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# Towards a responsible future in inland fisheries

## EIFAAC 2012 SYMPOSIUM
## Hämeenlinna, Finland
## 22-24 October 2012

## ABSTRACTS

Markku Pursiainen & Anneli Kinnunen (eds.)

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**Abstract**

The European Inland Fisheries and Aquaculture Advisory Commission (EIFAAC) of UN/FAO have biannual Sessions for the 33 member states. The Session offers a good possibility and synergy to organize a Symposium concentrating on some selected pan-European subject in inland fisheries and aquaculture. The 27th Session of EIFAAC was held in Hämeenlinna, Finland, on 24–26 October 2012. Prior to the Session the Ministry of Agriculture and Forestry of Finland together with the Finnish Game and Fisheries Research Institute hosted the Symposium "*Towards a responsible future in inland fisheries – Management-related collaboration in inland fisheries and aquaculture*", with a special emphasis on collaboration in fisheries management. This document is a collection of the abstracts of oral or poster contributions in the Symposium.



**Keywords**

eifaac, symposium abstracts, fisheries management, inland fisheries, aquaculture

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**Additional information**

Selected papers will be published in BER (Boreal Environmental Research)

# Kuvailulehti


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| **Tekijät**<br>Markku Pursiainen & Anneli Kinnunen (toim.) | | | |
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**Tiivistelmä**

Yhdistyneiden kansakuntien FAO:n alainen Euroopan sisävesikalatalouskomissio (EIFAAC) järjestää kahden vuoden välein komission 33 jäsenvaltion yleisistunnon. Istuntojen yhteydessä on usein tapana järjestää johonkin keskeiseen yleiseurooppalaiseen kalatalouden teemaan paneutuva symposium. EIFAACin 27. istunto järjestettiin Hämeelinnassa 24.–26. lokakuuta 2012. Istuntoa 22.–24. lokakuuta 2012 edeltäneen symposiumin järjestivät Maa- ja metsätalousministeriö ja Riista ja kalatalouden tutkimuslaitos. Symposiumin teemana oli tulevaisuuden vastuullinen kalatalous, jossa korostettiin yhteistyön merkitystä kalavarojen hoidossa ja hyödyntämisessä (*Towards a responsible future in inland fisheries – Management-related collaboration in inland fisheries and aquaculture*). Käsillä oleva dokumentti on symposiumesitelmien ja postereiden tiivistelmäkooste.



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| **Asiasanat**<br>eifaac, symposium abstracts, fisheries management, inland fisheries, aquaculture | |
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| **Muita tietoja**<br>Valittuja artikkeleita julkaistaan BER-sarjan erikoisniteenä | |

# Contents

# Forword

European Inland Fisheries Advisory Commission (EIFAC), a regional fishery body of FAO, was established in 1957 by the FAO Council under Article VI-1 of FAO Constitution. EIFAC held its first session in 1960 in Dublin, Ireland.

The mission of EIFAC is to promote the long-term sustainable development, utilization, conservation, restoration and responsible management of European inland fisheries and aquaculture, consistent with the objectives and principles of the FAO Code of Conduct for Responsible Fisheries and other relevant international instruments, and to support sustainable economic, social, and recreational activities towards these goals through:

- providing advice, information and coordination;
- encouraging enhanced stakeholder participation and communication; and
- the delivery of effective research.

The Council of FAO in its 140th Session has adopted Resolution 3/140, taking note that the Twenty Fifth Session of EIFAC, held in Antalya, Turkey, from 21 to 28 May 2008 had agreed to change the name of EIFAC, introducing aquaculture in order to recognize the importance of aquaculture to the countries in Europe and to properly reflect the activities of EIFAC, and decided to approve the revised name and Statutes of the Commission, whereby the European Inland Fisheries Advisory Commission (EIFAC) is now called European Inland Fisheries and Aquaculture Advisory Commission (EIFAAC). 33 member states and European Union are the members of the Commission.

In the twenty-fifth Session of the Commission in Antalya, Turkey, in 2008, the delegate of Finland preliminary informed the Commission that Finland is prepared to host the 27$^{th}$ Session in 2012, which was again approved in the 26$^{th}$ Session in Zagreb, Croatia, in 2010.

The twenty-seventh Session of EIFAAC, originally planned to be held 13-15 June 2012 in Hämeenlinna, Finland, was postponed regardless of the host country and it turned out to be impossible to organize the Symposium, planned to be held prior to the Session in 11-13 June 2012 independently without the benefit of the synergy with EIFAAC Session. It was then decided to organize the 27$^{th}$ Session from 24 Oct (noon) to 26 Oct. Therefore it was agreed that the Session would be preceded by the symposium from 22 Oct to 24 Oct, noon.

The main target of the Symposium titled “Towards a responsible future in inland fisheries – Management-related collaboration in inland fisheries and aquaculture” consists of four sessions and a poster session. The Symposium is organized hosted, according to the new procedures of EIFAAC, by the host country only. Anyhow, EIFAAC’s umbrella has been, and still is, of a great value in organizing this kind of event. On the national level, the Symposium is supported by the Ministry of Agriculture and Forestry of Finland, and organized by the Finnish Game and Fisheries Research Institute. The scientific and organizing groups provided their expertise and valuable help in the complicated preparations of the event.

# Program and timetable

EIFAAC Symposium 2012
Hämeenlinna, Finland 22 – 24 October 2012
www.rktl.fi/eifaac

# Towards a responsible future in inland fisheries

## Management-related collaboration in inland fisheries and aquaculture

## Symposium program and timetable

(Minor alterations possible)

### Sunday 21 October

16:00-20:00 Registration desk open

*(18:00-18:30 Meeting of the Scientific Group and Symposium rapporteurs)*

### Monday 22 October

08:00-20:00 Registration desk open

**09:00-09:30 Opening of the Symposium**
*Director general Pentti Lähteenoja (Ministry of Agriculture and Forestry)*

**SESSION 1 View to the management of freshwater fisheries**
*Chairperson Tapio Hakaste*

09:30-10:10 Challenge of managing inland fisheries
*Suuronen P. & Bartley, D.M.* (Key note)

10:10-10:30 Environmental river enhancement
*Delanty, K., O'Grady, M. & King, J.*

**10:30-11:00 Coffee break**

11:00-11:20 Pikeperch in the Archipelago Sea: dependence of recruitment on the spawning stock biomass and temperature
*Heikinheimo, O., Auvinen, H., Pekcan-Hekim, Z. & Raitaniemi, J.*

11:20-11:40 Improving the status of river fish communities in changing climate: from in-stream habitat restoration to catchment management
*Vehanen, T., Sutela, J. & Harjunpää, A.*

11:40-12:00 Northern inland fishery will be challenged by climate change – case Lake Säkylän Pyhäjärvi (SW Finland)
*Ventelä A.-M., Tarvainen M., Kirkkala T. & Sarvala J.*

12:00-12:20 Modeling stock re-building trajectories of Baltic salmon in regulated rivers across alternative scenarios – a science-based tool for management
*Erkinaro, J., Mäki-Petäys, A., van der Meer, O., Romakkaniemi, A., Orell, P & Rivinoja, P.*

**12:30-14:00 Lunch**

14:00-14:20 Catchment-wide electrofishing as a means of salmon stock assessment in Ireland
*Gargan, P. & Roche, W.*

14:20-14:40 Extending sustainable fisheries management to the entire Lake Vesijärvi – effects on fish community and catches
*Ruuhijärvi, J. & Ala-Opas, P.*

14:40-15:00 Micro satellite DNA studies of brown trout (Salmo trutta L.) populations in Ireland – a valuable management tool
*O'Grady, M.F.*

**SESSION 2 Collaboration and fisheries management**
*Chairperson Jukka Muhonen*

15:00-15:30 Governance of fisheries and aquaculture operations, importance of images and co-operation
*Mäkinen, T. & Salmi, P.* (invited speaker)

**15:30-16:00 Coffee break**

16:00-16:20 Co-management in the Netherlands; collaboration between recreational fishing, commercial fishing and water authorities in Fishery Management Committees
*Aalderen van, R.A.A.*

16:20-16:40 Training needs analysis of fishermen in the Batinah Coast of Oman
*Belwal, R., Belwal, S. & Al Jabri, O.*

16:40-17:00 Exploring the role of participatory research in fisheries governance and management – a case study from Lake Vättern, Sweden
*Sandström, A. & Norrgård, J.*

17:00-17:20 Different interpretation of sustainability in aquaculture – case of two Baltic Sea neighbors
*Mäkinen, T., Forsman, L. & Salmi, P.*

17:20-17:40 What do Lake Lipno stakeholders want? Analysis of stakeholder groups and preferences based on interviews for a Czech reservoir resource
*Dankel, D. J., Jankovský, M., Boukal, D. S., Heino, M.*

**18:00-20:00 POSTER SESSION** (list of posters at the end of the program)
*Introduced by Petri Heinimaa*

## Tuesday 23 October

08:00-20:00 Registration desk open

**SESSION 3** **Fisheries management and fish populations**
*Chairperson Hannu Lehtonen*

09:00-09:40 Fish and their management in European reservoirs
*Kubecka, J.* (Key note)

09:40-10:00 Mixed stock and multi-species fisheries management by large scale stocking of whitefish, brown trout and Arctic charr in a large Lake Inari, northernmost Finland
*Niva, T.*

10:00-10:20 Relation between food availability and the level of bream economic catches in a lowland dam reservoir in Central Europe
*Prus, P.*

**10:30-11:00 Coffee break**

11:00-11:30 Can we manage fish populations - case studies from Finland
*Sarvala, J.* (invited speaker)

11:30-11:50 Ecosystem effects of non and size-selective perch fishing in a small forest lake
*Olin, M., Estlander, S., Vinni, M., Hellen, N., Tiainen, J., Rask, M. & Lehtonen, H.*

11:50-12:10 Potentials for tailor made eel management at river basin and smaller management units
*Heinen, A. & Kruitwagen, G.*

12:10-12:30 Is different fishery management in boreal large lakes reflected in salmonid stocks?
*Syrjänen J. T., Norrgård J. R., Huusko A., Urpanen O., Valkeajärvi P. & Sandström A.*

**12:30-14:00 Lunch**

14.00-14.20 Effects of size selective fishing on pike stocks after 5 years
*Tiainen, J., Olin, M., Rask, M., Ruuhijärvi, J. & Lehtonen, H.*

14.20-14:40 How do alternative minimum size limits perform in the management of pikeperch Sander lucioperca stocks differing in growth and maturation patterns?
*Vainikka, A., Hyvärinen, P., Olin, M. & Ruuhijärvi, J.*

**SESSION 4** **Role of crayfish in the freshwater fisheries management**
*Chairperson Anne-Mari Ventelä*

14:50-15:30 Freshwater crayfish and ecosystem services in a changing world
*Gherardi, F.* (key note)

**15:30-16:00 Coffee break**

16.00-16:30 How to achieve and manage a sustainable fishery of signal crayfish?
*Edsman, L., Sandström, A. Engdahl, F., Ågren M., Andersson M., Asp A., Bohman P., Fjälling A., Nyström P., Olsson, K. & Stenberg, M.*

16:30-16:50 Reproduction success of the signal crayfish in Northern latitudes
*Savolainen, R., Railo, E. & Pursiainen, M.*

16:50-17.10 Predation of introduced signal crayfish on salmonid fish eggs during long winter incubation period in large boreal lakes
*Ruokonen T.J., Karjalainen, J., Martikainen, A. & Pursiainen, M.*

17.10-17:30 Distribution of the noble and signal crayfish in Finland with the perspective of aquatic resources for crayfish
*Pursiainen, M.*

*(17:40-18:30 Meeting of the Scientific Group, Symposium rapporteurs, key note and invited speakers)*

## Wednesday 24 October

08:00-20:00 Registration desk open

**Session 4** **Role of crayfish in the freshwater fisheries management (cntd)**
*Chairperson Anne-Mari Ventelä*

09:00-09:30 How to minimize the risk of the plague in crayfish population management
*Viljamaa-Dirks, S.* (invited speaker)

09:30-09:50 Noble crayfish (*Astacus astacus* L.) stocking success in south-eastern Finland
*Erkamo, E., Rajala, J. & Tulonen, J.*

09:50-10:10 To be or not to be a pathogen: co-evolution of crayfish plague (*Aphanomyces astaci*) and its native European freshwater crayfish hosts
*Jussila, J., Makkonen, J., Kortet, R, Vainikka, A. & Kokko, H.*

