



NoWPaS's coming home it's coming home it's coming...

**Trondheim, Norway**

**March 22nd – 25th 2012**

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# Sessions and detailed schedule

## Wednesday 21 March Committee meeting and arrivals

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Time	Activity
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17:00-18:00	Committee meeting (Michael, Monica, Petra and Roser)
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18:30	Dinner keynote speakers and Committee members
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21:00	<b>Ice breaker at Den Gode Nabo</b>
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*Please note that it is possible to have dinner at Den Gode Nabo and it is a very convenient option for gathering beforehand. A table will be booked from 19:00 - ask for NoWPaS booking!*

## Thursday 22 March NoWPaS day 1; Excursion

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Time	Activity
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08:00	<b>Coach departs from Trondheim Courthouse (Tinghus)</b>
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08:50	<b>Arrival at Lundamo</b>
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09:00	<b>Lundesokna river field visit</b>
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10:00	<b>Coach departs Lundamo</b>
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11:30	<b>Arrival at Haukvik gene bank</b>
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11:30	<b>CEDREN presentation</b>
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11:45	<b>Lunch</b>
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12:15	<b>Gene bank visit</b>
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14:00	<b>Coach departs Haukvik gene bank (30 minute stop at Orkanger for shopping)</b>
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17:30	<b>Arrival at Sletvik</b>
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18:00	<b>Dinner</b>
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Social activities

**Friday 23 March**  
**NoWPaS day 2**

<b>Time</b>	<b>Activity</b>
08:30	<b>Breakfast</b>
09:00	<b>Opening</b> - NoWPaS Committee
09:10	<b>Invited speaker</b> – SOFIA CONSUEGRA
10:00	Break
10:10	<b>Session I – Genetics and Populations – Chair Petra Rodewald</b>
	<b>Charles Ikediashi</b> – <i>The assignment of Atlantic salmon found in the River Mersey and future work (probably!)</i>
	<b>Jordi Gil</b> – <i>Mechanisms in intra-specific reproductive isolation in brown trout (Salmo trutta L.) between Mediterranean and Atlantic lineages</i>
10:50	Coffee break
11:10	<b>Session II – Genetics and Evolution – Chair Petra Rodewald</b>
	<b>Siim Kahar</b> – <i>Evolution in action – natural selection on physiological and morphological traits of Atlantic salmon in multiple natural environments</i>
	<b>Elgan John</b> – <i>Disentangling the roles of fisheries and the environment on the evolution of exploited Atlantic salmon populations</i>
	<b>Monica F. Solberg</b> – <i>Domestication-mediated changes in growth reaction norms of Atlantic salmon Salmo salar L.</i>
12:10	<b>Lunch</b>
13:10	<b>Invited speaker</b> – SIGURD EINUM
14:00	Break
14:10	<b>Session I – Behaviour - Chair Roser Casas-Mulet</b>
	<b>Zoé Gauthey</b> – <i>Evolution of reproductive system in Salmo trutta</i>
	<b>Petra Rodewald</b> – <i>To eat or what to eat – Does enriched rearing influence foraging under predation risk of Atlantic salmon parr?</i>
	<b>Carole-Anne Gillis</b> – <i>Stable isotopes to evaluate bottom-up effects of the mat-forming diatom Didymosphenia geminata on Salmo salar food web dynamics</i>
17:00	<b>Dinner</b>
	Social activities

**Saturday 24 March**  
**NoWPaS day 3**

<b>Time</b>	<b>Activity</b>
08:30	<b>Breakfast</b>
09:00	<b>Opening</b> – NoWPaS Committee
09:10	<b>Invited Speaker</b> – FRANCISCO MARTINEZ-CAPEL
10:00	Break
10:10	<b>Session III – Environment and Habitat – Chair Monica F. Solberg</b>  <b>Paolo Vezza</b> – <i>Mesohabitat suitability modeling for the conservation of endemic salmonids in the Mediterranean area</i>  <b>Juan Diego Alcaraz-Hernández</b> – <i>Relations between brown trout density and mesohabitat characteristics by means of generalized additive models (GAMs)</i>
10:50	Coffee break
11:10	<b>Session IV – Hydropower – Chair Monica F. Solberg</b>  <b>Roser Casas-Mulet</b> – <i>Linking hyporheic interactions with salmon egg survival in hydropeaking scenarios</i>  <b>Michael Puffer</b> – <i>Spatial habitat selection of Atlantic salmon (<i>Salmo salar</i> L.) YOY</i>
12:10	<b>Lunch</b>
13:10	<b>Invited speaker</b> – NIELS JEPSEN
14:00	Coffee Break
14:10	<b>Session II – Migration and Conservation- Chair Michael Puffer</b>  <b>Johnny Norrgård</b> – <i>Multiplicative loss of landlocked <i>Salmo salar</i> L. smolts during downstream migration through multiple dams</i>  <b>Rebecca Stringwell</b> – <i>Using reconditioned kelts in Atlantic salmon conservation projects: the importance of maternal effects</i>  <b>Lovisa Wennerström</b> – <i>Stopping compensatory release of salmon in the Baltic Sea – Good or bad for the salmon gene pools</i>
15:10	<b>Group discussion – the planning of next year’s NoWPaS</b>
17:00	<b>Dinner</b>

