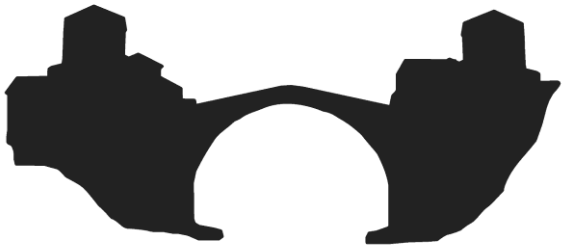
# FITFISH ANNUAL CONFERENCE

## 21st April 2017
## Mostar
## Bosnia & Herzegovina





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Poštovane kolege,

Želimo da Vas pozdravimo i zaželimo dobrodošlicu na konferenciju"Plivanje riba i implikacije za migraciju i akvakulturu (FITFISH)" u okviru COST Akcije FA1304, koja se održava u Hotelu "Ada" u Blagaju, nedaleko od Mostara. Cilj ove konferencije je unapređivanje metoda istraživanja iz oblasti: funkcionalni mehanizmi koji su odgovorni za korisne efekte plivanja, migracije riba i vježbe u akvakulturi. Na ovoj konferenciji će također biti riječi o nekim novim saznanjima iz oblasti fiziologije kao i potencijalnim efektima izgradnje minihidrocentrala na migracije Salmonida. Ova konferencija će svakako dati uvid u napretke u polju migracije ribai nadamo se da će probuditi još veći interes kada su u pitanju nova saznanja u akvakulturi, monitoringu populacija riba kao i modeliranju efekata na određene populacije. S tim u vezi, također postoji potreba da se sva saznanja koja su stečena na ovoj konferenciji pretvore u implikativno izvodljive metode, koje će se moći upotrijebiti za konzervaciju i zaštitu ugroženih vrsta i po mogućnosti napraviti implementaciju zakona kako bi određene vrste bile zaštićene i stavljene na IUCN-ovu Crvenu listu ugroženih vrsta.

Želimo Vam ugodan i koristan boravak na ovoj konferenciji i nadamo se da ćete uživati u ugodnom ambijentu i toplom hercegovačkom proljeću.

Sanel Riđanović (Lokalni organizator)
Josep Planas (Potpredsjednik FITFISH Akcije)
Arjan Palstra (Predsjednik FITFISH Akcije)

Dear colleagues,

We would like to greet you and welcome you to the annual conference "Swimming of fish and implications for migration and aquaculture (FITFISH)" in the framework of COST Action FA1304, which will be held at the Hotel "Ada" Blagaj, near Mostar. The aim of this conference is to promote novel research methods in the fields of: functional mechanisms responsible for the beneficial effects of swimming, fish migration and exercise in aquaculture. The new findings in the field of physiology and potential effects of the construction of small hydropower plants on the migration of salmonids will also be explored. The conference will certainly provide an insight into the advances in the field of fish migration and, we hope, it will awaken even more interest regarding new knowledge in aquaculture, fish population monitoring, and modeling of effects on certain fish populations. There is a need to transform all the acquired knowledge into feasible applicative methods, which will be used for conservation and protection of endangered species and possibly as a platform for implementation of the law, so that certain endangered species could be protected and placed on IUCN's Red list of endangered species.

We wish you a pleasant and useful stay at this conference, and we hope you will enjoy the pleasant surroundings and the warm spring of Herzegovina.

Sanel Riđanović (Local organiser)
Josep Planas (FITFISH Action Vice Chair)
Arjan Palstra (FITFISH Action Chair)

**Annual conference of FITFISH project will be held at the Hotel "Ada" in Blagaj which is located in close proximity to Mostar**

The hotel „Ada" is located in the suburb of Blagaj, 10 minutes drive from the centre of Mostar. It is located on the banks of a picturesque Buna river, the site of several european and world fly-fishing championships,in the vicinity of numerous historical and cultural attractions.Mostar is one of the most popular tourist destinations in the Balkans, with its famous Old bridge (Stari most) and many other UNESCO heritage sites and points of interest.

**Address**
Hotel Ada
Blagaj 88000
Mostar
Bosnia and Herzegovina

**Phone**

+387 62 545 948

**Web site**
http://ideo.ba/~ada/web/

**THURSDAY, APRIL 20, 2017**

**ORAL PRESENTATIONS**

8.30 **Registration of attendance**

9.00 **Welcome**
Sanel Riđanović (*Head of Department of Biology, University "Džemal Bijedić" in Mostar, Bosnia & Herzegovina*)

9.10 **MC meeting**
Arjan Palstra, Rian Schelvis

10.30 **Coffee-break**

10.45 **MC meeting**
Arjan Palstra, Rian Schelvis

12.00 **Lunch break**

13.30 **Parallel WG meetings incl. coffee break:**

**Working group 1 - Functional mechanisms behind the beneficialeffects of swimming**
Paolo Domenici (*CNR-IAMC, Italy*)
Gudrun De Boeck (*Department of Biology, University of Antwerp, Belgium*)

**Working group2 - Fish migration: Status and progress**
Johannes Sturlaugsson (*Laxfiskar, Fornubudir, Hafnarfjordur,Iceland*)

**Working group 3 - Exercise in Aquaculture**
Helgi Thorarensen (*Holar University College, Iceland*)

**Working group 4 - Transfer of knowledge to end users**
Simon MacKenzie (*University of Stirling, United Kingdom*)

**Working group 5 - Training of early stage researchers: Status and progress**
Mirjana Lenhardt (*Institute for Multidisciplinary Research, University of Belgrade, Serbia*)
Stefano Marras (*Institute for the Coastal Marine Environment, National Research Council*)