10:10-10:30 The Swedish Action Plan for Noble Crayfish
*Edsman, L.*

**10:30-11:00 Coffee break**

## Closing session

*Chairperson Cathal Gallagher*

11:00-11:20 Towards targeted research in the fish and crayfish management
*Summary of the scientific outcome of the Symposium by Raine Kortet*

11:20-11:50 Governance development in the fisheries management; Symposium resolutions and recommendations to the EIFAAC session
*Summary of the administrative outcome of the Symposium by Rudolf Müller*

11:50-12:10 EIFAAC Symposiums after restructuring of EIFAAC
*Tomas Brenner, EIFAAC Chairperson*

12:10-12:30 Closing of the EIFAAC 2012 Symposium
*Eero Helle, Director General, Finnish Game and Fisheries Research Institute*

**19:00-20:30 Reception, treated by the city of Hämeenlinna**
Joint event, Symposium and Session participants
City Hall / Raatihuoneen juhlasali

## List of posters (in order of contributions in the poster session)

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*Salmi, P.*

Fishing regions, part of hierarchy or a network
*Hakaste, T.*

Sustainability of interlocked fishing district -management concept for commercial fishing in Finnish lake fishery
*Muje, K., Marjomäki, T.J., Karjalainen, J., Sipponen, M., Lindroos, M., Valkeajärvi, P.*

Finnish-Estonian HEALFISH and Finnish-Russian RIFCI -twin projects for the benefit of Gulf of Finnish salmonid stocks
*Kaukoranta, M., Kulotie, P. & Vaittinen, M.*

Recovery of acidified lakes in Finland and subsequent responses of perch and roach populations
*Rask, M., Vuorenmaa, J., Nyberg, K., Mannio, J., Olin, M. & Kortelainen, P.*

Food of great cormorants (Phalacrocorax carbo sinensis) in the Archipelago Sea, southwestern coast of Finland
*Salmi, J.A., Auvinen, H., Raitaniemi, J., Lilja, J. & Maikola, R.*

Fish population recovery and research in “Rivers and fish – our common interest” (RIFCI)
*Saura, A. & Peuhkuri, N.*

Research in experimental settings strengthens the knowledge of freshwater fish ecology and management
*Saarikettu-Känsälä, M., Hyvärinen, P., Korhonen, P.K. and Huusko, A.*

Characteristics of yield per swept area for professional vendace trawling
*Marjomäki, T.J., Huolila, M. & Valkeajärvi, P.*

Innovation and research network in changing climate - case crayfish
*Ruokonen T.J., Jori M., Ventelä A-M., Tarvainen M., Karjalainen J.*

Producing cormorants (Phalacrocorax carbo sinensis) in the Baltic Sea region for Europe -– is more extensive management needed?
*Heinimaa, P.*

Preserving endangered fish species and stocks by Aquaculture in Finland
*Heinimaa, P., Makkonen, J. and Määttä, V.*

Effects of replacing fish meal/oil with plant sources in diet of Beluga sturgeon (Huso huso) on growth parameneters
*Agh, N., Jalili, R. & Bahram Beigi M.*

Replacement of dietary fish meal/oil with plant sources on growth performance, immune responses, blood indices and disease resistance in rainbow trout (*Onchorhynchus mykiss*)
*Agh, N., Jalili, R., Tokmechi, A., & Noori, F.*

Effect of dietary Bovine Lactoferrin on rainbow trout (Oncorhynchus mykiss) fecundity
*Ahmadian, E, Agh, N. & Jalili, R.*

Effects of dietary protein sources on growth performance, feed utilization and digestive enzyme activity in rainbow trout (*Oncorhynchus mykiss*)
*Noori, F., Jalili, R., Agh, N.*

Developing responsible aquaculture in the Baltic Sea region (Aquabest)
*Vielma, J.*

## Symposium proceedings

The Proceedings of the EIFAAC 2012 Symposium will be published as a Special Issue of the journal **Boreal Environment Research** (BER). Only original, previously unpublished research reports or reviews will be included in the Proceedings.

The Instructions for Authors are found on the website of BER (www.borenv.net). Send your manuscript in PDF format to the Managing Editor Krzysztof Raciborski by email (sekj@helsinki.fi), along with the completed **Submission form**. In the subject field of your email message, write EIFAAC.

Please submit your manuscript as soon as possible after the Symposium, but until the end of February 2013 at the latest. The manuscripts selected for potential publication will be peer-reviewed by at least two unbiased referees, and only high-quality papers will be accepted.

The Special Issue is planned to be published by the end of 2013. To enhance the process, please follow carefully the Instructions for Authors of BER when preparing your manuscript.

# Opening of the symposium

Director General Pentti Lähteenoja (Ministry of Agriculture and Forestry)

Dear FAO Representatives, Distinguished Scientists, Ladies and Gentlemen,

It is a great pleasure for me to welcome you here in Finland. Finland is most pleased to again host this EIFAAC symposium, after so many years. Finland is well known for our thousands of lakes and extensive waterways, which is also why fishing is so very important for us. This provides a very suitable framework for the Symposium, Towards a Responsible Future in Inland Fisheries.

The EIFAAC Symposiums have a long history and they have been an important meeting place for people involved in fisheries. One important feature of the EIFAAC Symposiums has been that they have given the opportunity to a wide range of persons representing science, administration and management to participate and discuss within each other.

It was indeed a setback for the organisation when FAO could not support the Symposium after the very successful one in Turkey, Antalya in 2008. When Finland decided to host the 27th EIFAAC Session, it was considered important to find a way to continue the tradition of EIFAAC-related Symposiums. This time the Symposium is organised by the host country. We hope that this tradition will continue also in the future. Exchange of information and experiences and arenas for international discussion on inland fisheries are a vital part of the EIFAAC work.

The world keeps changing fast and in many ways, and fisheries and aquaculture must also adapt to this. We are facing major problems, such as those relating to climate change. Important changes in the society also make it necessary to find new solutions, including biologically and socially more sustainable practices for managing fisheries and better ways to apply governance in inland fisheries.

The role of crayfish in Finnish inland fisheries has grown in importance in the past decade, after a long decline mainly due to crayfish plague. Crayfish as a theme is particularly well suited to the surrounding area, traditionally known as one of the main areas for crayfish culture in Finland.

Each year, almost half of the Finnish population goes fishing, which is among our most common outdoor activities. This means that we need research on recreational fishing, and especially the socio-economic issues that are important for the sustainability of fisheries in the modern, and changing society. The yearly catch from Finnish inland waters is about 30 000 tonnes, and 90 per cent of the catch is taken by recreational fishers. The estimated value of the catch is about 50 M€, but besides this recreational fishing produces a great deal of other values and value added. The most common species caught by recreational fishers are pike, perch, roach, pike-perch and whitefish. Professional fishing is mainly targeted to the small whitefish, vendace.

Right now we are gathered here on the shore of Lake Vanajavesi, a very typical water system in southern Finland. Lake Vanajavesi is well known for its pike-perch, and it offers attractive fishing opportunities for many thousands of Finns. It also supports some small-scale commercial fisheries and fishing tourism. There are many other lakes within the Hämeenlinna area and the town provides excellent opportunities to go fishing or catch crayfish for all its inhabitants.

At the moment, there are several important projects under way in the Finnish fisheries administration. A major overhaul of the Finnish Fishing Act is being prepared. Quite recently we completed a national fish passage strategy, and at the moment we are renewing our crayfish management strategy.

To conclude, I wish you all a most interesting and successful Symposium and hope that you will enjoy your stay here in Hämeenlinna.

# SESSION 1: View to the management of freshwater fisheries

## Challenge of managing inland fisheries – using the ecosystem approach

Suuronen, P. & Bartley, D. M.
FAO Fisheries and Aquaculture Department, Viale delle Terme di Caracalla, 00153 Rome Italy. E-mail: petri.suuronen[at]fao.org

Inland water fisheries are an important source of food and livelihood, particularly in poorer countries and in the rural regions. Ninety percent of inland fishery production comes from developing countries. Globally, inland fisheries provide employment for some 60 million people. Nonetheless, the socio-economic importance of inland fisheries is often undervalued and the opportunities are inadequately addressed in national and international policies for development.

Although irresponsible fishing can seriously impact the sector, many of the threats of inland fisheries originate from outside the sector. These include loss and degradation of habitat, drainage of wetlands, dam construction, pollution and eutrophication. These drivers are strong and widespread, and are often acting together, causing substantial decline or change in inland fishery resources. Those who have most need of the benefits inland fisheries can provide, are particularly at risk from these pressures. Although changes in the practices are needed within the sector, the future of inland fishery sector depends largely on responsible development in other sectors. There exists a great need for policies and governance on inland fisheries to be closely integrated with those of other sectors, including aquaculture.

The ecosystem approach to fisheries (EAF) is an integrated approach to fisheries management that strives to balance a diversity of societal objectives, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by aquatic ecosystems. Although FAO developed this approach initially for marine fisheries, the same principles apply to inland fisheries. Implementation of the approach to inland fisheries presents special challenges that arise from the multiple uses of inland waters, the extent of influences that are external to the fishery sector, and the difficulties in acquiring accurate information on the sector. The basic elements of an ecosystem approach include identification of relevant stakeholders, identification of broad and specific objectives of management that may include more than maximizing fishery production, and establishment of a monitoring system with appropriate indicators. By addressing both the human and ecological dimensions of sustainability, the EAF represents the realization of sustainable development in fisheries. EAF will require a broadening of the the scope of fisheries research that is supporting management.

*Key words*

*inland fisheries; challenges; ecosystem approach; fishery management; sustainable use*

## Environmental river enhancement

Delanty K., O'Grady, M. & King, J.
Inland Fisheries Ireland, Swords Business Campus, Swords, County Dublin, Ireland. E-mail: Karen.Delanty[at]fisheriesireland.ie

Ireland's inland fisheries and waterways are an important part of our natural heritage and today, arterially drained rivers form part of that aquatic environment. These drained rivers are a result of a number of large and small scale arterial drainage schemes which have been carried out, across the country, by the Office of Public Works (OPW) since the 1940's. Maintenance has been and continues to be required on a number of these schemes since their initial drainage. While such works substantially reduced flooding in many areas and brought much benefit to agriculture there were unfortunately negative impacts on fisheries, angling and on the river corridor habitat.

The impacts of drainage on a river channel was often quite severe leading to disturbance both within the channel and along the river corridor. The majority of drained rivers resulted in uniform straightened shallow channels that were excessively wide and often entrenched. Such changes to the hydromorphology led to changes to the whole aquatic environment, impacting fish communities, flora and fauna both instream and on along the banks. Natural recovery of the channel post drainage was not always possible as the river was not always capable of generating sufficient energy to reorganise bed materials into a natural physical form and so the normal sequence of a riffle/glide/pool could not be re-established. As a consequence of the excavation of the channel bed gravels, cobbles and boulders were often removed and placed on the bank as spoil heaps. Other problems associated with drained rivers included no recovery of the riparian zone where rivers were not fenced off, or where you do have fencing, tunnelling may have occurred in the form of a dense monoculture of trees, usually of alders. Bank erosion is frequently evident leading to excessive siltation within in many of these channels which in turn may encourage excessive weed growth often in the form of water celery. All of these will generally have a negative impact on the fisheries potential of the drained channel.

Over the years a number of National and European legislative requirements, in particular the Water Framework Directive, have been implemented. This has put pressure on agencies dealing with the aquatic environment to review work practices and implement measures that would have an overall benefiting impact on the river corridor and where necessary implement a series of measures that would improve channel morphology.

The EREP (Environmental River Enhancement Programme) is an OPW funded project that is being co-ordinated and managed by the IFI and has an initial term of five years, 2008-2012. The programme will focus on the enhancement of drained salmonid rivers in Ireland and provide an appraisal of the ecology of the river corridor and of the positive impacts of the enhancement works.

*Key words*

*hydromorphology, river enhancement, Water Framework Directive*

# Pikeperch in the Archipelago Sea: dependence of recruitment on the spawning stock biomass and temperature

Heikinheimo, O., Pekcan-Hekim, Z. & Raitaniemi, J.
Finnish Game and Fisheries Research Institute, P.O. Box 2, Viikinkaari 4, 00791 Helsinki, Finland. E-mail: outi.heikinheimo[at]rktl.fi

Pikeperch (*Sander lucioperca*) is an important target species for commercial and recreational fisheries in the Archipelago Sea, south-western coast of Finland. Wide fluctuations in the year-class strengths are known to be linked to summer temperatures, but the role of the size of the spawning stock has not been studied before. In this study, a stock-recruitment relationship with temperature as an environmental variable was fitted to stock assessment data based on a long time series of catch statistics and commercial catch samples. As expected, the summer temperature (mean water temperature in July –August) was the most important factor that determined the year class strengths. The results indicate that there was also a density-dependent effect: negative impact of the size of the spawning stock on the number of recruits produced per unit of spawning stock biomass. The coefficient of determination of the stock-recruitment model was close to 0.8. The stock-recruitment relationship is important for predicting future year-class strengths of pikeperch under different scenarios such as climate change, and modeling the effects of fishing or fisheries management.