Social activities

**Sunday 20 March**  
**NoWPaS day 4**

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<b>Time</b>	<b>Activity</b>
09:00	<b>Breakfast</b>
10:00	<b>Coach departs Sletvik</b>
12:00	<b>Stop at Trondheim</b>
13:00	<b>Stop at Værnes airport</b>

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# Preface

## **NoWPaS – International (formerly Nordic) Workshop for PhD and post-doctoral fellows on anadromous *Salmo salar* and *Salmo trutta* research**

During the last few decades, research on *Salmo salar* L. and *Salmo trutta* L. has increased and will most likely intensify in the future. Research conducted by PhD and post-doctoral students will play an important and central role in the advancement of our knowledge of these ecologically and socially important species. In order to maximize the research quality of PhD studies, NoWPaS (Nordic Workshop for PhD students on *Salmo salar* and *Salmo trutta* research) was established in 2005 with the aim of building an international network to promote collaboration and the exchange of knowledge. The previous workshops have been held in Norway, Sweden, Finland, Denmark, England, Scotland and France in 2005-2011. In total, more than 200 young researchers have given oral presentations combined with extended lectures by invited speakers on each workshop. Previous key-note speakers have been Sigurd Einum (NTNU, Norway), Eva Thorstad (NINA, Norway), Tormod Skei (Statkraft Norge), Neil Metcalfe (Glasgow University, Scotland), Torgny Bohlin (University of Gothenburg, Sweden), Rick Cunjak (New Brunswick University, Canada), Ari Huusko (Finnish Game and Fisheries Research Institute, Finland), Malcolm Elliott (Freshwater Biological Association, England), John Armstrong (Fisheries Research Services Freshwater Laboratory, Scotland), Michael M. Hansen (DTU, National Institute of Aquatic Resources, Denmark), Berton Lee Lamb (US Geological Survey, USA), Jan Heggenes (Telemark University College, Norway), Brian Shields (Environment Agency, England), David Sear (University of Southampton, England), Thom Hardy (Utah Water Research Laboratory, USA), Ken Bovee (US Geological Survey, USA), Mike Dunbar (Centre for Ecology and Hydrology, England), Clive Trueman (University of Southampton, England), Alan Youngson and Iain Malcolm (Marine Scotland, Freshwater Laboratory, Scotland), Phil Roni (Northwest Fisheries Science Centre, Seattle, USA), Ken Whelan (Irish Marine Institute, The Atlantic salmon trust and University College Dublin, Ireland), Tom Cross (University College Cork, Scotland), Jacques Labonne (UMR ECOBIOP INRA (Institute National de la Recherche Agronomique)/ UPPA (Université de Pau et des Pays de l'Adour, France), Jaakko Erkinaro (Finnish Game and Fisheries Institute, Finland) and John Reynolds from Simon Fraser University, Canada. This year's workshop will be held in Trondheim, Norway, returning to its origin and we are delighted to have as our keynote speakers Sofia Consuegra (IBERS, Aberystwyth University, Wales), Sigurd Einum ((NTNU/NINA, Norway), Fransisco Martínez Capel (University of Valencia, Spain) and Niels Jepsen (DTU, Technical University of Denmark).

The objectives of the network are twofold: Firstly, we wish to arrange an annual independent workshop where the participants can gather, exchange knowledge and ideas, and hold discussions in an interdisciplinary forum. Secondly, we wish to invite key researchers to give lectures and short courses within the field. Through this framework, we intend this workshop to be mutually beneficial to all delegates and therefore help promote research. The delegates of this

workshop are the future experts within this field of research. Therefore it is very important that these young scientists establish connections, with thoughts of future collaboration in mind, within an international environment. As an overview, the workshops will have the following main objectives; *i*) Participating doctoral and post-doctoral students shall present the results of their research. In this way, they will have the opportunity to receive feedback on their own work and to be informed of the work of fellow delegates as well as developments within the field; *ii*) Senior scientists within the field will be invited to present talks on their work and highlight areas where future research is required; *iii*) The homepage ([www.nowpas.eu](http://www.nowpas.eu)) is to be improved so that publications and information on international conferences, workshops etc. can be easily accessed. This homepage will therefore act as an information centre.

# Acknowledgements

NoWPaS-2012 has primarily been based on voluntary work by the steering committee. It is not possible to put into words the effort they have put into this network. Their contribution and quality of work have been tremendous and of vital importance. On behalf of the committee great thanks goes to first of all the participants and their contributions which make the basis for this network; without them this would of course not be possible. Further, thanks go to key-note speakers for their oral presentations, and for giving up their time to participate and interact with the network.

