within the Natura 2000 site we are protecting many species in the Soča river. Some of them are fish species such as the *marble trout* (*Salmo marmoratus*), the *souffia* (*Leuciscus souffia*), the *Italian barbel* (*Barbus plebejus*) and the *European bullhead* (*Cottus gobio*), the *white-clawed crayfish* (*Austropotamobius pallipes*), and some alpine rivers habitats, for example Alpine rivers and woody vegetation with Eleagnus willow (*Salix eleagnos*) along their banks.

The protection objectives of the Natura 2000 site are defined in the Natura 2000 Site Management Program (2015-2020). The protection objectives of the protected area and the preservation of the protected features of the river are achieved primarily through the incorporation of nature conservation guidelines in the certification procedures for fishing and water management programs, through expert opinions in processes for acquiring nature protection consents and permits for interventions in the natural areas, on the level of expert opinions and through permanent communication with stakeholders, especially with representatives of local communities.

PROJECT Life for Lasca: Urgent measure to conserve nearly extinct species *Protochondrostoma genei*

Dr. Marko Rajkovič

Fishery Expert

Aim of the project is to conserve extremely endangered fish species Lasca and thus to prevent its extinction. We will develop a Management plan for the species, which will include breeding in captivity, threats reduction and the species reinforcement in the wild.

Lasca (*Protochondrostoma genei*) is a freshwater cyprinid fish species, commonly named South European Nase. It inhabits northern Italy and western Slovenia. Its populations are in drastic decline. In Slovenia Lasca remained in Reka river basin in Goriška Brda area, where the population counts only a few 100 specimens. The main reason for Lasca populations decline is its prime competitor Common Nase (*Chondrostoma nasus*). This non-indigenous species caused extinction of Lasca in Vipava river basin (Natura 2000 site), since both species compete for the same habitat. This is why it is highly important to depress the non-indigenous species populations, before Lasca is released in the wild.

Currently, other threats to Lasca are not well researched. We hope that during the project more data on threats will be revealed. However, common threats to fishery conservations such as habitat degradation, water extraction and pollution are not to be excluded.

PROJECT VIPava: Measures for the conservation and improvement of the status of endangered animal species and habitats in the Vipava valley

Dr. Nino Kirbiš

Expert Associate

The project VIPava aims to improve the status of some endangered animal species and their habitats in the Vipava valley area. We will present only measures for species that are bound to aquatic habitats.

The river Vipava was greatly changed during the flood safety regulation works carried out on the river in the 1980s. During the project, we plan to restore freshwater habitats for these endangered species: *Italian agile frog* (*Rana latastei*), *Italian crested newt* (*Triturus carnifex*), *Yellow-bellied toad* (*Bombina variegata*), *European otter* (*Lutra lutra*) and *European pond turtle* (*Emys orbicularis*).

The habitat of the amphibians will be restored by improving the water flow through the meander in Brje. New ponds will also be created to provide spawn habitat. The status of the European otter will be improved by improving its feeding habitat. We will restore an old side channel in Dolenje that was filled up with material after the regulation works. The new channel will provide habitat for fry and juvenile fish. Four artificial barriers impassable for fish will be redesigned so that they will enable fish migration. Invasive species of freshwater turtles (mostly pond sliders (*Trachemys scripta*)) will be removed from the environment to improve the habitat for the European pond turtle. The project will last till 2021.

PROJECT Life Stržen LIFE16 NAT/SI/000708: Improvement of Natura 2000 statuses with renaturation of Stržen's riverbed on intermittent Cerknica Lake, agricultural management and fisheries management of Cerknica Lake

Dr. Ana Gabrejna - Project coordinator LIFE STRŽEN

Dr. Dejvid Tratnik - Project coordinator KRAS.RE.VITA

The project VIPava aims to improve the status of some endangered animal species and their habitats in the Vipava valley area. We will present only measures for species that are bound to aquatic habitats.

The river Vipava was greatly changed during the flood safety regulation works carried out on the river in the 1980s. During the project, we plan to restore freshwater habitats for these endangered species: *Italian agile frog* (*Rana latastei*), *Italian crested newt* (*Triturus carnifex*), *Yellow-bellied toad* (*Bombina variegata*), *European otter* (*Lutra lutra*) and *European pond turtle* (*Emys orbicularis*).

The habitat of the amphibians will be restored by improving the water flow through the meander in Brje. New ponds will also be created to provide spawn habitat. The status of the European otter will be improved by improving its feeding habitat. We will restore an old side channel in Dolenje that was filled up with material after the regulation works. The new channel will provide habitat for fry and juvenile fish. Four artificial barriers impassable for fish will be redesigned so that they will enable fish migration. Invasive species of freshwater turtles (mostly pond sliders (*Trachemys scripta*)) will be removed from the environment to improve the habitat for the European pond turtle. The project will last till 2021.

The AQUALIFE Project

Dr. Tiziana Di Lorenzo

Research Institute on Terrestrial Ecosystems of the CNR

Il progetto AQUALIFE (LIFE11BIO/ IT/ 231) è stato cofinanziato dall'Unione Europea nell'ambito del programma LIFE. Il progetto è stato sviluppato da tre beneficiari: il Parco Nazionale del Gran Sasso e Monti della Laga (primo beneficiario), l'Università dell'Aquila (partner e coordinatore scientifico) e la Regione Abruzzo (partner). Il progetto, iniziato a settembre 2013 e terminato nell'agosto 2018, è stato cofinanziato da Enel Produzione SpA, una società italiana che opera nel settore della produzione di energia elettrica.