*Key words*

*Sander lucioperca, stock assessment, stock-recruitment relationship, Baltic Sea*

## Improving the status of river fish communities in changing climate: from in-stream habitat restoration to catchment management

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Increased awareness of the degradation of the freshwaters has led authorities to increase management efforts. Examples of these are Clean Water Act in the U.S. and European Union Water Framework Directive (WFD). WFD enforces the development of assessment and mitigation methods to monitor and improve the ecological status of inland waters using information from different biological quality elements like riverine fish communities. In Finnish rivers the main pressures are morphological (dams, flood control, dredging) and water quality (agriculture, forestry and peat mining) pressures. In addition, the largest area of Acid Sulfate Soils (ASS) in Europe is found in Finnish coastline. An important question for the future is where should we focus on in our management efforts to effectively improve the status of rivers? The main focus in Finnish rivers has been in physical in-stream habitat restoration. In the current paper we show that in-stream restoration can be an ineffective method to mitigate fish populations. Large-scale regional factors, like extreme weather conditions, may overwhelm local restoration efforts especially in cases when also the catchment is adversely affected by anthropogenic pressures. Water quality, especially loading of solids and phosphorus from agriculture land, can have a large impact on riverine fish populations. We also show that that acid releases from ASS soils used as agricultural land, usually connected to heavy precipitation events, have lead to severe degradation of the fish biota in the rivers of the area. Based on climate scenarios temperatures will increase in the Finland especially in winter with increasing winter precipitation and frequency of extreme weather events. Heavy precipitation events will increase the possibility of nutrient loading from agricultural lands and acid releases from ASS soils. Our results suggest that in the future a wider perspective should be adopted in restoration efforts; from in stream restoration to the management of the entire catchment.

*Key words*

*river fish community, river restoration, water quality, ASS soils, WFD*

# Northern inland fishery will be challenged by climate change – case Lake Säkylän Pyhäjärvi (SW Finland)

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Säkylän Pyhäjärvi (SW Finland, North Europe) is large (155 km2) and shallow lake (5.5 m), which has vital commercial fishery, with 20 fishermen. The lake is eutrophicated and has been target of an intensive restoration program since early 1990s. The most important commercial catch species are vendace (Coregonus albula) and perch (Perca fluviatilis). The annual harvest rate approaches the total production of vendace, implying that the fishery for decades has acted as intensive biomanipulation. In addition to this commercial fishery, Pyhäjärvi restoration project has subsidized the harvest of commercially unwanted fish species (roach, ruffe, smelt) since 1995, aiming to improve water quality. Thus, the biomanipulation of this lake has not been a short term restoration measure, repeated once or twice as in most reported lake biomanipulation projects, but it has continued for more than 17 years and will be continuously needed, as in spite of all the catchment measures, the external load reduction is still not efficient enough and will progress too slowly in agricultural areas.

The majority of the vendace and perch catches are taken in winter, using seine-netting from below the ice. The lake is located in the cool climate zone and is normally ice-covered for 141 days in average. Ice-out has shifted to an earlier date, and the duration of ice-cover is decreasing, quite dramatically so in the 2000s. Also, there was a significant decline in vendace year class size during the period 1971-2010, which can be linked with climatic conditions. As the commercial fishery in Pyhäjärvi is mainly based on winter seining of vendace through the ice, it is currently seriously challenged by climatic variation

*Key words*

*inland fishery, biomanipulation, eutrophication, climate change*

## Modeling stock re-building trajectories of Baltic salmon in regulated rivers across alternative scenarios – a science-based tool for management

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Baltic salmon population re-building trajectories were modeled for strongly regulated rivers of the Bay of Bothnia. We developed a simple population model where vital life-history parameters were entered as Pert distributions and Monte Carlo sampling was utilized to simulate population size over a 50-year time span. Parameter values were based on literature and the general life-history model used for Baltic salmon population modeling by the International Council for the Exploration of the Sea. Several realizations of possible future scenarios indicated that central morality parameters included those that can be regulated by regional, national or international management decisions. Population development was also strongly affected by salmon post smolt mortality at sea, an environment-driven factor, which cannot be affected in short term by direct human intervention. Management decisions include regulating fishing mortality in offshore, coastal and estuarine fisheries, but also managing the environment by assuring safe smolt passage at hydrodams and favorable egg to smolt survival in fluvial environment through habitat restoration in free-flowing stretches of the former salmon rivers. The model indicated that these factors in freshwater life stages may also play an important role in determining the realized trajectories in salmon population restoration. The model can be used as a simple tool with a capacity of demonstrating the crucial parameters, in planning the management decisions for re-building salmon stocks in regulated rivers.

*Key words*

*Baltic salmon, regulated rivers, life history model, stock re-building trajectories, management scenarios*

## Catchment-wide electrofishing as a means of salmon stock assessment in Ireland

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Conservation Limits have been set for all 148 Irish salmon rivers and recreational and commercial inshore fisheries are now regulated relative to these conservation limits being met on a river by river basis annually. The Standing Scientific Committee (SSC) of Inland Fisheries Ireland annually review all data for salmon rivers to provide scientific advice on the attainment levels of salmon conservation limits on each river. Data generated on an annual basis from salmon rod and commercial catches and counter data is analysed to determine if rivers are meeting their spawning targets.

Many small rivers or rivers deemed not to be meeting their conservation limit are closed to angling and commercial exploitation. Therefore there is no direct measure of salmon runs to advise on stock status for future years. It will not be possible to install fish counters in all rivers to assess stock status and many rivers (up to 107 in 2007) were closed and could remain so unless other measures of stock strength can be found. An indirect measure of salmon abundance, i.e. catchment wide electrofishing, is being developed in Ireland to provide a means of assessing salmon abundance on rivers with no direct means of assessment. In many rivers without counters, which are closed to angling and have unreliable salmon redd count data, this juvenile salmon index may be the only feasible measure of salmon abundance.

Data from the catchment-wide electro-fishing survey programme indicates that the technique is very valuable in assessing the status of juvenile salmon stocks in catchments nationally. As the abundance of salmon fry during the summer period is an index of salmon spawning in the previous winter, the technique has potential to assess salmon stock status. Catchment-wide electro-fishing is also important in providing managers with information on the distribution and abundance of salmon fry and to identify management issues in a catchment or tributary. The absence or low density of salmon fry may be related to water quality issues, obstructions, or habitat damage and areas of low abundance can be investigated.

*Key words*

*conservation limits, salmon, catchment-wide electro-fishing*

# Extending sustainable fisheries management to the entire Lake Vesijärvi – effects on fish community and catches

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The management procedure successfully implemented in the Enonselkä basin (2600 ha) of Lake Vesijärvi, southern Finland, since 1990s was extended on the other basins of the Lake (8400 ha) during last decade. Management fishing targeted on cyprinids in 2002-2005 and mesh size restriction of gillnets (23-49 mm forbidden) applied on the whole lake 2008 onwards were the main measures. A raised minimum size limit of 42 cm for pikeperch was prescribed in 2008 also.

Fish community was monitored with annual sampling with NORDIC multimesh survey nets. Fish catches were estimated with mailed questionnaires.

The fish community shifted towards dominance of percids and share of cyprinids declined. The proportion of predatory fish in the catches of NORDIC nets rose from 10 % measured in weight in 2002-2004 to 35-45 % in 2009-2011. A parallel increase of the catches of pikeperch and big perch was observed. The changes improved the ecological status as well as the fisheries of the Lake Vesijärvi.

*Key words*

*lake management, inland fisheries, sustainability, fish community*

# Micro satellite DNA studies of brown trout (Salmo trutta L.) populations in Ireland – a valuable management tool

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Ireland has a number of large, shallow, naturally eutrophic lakes which are managed as wild brown trout (Salmo trutta L.) fisheries. The trout spawn in the riverine sub catchments to these lakes. Young trout migrate to the lakes as 0+, 1+ or 2+ year old individuals, only returning to their natal streams to spawn. Optimising the production of wild trout in these rivers is key to the provision of quality trout angling in the lakes.

This paper describes the findings of a microsatellite DNA study designed primarily to establish the extent to which individual sub catchments make a contribution to the adult trout stock in their recipient lake.

The pattern of gene flow, from one sub-population to another, within individual lake basins, is described. The usefulness of these data in illustrating the value of a hatchery programme on one lake is highlighted.

These studies can also be used to illustrate the extent of trout movement from one lake basin to another.

The impacts of how anthropogenic changes on the landscape have affected the "genetic stature" of trout populations and their distribution are described.

Results indicate that this type of study can be an extremely powerful management tool, allowing one to concentrate available resources to maximum effect and ensuring that "special genetic strains" of trout can be protected in conservation terms.

*Key words*

*brown trout, management tool, genetics*

# SESSION 2: Collaboration and fisheries management

## Governance of fisheries and aquaculture operations, importance of images and co-operation

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The governance challenges in fisheries and aquaculture have become increasingly complex, diverse and dynamic. No individual or group alone, public or private, possess sufficient knowledge and information in order to adequately address the related problems - thus there is a need to focus on interaction and collaboration. In spite of this development, a top down management style, with, perhaps, added stakeholder consultations, has become the overwhelming strategy in the decision making of fisheries and aquaculture. This strategy has rarely provided sustainable solutions to the problems regarding fishing restrictions, overfishing or environmental regulation of aquaculture, but more often contributed to pertinent conflicts.

A broader societal view to these problems can be addressed by the help of an interactive governance approach (Kooiman et al. 2005). According to this framework, the image of fisheries and aquaculture contain assumptions of fundamental matters such as the relation between man and nature, and the role of government in modern society. These varying images are critical, because they determine the 'management toolkit' applied and actions taken. One of the most influential images in fisheries management is the 'tragedy of the commons' notion by Hardin (1968), suggesting that humans are relatively short-sighted, non-communicative, and profit maximizing beings. This image persists widely, although Hardin's assumptions have been repeatedly rejected by many authors, who have studied the real-life behavior of fishers, for instance. There is a need to learn from experiences and develop 'shared images', which requires stakeholder involvement.

In the Baltic Sea, and the Archipelago Sea in particular, commercial fishing and aquaculture have been squeezed into an increasingly narrow operational space. Fish farming has been challenged, because of the industry's contribution to the eutrophication of the Baltic Sea. This image seems to hamper the development of the environmental permit system towards increasing the profitability of fish farming and similarly reducing the net nutrient load. Due to wide-spread 'overfishing image' of commercial fishing, the small-scale commercial fishers have faced problems in getting fishing permits to privately owned waters, although fish stocks in the Archipelago Sea are in good shape. On-going planning procedures and co-operative projects, for instance, provide forums for interaction and shared image formation between the stakeholders in order to reach sustainable solutions.

*Key words*

*interactive governance, collaboration, fisheries, aquaculture, Baltic Sea*

# Co-management in the Netherlands; collaboration between recreational fishing, commercial fishing and water authorities in Fishery Management Committees

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Fish stocks are a reflection of the environmental conditions and human impact on aquatic ecosystems. Both commercial fishing and recreational fishing affect fish stocks, but will themselves also benefit from a good fish stock. Since the introduction of the European Water Framework Directive (WFD) water authorities have also increasing interest in fish stocks. It is therefore logical that these parties cooperate to optimize resources. In the Netherlands, this cooperation has been taking place since 1999 through Fishery Management Committees (FMC). There are currently FMCs set for all waters in the Netherlands. A FMC is a platform where stake-holders tune their fishery activities. The FMC has to come to an agreement on the use and management of fish stocks. The participating parties remain autonomous, although they are obliged to cooperate with the FMC. Cooperation is defined in an agreement. The stake-holders are also obliged to create a joint fishery management plan. This plan describes the current fishing activities, the targets and proposed measures. Fishing activities also include monitoring, enforcement and regulation. The water authority reviews whether the activities are according to the fish targets of the WFD. Fishing may only be performed after a positive review.