One of the main principles of this workshop is that it is free to attend for all participants presenting their results (keynote speakers included). Transport costs are covered for the invited scientists and subsidized for the majority of participants (depending on the final budget). This principle would not be possible without the generous support of all our investors, shown below



# Organizing committee 2012

**The organizing committee of NoWPaS-2012 has consisted of the following people:**

- Roser Casas-Mulet, NTNU, Norway
- Michael Puffer, NTNU, Norway
- Petra Rodewald, University of Helsinki, Finland
- Monica F. Solberg, Institute of Marine Research/University of Bergen, Norway
- Ciar O´Toole, University College Cork, Ireland

## **Web administrator**

- Dave McCormick (Ir)

## **Associate committee**

- Morten Stickler (No)
- Pauliina Louhi (Fi)
- Kirsten MacKenzie (UK)

## Plenary talks summaries

### ***THE SALMON CONQUISTADOR: GENETIC VARIATION AND COLONISATIONS IN THE OLD AND NEW WORLDS***

Dr. Sofia Consuegra

The current distribution of salmonids in Europe has been largely shaped by the effects of the Last Glacial Maximum (LGM). Thus, around 20,000 years ago much of the salmonids range was covered by ice and many of the present populations, particularly at the Northern edge of the distribution, were recolonised from Southern refugia. The signature of post-LGM colonisers can still be seen in the distribution of genetic diversity of extant populations, particularly in the mtDNA. However, the abundance and genetic structuring of current salmonid populations is rapidly changing by the effects of more recent influences, such as selective exploitation, habitat loss, disease outbreaks and climate change, leaving a complex genetic signature in neutral and adaptive variation. More recently, salmonids have begun a second, more extreme colonisation adventure, this time out of their natural range, in South America. However, this time colonisation has not been a natural event but primarily the result of farmed fish escaping from the ever expanding salmon industry. Not all salmonid species introduced in this way are displaying the same ability to adapt and become established in the wild outside their natural range. Some species - like rainbow trout - are flourishing in the New World, while others - like Atlantic salmon, are not. Understanding the genetic basis of salmonid invasion successes and failures can give us an insight into the differences between natural colonisation and human-mediated introductions, and thus help us better predict and mitigate the potential impacts of salmonid invaders.

***SEX, SPACE AND DENSITY DEPENDENCE: WHY NON-  
SPATIAL APPROACHES MAY (SOMETIMES) BE  
INNAPPROPRIATE FOR MODELING HABITAT EFFECTS ON  
POPULATIONS***

Prof. Sigurd Einum

Habitat models are commonly used in management of wild populations, either to explain current population trends or to predict future responses to habitat changes. The simplest approach to this problem is to quantify the total amount of habitat resources available, and to assume that this will be more or less proportionally related to the population's carrying capacity. However, this approach neglects the effect that the spatial structuring of habitat resources can have on population dynamics. For many organisms, resources required for reproduction and early life stages are particularly patchily distributed, and in this presentation I will summarize how and why effects of this can be important for understanding population dynamics in general, as well as for shaping habitat management decisions. Using case studies from Atlantic salmon, I will show how the spatial distribution of breeding is a temporally stable characteristic that is unique and different among populations, and that these distributions will have major impacts on the resulting spatial distributions of the resulting juveniles and the potential utilization of suitable habitat for these. Furthermore, because juvenile competitive effects occur over surprisingly fine local spatial scales, the resulting heterogeneity in juvenile densities have pronounced effects on diet, growth rates and survival. There is also evidence for both direct and time-lagged density dependence in the spatial distribution of breeders, and this is predicted to translate into reduced population growth rates compared to predictions based on non-spatial models. The complications introduced into habitat management by such processes are likely of importance for a wide range of organisms, perhaps particularly for organisms that reproduce in a spatially heterogeneous manner, that have strong resource competition during early life stages, and that have limited offspring mobility.

# ***HABITAT SUITABILITY MODELING AT MESO-SCALE IN THE TURIA AND JUCAR RIVER BASINS***

Dr. Francisco Martínez-Capel

In freshwater ecology, the first approach to model habitat suitability was developed at the microhabitat scale, based on the link between hydraulic variables (to be measured or simulated) and their suitability for freshwater fish. The hydraulic simulation provided the capability of prediction, i.e. to evaluate habitat suitability at different flows; but, on the other hand, the models reliability was frequently limited by the small extent of the analyzed river reaches. The IFIM, as well as the Habitat Evaluation Procedures, provided a scheme of work to evaluate microhabitat suitability and to weight such evaluation at a “macrohabitat” scale, considering mainly water temperature and quality. In the past 2 decades, one can observe new developments of habitat simulation methods at the mesohabitat scale. Some of these methods rely on “classic” classifications by Hydro-morphological Units (HMUs); other apply different classifications more related to landscape ecology, by gathering microhabitat types at the meso-scale.

In the Jucar River Basin (Eastern Spain) it was applied a stratified method for sampling fish populations, targeting at brown trout (2003-2006). It was adapted from the visual method, well known in the USA as Hankin & Reeves method, at some stage called BVET. In the frame of a PhD thesis and technical support for the environmental administration, one of our objectives was to link the fish abundance with habitat features at the scale of HMUs. A review of the methods and results will be presented, including the characterization of HMUs and their relations with trout, using different statistical techniques. The current work in the Cabriel River will also be presented; this meso-scale study comprises a 3-year database of habitat-fish community which offers new perspectives for the habitat suitability modeling. In this river, the habitat was evaluated based on HMUs in an experimental study, focusing on the environmental flows for the endangered Jucar nase (Costa et al., River Research and Applications). Furthermore, this presentation aims to stimulate a debate about the range of possibilities for the habitat suitability modelling and the habitat simulation at the scale of ecologically-significant hydromorphological units.