19.00 – 22.00 **Dinner**

**FRIDAY, APRIL 21, 2017**

8.45 **Welcome**
Rašid Hadžović (*Ministry of Education and Science of HNK*)
Sead Pašić (*University „Džemal Bijedić" Mostar, rector*)

9.00 **The potential impact of small hydro power plants on genetic biodiversity and migration of salmonid species in the Neretva river**
Sanel Riđanović (*Department of Biology, University „Džemal Bijedić" Mostar*)

9.30 **The role of physiology in the causes and consequences of fisheries-induced evolution**
Shaun Killen (*Institute of Biodiversity, Animal Health & Comparative Medicine, University of Glasgow*)

10.00 **The application of swimming exercise to increase DNA vaccine efficacy in salmon aquaculture**
Ian Mayer (*Norwegian University of Life Sciences, Faculty of Veterinary Medicine and Biosciences, 0033 Oslo, Norway*)

10.30 **Coffee-break**

11.00**Swimming for success**
Steven J. Cooke (*Fish Ecology and Conservation Physiology Laboratory, Dept. of Biology and Institute of Environmental Science, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6 Canada*)

11.30 **Cortisol induces pathological cardiac growth and impaired swimming performance in rainbow trout**
Øyvind Øverli (*Department of Food Safety and Infection Biology, Norwegian University of Life Sciences, Oslo, Norway*)

12.00 **Fish migration research in Scotland: Current state and future directions**
Colin Bull (*University of Stirling, Stirling FK9 4LA , Scotland*)

12.30 **Lunch**

14.00 **Swimming conditions of the yellow perch (*Perca flavescens*) in rectangular and round tanks**
Ana Gavrilović (*Juraj Dobrila University of Pula, Department of Natural and Health Sciences, Zagrebačka 30, 52100 Pula, Croatia*)

14.30 **Parasites, performance and patterns of host activity: Incorporating infection into our understanding of animalmovement**
Dominique Roche (*Institute of Biology, University of Neuchâtel, 2000 Neuchâtel, Switzerland*)

15.00 **Coffee-break**

15.30 **Effects of extensive swimming on weight gain, swimming performance, energy budget and gene expression of common carp (*Cyprinus carpio*)**
Božidar Rašković (*Institute of Animal Science, Faculty of Agriculture, University of Belgrade Nemanjina 6, Zemun, 11080 Belgrade, Serbia*)

16.00 **Limiting maximum metabolic rate: Is osmorespiratory compromise playing a major role?**
Patricia Ferreir (*CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Terminal de Cruzeiros Porto de Leixões, Av General Norton de Matos, S/N4450-208 Matosinhos, Portugal*)

16.30 **Can exercise enhance brain plasticity, cognition and foraging behaviour in Atlantic salmon?**
Daan Mes (*Department of Production Animal Clinical Sciences, Norwegian University of Life Sciences, Oslo, Norway*)

17.00 **Posters and drinks**

19.00 -22.00 **Dinner**

**POSTERS**

P1 **Impact of the electric barrier and fish scaring system on the activity and movement of fish analysed by means of a multibeam sonar ARIS**
Beata Schmidt (*National Marine Fisheries Research Institute, Kołłątaja Str. 1, 81-332, Gdynia, Poland*)

P2 **Obstacles of migratory fish on swimming way in Turkey**
Devrim Memiş (*Ordu str. No:8 Laleli/İstanbul, İstanbul University Fisheries Faculty*)

P3 **Aquahealth for fish swimming**
Damir Kapetanović (*Ruđer Bošković Institute, Bijenička c. 54, Zagreb, Croatia*)

P4 **Assessment of ecological flow rates in small scale hydropower plants: A case study from Turkey**
Ahmet Alp (*University of Kahramanmaraş Sütçü İmam, Faculty of Agriculture, Department of Fisheries, Kahramanmaraş, Turkey*)

# ABSTRACTS:
# ORAL PRESENTATIONS

## THE POTENTIAL IMPACT OF SMALL HYDRO POWER PLANTS ON GENETIC BIODIVERSITY AND MIGRATION OF SALMONID SPECIES IN THE NERETVA RIVER

SANEL RIĐANOVIĆ[1], PAVLE SPASOJEVIĆ[1], LEJLA RIĐANOVIĆ[1], DENISA ŽUJO ZEKIĆ[1]

[1]*Department of Biology, University „Džemal Bijedić" Mostar, Univerzitetski kampus bb, 88000 Mostar, Bosnia and Herzegovina*

The river Neretva is the longest karst river in the Dinaric Alps, and the largest tributary of the Adriatic sea from the Balkans. It is internationally recognised for its outstandingly rich biodiversity, including endemic Salmonid species. The habitat fragmentation, caused by dams, prevents natural upward migration of fish to suitable spawning areas, while also preventing gene flow between emerging local populations. Salmonid populations in the Neretva are currently fragmented into five local populations, physically isolated by high dams, without adequate migration passages. There is a decrease of the overall genetic diversity of the fragments, due to genetic drift. With the absence of gene flow, fragmentation typically leads to an increase of inbreeding and the loss of genetic diversity, leading to genetic differentiation and a higher risk of extinction.

A planned construction of a number of SHPPs on the Neretva River, and its tributaries, would cause uneven fragmentation of emerging populations. The newly formed fragments would be very small, leading to an increased variation in allelic frequencies. Smaller populations are also subjected to mutational meltdown which leads to reduced fitness, decrease of a population size, and accumulation of deleterious mutations. It is possible that some of the smallest fragments of populations of Salmonids in the waters of Neretva are already experiencing this process. Some isolated small populations of brown trout are possibly extinct due to mutational meltdown.