*Key words*

*Co-management, fishery management, water authorities, Water Framework Directive*

## Training needs analysis of fishermen in the Batinah Coast of Oman

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Fishing in Oman is rooted in its prehistoric coastal adaptations of the 5th and 4th millennia B.C.. The contribution of fishing to Oman's socio-economic well-being is hardly debatable. In the past 30 years, Oman has remarkably developed in certain sectors, but fishing industry has not matched this pace despite realizing the need. The government sought to revive the industry in 1978. The Ministry of Fisheries took a number of steps to develop it further and also to preserve the livelihood of the traditional fishermen. Surprisingly, the growth and development of fishing over the years have remained insignificant. While only a few fishermen became better off, a majority still struggle for their subsistence, particularly in the Al Batinah coast of Oman (Belwal et al., 2010). It is worth mentioning that the Al-Batinah coast caters to almost 30% of the population in Oman and is a home to the largest number of fishermen in the Sultanate, but accounts for the 20% of the national catch and lowest earning. Consequently, the traditional fishermen families are losing hope in this profession and seeking asylum in other industries. The situation gets worst when some of the traditional fishermen are aging, many have very limited educational levels, and there are minimal alternative employment opportunities. For some promising fishing folks, when jobs in the other industries are unfolding, preserving this traditional artisanal industry seems a big challenge. Notwithstanding, fishing as a main non-oil economic activity provides direct income to around 28,500 fishermen in Oman and contributes to more than 32%, 27%, and 11% of the total agricultural production, the total food export, and the non-oil export values respectively. Oman cannot afford to ignore this industry at a time when it contemplates revenues from diverse sources. From the review of literature and our earlier study we observe that behavioural problems in this case dominate the technical ones and need management interventions in tandem to the technical solutions. We feel an urgent need to identify and categorise the fishermen's actual needs. We believe that the fishermen, who hitherto have been relying more on the traditional practices, need a carefully planned training programme that address their specific needs. Identification of training needs is, therefore, crucial to cherish sustainable fishing in the region and to provide fishermen a better livelihood. Using Factor Analysis this paper identifies and categorizes the training needs of fishermen by surveying 1934 fishermen on the Batinah Coast

*Key words:*

*training needs analysis, fishermen, Batinah Coast, Oman, factor analysis*

# Exploring the role of participatory research in fisheries governance and management – a case study from Lake Vättern, Sweden

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Evolving management regimes have changed the role of fishermen and the interactions between fishermen and scientists. In order to bridge this emerging gap between stakeholders and scientists there has been several initiatives in recent years to enhance the participation of fishermen in research and management. These initiatives have included management issues as well as the process of providing scientific advice, often through various co-management bodies. We present a case study in Swedish Lake Vättern, where a fisheries co-management group started in 2004. Channeled through this group, several approaches to involve fisheries stakeholders in research and management have so far been tested. Issues of interest to fishermen and stakeholders that has been explored have spanned from applied projects, such as selectivity of gear, to management issues and implementation of fishing regulations. Involving fishermen and stakeholders in both research and the management processes has resulted in a broader basis of knowledge. Our experiences so far are promising and suggest that participatory approaches may lead to a more transparent policy system, stronger legitimacy of policy and enhanced level of stakeholder commitment. We summarize our experiences from conducting participatory research in this specific case study and present some general recommendations for good practice in this field.

*Key words*

*Co-management, participatory research, governance, inland fisheries*

## Different interpretation of sustainability in aquaculture – case of two Baltic Sea neighbors

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Only small differences have been observed between the governance practices of aquaculture in Finland and Sweden. However, the statistics shows marked difference in the level of production in these two countries. In Finland 11.8 and in Sweden 9.2 million kg fish, mainly rainbow trout, was produced in 2010. Further on, the maximum size of a fish farm in the Baltic coast and lakes seems to be highly different: in Finland the biggest permissions usually allow a farmer to cause a nutrient load responding an annual production of 100-150 tons/year but in Sweden have recently been granted permissions of over 500 in Baltic Sea area and up to 2000 in regulated reservoir lakes, e.g., ten to fifteen fold of Finnish permission size. This makes Sweden an attractive region for the Finnish fish farmers looking ways to improve profitability of their activities.

The environmental regulation of aquaculture in Finland has, together with a tight concurrence from Norwegian salmon farmers, led to a situation in which the production of the rainbow trout has been going backwards the last decade. About 90% of the production takes place in Baltic in net cage farms. In Finland permission for a net cage farm in inland water areas is, although principally allowed according to the regulations and laws, practically banned. Neither Finland, nor Sweden is self-sufficient with its fish production but dependent on import, mainly from Norway.

The most probable future scenario with today's situation and trends seems to be one in which the Finnish farmers export their knowhow, capital and their inspired spirit of entrepreneurship to Sweden. To a country which in this scenario will soon surpass Finland as a fish production area.

The less probable future scenario is a balanced development where using spatial planning and wide co-operation with stakeholders harmonizing social, economical and environmental goals would take place. This would ensure equal playing field for fish farmers in both Baltic countries. The self–sufficiency in salmonid production could be possible in this scenario.

*Key words*

*aquaculture, sustainability, environmental regulation, governance, reservoir lakes*

# What do Lake Lipno stakeholders want? Analysis of stakeholder groups and preferences based on interviews for a Czech reservoir resource

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Lake Lipno, a man-made reservoir in Southern Bohemia, is the largest freshwater body in the Czech Republic (47 $km^2$). The reservoir provides various services that include recreational fishing, boating, swimming, flood protection, and production of hydroelectricity. However, it is difficult to propose adequate management of the lake's resources given the lack of explicit data on stakeholder groups and coalitions in countryside areas such as around Lake Lipno. Local stakeholders could be a priori categorized as recreational fishermen, tourists, locals and local property owners, river authorities and power plant representatives. These categories should differ in their perspective on the relative importance of the services provided by the reservoir. To understand the amount of variation within and among the stakeholder categories, we designed a questionnaire which we carried out face-to-face with individual stakeholders in the summer 2010 (n = 183 interviews) and fall 2010 (n = 90 interviews). Each individual provided his/her own identification with one of the main stakeholder categories and answered questions related to the main services. The data shows that individual stakeholder preferences vary greatly, making their classification less straightforward. We use methods of cluster analysis to group the stakeholders, discuss how much detail is required to define main stakeholder groups, and relate the results to the a priori defined categories. These results can be used to identify possible management strategies that maximize stakeholder satisfaction for Lake Lipno.

*Key words*

*recreational fisheries, stakeholder participation, utility, watershed management*

# SESSION 3: Fisheries management and fish populations

## Fish and their management in European reservoirs

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Man-made reservoirs differ from lakes and rivers in multiple hydrological and ecological features. In the lecture I will review their key features and argue that a good understanding of the ecological processes in reservoirs is indispensable for sound fisheries management measures. This understanding advanced significantly by recent quantitative and holistic studies. I will focus primarily on the succession of fish communities, limnological conditions and influence of various stressors on fish populations in reservoirs.

Except of Southern Europe, true exotic invasive fish species are not particularly successful in reservoirs: only relatively few, eurytopic and flexible species (*Rutilus, Abramis, Alburnus, Blica, Perca*) are able to spontaneously dominate in newly built reservoirs. Further development of the fish community then depends on local conditions and management. In many European reservoirs, some components of the community are under fairly strong fishing pressure by recreational anglers, which undoubtedly shape the community. Particularly common is overexploitation of predatory fish, such as pike, pikeperch or salmonids, due to their high popularity and consumer value. Piscivores in many reservoirs thus have to be maintained by artificial stocking, which may be costly and inefficient.

In the absence of strong piscivorous guild, the food chains in reservoirs are not top-down controlled. The cascading effects can lead to negative consequences on water quality and exacerbate problems associated with eutrophication. In Central Europe (at altitudes below 700 m), the bulk of the fish stock is often represented by nonpredatory omnivorous fish such as *Rutilus, Abramis* and *Alburnus*, which are typically underexploited and their populations are dominated by old large individuals. They typically outnumber perch, *Perca fluviatilis*, which can be very successful in less eutrophic or turbid habitats that prevent the development of cyprinids. Several other cyprinid species (*Cyprinus, Chondrostoma, Barbus)* can be dominant in reservoirs in the warmer conditions of Southern Europe.

In summary, fish stocks in many reservoirs can hardly be considered in good state both from the view of fisheries production and ecological quality. The unsatisfactory state will inevitably interfere with the philosophy of the Water Framework Directive of the EU which would require achieving better ecological potential of the reservoirs which are considered as heavily modified water bodies. The improvement of the conditions might require a number of measures such as more stringent protection of predatory fish, changes of hydrological regime, regulatory catches of undesirable species, and these measures might be difficult to achieve in many cases. Effective improvement of ecological potential and fisheries will not be possible without thorough understanding of functioning of the system.

*Key words*

# Mixed stock and multi-species fisheries management by large scale stocking of whitefish, brown trout and Arctic charr in a large Lake Inari, northernmost Finland

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The Lake Inari salmonid fish stocks support substantial professional and recreational fisheries in northern Finland. Due to regulation of Lake Inari, large scale stocking has been important fisheries management tool from the early 1980's. Only local stocks that have been regularly renewed from the wild have been used for broodstocks at the hatcheries and subsequent stocking. Based on annual mass marking, the proportion of stocked fish in the Lake Inari catch in 2000s has varied from 11 % to 58 % in whitefish, 41-82 % in brown trout and 44-72 % in Arctic charr. Decreasing growth rate and increasing proportion of wild fish in the catch of whitefish indicate that strong natural reproduction of whitefish has resulted in dense stocks that should be managed by increased fishing effort and decreasing stocking volume. In brown trout and Arctic charr, high density stocks of vendace, which is important food resource for these species, has resulted in high growth rate and increased survival of these salmonid species. In addition, spawning populations of the salmonid species in the wild, including wild and stocked individuals, have increased correspondingly. The proportion of wild fish in the population of brown trout and Arctic charr was positively correlated with age of fish, indicating that stocked fish have been caught relatively fast at lower ages in the mixed stock fishery of Lake Inari. These results suggest that brown trout and Arctic charr should be managed by increased releases during the periods of high vendace. Finally, based on genetic analyses in brown trout, at least 28 locally and genetically distinct populations live in the rivers running to the Lake Inari, suggesting that large scale stocking do not necessarily decrease genetic variation if local stocks are used in the hatcheries.

*Key words*

*mixed stock fisheries, stocking, whitefish, brown trout, Arctic charr*

# Relation between food availability and the level of bream economic catches in a lowland dam reservoir in Central Europe

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Chironomids are known as main food source for adult bream (*Abramis brama* L.) in many freshwater habitats. *Chironomus* sp. is a dominant benthos component in lowland dam reservoirs, reaching very high densities and biomass. Multi-annual data on *Chironomus* sp. numbers fluctuations and the level of bream economic catches in Zegrzyński reservoir (Central Poland) were compared. A statistically significant dependence was found between average annual numbers of *Chironomus* sp. and amount of bream commercial catches in Zegrzyński reservoir for all twelve years studied. This dependence was stronger in eight years of studies with extremely low and high numbers of *Chironomus* sp. Changes of monthly catches of bream showed also certain similarity with those of *Chironomus* sp. numbers, especially in seasons with high abundance of *Chironomus* sp. in spring. Fast growth of body weight per body length unit and high Fulton coefficient values were observed in the reservoir studied, indicating good growth conditions for bream. Fish concentrations in the reservoir in the years with high *Chironomus* sp. abundance are probably the cause of higher bream economic catches in these years.

*Key words*

*Bream, dam reservoir, economic catches, fish food base, Chironomus*

## Can we manage fish populations - case studies from Finland

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The general aim of fisheries management is to maximize the sustainable productivity in fishing waters. For this purpose, the fishing pressure is often adjusted through various restrictions. Species introductions as well as supplementary stocking of native species have also been traditional management measures counterbalancing exploitation. Habitat improvement has been used to enhance fish populations particularly in running waters. In some cases, however, the aim has been to control unwanted fish populations to enhance commercially important species or to improve water quality. Here I review some Finnish case studies in which the control measures included intensified fishing and/or piscivore stocking.