***TELEMETRY – EVALUATION OF TAGGING METHODS AND  
EXAMPLES OF HOW MANAGEMENT WAS IMPROVED  
DIRECTLY THROUGH RESULTS FROM TELEMETRY STUDIES***

Dr. Niels Jepsen

When using telemetry to study fish behavior and performance, the assumption of lack of adverse effects of handling and tagging is crucial. Despite of this, only few studies have dealt with testing this assumption in detail. In this presentation I will share results and conclusions from a number of previous and recent studies aiming at evaluating the effects of what we put our poor experimental fish through. In addition, I want to share with you some cases where results from telemetry studies have played an important role in management successes in Denmark. This will include restoration of nearly extinct salmon populations, improvement of sea-trout migrations and adaptive cormorant management.

# Abstracts

## THE ASSIGNMENT OF ATLANTIC SALMON FOUND IN THE RIVER MERSEY AND FUTURE WORK (PROBABLY!)

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**Key words:** genetic assignment, microsatellite DNA, Mersey, Historic DNA

### **Abstract:**

After the Industrial Revolution, extensive polluting of the river Mersey in northwest England led to the extirpation of Atlantic salmon by the 1950s. After an extensive restoration programme, which began in the 1970s, the first salmon in decades was caught by the Environment Agency in 2001. We genotyped, at 14 microsatellite loci, 138 adult and one juvenile salmon caught within the Mersey between 2001 and 2011. Using genetic assignment methods and a recently compiled microsatellite baseline, this study identifies their probable regions of origin. The adult salmon appear to have multiple source regions, but the greatest proportion (45-60%) assign to the region just north of the Mersey, including the Solway Firth and northwest England. Rivers in east Scotland, followed by rivers in Wales and southwest England are the next biggest contributors. The results suggest that salmon are more likely to stray southwards down into the Mersey, than northward, which we speculate to be due to a clockwise gyre in the Western Irish Sea. Surprisingly, three salmon assign to rivers in France and a similar number assign to rivers in Northern Ireland. The juvenile assigns to the Solway and northwest England region. I will also update on my plans and progress in identifying changes in population structure and effective population size in rivers across Europe.

# MECHANISMS IN INTRA-SPECIFIC REPRODUCTIVE ISOLATION IN BROWN TROUT (*SALMO TRUTTA* L.) BETWEEN MEDITERRANEAN AND ATLANTIC LINEAGES

Jordi Gil<sup>1</sup>, A. Caudron<sup>1,2</sup> and J. Labonne<sup>2</sup>

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**Keywords:** native brown trout, reproductive isolation, sexual selection, conservation, demogenetic model.

## Abstract:

The natural distribution area of the brown trout (*Salmo trutta*, L.) in the French water system reveals the existence of two genetically distinct lineages; the Mediterranean lineage present in the Mediterranean drainage basin and the Atlantic lineage on the Atlantic side. Native Mediterranean populations are threatened by a century of stocking using domestic trout belonging to the Atlantic lineage. The spatial distribution of the admixture degree between native and non-native strains highlights contrasted situations with many populations highly admixed by non-native gene and some pure or nearly pure Mediterranean populations. This heterogeneous distribution of the admixture could be explained by ecologically or sexually mediated reproductive isolation between the two lineages. Our aim is to investigate the pre and post zygotic mechanisms for isolation in natural environment.

Pre-zygotic isolation is studied by using subaquatic camera *in natura*. We hypothesize that either intrasexual competition or intersexual preference could be dependent on genetic or phenotypic similarity between individuals by various mechanisms. For instance, the Mediterranean strain may show a superior competitive ability on the spawning grounds and therefore gain access to either better habitat or partners. This will also allow us to enrich our knowledge of sexual selection and mating behavior in Mediterranean brown trout and also the interactions between the two lineages.

Regarding post-zygotic isolation we will monitor eggs and newly hatched survival for ecologically contrasted situation in both controlled and natural environments in order to search for a fitness differential explaining the observed admixture gradient.

The purpose of this work is to develop a practical tool as a demo-genetic model accounting for eco-evolutionary dynamics. This tool will be use to assess the demographic and genetic effects of conservation strategies on wild populations to help managers in their decision-making for implementing more effective actions.