The aim is to analyse mitochondrial DNA, with the goal of determining haplotype and potentional interspecies hybridisation; nuclear marker LDH (lactated hydrogenase), in order to establish existence of interspecies hybridisation; molecular analysis of appropriate microsatellite loci with the view of analysing genetic variability and population structure. Data will be used to analyse abundance and the current status of populations. It is expected to establish a link between disruption of migratory fish routes and the current ecological status (abundance, dynamics, regeneration, genetic diversity) of Salmonid populations, determine the effects of fragmentation of populations and conduct a detailed genetic analysis of endemic and critically endangered populations. Measures of conservation and protection of these species are to be considered, including concerted efforts in placing them on the IUCN red list of critically endangered species.

***Key words:*** *habitat fragmentation, Neretva, MHPPs, Salmonids, critically endangered species*

**NOTES**

## THE ROLE OF PHYSIOLOGY IN THE CAUSES AND CONSEQUENCES OF FISHERIES-INDUCED EVOLUTION

SHAUN KILLEN[1], BARBARA KÖCK[1], AMELIE CRESPEL[1], TRAVIS VAN LEEUWEN[1], JACK HOLLINS[1],DAVIDE THAMBITHURAI[1], ANITA RACZ[1], MATT GUZZO[1], DAVID BAILEY[1], JAN LINDSTRÖM[1], KEVIN PARSONS[1]

[1]*Institute of Biodiversity, Animal Health & Comparative Medicine, University of Glasgow*

There is increasing evidence that intense commercial fishing pressure is not only depleting fish stocks but also causing evolutionary changes to fish populations with serious consequences for the viability of marine fish communities. Although current research on fisheries-induced evolution (FIE) has focused almost exclusively on the effects of size-selective harvest on reproductive potential of wild populations, there are a range of additional traits that could also affect the selectivity of fishing gears but which have not been investigated. For example, overlooked within the context of FIE is the likelihood that, within a given species, variation in physiological traits among individuals – and especially those related to energy balance and swimming performance – could make some fish more catchable or more likely to suffer mortality after discard. Selection on these traits could produce major shifts in the fundamental structure and function of fish in response to fishing pressure that are yet to be considered but which could directly determine population resource requirements, resilience, geographic distributions, and responses to environmental change. This project combines innovative approaches in the laboratory with cutting-edge acoustic tracking technology in the field to address this gap in knowledge with three main goals: (1) to examine whether physiological traits make some individuals more vulnerable commercial fishing gears, and whether the environment modulates such effects; (2) to investigate the extent to which physiological traits influence recovery and survival after escape from fishing gear or discard; and (3) to determine whether selection on catchability generates changes in physiological traits that reduce population resiliency or erode the ability to cope with environmental change. Results will be presented from laboratory simulations of commercial fishing procedures, which allow investigations into trait repeatability and covariation not possible in the wild. We will also summarize ongoing work in the natural environment to examine how physiological traits influence habitat use and thus fishing gear encounter rates. Given that several fisheries have not recovered despite lengthy moratoriums, there is a pressing need to understand the long-term physiological effects of FIE on fish stocks and their capacity to rebound after fishing pressure is lifted.

***Key words:*** *metabolism, aerobic scope, selection, fishing, anthropogenic impacts*

**NOTES**

# THE APPLICATION OF SWIMMING EXERCISE TO INCREASE DNA VACCINE EFFICACY IN SALMON AQUACULTURE

IAN MAYER[1], JOSEP PLANAS[2]

[1]*Norwegian University of Life Sciences, Faculty of Veterinary Medicine and Biosciences, 0033 Oslo, Norway*

[2]*International Pacific Halibut Commission, 2320 West Commodore Way, Seattle, WA 98199-1287, USA*

Aquaculture has grown dramatically over the last decades globally, and plays an increasingly important role in world food security. The continuous development of improved vaccine strategies to protect against disease is of critical importance for the continued growth in global aquaculture. One recent development has been the introduction of DNA vaccines which have shown promising results in combating disease in farmed fish, including salmonids. DNA vaccination is based on the administration of the gene encoding the vaccine antigen, rather than the antigen itself. Subsequent expression of the antigen by cells in the vaccinated hosts triggers the host immune system. A single injection of microgram amounts of DNA induces rapid and long-lasting protection in farmed salmonids against a number of economically important viruses. However, DNA vaccination is a relatively new technology, and the most effective delivery strategy for mass vaccination of small fish has yet to be fully developed, although the most efficient delivery route at present is intramuscular (IM) injection. The effectiveness of current vaccination protocols providing improved protection in fish is in great part due to the excellent ability of skeletal muscle cells to take up the vaccines and efficiently present antigens in their cell membrane to immune cells. This talk will discuss the hypothesis that the efficacy of DNA vaccines through the expression of immune genes in skeletal muscle can be optimized by swimming-induced muscle contraction. It is proposed that the contractile activity of skeletal muscle fibers in salmonid fish subjected to forced swimming regimes may positively influence the uptake and expression of DNA vaccines leading to improved antigen production and presentation, consequently leading to increased immunological protection. Potential important practical applications of enhanced swimming exercise regimes in salmon aquaculture, especially in relation to new DNA vaccination strategies will be discussed.

***Key words:*** *swimming exercise, DNA vaccination, immune response, salmonids, aquaculture*

**NOTES**

## SWIMMING FOR SUCCESS

STEVEN J. COOKE[1], JACOB BROWNSCOMBE[1]

[1]*Fish Ecology and Conservation Physiology Laboratory, Dept. of Biology and Institute of Environmental Science, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6 Canada*

Wild animals maximize fitness through certain behaviours (e.g., foraging, mating, predator avoidance) that incur metabolic costs and often require high levels of locomotor activity (i.e., Swimming). Consequently, the ability of animals to achieve fitness relies, at least in part, on their physiological capacity to obtain oxygen from their environment and to deliver it to the tissues that require oxygen. Capacity for swimming is one way to assess the potential throughput for this oxygen delivery system relative to the constraints imposed by environmental and ecological factors such as temperature, predation, and landscape characteristics. Here we outline a number of approaches to studying swimming in wild fish using biologging and biotelemetry platforms. We explore how environmental factors and physiological limitations influence swimming capacity and metabolism in relation to fitness-enhancing activities including foraging, migration to spawning grounds (including fishway use) and parental care. Using several case studies spanning marine and freshwater fish we explore the critical role of swimming in achieving biological fitness, while also demonstrating how environmental factors impose energetic constraints on animals that shape physiological and behavioural characteristics. Interactions among environmental and ecological factors, fish behaviour, and fish physiology offer important avenues of mechanistic inquiry to explain ecological dynamics and demonstrate how swimming is fundamental to the ecology of fish.