Finnish Game and Fisheries Research Institute experimentally removed coarse fish from several small lakes in the Evo district in southern Finland during a period of twelve years (1977-1988). The small lake Syrjänalunen (61°N, 25°E; area 0.88 ha) was fished with one pound-net in spring (April-June). The average annual catch was 27 kg $ha^{-1}$, two-thirds of which was roach (*Rutilus rutilus*). The roach catches were initially high (26-44 kg $ha^{-1}$ $a^{-1}$), later they decreased fluctuating widely over a few years, and finally stabilized to a lower level (5-11 kg $ha^{-1}$ $a^{-1}$). Catch-per-unit-effort showed a similar trend. This development was accompanied with clear changes in the population structure of roach. The exploitation led to a shift from a dominance of few year-classes in the unexploited state to a strongly skewed size distribution dominated by successively recruited young age groups in later years. Mean mass at age increased in the older age groups for most of the period. In contrast, the mean mass of the young age groups decreased, probably because of a more successful reproduction of the better fed adult roach. The initial biomass of the unexploited roach population, estimated from the decline of the catch-per-unit-effort, was at least 80 kg $ha^{-1}$; the minimum estimates for the annual production were 4-25 kg $ha^{-1}$ $a^{-1}$. The population biomass diminished to about 1/6 – 1/12 of the initial level. At the same time, annual production to biomass ratio increased from 0.3 to 0.5. Owing to the improved growth and reproduction in the exploited population, total production did not decline until towards the end of the intensified fishing period. In spite of the considerable fishing effort and the relatively high catch levels obtained, it took several years to diminish the roach population. Follow-up fishing in 1993 and 1996 showed that when the removal fishery ceased, roach recruitment quickly reduced and the population structure approached the original situation.

In the eutrophicated lake Köyliönjärvi in southwest Finland (61°N, 22°E; 12.5 $km^2$, mean depth 3.1 m) intensive fishing has been attempted in order to improve the water quality. Mass removal of fish was performed in 1992-1998 and again in 2002-2004, first by winter seining and later by a modified light trawling system. During the first intensive fishing period, the fish stock declined to 12-25% of the initial biomass, the proportion of roach and bream decreasing and that of smelt increasing through the period. In this hypertrophic lake, however, these fish stock reductions resulted in only marginal improvements of water quality. The stock reduction also led to improved growth and reproduction of roach, making it apparent that a sustained control of roach requires strengthening of the piscivore populations to create a new equilibrium fish community, in which fish consumption by piscivorous fish (in this case pikeperch) equals the production of prey fish. Intensified stocking of

young-of-the-year pikeperch was performed, but because of excessive pre-maturity mortality, attempts to establish a self-sustaining pikeperch population in Köyliönjärvi were not successful, and the roach and smelt populations could not be permanently reduced.

These cases exemplify how difficult it is to control highly resilient coarse fish populations that have a large reproductive potential.

*Key words*

*population management, roach, removal fishery, piscivore stocking*

## Ecosystem effects of non and size-selective perch fishing in a small forest lake

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Recently, the ecosystem-approach has been emphasized in fisheries management. In addition, the importance of large fish individuals for population persistence but also for ecosystem health has been argued for. In this work, the ecosystem effects of non and size-selective (large individuals released) fishing of perch in a small lake were studied in 2007-2012. The lake Iso Valkjärvi is pristine, clear water forest lake (3.78 ha) in southern Finland. The lake has been divided into two similar halves by plastic wall. The fish community has mainly two species, perch (*Perca fluviatilis*) and pike (*Esox lucius*). In one side of the lake, fishing targeted all size of perch, in the other side, >15 cm perch were released. Target catch was half of the yearly estimated biomass of all or ≤15 cm perch. Different trophic levels (phytoplankton, zooplankton, macroinvertebrates and fish) were sampled. First results showed massive fry production of perch, faster growth of pike, and increased predation on zooplankton on both lake sides. On the non-selective side, predation on large macroinvertebrates was reduced. Generally, the ecosystem effects of fishing were lower in the side were >15 cm perch were released.

*Key words*

*perch, Perca fluviatilis, size-selective fishing, ecosystem effects*

## Potentials for tailor made eel management at river basin and smaller management units

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Fisheries on yellow and silver eels form a major contribution to the Dutch inland fisheries. Over the last decades a decline in the immigration of glasseel has been observed all over Europe. The decline forms a major stressor for the Dutch inland fisheries.

Following the implementation of the European Eel regulation, the European member states have developed national eel management plans. Each plan consists of a set of measures that have to ensure that a minimum level of silver eel escape from the different watersheds. The Dutch eel management plan is no exception.

Given the complexity of the eel habitat and limited enforcement capacities of the government, the Dutch eel management plan centers around a total ban on the use of gear that catch eel during the months of September-December. This measure was disproportionally negative for the silver eel fishers. Besides this, the other negative side-effect of the measure are that the fishers have to try to make a living in just 5 month of the year, by-catch of valuable pike-perch and mitten crab are lost and an increased number of migrating silver eels is damaged by pumping stations.

In the Netherlands, scientists, fishers and government have therefore started an experiment with decentralized management that allows fishing the whole year round. In a pilot area the fisheries is regulated through a quota based system. Tested in 2011 the results are encouraging and the participating fishers are enthusiastic.

*Key words*

*Anguilla anguilla, management, quota, transparency, fishers' participation*

## Is different fishery management in boreal large lakes reflected in salmonid stocks?

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Fishery management differs between Swedish, Finnish and Russia Karelian inland waters by fishing regulations and conservation status of endangered salmonid species. In large lakes in Sweden, gillnet fishing is strongly regulated. In Lake Vänern, wild individuals of landlocked Atlantic salmon and brown trout are protected, that is, they must be released in fishing. In Lake Vättern, three large areas, historically desirable for fishermen, but considered as important rearing areas for juvenile salmonids, are closed for fishing. In addition, seasonal closures of areas are also used to protect migrating salmonids, both in lakes and rivers. In Finnish lakes, gillnet fishing is only slightly regulated, and wild salmonids are only recommended to be released, and just in a few lakes. Gillnet is the main method in salmonid catch in Finnish lakes, but trolling in Swedish lakes. In this study, gillnet fishing effort, state of spawning stocks, estimated number of wild smolts, and catch of stocked smolts were compared in most important salmonid lakes in Sweden and Finland and in Lake Pääjärvi in Karelia. In four lakes, CPUE of large salmonids in trolling could be compared, too. Gillnet fishing effort per lake hectare was much higher in Finland, and the state of wild and stocked spawning stocks was better in Sweden and in Lake Pääjärvi. Number of wild smolts and mass catch of stocked smolts were also higher in Sweden. Northern Lake Inari was an exception among the Finnish lakes by salmonid stocks. Differences in the salmonid stocks between the Finnish lakes and the other lakes are most likely because of high fishing mortality of wild and stocked fish due to widely used gillnet fishing in Finnish lakes.

*Key words*

*fishing effort, fishing regulation, inland waters, management measures, migratory salmonids*

## Effects of size selective fishing on pike stocks after 5 years

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Pike (*Esox lucius*) is one of the most important species in Finnish recreational fishing with 8510 tn catch per year. Pike fishing have no restrictions, which causes concern about its sustainability. The aim of this study was to estimate and monitor pike abundances and size structures along size-selective fishing. Study was conducted in four pristine lakes (2.1-13.8 ha, in research use only), with dominating species roach, perch and pike. Pike abundances and size structures were estimated by capture-mark-recapture program (Petersen) with multigear sampling: wire traps, fyke nets, gillnets, and angling. Each ≥30 cm pike was tagged with Carlin-tag (2006) or T-bar anchor tag (since 2007), sexed and measured for length. The estimated population sizes ranged from 11 to 43 ind. $ha^{-1}$. Experimental size selective pike removal was conducted by removing 50% of the biomass of targeted subpopulation. Two different treatments used were minimum length limit (MLL) of 40 cm and harvestable slot-length limit (HSL) of 40-65 cm. Biomass and share of large individuals decreased in MLL but increased in HSL lakes. According to our results size selective fishing with moderate effort can rapidly change the size structure of pike populations. At the same time, harvestable slot-length limit managed to retain big pikes in lake, which is considered essential feature of sustainable fishing.

*Key words*

*pike, Esox lucius, mark-recapture, size-selective fishing, sustainability*

# How do alternative minimum size limits perform in the management of pikeperch *Sander lucioperca* stocks differing in growth and maturation patterns?

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Due to the multitude of participants and a diverse range of used fishing gear freshwater fisheries are often managed using minimum size limits (MSL) rather than regulations of total fishing effort or catch. While high MSLs can secure natural recruitment, too high MSLs may decrease the individual growth rate, even through selection if only the largest individuals are harvested. We examine the ecological and evolutionary impacts of varying fishing efforts under varying MSLs, with and without stockings, in an age-, size-, and maturity-structured evolutionary model which is parameterized for four Finnish pikeperch *Sander lucioperca* stocks differing in growth and maturation patterns (Lake Oulujärvi, L. Pääjärvi, L. Vanajavesi and L. Vesijärvi). Based on the most comprehensive L. Oulujärvi data, nation-wide MSL of 370 mm maximizes deterministic biomass yield but does not prevent severe recruitment overfishing under further increased fishing pressures or stochasticity in recruitment success. The locally imposed MSL of 450 mm better ensures stable yields even in the absence of stockings that appear inefficient when natural recruitment is successful and growth is density-dependent. Further increases of MSL would reduce the risk of recruitment overfishing but also reduce yield especially if there was discard mortality for undersized fish. Evolutionarily stable size at maturation decreases under strong fishing mortality but less with high MSLs. We discuss how the predictions change with changing pikeperch life-history parameters.

*Key words*

*Ecological, evolutionary, inland fisheries, management, sustainability*

# SESSION 4: Role of crayfish in the freshwater fisheries management

## Freshwater crayfish and ecosystem services in a changing world

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Crayfish are the largest and amongst the longest lived invertebrates in many and diversified freshwater communities, and often occur at high densities (Gherardi et al. 2010). Most of them are keystone consumers and constitute the main prey of several species of fish, birds, and mammals (Gherardi et al. 2010). Hence, native crayfish population decline and the introduction of invasive species may profoundly affect the structure and functioning of ecosystems and the services that inland waters provide and organisms, humans included, depend upon (Gherardi 2007). Here, I will analyze the positive and negative impacts that freshwater crayfish exert, either directly or indirectly, on the different categories of ecosystem services (see also Gherardi 2011a, Lodge et al. 2012) as defined by the Millennium Ecosystem Assessment (2005) (i.e. provisioning, regulating, supporting, and cultural services). I will also attempt to anticipate how both intensified threats to native crayfish from climate change and other drivers of change, and prospected increase in alien crayfish's invasion (Gherardi 2011b) will affect freshwater ecosystems and their services.

This is a contribution to the Marie Curie IOF project CHAOS "Climate change and species invasions in aquatic systems: a comparative perspective" (project n° 251801; EC's Seventh Framework Programme for Research).

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*Key words*

*freshwater crayfish, inland waters, ecosystem services, climate change, invasive alien species*

## How to achieve and manage a sustainable fishery of signal crayfish

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The signal crayfish fishery in Sweden has become increasingly important during the last decade both for the commercial licensed fishery and for many fishing right owners in rural areas. In the second largest lake, Lake Vättern, the landed catch has increased radically, mainly as a result of increased effort, and the crayfish now constitutes 95% of the value of the commercial fishery. There have however been strong fluctuations in the catch of signal crayfish in many other lakes during the last years creating concern about the future of the fisheries. In addition the total commercial catch in Lake Vättern has decreased by 40% the last three years. Opinions differ greatly concerning the status of the stocks and the impact of the fisheries as well as on the best management strategies for the crayfish fishery. The main obstacle for sound management advice is lack of knowledge. In close cooperation between managers, fishermen and scientists a project was initiated in 2009, where existing fisheries of different magnitude have been closely followed and detailed information collected. The information has served as a basis for further analyses and modeling. Several approaches to assess the status of crayfish fisheries are presented and compared. The methods range from straightforward indices calculated purely from simple fisheries statistics to more complex models such as length-based cohort analysis. We evaluate different assessment approaches as well as high-light obvious knowledge gaps needed to be bridged in order to succeed with robust assessments of the crayfish fishery.

*Key words*

*signal crayfish, fishery, sustainable management strategies, models*

## Reproduction success of the signal crayfish in Northern latitudes

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In Finland the native noble crayfish (Astacus astacus) thrives in northerly conditions, producing exploitable populations as far north as the polar circle. The signal crayfish (*Pacifastacus leniusculus*), is successfully introduced in Southern Finland. Without limiting environmental factors, signals will gradually spread further north. We ask if temperature might determine the northern distribution of the signal crayfish in Finland. We simulated the temperature developments of Southern Lapland in the autumn and winter conditions (River Kemijoki 66°22N, 26°41E), and the milder temperature development of Southern Finland (Lake Saimaa 61°04N, 28°16E) under laboratory conditions during 280 days with three consecutive tests. In the southern conditions 96% of the females produced fertilized eggs in the autumn. In June, some 85% of the females were still carrying eggs that had survived the winter well. In the northerly conditions, where the water freezes rapidly during the mating season, about 75 % of the females produced fertilized eggs. In temperatures corresponding to northern deep lake basins (min 4°C), about 70 % of the females were still carrying eggs in June, but the amount of eggs and stage 2 juveniles per female were only about half of that of the southern test groups. Instead, the extremely cold winter conditions (closing 0ºC) of the northern river dramatically aggravated signal reproduction. The early egg development was disturbed and the eggs were destroyed during the winter. In conclusion, the extreme conditions in the North; suddenly decreasing temperature in autumn, extreme coldness in winter, and late hatching, decrease remarkably the reproduction success of the signal crayfish. On the further studies we compared the effects of temperatures on the growth and survival of 2-stage juveniles in their first summer. The test groups simulated the natural temperatures and length of the growing season on the two latitudes in question. After the 16-week test period, the results show that the juveniles of the Saimaa groups weighed on average twice what those of the Kemijoki group.