# EVOLUTION IN ACTION – NATURAL SELECTION ON PHYSIOLOGICAL AND MORPHOLOGICAL TRAITS OF ATLANTIC SALMON IN MULTIPLE NATURAL ENVIRONMENTS

Siim Kahar<sup>1</sup>, K. Vuori<sup>1</sup>, J.-P. Vähä<sup>1</sup> and A. Vasemägi<sup>1</sup>

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**Key words:** adaptation, contemporary evolution, common garden experiment, oxidative stress

## **Abstract:**

Despite a wealth of information about natural selection acting on phenotypic traits, we still know very little how contemporary phenotypic selection transforms to changes at physiological and protein level. Furthermore, only few studies to date have studied the adaptive significance of the physiological traits, e.g. oxidative stress (OS) tolerance, although such traits may play a crucial role in survival in wild environment. In present study we made controlled crosses and created families from two Atlantic salmon populations with different genetic background. We estimated enzyme activities of three OS related enzymes (GR, GST and SOD) at fry stage of samples from each family to assess the variation among families and between populations. In addition, we stocked known number of fry from each family to multiple habitats in two rivers suitable for salmonids. After the first summer extensive sampling was carried out at each site. Sampled juveniles were assigned to the family of origin using molecular markers and variation in survival and growth among families and between populations were estimated. Preliminary results show large variation in OS related enzyme activities, survival and growth among families and between populations. Large differences among families and among individuals within families were also observed in different habitats. Final results will be discussed in more detail.

# DISENTANGLING THE ROLES OF FISHERIES AND THE ENVIRONMENT ON THE EVOLUTION OF EXPLOITED ATLANTIC SALMON POPULATIONS

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**Key words:** climate change, phenotype, fisheries, SNP, Microsatellites

## **Abstract:**

Climate change and commercial exploitation can induce evolutionary change upon fish stocks, but their relative roles remain controversial. Most studies of climate or fisheries-induced evolution have focused on phenotypic traits. Genetic changes have been much more difficult to detect due to their polygenic nature and the difficulties in the analysis of gene-environment interactions. Consequently, the genetic effects on fish stocks resulting from exploitation vs. environmental change have remained largely unexplored, despite the fact that these are likely to have different evolutionary consequences and will call for different management plans. Here we will use long-term phenotypic and genetic data of Atlantic salmon to tease apart the evolutionary effects of climate change from those of fishing, building on our recent work on drivers of salmon adaptive change.

We will examine five Atlantic salmon populations located along an extensive latitudinal gradient, from Spain to Norway. Analysis of contemporary and archival scales, as well as climatic records, will be used to examine historical variation in growth, and age and size at maturation. A panel of 14 microsatellites and SNPs will be used to examine temporal changes in genetic structure, and genetic and life-history data will be used to compare two measures of population divergence,  $F_{st}$  (genetic) and  $Q_{st}$  (quantitative), in order to detect signatures of selection.

# DOMESTICATION-MEDIATED CHANGES IN GROWTH REACTION NORMS OF ATLANTIC SALMON *SALMO SALAR* L.

Monica F. Solberg<sup>1,2</sup>, Ø. Skaala<sup>1</sup>, F. Nilsen<sup>2</sup> and K.A. Glover<sup>1</sup>

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**Key words:** Genetic interaction, farmed escapees, common garden, genotype x environment interaction, genetic variation, genetic-based plasticity

## **Abstract:**

Domestication is an evolutionary process driven by directional selection for desirable traits in addition to inadvertent selection. In Norway, the domestication of Atlantic salmon has been ongoing for more than 30 years, and directional selection for 9-10 generations has resulted in farmed salmon deviating from wild salmon in several traits. This makes Atlantic salmon an ideal species in which to investigate domestication-mediated changing in traits not deliberately selected for, both in their expression and in their reaction norms.

Here we report the results of a common garden experiment, studying the growth reaction norms of Atlantic salmon *Salmo salar* L. of farmed, hybrid and wild parentage, at the family level, reared under hatchery conditions or in the presence of an environmental stressor.

# EVOLUTION OF REPRODUCTIVE SYSTEM IN *SALMO TRUTTA*

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**Key words:** sexual selection, parental investment, brown trout

## **Abstract:**

The rules of sexual selection in natural populations are usually poorly documented, and even less accounted for in either basic research or applied policies for environmental management. In behavioural ecology, theoretical models help to predict the evolution of traits and behaviours. Kokko & Jennions (2008) proposed a theoretical model which predicts sex-roles evolution under the interaction of multiple parameters that shape sexual selection. It assumes a tradeoff between i) providing parental care (by increasing offspring's fitness), being no longer available for mating, and ii) avoiding parental care, therefore staying in the mating pool to improve mating prospects. Selective pressures influence individual tactics by acting on costs and benefits both outside the mating pool (predation, offspring mortality) and inside the mating pool (Operational Sex Ratio, Adult Sex Ratio). The aim of my project is to test Kokko & Jennions's model in *Salmo trutta*, in order to investigate possible evolutionary change in reproductive behaviour. Indeed, brown trout display an impressive range of behavioural variation related to environmental cues. From video analysis of observations in natural and semi-natural conditions, I will first describe and quantify individual behaviours involved in intersexual preference and intrasexual competition. Phenotypic traits such as color patterns, body size and adipose fin size will then be measured and their effects will be inferred on reproductive behaviour. By estimating offspring survival, I will finally be able to assess the costs and benefits of each tactic with regard for traits and environmental conditions. These data will help parameterizing the model, which will provide specific predictions for brown trout mating system evolution.