***Key words:*** *swimming; parental care; migration; exercise; fish passage.*

**NOTES**

## CORTISOLINDUCESPATHOLOGICAL CARDIAC GROWTHAND IMPAIRED SWIMMING PERFORMANCE IN RAINBOW TROUT

IDA. B. JOHANSEN[1,2,3], ERIK SANDBLOM[4], PETER V. SKOV[5], ALBIN GRÄNS[6], ANDREAS EKSTRÖM[4], IDA G. LUNDE[7,8,9], MARCO A. VINDAS[1], LILI ZHANG[7,8], ERIK HÖGLUND[5], MICHAEL FRISK[7,8], IVAR SJAASTAD[7,8], GÖRAN E. NILSSON[1], ØYVIND ØVERLI[3]

[1]*Department of Biosciences,University of Oslo, Blindern, Oslo, Norway*

[2] *Bjørknes College, Oslo, Norway*

[3]*Department of Food Safety and Infection Biology, Norwegian University of Life Sciences, Oslo, Norway*

[4]*Department of Biological and Environmental Sciences, University of Gothenburg, Gothenburg, Sweden*

[5]*National Institute of Aquatic Resources, Technical University of Denmark, North Sea Science Centre, Hirtshals, Denmark*

[6]*Department of Animal Environment and Health, Swedish University of Agricultural Sciences, Skara, Sweden*

[7]*Institute for Experimental Medical Research, Oslo University Hospital andUniversity of Oslo, Oslo, Norway*

[8]*KGJebsen Cardiac Research Center and Center for Heart Failure Research, University of Oslo, Oslo, Norway*

[9]*Department of Genetics, Harvard Medical School, Boston, MA, USA*

In migratory salmonid fish circulatory levels of the corticosteroid "stresshormone" cortisol surges towards the end of homing migration and spawning. Simultaneously, stress and elevated cortisol levels have been suggested to induce pathological heart growth and cardiovascular disease in humans and other mammals. We here show that, compared to controls, cortisol treated fish had considerably larger hearts that generated lower maximum stroke volume and cardiac output and exhibited reduced aerobic swimming performance, in line with impaired cardiacperformance and reduced overall circulatory oxygen transporting capacity. Clearly, cortisol-inducedcardiac remodeling differs from the adaptive ventricular remodeling that fish routinely exhibit in response to environmental changes. We do speculate, however, that cortisol can be involved in adaptive cardiac hypertrophy in salmonids given the right circumstances.Peak plasma levels of corticosteroids during salmonid sexual maturation and spawning migration are similar to those occurring during chronic stress. This hyper-activation of both the hypothalamus- pituitary-interrenal (HPI) - and gonadal (HPG) axes coincides with massive cardiac growth and improved mechanical performance and cardiac pumping capacity. One explanation could be that cortisol serves as a pro-hypertrophic stimulus, but that other factors (e.g. anabolic sex steroids) are necessary for the

hypertrophy to be accompanied by adaptive changes such as increased force-generating capacity. The exact combination of circumstances such as life cycle, migratory stages, and exposure levels promoting adaptive vs maladaptive cardiac hypertrophy clearly deserves further scrutiny.

***Key words:*** *cardiosomatic index, coping style, output, salmonidae, scope, stress*

**NOTES**

## FISH MIGRATION RESEARCH IN SCOTLAND: CURRENT STATE AND FUTURE DIRECTIONS

COLIN BULL[1], SIMON MACKENZIE[1]

[1]*University of Stirling, Stirling FK9 4LA, Scotland*

The freshwater fish community in Scotland is relatively impoverished and dominated by salmonids. We have many economically important rod fisheries and fish populations of international significance, and management actions operate alongside human activities that may effect changes to fish migration patterns. Our Scottish meeting brought together experts from the hydropower industry, government regulators and research sectors to discuss the current knowledge and initiatives in fish migration in rivers and the near shore marine environment, and where research priorities should be focused.

Several common themes emerged during the meeting including a requirement to better account for the individual variation explaining successful passage at complex river barriers, and understanding migration delay and smolt behavior exiting standing waters. Our group discussed telemetry tools, and rapid assessment methods aiming to further our understanding and assessment of fish migration behaviors. It became clear through discussion that there appear to be wide natural variations in migration strategies exhibited by the same species under different environmental conditions, and that there is a need to better understand the impact of natural, as well as man-made migration delays. Identifying critical knowledge gaps and the translation of research into government regulation and policy regarding river management and fish migration is complex, and requires an interdisciplinary approach to be successful.