*Key words*

*Pacifastacus leniusculus*, signal crayfish, reproduction, egg development, temperature, northern distribution

# Predation of introduced signal crayfish on salmonid fish eggs during long winter incubation period in large boreal lakes

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Egg mortality of autumn-spawning salmonids in boreal freshwater systems during the long winter incubation period has been observed to be very high. In the worst case, only 1.5 ‰ of the all produced eggs of vendace population (*Coregonus albula*) may hatch and deliver viable larvae. However, the annual variation is high and in many cases the ultimate causes of the mortality remains open. Invasive species may cause dramatic changes in their new habitats. Introduced signal crayfish has been suspected to increase egg mortality of commercially important coregonid species. In this study, the potential of crayfish predation on the salmonid eggs were examined by lab experiments and bioenergetics modelling. The maximum food consumption rate and functional response of crayfish predation were tested at low temperatures (>6°C) typical during the salmonid egg incubation. Bioenergetics model construction was used to quantify the potential predation rates under lake conditions. The contribution of fish eggs on the diet of crayfish was studied using stable isotope analysis. Our results reveal that signal crayfish can consume considerable amounts of fish eggs. Temperature affected feeding rates significantly so that activity and consumption declined with lowering temperature. The potential population interactions between signal crayfish and coregonids were simulated in Lake Pyhäjärvi, SW Finland

*Key words*

*Coregonid, egg predation, lake, Pacifastacus leniusculus*

# Distribution of the noble and signal crayfish in Finland with the perspective of aquatic resources for crayfish

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The distribution of the only native crayfish species, noble crayfish (*Astacus astacus*) was southern, between 60 and 62 N in the beginning of the 20$^{th}$ century. From 1900 until 1970 the distribution was expanded up to the polar circle, 66 N. The first introductions of the signal crayfish (*Pacifastacus leniusculus*) were done in late 1960's and 1970's in several selected lakes in the southern part of the country. The distribution of the noble crayfish covered at that time most of the water systems, although the populations were severely influenced by the crayfish plague, and the signal crayfish distribution was very random. Since then, especially in 1980's and 1990's restocking and introduction of the both species has been widely practiced. This activity has not influenced very much on the northern distribution level of the noble crayfish indicating that the present climatic conditions limit the distribution to be settled down at the polar circle. In numbers, on the noble crayfish distribution area in Finland there is at present more than 38x10$^3$ lakes covering 2,7x10$^6$ hectares of the total lake area.

The introductions of the signal crayfish have been rather successfully guided by the fisheries authorities, and even the distribution covers broadly some water systems, it is mainly limited into the southern Finland. The northernmost single occurrences are at the level of 65 N, but the productive populations have been reported to exist at the level of 63 N. The signal crayfish have been introduced or reported to occur with regularity only in 562 lakes. Since the individual lakes are large, and often combined with each other, the total lake area occupied by the signal crayfish is relatively large, 1,0x10$^6$ ha.

This investigation clearly demonstrates that the noble crayfish have a lot of resources to thrive. Crayfish plague control is improving, and signal crayfish introductions have at least so far been discreet. Therefore Finland has very good possibility to maintain, manage, and utilize the most valuable noble crayfish populations without causing any notable danger to the species.

*Key words*

*Astacus, Pacifastacus, distribution, control, introductions*

## How to minimize the risk of the plague in crayfish population management?

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Crayfish plague, caused by the fungal-like organism Aphanomyces astaci, has been the main reason for the management problems concerning the highly susceptible noble crayfish populations in Finland. When entering a dense population, the plague causes a population crash with high and often noticeable mortality. However, evidence of recovering, plague carrying populations or disease introductions with a considerably long latent period has been presented during the last decade. The capability of the plague organism to persist in the highly susceptible European crayfish species was earlier considered impossible, mainly based on laboratory infection trials. This consideration led to the management strategy that allowed a re-introduction attempt to be made soon after a plague episode had wiped out the population. As we know now, a few plague carrying individuals that survive in the water body will prevent the possibility to a successful long term revival of the population.

The outcome of a crayfish plague infection depends at least on the size, form and locality of the water body, the dispersal and density of the crayfish population, the individual resistance factors of the crayfish and the virulence of the crayfish plague strain. Since it became possible through molecular methods to recognize separate genotypes of the crayfish plague agent there has been speculation of the variation of virulence, which now has been verified through laboratory trials as well as clinical evidence. It seems that at least in Finland, later introductions of the plague genotype carried by the signal crayfish are much more efficient in causing mortality in noble crayfish in comparison with the first genotype that entered Finland more than a century ago. Those noble crayfish genotype strains – as we call them while the original host species has not been recognized yet- have the capability to hide in the weak remains of the once productive noble crayfish populations, thus forming a challenge to a profitable crayfish fishery.

Despite the plague problem, the noble crayfish is worth taking care of, both in economic as well as conservational viewpoint. It means that tools are needed to manage the situation of a plague infection. When re-introduction is considered, both the donating population, as well as the receiving water body has to be controlled for the presence of plague carriers. Powerful molecular methods exist that can recognize even one spore from the crayfish cuticle or a few from the water column. Unfortunately the plague agent is not evenly present in the crayfish nor in the water, which means less reliability of our test methods regardless of the optimal specificity. Sampling of wild populations is notoriously difficult and in case of the plague infection, probably biased towards less infected individuals. When wild populations with a known crayfish plague history were surveyed, reasonable results could nevertheless be achieved. More reliability can be gained through a repeated investigation during a longer observation period of at least two years. Cage experiments have been successfully employed in examining the suitability of the water body for crayfish and carefully designed are still valuable in combination with a laboratory diagnosis. Health certification remains, however, always an estimation of the situation with a reliability of less than 100 %.

Once a low virulent crayfish plague strain has entered a complex or large scale water body, there is very little to be done to get rid of it. However, even dense subpopulations can develop and exist

for long periods. In managing the fisheries and introduction programs for crayfish, it will be necessary to classify populations according to their crayfish plague status and create directions of exploitation for the different classes. It will be a challenge for the future to turn the idea of whenever there is noble crayfish, there cannot be plague, to the more realistic whenever there is crayfish, there can be plague. The classical disinfection of the traps- prevention is clearly not enough, but we need to keep on gathering more information of the epidemiology of crayfish plague in different circumstances.

*Key words*

*crayfish plague, management, health certification*

# Noble crayfish (*Astacus astacus* L.) stocking success in south-eastern Finland

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Finnish Game and Fisheries Research Institute and its partners monitored the success of the introduction and restocking of the noble crayfish *(Astacus astacus)* by test trappings in Etelä-Savo province in south-eastern Finland during the years 1993-2010. Trapping results were completed by postal enquiry addressed to the water owners in the years 2009-2010. The survey covered 158 noble crayfish stockings, while the average follow-up period was 16 years. In about 15 % of the cases, it could not be concluded whether the stocking was successful. In the cases where the success of stocking could be evaluated, about a third of noble crayfish stockings proved to be successful, 38 % failed, and the rest produced weak and / or very slow growing populations. The stocking success was analyzed against lake size and morphometry, elevation, geographical location, water quality, origin and size of introduced crayfish, and crayfish plague *(Aphanomyces astaci)*. The plague was supposed to be the most important cause of failure in noble crayfish stockings. At least 16 studied crayfish populations suffered mass mortality during the monitoring period, and in most cases, the only obvious explanation was crayfish plague infection. The plague was obviously responsible for eight other cases of totally vanished crayfish populations although no mass mortality was observed. In addition, a chronic plague was suspected to be the main reason behind many slow developing, sparse or fluctuating populations. The existence of sparse crayfish population at the time of restocking seemed to impair the stocking success. It was concluded that if the mean CPUE in test trappings prior to the introduction is more than 0.1 crayfish/ trap/night, the stocking has no profit. The proportion of clearly successful stockings was highest (38%) in 50-500 ha lakes and lowest (22%) in lakes larger than 500 ha and in rivers (19%).

*Key words*

*noble crayfish, stocking, environment, water quality, crayfish plague*

## To be or not to be a pathogen: co-evolution of crayfish plague (*Aphanomyces astaci*) and its native European freshwater crayfish hosts

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The crayfish plague (*Aphanomyces astaci*) has devastated most of the native European freshwater crayfish stocks since its invasion to Italy about 150 years ago. The pathogen has so far been considered as an obligate killer, which, in most cases, has caused acute epidemics resulting in mass mortalities. Little is known about the evolution of virulence in this pathogen or the evolution of increased host resistance towards the pathogen. However, it has been speculated that some wild stocks have survived from acute infections and would presently be chronically infected. The failures of the management actions taken to revitalize collapsed stocks have largely been considered to have been caused by the disease agent being present in the water courses due to several unknown or unexplained reasons. We have recently discovered that a robust noble crayfish (*Astacus astacus*) population in the north eastern Finland (Lake Mikitänjärvi) acts as a carrier of crayfish plague with some visible gross symptoms. The infection level has remained quite low during 2009-2011 and despite the chronic infection the population is productive enough for commercial crayfisheries. The infection studies carried out in our laboratory, with the Lake Mikitänjärvi crayfish and crayfish from the other populations, have provided indications of increased resistance of the noble crayfish against certain crayfish plague isolates and varying virulence among the different strains of crayfish plague. Recently, we have also shown that the Turkish narrow clawed crayfish (*Astacus leptodactylus*) stocks that collapsed during 1980's crayfish plague epidemics currently act as carriers of crayfish plague while still yielding commercial catches. We speculate that the extremely high killing rate of the crayfish plague on the native European freshwater crayfish imposes high selection pressure that could have resulted in increased resistance of the crayfish stocks. Furthermore, the crayfish plague might have evolved towards lesser virulence, since killing of its own habitat could cause the extinction of the pathogen. Thus, the short period of co-evolution of the devastating pathogen and its susceptible European hosts, roughly 150 years, could have resulted in an increasingly less virulent parasite-like status of crayfish plague, similarly to the situation in North America. Such rapid evolution would have implications to the management of indigenous crayfish stocks and should affect the conservation attempts of endangered freshwater crayfish in Europe

*Key words*

*Aphanomyces astaci, crayfish plague, evolution, virulence, resistance*

## The Swedish action plan for noble crayfish

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The noble crayfish is native to Sweden. The number of localities with noble crayfish is now less than 1,000, compared to the over 30,000 localities that existed at the beginning of the 20th century. Due to this major decline the crayfish is classified as critically endangered (CE) since 2010 on the Swedish National Red List. The noble crayfish has mainly been reduced by the disease crayfish plague which today is spread through illegal releases of the plague-carrying signal crayfish. Habitats have also been destroyed by acidification, discharges, water regulation and sloughing of suitable habitats. A revised action plan to protect the noble crayfish (Astacus astacus) was produced, containing proposals for measures that should be implemented in the period 2008–2013. The following must be done to save the noble crayfish in Sweden:

- Provide information about the noble crayfish's biological and economic value and about the consequences of the illegal release of signal crayfish.
- Perform inventories and map the stocks of noble crayfish and signal crayfish.
- Decide on administration plans and protected areas for noble crayfish.
- Restore the breeding environment for noble crayfish through liming and restoration.
- Remove illegally released signal crayfish and establish migration barriers in order to reduce damage to noble crayfish populations from illegal releases.
- Reintroduce noble crayfish where they have a chance to survive.
- Regulate fishing, transport and retail of live signal crayfish within selected areas in order to reduce the risk of illegal releases.
- Involve the public and the owners of fishing rights. This is an important precondition for the success of efforts to protect the noble crayfish. Fishing in itself does not represent a threat to the species.

The vision is that our grandchildren will be able to fish noble crayfish in lakes and watercourses in the future.

*Key words*
*noble crayfish, conservation, utilization, threats, actions*

# POSTER SESSION

## Fishing regions, part of hierarchy or a network

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Fishing regions (FR) are administrative organisations between grass-root level and regional state administration. Their main tasks and member groups are mainly defined in the Finnish fisheries legislation. FR's have been criticized for slow and sometimes inefficient action. Although this organisation is part of the administration hierarchy, network-like structures can be found in it.