# TO EAT OR WHAT TO EAT – DOES ENRICHED REARING INFLUENCE FORAGING STRATEGY IN THE PRESENCE OF A PREDATOR?

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**Key words:** parr, PIT-tag, burbot, *Lota lota*, Atlantic salmon, *Salmo salar*

## **Abstract:**

Hatchery reared fish have shown to develop maladaptive behaviour compared with wild conspecifics. Here we examine if an enriched rearing method can promote foraging under predation risk compared to salmon reared using standard rearing methods. In the wild a trade-off between to eat or not to eat and what and where to eat has to be made depending on the predator and level of predation risk. Fish reared in enriched environments have shown to be less bold towards predators and to be faster learners than fish reared in standard environments. We therefore expect the enriched fish rather than the standard fish to be able to change foraging strategy in the presence of a predator. Parr reared with enriched and standard methods were released in semi-natural streams containing burbot predators. Parr stomachs were flushed after 24 hours and food items categorized into prey types. Differences in stomach contents and salmon antipredator behaviour between the treatments will be analyzed and the results discussed.

# STABLE ISOTOPES TO EVALUATE BOTTOM-UP EFFECTS OF THE MAT-FORMING DIATOM *DIDYMOSPHENIA GEMINATA* ON *SALMO SALAR* FOOD WEB DYNAMICS

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**Key words:** *Didymosphenia geminata*, invasive diatom, *Salmo salar*, stable isotopes, food web

## **Abstract:**

In 2006, blooms of *Didymosphenia geminata* Schmidt (didymo) were, for the first time, officially identified in the Matapedia River, an Atlantic salmon (*Salmo salar*) river of the Gaspé Peninsula (Québec, Canada). This invasive alga can form thick and extensive benthic layers in stable flow oligotrophic rivers (Spaulding & Elwell, 2007). Recreational fishing of Atlantic salmon is the main economic activity of the Matapedia river valley and there are concerns that didymo may constitute an additional stressor for this salmon population. In a previous study, Gillis and Chalifour (2010) showed that the presence of didymo caused significant changes in macroinvertebrate community. Therefore, its presence is suspected to alter diet and foraging behavior of juvenile Atlantic salmon through food web interactions. In an attempt to determine the bottom-up effects of didymo through stable isotope analysis, we sampled two didymo contrasting sites of the Upsalquitch River, a neighbouring watershed to the Matapedia River, which has been affected by didymo since 2007. At each site, four macroinvertebrate taxa, 12 fry and 12 parr were sampled. Juvenile Atlantic salmon muscles and livers were then extracted for analysis. Preliminary results show that carbon was slightly higher for juvenile salmon sampled at sites where didymo is present, suggesting that these consumers have a more depleted diet than those in didymo-free sites (McCutchan *et al.*, 2003). Further results, currently under analysis, will be presented and implications of didymo invasions for Atlantic salmon populations will be discussed.

# MESOHABITAT SUITABILITY MODELING FOR THE CONSERVATION OF ENDEMIC SALMONIDS IN THE MEDITERRANEAN AREA

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**Key words:** habitat modelling, mesohabitat, salmo, Mediterranean streams, hydromorphology

## **Abstract:**

In the context of water resources planning and management, endemic and threatened fish species should be the targets of biodiversity safeguard and wildlife conservation actions. In particular, research on river ecology has indicated that the prediction of fish presence related to the habitat characteristics can be considered as an important tool for the definition of environmental flows and habitat restoration measures. In this research, Random Forest is used to relate the presence of brown trout (*Salmo trutta fario*) and marble trout (*Salmo trutta marmoratus*) to environmental variables linked to the hydro-morphology, elevation of the study sites and aquatic and riparian vegetation. Data collected in Spanish and Italian streams are respectively used to predict the presence of adult and juvenile life stages of these two endemic fish species. The main aims of this study are (i) to examine the feasibility of using Random Forest in building habitat suitability models for fish, (ii) to compare the model results for the two life stages, (iii) to select the most important habitat attributes for the fish presence across different streams and (iv) to evaluate the potential transferability of the models. The preliminary results of this research are discussed, as well as possible future developments and applications for other endemic Salmonids in the Mediterranean area, showing potentials and limitations of Random Forest in building habitat suitability models for fish.

# RELATIONS BETWEEN BROWN TROUT DENSITY AND MESOHABITAT CHARACTERISTICS BY MEANS OF GENERALIZED ADDITIVE MODELS (*GAMs*)

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**Key words:** *Salmo trutta*, mesohabitat, Mediterranean stream, *GAMs*

## **Abstract:**

Brown trout populations of (*Salmo trutta*) were studied along with their relation to instream habitat characteristics in the Valencia region (Eastern Spain). The relation habitat-abundance was determined with a multivariate approach: Generalized Additive Models (*GAMs*).

The habitat characterization followed a field protocol adapted from the Basinwide Visual Estimation Technique, *BVET*. In particular, four basic types of mesohabitats or hydromorphological units (*HMUs*) were identified (i.e. pool, glide, riffle and rapid) and characterized with the following variables: *HMU* length (m), mean width (m), mean and maximum depth (m), volume (m<sup>3</sup>), substrate types (%), shadow (%), fine sediments (%), relative distance between riffles (m) and cover index. Fish data were collected by sampling the *HMUs* with electrofishing during the summer season between 2003 and 2006. All the trouts were measured in terms of weight and fork length and classified according to age class.