***Key words:*** *Fish migration, Scotland, migration delay, research priorities*

**NOTES**

## SWIMMING CONDITIONS OF THE YELLOW PERCH (*PERCA FLAVESCENS*) IN RECTANGULAR AND ROUND TANKS

ANA GAVRILOVIĆ[1], JURICA JUG-DUJAKOVIĆ[2], STEVEN VAN GORDER[3], ALEXIS CONIDES[4]

[1]*Juraj Dobrila University of Pula, Department of Natural and Health Sciences, Zagrebačka 30, 52100 Pula, Croatia; anag@unipu.hr*

[2]*Sustainable Aquaculture Systems Inc., 715 Pittstown Road, Frenchtown, NJ 08825, USA*

[3]*Fresh Culture Systems, Inc., 630 Independent Rd., Breinigsville, PA USA*

[4]*Hellenic Centre for Marine Research, Ag. Kosmas, Hellinikon 16 777, Athens, Greece*

15 g yellow perch (*Perca flavescens*) fingerlings were stocked in two round and two rectangular 12000 liter tanks. Each tank represented a separate closed recirculation system maintaining a biofilter, a mechanical filter, a CO2 stripper, and an oxygen/ozone injection column. The tanks were designed to efficiently remove all settleable solids, thus maintaining optimal water quality. The round tanks had a tangential water inlet below the water surface, and a central effluent port, thus creating a circular flow. The "cross-flow" rectangular tanks had a series of water inlets at one side, and drains on the other side of the bottom creating a tubular cross tank current. The aim of the study was to observe behavior and swimming of yellow perch in these two conditions, and quantify the effect of these conditions on their growth.

The fish were fed a slow sinking pellet. Perch proved to be very timid (compared to sea bass, trout and tilapia grown in the same culture systems) reacting to any activity above and inside the tanks. It was important to provide hydrodynamic water flow characteristics while not disturbing the fish, so that they could maintain efficient positioning while feeding. When not feeding, the fish would swim indiscriminately, not always orienting against the flow of the water, a posture which was more pronounced in the rectangular tanks. In round tanks the administered pelleted feed would follow the current while slowly sinking, and the fish would position themselves to consume the moving food pellets. This pattern was less noticeable with cross-flow tanks, where more feed would reach the bottom of the tank and be removed uneaten.

At the beginning of the study, the 120 day old fish stocks had an average wet weight ranging between 14.7 and 18.1g. Eight months later, at the end of the experiment, the mean weight of fish was 176.1 g in the round tanks, and 160.1g in the rectangular tanks. The difference of 16 grams of growth between tank designs represents an approximately 10% weight difference, or expressed in time, a month of growth under comparative rearing conditions.

***Key words:*** *yellow perch, tank shape, swimming, behavior, growth*

**NOTES**

## PARASITES, PERFORMANCE AND PATTERNS OF HOST ACTIVITY:INCORPORATING INFECTION INTO OUR UNDERSTANDING OF ANIMALMOVEMENT

DOMINIQUE G. ROCHE[1], ALLISON K. SHAW[2], SANDRA A. BINNING[1]

[1]*Institute of Biology, University of Neuchâtel, 2000 Neuchâtel, Switzerland*

[2]*Department of Ecology, Evolution, and Behavior, University of Minnesota, Saint Paul, MN, USA, 55108*

Studies of animal exercise and movement largely assume that individuals are healthy and performing to the best of their abilities. However, wild animals face numerous ecological challenges that can compromise their health and reduce their ability to exercise maximally. By stimulating the immune system and diverting resources away from non-essential activities, parasites bacteria and viruses (hereafter parasites) have the potential to dramatically influence the ways in which individuals allocate energy to movement. Yet, the role of parasites and disease in influencing patterns of animal activity and performance remains relatively unexplored, perhaps because animals often hide signs of sickness, and parasites tend to be small and inconspicuous to researchers. This talk will discuss how parasite infection affects host locomotor performance and activity, including impacts on host physiology, morphology and movement. I will also discuss examples of behavioural strategies that some hosts develop to help overcome the disadvantages imposed by infection. Finally, I will highlight recent theoretical and empirical research investigating the important role that parasites play in driving the evolution of seasonal migration and large-scale host movement patterns more broadly.

***Key words:*** *dispersal, locomotion, migration, movement, pathogen*

**NOTES**

# EFFECTS OF EXTENSIVE SWIMMING ON WEIGHT GAIN, SWIMMING PERFORMANCE, ENERGY BUDGET AND GENE EXPRESSION OF COMMON CARP (CYPRINUS CARPIO)

BOŽIDAR RAŠKOVIĆ[1], JYOTSNA SHRIVASTAVA[2], GUDRUN DE BOECK[2]

[1]*Institute of Animal Science, Faculty of Agriculture, University of Belgrade Nemanjina 6, Zemun, 11080 Belgrade, Serbia*

[2]*SPHERE, Department of Biology, University of Antwerp Groenenborgerlaan 171, BE-2020 Antwerp, Belgium*

A trial was conducted with common carp (*Cyprinus carpio*) juveniles to determine whether constant swimming at different speeds has an influence on body weight and other nutrition- and physiological- related endpoints. The trial lasted for 28 days and was undertaken in three large (1600 L) raceways at the experimental setup located in mesocosm facility at the University of Antwerp. Three groups of 100 fish (mean weight of 4.87 g) were established and each common carp group was submitted to a constant swimming regime at different speeds: 0 (control), 1.5 and 2.5 body lengths per second (BL/s). Additionally, at the end of each week, 8 randomly selected fish per group were transferred to Blazka-type respirometers for evaluation of swimming performance. The results showed a significant increase in weight gain of common carp swimming constantly at 2.5 BL/s compared to both control and 1.5 BL/s group at the end of weeks 1, 3 and 4. Contrary to the weight gain, there were no significant differences between groups in critical swimming speed (Ucrit) and oxygen consumption, although there is a trend of increasing oxygen consumption and decreasing Ucrit in each group during the course of the trial. The majority of other endpoints show no difference between groups (especially in energy budget of liver and muscles), but in some parameters, significant difference in 2.5 BL/s group was established at the end of the trial. That was the case with hepatosomatic index, as well as with gene expression of three studied genes: growth hormone receptor, insulin growth factor and cytochrome c oxidase. The results of our study and other studies show that the majority of fish species demonstrate the same pattern, which could potentially be very important to aquaculture: to increase weight gain during extensive swimming. This principle is well established for salmonid species, but in our study common carp also showed beneficial effects of sustained swimming, even though it is perceived as "lazy" fish, primarily because of its feeding habits in natural ecosystems. Results obtained in this trial give prospective for long-term studies (>90 days) of effects of extensive swimming to common carp in aquaculture.