FR networks are thin, with only limited resources for simultaneous activities. Networks are based on strong social bounds, which are typical for small communities and good for building trust between stakeholders. This is an advantage for managing fish stocks where strong trust between stakeholders is needed, but not efficient for exchanging information needed for adaptation in the modern rapidly changing operational environment.

The networks appeared to be strongly closed. In most cases these networks allow participation within the framework of water area owners. Outside this framework it is much harder to get an influential position. Decisions are mostly based on consensus, and new ideas are adopted slowly. Also many characteristics in the network culture and main actor's similar frames of reference have an impact that favours slow action in the network. The network perspective can give useful information for when trying to develop of the organisation.

*Key words*

*fishing region, network, network closedness, network culture, social bounds*

# Easy access and paper free solutions as the effective management tools for popularisation of recreational fisheries in Estonia

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Organisation and control of hobby fishery in all waters of Estonia, with population of 1.3 million, are managed centrally by the governmental institutions. For easier purchase of licenses for hobby fishery several innovative approaches have been introduced during the period from the Soviet rule up to Republik of Estonia. New solutions applied to improve an access to the hobby fishery have been effective tools to increase substantially the number of hobby fishermen.

The last quantitative jump in number of fishermen was connected to the introduction of mobile phone payment. The use of unified license purchasing system (connecting mobile phone, internet and retail) gave an excellent opportunity for Estonia to enforce an entirely paper-free hobby fishery, as on-site control of fishing right baseon identity document only. In addition to the increase of the legally fishing hobby fishermen innovative solutions guarantee a high quality real-time statistics of the caracteristics of the recreational fisheries sector (age and sex composition of the license owners, temporal and spatial dimension etc). The reliable statistics create a basis for scientific approach which leads to reasonable management decisions.

*Key words*

## Sustainability of interlocked fishing district -management concept for commercial fishing in Finnish lake fishery

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The Finnish lake fisheries is one of the most extensive commercial inland fishery systems in Europe. It produces a considerable share of fish for domestic human consumption and also for export. Vendace (*Coregonus albula* (L.)) is the overwhelmingly most important target species. The fluctuation of vendace stocks has been a major issue for the persistence and development of commercial Finnish lake fishery. A number of issues concerning commercial use of the inland fish resources, such as access and fair distribution of environmental goods among interest groups stem from the long history of private ownership of land and from the multi-species and -purpose fishing nearly everywhere on the lakes. In this study a novel management approach, interlocked fishing district (IFD), is studied as a solution to the question of improving overall sustainability of developing commercial lake fishery in the context of private ownership of fishing rights. The methods used include YPUE- and economic modellings, document analysis, surveys and focus-groups studies among key interest groups and an economic case study on a real-scale application of IFD. The results indicate that the present institutional and management structure in lake fisheries includes elements that do not comply with sustainability. Within the key interest groups, there is considerable need and readiness to apply IFD-type of resource management for commercial fishing. IFD includes qualities that could advance ecological, socio-economic, community and institutional sustainability in commercial fishing and fisheries management. Applying IFD is possible within the present legislation, yet any application requires case-specific approach. Successful application of IFD would advance resource-based and adaptive management of aquatic resources

*Key words*

*Commercial lake fishing, fisheries management, fishing rights, private ownership, sustainability.*

## Finnish-Estonian HEALFISH and Finnish-Russian RIFCI -twin projects for the benefit of Gulf of Finnish salmonid stocks

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Twin projects: HEALFISH, “Healthy fish stocks, indicator of proper river basin management”, Central Baltic Interreg funded Finnish-Estonian project and RIFCI “Rivers and fish – our common interest”, EU ENPI instrument funded Finnish-Russian project have been running for about 1,5 years in rivers, discharging into Gulf of Finland. Our poster describes the main scopes of the projects: dissemination of the best practices of river catchment management and river restoration in Estonia, Finland and Russia in chosen pilot rivers, actual river restoration measures, including removal of obstacles for fish migration , fish studies (e.g. electro fishing, smolt trapping, egg survival studies), genetic studies of Gulf of Finland trout and salmon stocks and learning by doing training of experts planning the restoration measures as well as those carrying out the actual construction work. By enhancing the condition of the pilot rivers and their salmonid stocks, the projects are obtaining know-how as well as practices that can be multiplied in other rivers in the region. The entire goal of the projects is to work out updated, detailed management plan for trout, salmon and other anadromous fish species for the entire Gulf of Finland region. The results are planned to be published in the format of Finnish Fish Atlas.

*Key words*

*River basin managemet, trout, restoration, genetics, Gulf of Finland*

# Recovery of acidified lakes in Finland and subsequent responses of perch and roach populations

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A considerable number of small headwater lakes in Finland were suffering from acidification and damage to fish populations during the 1980s. The national lake survey in 1987 estimated the number of acidic lakes to be 4900. A fish status survey at the same time reported declines and even extinctions of sensitive fish species, mainly roach (Rutilus rutilus) populations. Further, some perch (Perca fluviatilis) populations disappeared from lakes most sensitive to acidic deposition. In early 1990s, successful sulphur emission reductions in Europe began to affect the water quality of acidified lakes resulting in clear chemical recovery. This was seen in increases of pH and alkalinity and decreases in aluminium and sulphur concentrations in the 1990s followed by increased concentrations of organic carbon (TOC) in 2000s. The first signs of recovery in affected perch populations were also observed already in the early 1990s. New strong year-classes appeared after successful reproduction and the structure of most of the affected perch populations turned normal until the end of 1990s. Successful re-establishment of disappeared perch populations still emphasized the significance of the chemical recovery of the lakes. For roach little if any recovery of affected populations has been recorded. This may be due to the high sensitivity of roach compared to perch and the recent level of chemical recovery. In addition, the increases in TOC concentrations of lakes in 2000s have increased the organic acidity and decreased the recovery from precipitation-induced acidification and – consequently – restrict the recovery of acid sensitive fish species like roach.

*Key words*

*acidification, recovery, water chemistry, Perca fluviatilis, Rutilus rutilus*

## The Finnish fisheries-cormorant debate: collaboration or conflict?

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This presentation studies Finnish fisheries-cormorant debates in the 2000s, and the cormorant's effect on commercial fishing. The number of nesting great cormorant pairs in Finland has increased from 10 in 1996 to 18000 in 2011. The rapid population growth has raised contradictions along the Finnish coasts alike in many other parts of Europe. Fisheries-related conflicts stem from the bird's fish predation. In addition to effects on fish populations, a direct effect on fishery is cormorants' eating fish from the gear, with consequent damages to fishing gear and to the fish. Commercial fishers have also observed that the behavior and good fishing localities of several fish species have changed in the Finnish coastal areas. In 2009, one half of the Finnish commercial coastal fishers interviewed stated that the cormorant was a hindrance to their livelihood.

A difference of perception has been related to the proof that is needed for damage mitigating measures: whether action should be taken to prevent possible cormorant-induced damage in the future or whether one should wait for scientific proof of the damage before any action is taken. The lack of scope for problem mitigation has resulted in local frustration and illegal disturbances of the cormorant colonies. More than half of the colonies have been disturbed at least once. The cormorant is protected according to the EU Bird Directive and no disturbance of the colonies is allowed without a special permission granted by the environmental authorities. As a result of negotiations in a cormorant advisory board of the south-western coastal region, first permissions for disturbance and culling of cormorants were granted in 2010.

*Key words*

*commercial fishing, great cormorant, environmental management, collaboration, conflicts*

# Food of great cormorants (*Phalacrocorax carbo sinensis*) in the Archipelago Sea, southwestern coast of Finland

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The Archipelago Sea, a brackish water area (5–6‰) in the northern Baltic Sea, is important in Finland for the commercial coastal fishery targeting pike-perch (*Sander lucioperca*) and perch (*Perca fluviatilis*). Cormorants started to inhabit the area in the shift of the millennium and the number of nesting pairs rose above 4 000 in 2008. The commercial catches of pike-perch and perch have diminished during the recent years. Samples of cormorant pellets and regurgitates were collected in the nesting colonies and resting places. In 2009 and 2010, the share of pike-perch and perch in the diet of cormorants was between 8-11% and 26-27 % (weight), respectively. The number of pike-perch and perch consumed by the cormorants were in the same level as the combined catches of commercial and recreational fisheries. The predation targeted on smaller pike-perch than the main part of fisheries, but overlapped more in the case of perch. We also compare the size distributions of fish in the diet of cormorants and in the shallow bays where cormorants harvest. Using historical mortality values we calculate how much catch in fisheries the fishes predated by cormorants would have created

*Key words*

*commercial fishing, great cormorant, feeding, size distribution, consumption*

# Producing cormorants (*Phalacrocorax carbo sinensis*) in the Baltic Sea region for Europe – is more extensive management needed?

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The Baltic Sea region produces two thirds of the new Cormorants (Phalacrocorax carbo sinensis) in Europe and the amount of breeding pairs is still increasing in the area. Most of the Cormorants nesting in the Baltic Sea region migrate to continental Europe for winter thus foraging there in fish ponds and natural water areas causing damages especially for aquaculture industry and fish stocks. Management actions to prevent damages to fish stocks, fisheries and aquaculture are mainly based on national goals. EU bird directive is carried out in the EU member countries in different ways influencing the possibilities to create common management goals. Interactions between humans and Cormorants are not only a local or national issue but also a concern of pan-European dimension. Therefore the initiative to work for a pan-European management action is still urgent. To achieve this goal there should be coherent management plans for Cormorant populations in each country and especially in the major reproducing areas for example in the Baltic Sea region.

*Key words*

*cormorant, Baltic Sea, management, fishes*

# Fish population recovery and research in "Rivers and fish – our common interest" (RIFCI)

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The main aims of the Finnish-Russian collaborative project (RIFCI) are to achieve, by means of a number of measures, a good ecological condition of the target rivers and their surrounding nature in the Southeast Finland and Russia in order to ensure the existence and viability of the valuable salmonid populations inhabiting the rivers. The RIFCI project is funded through the European Neighbourhood and Partnership Instrument (ENPI). The project consists of six work packages (Acts). Act 4 deals with population recovery and research. In the Finnish side, electrofishing in 15 sampling areas was carried out in the cross-border river Mustajoki (r. Tchornaja) and its main tributary in 2011. The aim of the electrofishing was to estimate the distribution and the age structure of the native sea trout population and to establish a live gene bank (broodstock) of the trout population for cultivation. From all trout under 10 cm (35 individuals) DNA-samples were taken, and the trout over 10 (52 ind.) cm were tagged by t-bar tags. A total of 61 sea trout parr were moved to the FGFRI´s fish hatchery situated in the middle part of Finland to establish the broodstock. The DNA-analyses will uncover the relation of Mustajoki trout to other trout stocks around the Gulf of Finland area. By tagging the young sea trout it will be possible to follow the migration of fish in the rivers and the feeding migration in the sea area. The broodstock will be established in order to preserve the biodiversity of the threatened native population, as well as to enhance the local population in nature - if needed - and also to return local trout to rivers in south-eastern Finland running to the Baltic Sea. In autumn 2011, as part of Act 2 of RIFCI, Finnish and Russian students restored together the rapids for spawning and parr production areas of the sea trout in an ecocamp organised in the river Mustajoki area.

*Key words*

*sea trout, river restoration, broodstock, tagging*

# Research in experimental settings strengthens the knowledge of freshwater fish ecology and management

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Researchers of ecology are interested in understanding the features of natural mechanisms, such as species composition, abundance, population dynamics, diversity, and food web structure. Research on fish and fisheries is no exception to this. A traditional field study done in aquatic ecosystems provides highly realistic results. However, it may also cause substantial variation within replicates and limit the amount of test units to be set and used. Laboratory or semi-natural experiments are easier to control and good repeatability is more conceivable, but simultaneously the comparability with natural environments may decrease. Therefore, comparing the results of many studies, experimental or observational, conducted in the variety of systems, may help to search common patterns and innovations for relevant management measures. To this end, Finnish Game and Fisheries Research Institute has recently equipped a large research station, located in Paltamo, Finland (64$^{o}$ 29' N 27$^{o}$ 30' E), for experimental fish and aquatic ecology research. The facility includes both indoor and outdoor set-ups of streams, pools and combined stream-pool systems with high-level of replication opportunities. The structures and devices are designed to enable handy modifications for specific research purposes. All the settings can be enhanced with video arrays and PIT-telemetry devices for observing and monitoring a fish. The recent studies at the station have provided important knowledge, e.g., about ecological rearing methods of fish for stockings, behavioural basis of fish vulnerability to fishing, and winter ecology of stream fishes (more details at http://www.rktl.fi/tutkimuslaitos/toimipaikat/kainuu/). Researchers and research teams worldwide are encouraged to conduct their experimental research designs in this high standard facility.