The relations habitat-abundance were analyzed for immatures (< 2 years) and adults (≥2 years) and for slow (pool/glide) and fast water (riffle/rapid) mesohabitats separately. By means of a multivariate statistical approach, *GAMs* were calculated, and several relations were demonstrated. The results of the analyses were discussed in order to present the potential of *GAMs* in describing the abundance of brown trout populations in the Valencia region.

# LINKING HYPORHEIC INTERACTIONS WITH SALMON EGG SURVIVAL IN HYDROPEAKING SCENARIOS

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**Key words:** hydropeaking, egg survival, dewatering

## **Abstract:**

Sudden flow changes caused by hydropeaking are likely to become more frequent with increasing demand for renewable energy. These sudden fluctuations affect both the surface and subsurface flow regime and change the hydrological interaction patterns occurring in the hyporheic zone. The hyporheos plays an important role in freshwater ecology, especially for early stages of salmon embryo development. Such links have hardly been investigated in a hydropeaking scenario. The works presented aim to investigate the links between the survival of salmon embryo and the hydrological processes occurring in the hyporheic zone during hydropeaking.

An experimental set-up was started in December 2011 in the river Lundesokna (central Norway). A total of 14 pipes were buried at several depths (from 20 to 70 cm) across and along a 5 x 20 m side gravel bar subject to regular drying out and dewatering due to hydropeaking operations. A total of 12 cylindrical boxes were placed in along both the permanently wet area and the ramping zone on the same gravel bar. A total of 60 eggs were placed between two compartments (at 10 and 30 cm depth) in each of the cylinders. Water pressure sensors were placed in the pipes to monitor the hyporheic water level and flow with 1-2 minutes time resolution. In addition, temperature, conductivity and dissolved oxygen were collected at the same site for an expected period of 3 months, coinciding with early stages of salmonid egg development in this catchment. Egg compartments were checked for survival regularly after hydropeaking events had occurred. Dead eggs were counted and removed from the compartment.

Significant numbers of dead eggs were found in the ramping area in comparison with the ones in the permanent wet area, as expected. But mortality in the ramping area varied with both the relative position along the gravel bar and the relative position within the water level. Outside temperature also appeared to be an important factor controlling mortality.

# SPATIAL HABITAT SELECTION OF ATLANTIC SALMON (*SALMO SALAR* L.) YOY

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**Key words:** size dependency, density dependency, intraspecific competition, exploitation competition, interference competition, ideal free distribution, ideal despotic distribution

## **Abstract:**

To assess which Atlantic salmon YOY fish sizes are the most endangered from stranding in hydropeaked rivers, an experimental habitat use study was performed with Atlantic salmon YOY, ranging between 22 – 80 mm in fork length. Fish were released (May and June) at two different densities into artificial outdoor channels, which offered deep and shallow habitats, which could be rapidly separated (drop fence) from each other. At the end of the experimental period, fish were recaptured in either habitat by electro fishing. The results suggest that fish size was the most important factor affecting site selection, were probability of shallow habitat use was directly related to fish size. The probability of finding a 22 mm long fish in the deep habitat was about  $p = 0.5$ , for a 40 mm long fish it was about  $p = 0.8$  and for an 80 mm long fish it was about  $p = 1.0$ . In contrast, fish density did not affect site selection significantly. The smallest fish are the most vulnerable size class due to their restricted swimming performance, their low competitive achievements and low feeding/hunger capacity and therewith will suffer the most from unnatural rapid drops in water levels.

# MULTIPLICATIVE LOSS OF LANDLOCKED *SALMO SALAR* L. SMOLTS DURING DOWNSTREAM MIGRATION THROUGH MULTIPLE DAMS

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**Key words:** landlocked *Salmo salar*; smolt; hydroelectric power plants; migratory success; acoustic telemetry

## **Abstract:**

Relative little is known about the migration of landlocked stocks of Atlantic salmon *Salmo salar* L. Earlier migrations studies have mainly focused on upstream migration, and less is known about downstream migrating salmonids passing hydroelectric plants (HEPs). However, in watersheds with several HEPs multiplicative loss of downstream migrating salmon smolts can be high, contributing to population declines or extirpations. Here we report the results from a study of wild landlocked Atlantic salmon smolts in the River Klarälven. Salmon smolts, tagged with acoustic transmitters, were released at different locations, and followed as they passed 37 receivers along a 180 km long river segment, including eight dams as well as freeflowing control stretches. We found that 16% of the smolts successfully migrated along the entire river segment. Most losses occurred during HEP passages, with 76% of the smolts being lost during these passages, which contrast with the 8% smolt loss along unregulated control stretches. Migration speed was 83 % slower along regulated stretches than along unregulated stretches. The observed lower migration speed at regulated stretches was dependent on fish size, with large fish moving slower than small fish. Discharge affected migration speed, but not losses. As previously shown for anadromous populations, our study of landlocked salmon demonstrates similar negative effects of multiple passages of HEPs by downstream migrating smolts. Based on this and previous migration studies, we advocate using a holistic approach in the management and conservation of migratory fish in regulated rivers, which includes safe passage for both upstream- and downstream-migrating fish.