***Key words:*** *common carp juveniles, raceways, Ucrit, aquaculture*

**Acknowledgements:** This study was performed during a Short-Term Scientific Mission supported by the COST Action FA1304 "Swimming of fish and implications for migration and aquaculture (FITFISH)."

**NOTES**

## LIMITING MAXIMUM METABOLIC RATE: IS OSMORESPIRATORY COMPROMISE PLAYING A MAJOR ROLE?

PATRÍCIA FERREIR[1,2], HUGO FLÁVIO[1,2], HARRY HACKING[2], JANET GENZ[3], JONATHAN M. WILSON[1,4], JANE BEHRENS[2], JON C. SVENDSEN[2]

[1]*CIIMAR - Interdisciplinary Centre of Marine andEnvironmental Research,Terminal de Cruzeiros Porto de Leixões, Av General Norton de Matos, S/N4450-208 Matosinhos, Portugal*

[2]*DTU-Aqua - National Institute of Aquatic Resources,Jægersborg Alle1, 2920Charlottenlund, Denmark*

[3]*University of West Georgia, Carrollton 1601 Maple St, 30118, Georgia, United States of America*

[4]*Wilfrid Laurier University, 75 University Avenue WestWaterloo, Ontario, Canada*

The round goby (*Neogobius melanostomus*) is a benthic fish native to the brackish waters of the Black and Caspian Seas, however, it has invaded severalbrackish and freshwater areas in North America and northern Europe. Notably, there are no records of *N. melanostomus* in high salinity marine habitats and, the physiological mechanisms constraining the invasion into this environment are largely unknown.

The gills play major roles in both gas exchange and ionic regulation and it has been hypothesized that an osmorespiratory compromise impacts optimal performance of each process. The tradeoff of the large gill exchange capacity ideal for gas exchange is greater passive ion fluxes.Waters with high ionic contents (i.e. salt water) would result in greater passive ion uptake that would require greater active ion excretion. This osmoregulatorydisturbance may interfere with fish invasion patterns by disrupting the regular activity of the gills, thus modifying the usual physiological mechanisms.

To examine if the osmorespiratory compromise could constrain the invasion of *N. melanostomusinto* high salinity environments, this study compared ion regulatory performance of metabolic phenotypes exposed to 0, 15 and 30 ppt water). More specifically, Na +/K+ ATPase activity.

Additionally, we examined variation in two important $\dot{M}O_2$ measures, standard metabolic rate (SMR) and maximum metabolic rate (MMR) when *N. melanostomus* is exposed to increasing water salinities. Fish with an initially higher MMR (at the control salinity – 0ppt) are likely to be more challenged by environmental stressors than fish with a lower MMR.

It is expected that differences in the ionic content of the water may interfere in the osmorespiratory compromise, altering the expression of the Na+/K+-ATPase enzyme. Consequently, this deregulation will affect the round goby metabolism and change the maximum metabolic rate (MMR) values. Our results

will provide a better understanding of the physiological mechanisms that may constrain invasive species in the aquatic environment.

***Key words:*** *Osmorespiratory compromise, respirometry, sodium-potassium ATPase*

**NOTES**

# CAN EXERCISE ENHANCE BRAIN PLASTICITY, COGNITION AND FORAGING BEHAVIOUR IN ATLANTIC SALMON?

DAAN MES[1], ARJAN P. PALSTRA[2], MARCO A. VINDAS[3,4], IAN MAYER[1]

[1]*Department of Production Animal Clinical Sciences, Norwegian University of Life Sciences, Oslo, Norway*

[2]*Wageningen University & Research Animal Breeding and Genomics, Wageningen Livestock Research, Wageningen, the Netherlands*

[3]*Institute for neuroscience and physiology, Gothenburg University, Gothenburg, Sweden*

[4]*Uni Environment, Uni Research As, Bergen, Norway*

The rearing environment in hatchery- and aquaculture facilities has profound effects on fish development, quality and welfare. Compared to natural conditions, hatchery-reared fish are stimulus-deprived and kept under unnaturally high densities. As a result, fish reared under intensive aquaculture conditionsshow neuroanatomical differences and display deviating behaviour as compared to wild fish. This has both welfare and reproduction implications for fish raised in intensive aquaculture, particularly for fish reared for compensatory restocking programs.European restocking programs release millions of Atlantic salmonevery year. Currently, they are characterized by a high post-release mortality of restocked fish, primarily because hatchery-reared fish lack the behavioural plasticity to survive in an unpredictable environment. Therefore, it is necessary that we find novel hatchery protocols that adequately prepare fish for life in the wild. Environment enrichment, i.e. providing more variable experiences to animals by adding objects to the holding tanks, has been shown to improve neuroplasticity and cognitive capacity in salmon parr. However, environment enrichment is unpopular with hatchery owners because it compromiseshatchery operations and hygiene standards. Here we propose a study to determine if swimming exercise can function as a novel tool to enhance brain plasticity and cognition in Atlantic salmon. Swimming exercise has previously been shown to improve fish growth rates, feed conversion efficiency, welfare and flesh quality in cultured fish.Furthermore, mammalian studies demonstrate that exercise canincrease brain plasticity and cognitive performance in adult mice and rats. In the current study, we will subject salmonparrto an 8-week exercise regime at either a volitional swimming speed or optimal metabolic swimming speed. After this training period, we willquantify the expression of brain plasticity and neurogenesis markers bdnf, cfosandpcnain the telencephalon, which contains sub-regions that are functionally homologous to the mammalian limbic structures. Two cognitive behavioural studies will be performed:a maze test anda novel prey test. Understanding how exercise affects brain plasticity and cognition may help optimizing rearing conditions in restocking programs to improve fish quality and post-release survival.