Gli obiettivi principali del progetto AQUALIFE sono stati:

- 1) disseminazione di informazioni ai cittadini, alle parti interessate, agli utenti finali, sugli ecosistemi dipendenti dalle acque sotterranee (Groundwater Dependent Ecosystems - GDE);
- 2) selezione di una rete eterogenea di siti di monitoraggio in vari GDE nell'area pilota del progetto (regione Abruzzo, Italia);
- 3) creazione di metodi semplici ma innovativi per valutare il valore di conservazione dei GDE e il rischio ecologico a cui essi sono esposti a causa di attività antropiche quali il sovrasfruttamento delle acque sotterranee, l'inquinamento, le alterazioni morfologiche della zona iporreica (es. clogging, scomparsa delle sequenze buche/raschi, disconnessione dei fiumi dalle falde acquifere sottostanti e così via).

Le acque sotterranee determinano lo stato qualitativo e quantitativo dei GDE. È necessaria pertanto una gestione integrata delle acque sotterranee e superficiali al fine di fornire un'adeguata protezione di queste risorse idriche. Tra i diversi tipi di GDE conosciuti in tutto il mondo, il progetto AQUALIFE ha selezionato tre tipi di GDE principali:

- 1) le falde acquifere porose;
- 2) le sorgenti alimentate dalle falde acquifere;
- 3) la zona iporreica di corsi d'acqua e fiumi.

Gli ultimi due tipi di GDE sono inclusi anche nel Documento Tecnico CIS n. 9/2015 della Comunità Europea sugli ecosistemi acquatici associati alle acque sotterranee (GWAAES). Sfortunatamente i GDE per eccellenza, gli acquiferi, sono espressamente esclusi dal Documento Tecnico.

Il prodotto fisico del progetto è il software AQUALIFE, gratuito e di facile utilizzo. Il software già include le principali pressioni alle quali i GDE sono sottoposti in Europa, in modo da facilitare l'uso da parte degli utenti finali e delle parti interessate. Il software fornisce informazioni sullo stato ecologico dei GDE in tutta Europa, ma può essere utilizzato anche in paesi extraeuropei.

Integrated hydraulic-environmental restoration of the reclamation channels” - The LIFERINASCE Project (LIFE+13 ENV/IT/000169)

Dr. Aronne Ruffini - Reclamation Consortia of Central Emilia

Eng. Marco Monaci - Marco Monaci srl

Traditionally, flood risk management was based on accelerating the flow of water downstream. At the same time, the riverbeds have been confined within a space of dimensions as reduced as possible. The measures typically adopted in this regard have been riverbank construction, grinding and canalisation of riverbeds, or even their total coverage, excavation of sediments and vegetation removal.

The strategy adopted shows now some limits, especially in the light of the increasing frequency of extreme rainfall phenomena and the consequent increase of flooding risk, as well as the huge costs required for periodic maintenance of the defense infrastructural system.

The Project LIFE RINASCE (LIFE+13 ENV/IT/000169, <http://ambiente.regione.emilia-romagna.it/life-rinasce>), approved in July 2014, addresses the aforementioned problematic to demonstrate that the key concepts of the Water Directive 2000/60/EC and the Floods one 2007/60/EC in relation to the need of reducing floods risk and at the same time to improve the ecological state of waterways by restoring their space, can be also applied to the artificial water network managed by reclamation consortia.

The project, with a total value of € 2.076.390, is coordinated by the Consorzio di Bonifica dell'Emilia Centrale (Reclamation Consortium of Central Emilia) in cooperation with Emilia-Romagna Region.

RINASCE has allowed to realize 4 interventions of hydraulic-environmental restoration of a corresponding number of channels, for a total of about 7 km, through the realization of 3 hectares of floodable naturalistic plains along the canals, banks forestation for about 7 km and the realization of a naturalistic expansion cage for floods accumulation for an extension of about 3 hectares.

Conservation of Adriatic grayling (*Thymallus thymallus aeliani*) in the Soča river catchment

Dr. Dusan Jensek

Fish Specialist

Adriatic grayling in the Soča river catchment was severely introgressed due to the intense stocking of grayling from neighbour Danubian catchment in Slovenia which contains Danubian southern Alps lineage of European grayling. Two things were needed for its successful conservation, first the artificial propagation with the use of broodstock kept in captivity and the second, a way of genetic determination and selection of remaining Adriatic genes in the wild population.

Tolmin Angling Association built two rearing facilities, the Modrej hatchery and Tolminka fish farm which were together with dedicated work of fish farmers the base for successful artificial propagation. Cooperation with the genetic laboratory of Department for Animal science Biotechnical University, University of Ljubljana provided needed genetic analyses. Cooperation with Department of Aquaculture of University Szent Istvan University Godollo provided the sperm cryopreservation work needed for introduction of wild grayling genes into each cohort of grayling broodstock.