# USING RECONDITIONED KELTS IN ATLANTIC SALMON CONSERVATION PROJECTS: THE IMPORTANCE OF MATERNAL EFFECTS

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**Key words:** *Salmo salar*, maternal effects, domestication, individual level, rearing conditions.

## **Abstract:**

Female kelts are often reconditioned and used in salmon restoration projects over several years, but the effects of increasing the length of captivity on offspring fitness have seldom been examined. We compared egg-to-fry developmental rates and early alevin behaviour among offspring derived from wild mothers and those from kelts reconditioned over one or two years. In addition, eggs from each female were divided into large and small eggs and were individually followed from eyed stage to yolk sac reabsorption to determine the effects of maternal investment. Eggs were also planted in emergence traps and in the field to assess survival and patterns of emergence using microsatellite DNA loci for assignment. This project will shed light on the importance of maternal effects on fitness of juvenile salmonids reared for conservation.

# STOPPING COMPENSATORY RELEASES OF SALMON IN THE BALTIC SEA – GOOD OR BAD FOR THE SALMON GENE POOLS?

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**Key words:** *Salmo salar*, conservation genetics

## **Abstract:**

In light of the recent proposal from the European Commission to phase out compensatory releases of salmon in the Baltic Sea, we have studied genetic variability patterns for wild salmon populations and salmon hatchery stocks in the area. Review of previously published information as well as unpublished genetic data were used to cover the following questions: *i*) What genetic risks are associated with large scale releases of salmon with respect to remaining native populations? *ii*) How has the loss of salmon populations affected the overall capacity for Baltic salmon to maintain genetic variation? *iii*) What are the effects of releases on genetic variation between and within wild salmon populations? *iv*) How much of the overall genetic variability of Baltic salmon exists exclusively in hatcheries or is maintained only through breeding-release operations? Our work indicates that a large part of the original genetic variation in Baltic salmon has already been lost due to extinction of individual populations and reduction in population sizes. Hatchery stocks have in general lower genetic variation and are less diverged from each other than wild populations. However, reared stocks might also harbor unique genetic variation and may thus be important to conserve. The genetic effects of releases have not been monitored in the Baltic, but one genetic study indicates strong homogenization effects. Studies of salmonid releases in other areas have in several cases documented changed genetic composition and reduced variability and viability. The extent of this threat needs further investigation. Until such data is available large scale releases should be stopped in line with the precautionary principle. Stocking for conservation and restoration purposes, must be evaluated on an individual river-by-river basis. The fate of individual hatchery stocks should be determined case by case. Options may include: *i*) restocking of not self-sustained populations, *ii*) sacrificing stocks that do not contribute significantly to the total gene pool, and *iii*) keeping stocks as gene banks until reintroduction is possible.

# Participants list NoWPaS 2012

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Casas-Mulet Roser	Norway	<a href="mailto:roser.casas-mulet@ntnu.no">roser.casas-mulet@ntnu.no</a>	<i>Linking hyporheic interactions with salmon egg survival in hydropeaking scenarios</i>
Consuegra Sofia	England	<a href="mailto:skc@aber.ac.uk">skc@aber.ac.uk</a>	<i>The Salmon Conquistador: genetic variation and colonisations in the Old and New world</i>
Einum Sigurd	Norway	<a href="mailto:sigurd.einum@bio.ntnu.no">sigurd.einum@bio.ntnu.no</a>	<i>Sex, space and density dependence: why non-spatial approaches may (sometimes) be inappropriate for modeling habitat effects on populations</i>
Gauthey Zoe	France	<a href="mailto:zgauthey@st-pee.inra.fr">zgauthey@st-pee.inra.fr</a>	<i>Evolution of reproductive system in Salmo trutta</i>
Gil Jordi	France	<a href="mailto:jgil@dijon.inra.fr">jgil@dijon.inra.fr</a>	<i>Mechanisms in intra-specific reproductive isolation in brown trout (Salmo trutta L.) between Mediterranean and Atlantic lineages</i>
Gillis Carole-Anne	Canada	<a href="mailto:carole-anne.gillis@aquaconfluence.com">carole-anne.gillis@aquaconfluence.com</a>	<i>Stable isotopes to evaluate bottom-up effects of the mat-forming diatom Didymosphenia geminata on Salmo salar food web dynamics</i>
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Watz Johan	Sweden	<a href="mailto:johan.watz@kau.se">johan.watz@kau.se</a>	<i>The role of temperature in the foraging behaviour of juvenile stream salmonids</i>
Wennerström Lovisa	Sweden	<a href="mailto:R.STRINGWELL.393651@swansea.ac.uk">R.STRINGWELL.393651@swansea.ac.uk</a>	<i>Stopping compensatory release of salmon in the Baltic Sea – Good or bad for the salmon gene pools</i>
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