***Key words:*** *Behaviour, Brain plasticity, Restocking, Parr*

**NOTES**

# ABSTRACTS:
# POSTER PRESENTATIONS

# IMPACT OF THE ELECTRIC BARRIER AND FISH SCARING SYSTEM ON THE ACTIVITY AND MOVEMENT OF FISH ANALYSED BY MEANS OF A MULTIBEAM SONAR ARIS

BEATA SCHMIDT[1], RYSZARD KORNIJÓW[1], MARIUSZ ZALEWSKI[1], ADAM M. LEJK[1], KRZYSZTOF PAWLIKOWSKI[1], JOANNA CAŁKIEWICZ[1], SABINA ZIOŁA[2]

[1]*National Marine Fisheries Research Institute, Kołłątaja Str. 1, 81-332, Gdynia, Poland*

[2]*Wrocław University of Environmental and Life Sciences Grunwald Sq. 24, 50-363 Wrocław, Poland*

One of the ways of protection of fish against the harmful impact of turbines of water power plants is the installation of electric barriers applying electric current to scare away fish. Such barriers are also used for directing fish towards "entrances" to fish ladders, increasing the efficiency of reproductive migrations.

Fish protection system NEPTUN was installed on the Nysa Kłodzka River and Nysa dam reservoir located above (south-western Poland), in the immediate vicinity of the water dam. On the dam reservoir, it consisted of an electric barrier preventing fish from approaching the dam. On the river, an electric fish scaring system was installed, integrated with the electric barrier. Its task was to prevent concentration of fish near the dam, and to facilitate fish in finding the inlet to the fish ladder below the dam.

The research was conducted by means of a multibeam sonar ARIS (Adaptive Resolution Imaging Sonar). The comparison of the number of fish crossing the barrier in the dam reservoir and river over 6 days of measurements with the barrier on and off provided the basis for the determination of the efficiency of the barriers. The efficiency of the fish scaring system was determined by means of comparison of the number of fish in the monitored area before the commencement of activity of the system and after its completion.

The number of fish and their daily activity differed depending on the measurement site. The total number of observed fish in the river was almost 9 times higher than in the dam reservoir. In the river, the highest number of fish was recorded during daytime. Their activity considerably decreased by night. In the dam reservoir, a higher number of fish was observed only around dawn and dusk. The GLM analysis considering the meteorological conditions showed that the number of recorded fish, both in the dam reservoir and river, was affected by the wind direction and atmospheric pressure, and in the dam reservoir additionally by wind strength. The total efficiency of the barriers amounted to 99.4% and 79.7% in the river and dam reservoir respectively, and the efficiency of the fish scaring system – 38.2%.

***Key words:*** *fish protection, electric barrier, sonar ARIS*

**NOTES**

## OBSTACLES OF MIGRATORY FISH ON SWIMMING WAY IN TURKEY

DEVRİM MEMİŞ[1], ÖZCAN GAYGUSUZ[1], GÖKHAN TUNÇELLİ[1],MERİÇ ALBAY[1]

[1]*Ordu str. No:8 Laleli/İstanbul, İstanbul University Fisheries Faculty*

There are 33 rivers with a total length of 177,714 km on Turkey's 25 river basin. There are 368 fish species of 31 families, of which 153 are endemic in all inland waters (rivers, dam lakes, nature lakes etc.). Turkey has a rich variety of fish species. The life of migratory fish are threatened by human activities on rivers systems. These human activities that disrupt river integrity can be listed as; dam constructions, high levees and weirs, sand-gravel quarries, bridges, recreational works, water pollutions, over fishing, habitat losses, etc. The four endemic fish species (*Alburnus akili, A. nicaeensis, Aphanius splendens, Pseudophoxinus handlirschi*) belong to the Turkish inland fish fauna have completely extinct from the nature due to these activities.

In recent years, Turkey has gone to increase the number of Hydroelectric Power Plants (HEPPs) in rivers in order to supply the increasing electricity demand. However, almost none of the HEPPs that are completed or planned have fish passages. It is not known whether those who have fish passages work efficiently. The presence of gaps in the legislation such as the construction and supervision of fish passages and other obstacles cause the disappearance of migratory fish species which migrated for breeding and feeding in the river. This situation threatens the environment and biodiversity of Turkish fish fauna.

In particular, endangered fish species such as sturgeon, sea trout and European eel are much affected. For example, dams, HEPPs, regulators, bridges, sand-gravel quarries led to the losses of breeding and feeding habitats of sturgeons in the Sakarya River. The first HEPP on the Sakarya River is located about 90 km from the mouth of the river, and sturgeons try to spawn only this distance of 90 km if they do not encounter other obstacles. Sakarya River is 824 km long in total and there are 9 Dams / HEPPs on it, 7 of which are planned to be constructed. None of the fish passages with this dams or HEPPs were planned to migrate for sturgeons. They are planned technically for only small fish passing.

In order to solve swimming problems of sturgeons and other aquatic fauna in the river, firstly the fish passages of existing Hydroelectric Power Plants should be adapted to upstream and downstream migrations. All the structures and obstacles that prevent swimming activities in the river should be arranged gradually so that fish can migrate to reproduction and nutrition purposes in Turkey’s river systems.