*Key words*

*experimental research, research facility, fish, ecology, management*

## Characteristics of yield per swept area for professional vendace trawling

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Daily yield and effort records from commercial vendace (Coregonus albula) trawling from several lakes and years were analyzed to develop a standardized stock abundance index. The characteristics of yield per swept area (YPSA) were studied. The swept area as an effort index scaled the records from different lakes to a comparable level. Log-transformation of YPSA and trend fitting normalized the residual distribution and revealed regularities in the annual succession of YPSA. YPSA increased during early summer, peaked in August-September and declined towards the spawning season in October. Relatively high level of random variability prevailed after trend fitting. The residuals did no correlate with wind index. Typically, the residuals from different contemporary time series did not correlate indicating that no large scale environmental cue significantly synchronizes the short-term variability in YPSA. The few weeks around the annual maximum of YPSA may provide a suitable time window for a standardized stock abundance index.

*Key words*

*Coregonus, management, stock index, swept area, trawl*

## Innovation and research network in changing climate - case crayfish

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Introduced signal crayfish is among the most important species in Finnish inland fisheries. In large lakes abundant populations support economically important commercial fisheries and recreational value also increase rapidly. However, the ecological role of signal crayfish and factors which determine crayfish population dynamics in large boreal lakes are not well known.

EU funded national "SATAKUNTA – Innovation and research network in changing climate - case crayfish"- project is focusing on the ecological and economical role of introduced signal crayfish in Lake Säkylän Pyhäjärvi. The project attempts to identify the main threats and opportunities for crayfish fishery and to evaluate consequences of possible changes to fisheries system and environmental management. In a basis of existing data and by assembling an international network of crayfish researchers, we will produce different ecological and economical scenarios which can be used for adaptation of local fisheries systems and environment management in changing climate. The project is leaded by Pyhäjärvi Institute in collaboration with University of Jyväskylä and Ruralia Institute, University of Helsinki

*Key words*

*signal crayfish, climate change, inland fisheries, socio-economy*

## Preserving endangered fish species and stocks by aquaculture in Finland

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In Finland many migrating fish species or stocks have become endangered because of anthropogenic changes in nature. Many of these species and stocks have been however preserved by the means of Aquaculture as living gene bank. The Finnish Game and Fisheries Research Institute has 8 fish farms where altogether 12 fish species or forms and 55 fish stocks native to Finland have been preserved. Carefully established brood stocks preserve the biodiversity and produce milt and eggs for restocking purposes. More advanced techniques, such as individual tagging and genetic analyses of relationship of the individual brood fishes, are used to improve the genetic quality of the fertilized eggs. Cryopreservation has been used to deep freeze milt from endangered species and stocks for long term preservation and to enlarge the amount of founders for the new brood stocks of critically endangered fish species such as Saimaa land-locked salmon (Salmo salar) and Saimaa arctic charr (Salvelinus alpinus).

*Key words*

*aquaculture, endangered fish species, Finland*

# Effects of replacing fish meal/oil with plant sources in diet of Beluga sturgeon (*Huso huso*) on growth parameters

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This paper presents the result of studies on effect of replacing fish meal/oil with plant sources in feeding Beluga sturgeon *Huso huso* on growth parameters. The juvenile *Huso huso* (average weight 95 g) were selected and the experiments were carried out in 300 L polyethylene tanks in three replicates for each treatment. The experimental diets contained: 1) fish meal/fish oil (FM/FO) as control group, 2) fish meal/vegetable oil (FM/VO), 3) 40% replacement of fish meal+80% replacement of fish oil, 4) 60% replacement of fish meal+80% replacement of fish oil, 5) 80% replacement of fish meal+80% replacement of fish oil, 6) 100% replacement of fish meal+80% replacement of fish oil with plant protein and vegetable oil respectively. The source of plant protein was wheat gluten, corn gluten and soybean meal and the source of vegetable oils was a combination of canola:linseed:safflower oil blend (40:30:30, respectively). The fish were cultured for 45 days under optimal condition.

The results proved that complete replacement of fish oil with vegetable oil causes higher weight gain and SGR and lower FCR compared to the group diet on diet containing fish oil. Simultaneous replacement of up to 60% fish meal with plant protein and 80% of fish oil with vegetable oils did not result to any significant differences in growth parameters with control fish.

It was concluded that replacing up to 60% of fish meal and 100% of fish oil with plant sources seems advisable for feeding juveniles of *huso huso*. This can reduce the costs of production considerably and decreases the pressure on marine sources for production of fish feed.

*Key words*

*beluga sturgeon, plant protein, vegetable oil, growth*

# Replacement of dietary fish meal/oil with plant sources on growth performance, immune responses, blood indices and disease resistance in rainbow trout (Oncorhynchus mykiss)

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The aim of this study was to examine the effect of replacing fish meal/oil with plant sources on growth, immune responses, hematological parameters and disease resistance in rainbow trout. Rainbow trout with initial body weight of 15±2 g were cultured for a period of 60 days using seven experimental diets. The control diet contained 582.5 g $kg^{-1}$ fish meal and 128.9 g $kg^{-1}$ fish oil as the primary sources of protein and lipid. The 6 remaining diets all contained fish oil or the canola:linseed:safflower oil blend (40:30:30, respectively) as the primary lipid source and 350, 175 and 0 g $kg^{-1}$ of fish meal replaced with plant protein sources.

The results showed 40% replacement of fish meal with plant proteins and 100% replacement of fish oil with vegetable oils resulted in highest waight gain and SGR and lowest FCR, however not significantly different compared to control ish (P>0.05). But Growth indices significantly decreased by higher percentages of dietary plant protein (70% and 100%) replacing the fish meal. Total Replacement of either fish meal or fish oil with plant sources had no significant effect on fish humoral immune responses (lysozyme activity, Serum total immunoglobulin and Alternative complement activity). Neverthless immune parameters significantly decreased by complete replacement of fish oil along with 70-100% replacement of fish meal. Replacement of fish meal and fish oil with plant sources had no significant effect on some blood parameters (Hematocrit, hemoglobin, white blood cell, hetrophil and lymphocytes count) and fish mortality after 15 days of challenge with Yersinia ruckeri (P>0.05).

It was concluded that it is possible to replace whole dietary fish oil and 40% of fish meal with plant sources without any noticeable negative effects on growth indices, immune responces and blodd parameters. However, higher plant protein inclusion (70 and 100%) results in undesirable effects on growth and nutritional parameters. Humoral immune parameters are not affected by replacement of fish meal with plant sources. However fish immune responses are adversly affected when both fish oil and high percentages of fish meal are replaced by plant sources. Replacement of fish meal and oil with plant sources does not negatively affect the tolerance level of fish to bacterial challenge with Yersinia ruckeri.

*Key words*

*rainbow trout, plant protein/oil, growth, immunity*

# Effect of dietary Bovine Lactoferrin on rainbow trout (Oncorhynchus mykiss) fecundity

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The primary objective of salmonid brood stock management programme is the production of the maximum number of high quality eggs and fry from available broodstocks. Improvement in broodstock nutrition and feeding practices has shown to greatly improve the egg and sperm quality, gonadal development and fecundity. Bovine lactoferrin (Lf) is a glycoprotein with anti-microbial, anti-inflammatory, immunomodulatory and anti-cancer effects in fish. The present study was conducted to determine the effects of Lactoferrin on rainbow trout broodstock fecundity.

In the current study broodstocks were divided to 4 groups of 12 fish in each group (6 males and 6 females). Commercial trout feed (crude protein: 38%, crude lipid: 12%, ash: 10%, fiber: 3.5%) was crushed and supplemented with bovine Lf (Biopole SA, Les Isnes, Belgium, Lot No.LODB10) at levels of 0(control), 100, 200 and 300 mg $kg^{-1}$ diet. The diets were repelleted and fed to the experimental fish for 90 days. Statistical analysis of the results were carried out using one-way ANOVA followed by Duncan`s test at $P < 0.05$.

Minimum and maximum total fecundity was observed in fish fed control diet (304.8 ± 57 g) and diet containing 200 mg $kg^{1}$ Lf (400.2 ± 84 g), respectively. There was no significant difference in individual weights of the eggs produced by experimental fish compared to the control. The absolute fecundity was significantly higher in fish fed Lf compared to the control group ($P < 0.05$), but no significant differences among fish fed three different levels of Lf. Relative fecundity was significantly higher in fish fed 200 and 300 mg $kg^{1}$ Lf compared to the control fish and those fed 100 mg $kg^{1}$ Lf ($P < 0.05$). Results of this study also showed that bovine Lf supplementation decreases spawning time in rainbow trout especially in those fed 300 mg $kg^{1}$ Lf.

*Key words*

*rainbow trout, lactoferrin, fecundity*

# Effects of dietary protein sources on growth performance, feed utilization and digestive enzyme activity in rainbow trout (Oncorhynchus Mykiss)

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In this paper the effect of replacing fish meal with different protein sources was tested on digestive enzyme activity in rainbow trout. Six experimental diets containing different protein sources were tested: 1) 100% fish meal (FM), 2) 60% fish meal + 40% plant protein (60FM/40PP), 3) 30% fish meal + 70% plant protein (30FM/70PP), 4) 100% plant protein (PP), 5) 50% poultry by-product meal protein + 50% plant protein (50PP/50PM) and 6) 100% poultry by-product meal (PM). Rainbow trout with a mean initial weight of 15±2 g were fed experimental diets for 60 days.

The alkaline protease, lipase and amylase activity on day 0 of the experiment were 0.18 ± 0.05, 2.30 ± 0.18 and 2.32 ± 0.16 U, respectively. The alkaline protease activity on day 60 in 60FM/40PP (0.49 ± 0.05 U), 50PM/50PP (0.52 ± 0.09 U) and PM (0.49 ± 0.12 U) groups had no significant differences with control (0.57 ± 0.06 U); however this parameter was significantly lower in 30FM/70PP (0.27 ± 0.08 U) and PP (0.15 ± 0.04 U) groups compared with other feeding treatment ($P < 0.05$) (Figure 1). No significant differences on day 60 were detected in lipase activity of FM (3.73 ± 0.02 U), 60FM/40PP (3.67 ± 0.12 U), 30FM/70PP (3.40 ± 0.03 U), 50PM/50PP (3.43 ± 0.03 U) and PM (3.66 ± 0.03 U) groups. But fish fed 100% plant protein PP (3.18 ± 0.02 U) resulted in decreased lipase activity compared to other feeding treatments. The amylase activity did not show any significant differences among different treatments ($P > 0.05$).

Based on the results obtained from present study it was concluded that supplementation of 40% fish meal with combination of plant proteins (wheat and corn gluten and soybean meal) improves growth, enzymatic activity and muscle composition as high as control diet. However, inability of rainbow trout to use higher levels of plant protein in their diet could be due to scarcity of some essential amino acids and low alkaline protease enzyme activity. PBM together with plant protein sources (50%:50%) did not decrease digestive enzyme activity and had promising growth results. Therefore it may be used in rainbow trout feed after properly balancing its essential amino acids composition.

*Key words:*

*rainbow trout, plant protein/oil, digestive enzymes*

## Developing responsible aquaculture in the Baltic Sea region (Aquabest)

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Aquaculture has been the fastest growing food production sector globally during the last two decades. In opposite to the global and European trend, the production in the EU and especially in the Baltic Sea region has stagnated. It is widely accepted that aquaculture has great potential to feed growing human population in the era of declining wild stocks ("Blue Revolution"), but new production has to be built on sustainable practices and technologies. Aquabest, a project of the Baltic Sea Region Programme 2007-2014, will present a toolbox of innovative practices and technologies, test them, and provide a BSR Aquaculture Vision acceptable by stakeholders.

Aquabest (www.aquabestproject.eu) will target the following four specific problems and demonstrate practices to solve them.

1) Aquaculture relies upon nutrients imported from oceans thus contributing to eutrofication of the Baltic Sea.
2) Recent spatial planning knowledge has not been transferred to most BSR regions, and aquaculture has therefore not developed in offshore or other remote areas with less environmental effects, competition and conflicts.
3) Feasibility of recirculation farming has not been assessed and technology transferred throughout BSR regions.
4) Licensing systems do not encourage adoption of eco-efficient technologies and practices.

# Notes

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