***Key Words:*** *River, Fish, Migration, Obstacles, Fish passages, Swimming*

**NOTES**

## AQUAHEALTH FOR FISH SWIMMING

DAMIR KAPETANOVIĆ[1], DAMIR VALIĆ[1], IRENA VARDIĆ SMRZLIĆ[1], LORENA PERIĆ[1], JAKOV ŽUNIĆ[1], ANAMARIJA ĆUKURIN[1], EMIL GJURČEVIĆ[2], SNJEŽANA KUŽIR[2], BRANKA ŠEOL MARTINEC[2], KREŠIMIR MATANOVIĆ[2], KRISTINA PIKELJ[3], DARIJA VUKIĆ LUŠIĆ[4], ANA GAVRILOVIĆ[5], JURICA JUG-DUJAKOVIĆ[6], FABIO MARINO[7], DRAŽEN KNEŽEVIĆ[8]

[1]*Ruđer Bošković Institute, Bijenička c. 54, Zagreb, Croatia; kada@irb.hr*

[2]*Faculty of Veterinary Medicine, University in Zagreb, Heinzelova 55, Zagreb, Croatia*

[3]*Faculty of Science, University in Zagreb, Horvatovac 102a, Zagreb, Croatia*

[4]*Faculty of Medicine, University in Rijeka, Braće Branchetta 20/1, Rijeka, Croatia*

[5]*University Jurja Dobrile in Pula, Zagrebačka 30, Pula, Croatia*

[6]*Technology and Business Innovation Center for Mariculture, University in Dubrovnik, Ćira Carića 4, Dubrovnik, Croatia*

[7]*Centre for Experimental Fish Pathology, University of Messina, Piazza Pugliatti 1, Messina, Italy*

[8]*Croatian food agency, Ivana Gundulića 36, Osijek, Croatia*

Fish are always in intimate contact with their environment; therefore they are permanently exposed to different impacts. Comprehension that fish are in a very close contact with their environment, the bacterial genera present in the skin mucus seem to be those from the environment and it is apparent that there are many similarities between the bacterial communities in the water and those on fish. The internal organs of apparently healthy fish have been considered to be sterile, but isolations of bacteria from internal organs have frequently been reported. However, this bacterial community depends on the fish environment, fish species and its health status. For that reason, our project AQUAHEALTH (Aquatic microbial ecology as an indicator of the health status of the environment) proposes comprehensive study of physicochemical environmental conditions, as well as study of bacterial community within water column, sediment and fish as indicator of the aquatic environmental health status and its potential implications to human health. Fresh and marine water sampling will be conducted to assess inputs to the Ilova River, the Krka River and in the south part of East Adriatic (Malostonski bay), as well as the movement of nutrients and bacteria to identify and quantify the sources of pollution at each location. These three aquatic environments were chosen to cover different environmental rearing conditions and aquaculture technologies that due to our previous knowledge have different influence to the environment.

Fish swimming is elementary characteristic which providing their ability to develop, survive, grow and reproduce successfully. Swimming performance decreased following chronic exposure to environmental stress factors which contributing to health alteration. Non-optimal environmental parameters could be the trigger for opportunistic bacterial infections in fish. Until the appearance of clinical signs of disease infection is unrecognized and fish swimming is usually normal. Bacteria can affect all aspects of food production, in this case from aquaculture and fisheries through processing to retail, presence of some bacteria presenting a threat to the public health.

***Key words:*** *environment, bacteria, Ilova; Krka, Malostonski bay*

**NOTES**

# ASSESSMENT OF ECOLOGICAL FLOW RATES IN SMALL SCALE HYDROPOWER PLANTS: A CASE STUDY FROM TURKEY

AHMET ALP[1]; ADİL AKYÜZ[2]

[1]*University of Kahramanmaraş Sütçü İmam, Faculty of Agriculture, Department of Fisheries, Kahramanmaraş, Turkey; aalp46@gmail.com*

[2]*University of Kahramanmaraş Sütçü İmam, Faculty of Agriculture, Department of Biosystem Egineering, Kahramanmaraş, Turkey*

One of the most important environmental impacts of small scale hydropower plants is that not enough water have been released to the downstream. Ecological flow rate is defined as the flow that is necessary to ensure the sustainability and existence of habitats in a river after all water uses have been considered and out. Hydrological, hydroulic rate, habitat simulation and holistic methods are used to determine ecological flow rate. In the last 15 years, more than 1200 small scale hydropower stations have been constructed in Turkey and ecological flow rate of their majority were estimated with Tennat method (%10 of the daily flows) while some of them estimated according to wetted perimeter method.

In this study, ecological flow rates of Tekir Stream in Ceyhan River Basin and Bulam Stream in Euphrates River River Basin in Turkey were assessed using 4 different methods (Tennat, 7Q10, flow duration indices and wetted perimeter). Ecological flow rate in Tekir Stream was estimated as 0.537 $m^3/s$ in Tennant Method, 0.505 $m^3/s$ in 7Q10 Method, 0.875 $m^3/s$ in flow duration method, and 1.110 $m^3/s$ in wetted perimeter method. In Bulam Stream, ecological flow rate was also estimated as 0.366 $m^3/s$ in Tennant Method, 0.928 $m^3/s$ in 7Q10 Method, 0.960 $m^3/s$ in flow duration method and 0.910 $m^3/s$ in wetted perimeter method. Considering the ecological flow rates according to the wetted perimeter method, depth and flow velocity in Tekir Stream will be 30 cm and 0.41 m/s. In Bulam Stream the depth and flow velocity will also be 38 cm and 0.45 m/s.

Consequently, the 10% flow ratio determined based on Tennant Method is too low and it is considered that an optimum amount of ecological flow rate should be determined in consideration of other methods. Otherwise, stream habitats may be damaged, the migration and movements of the fish may be prevented and sustainability of the aquatic life may reduce.

***Key words:*** *Ecological flow, hydropower, habitat, Turkey*

**NOTES**