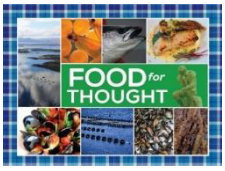
EAS THEMATIC GROUP ON
EUROPEAN PERCID FISH CULTURE

EPFC workshop 2016



Best Practice in Percid Fish Aquaculture

Venue: *Menteith,* Edinburg International Conference Center
Edinburgh, Scotland, UK

Date: Tuesday, 20th September 2016

Agenda:

TIME	TITLE	PRESENTED BY
12.00 – 13.00	**REGISTRATION**	
13.00 – 13.15	**Opening and Welcome**	
13.15 – 14.45	**Reproduction and hatchery**	**Damien Toner**
	The European Marine Biological Research Infrastructure Cluster (EMBRIC) aims to provide advanced genetic resources to support selective breeding of aquaculture species	**Ian Johnston,** University of St. Andrews, UK
	Costs and benefits of applying genetic selection in Percid aquaculture	**Ian Johnston,** Xelect, UK
	Recent advancements in hormonal stimulation of reproduction in Eurasian Perch, *Perca fluviatilis*	**Daniel Zarski,** UWM, PL
	Reproduction of pikeperch at Inagro 2016: food for thought	**Stefan Teerlinck** Inagro, BE
14.45 – 15.15	Break, 30 min, refreshments included	
15.15 – 16.45	**Production in RAS**	**Stefan Teerlinck**
	Exploring Biostability in RAS with Aquapri's new pikeperch facility	**Tahi Jackson Fu,** Aquapri, DK
	The effect of carbon dioxide on metabolism and growth in adult pikeperch *Sander lucioperca*	**Kathrin Steinberg,** GMA, DE
	Improving juvenile production in RAS – Progress and challenges	**Conor Behan,** Keywater Fisheries, IE
16.45 – 17.00	Break, 15 min, refreshments included	
17.00– 17.45	**Snapshot into science**	**Daniel Zarski**
	Egg quality in pikeperch (*Sander lucioperca*): Effects of year-round reproduction and broodstock characteristics	**Fabian Schäfer,** IGB, DE
	- no show -	**Benjamin Laramée,** ULaval, CAN
	Integration of the narrow-clawed crayfish (*Astacus leptodactylus*) into an operating pike-perch aquaculture system	**Tanja Soukup,** AWI, DE
	Research and practice: First steps to establish perch aquaculture in Northeastern Germany	**Frederik Buhrke,** LFA, DE
17.45 – 18.00	**SUMMARY & CLOSING OF THE WORKSHOP**	

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Met steun van de Vlaamse overheid

European Percid Fish Culture (EPFC) workshop 2016

The fifth workshop of the European Percid Fish Culture (EPFC) thematic group within EAS was held on **September 20th 2015 in Edinburgh** This year's topic was:

Best Practice in Percid Fish Aquaculture

Abstracts

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1 Reproduction and hatchery

1.1 The European Marine Biological Research Infrastructure Cluster (EMBRIC) aims to provide advanced genetic resources to support selective breeding of aquaculture species

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The European Marine Biological Research Infrastructure Cluster (EMBRIC) aims to provide advanced genetic resources to support selective breeding of aquaculture species

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Awards/Honours: 1984, Scientific Medal, Zoological Society of London; 1994, Silver Medal, 8th Plymouth Marine Sciences Lecturer; 1987, Elected Fellow of the Royal Society of Edinburgh; 2013, Society Experimental Biology, Bidder Lecturer.

Academic career (1973-2016): 1973-1975,NERC Research Fellow (Personal Award), University of Bristol; 1976-present, University of St Andrews: Lecturer (1976-84), Reader (1984-5), Personal Chair (1985-1997); Head of School Biology & Preclinical Medicine (1987-1992); Head of Division (School) Environmental & Evolutionary Biology (1997-2002); Director of Research, School of Biology (2002-2006); Director, Gatty Marine Laboratory (1985-2008); Director, Scottish Oceans Institute (2012-2016); Professor of Biology (0 FTE) (2016 – present); 1997-2000, Professor II, Institute Marine Research, Bergen, Norway; 2002-2011, Professor II, University of Nordland, Norway.

Research: Fish physiology and genetics. 340+ peer reviewed publications, H index 56 (Web of Science).

Research Councils, Learned Societies and European Science: 2005-2009, Vice-President and President Society for Experimental Biology; 1995-2000, Natural Environment Research Council; Chair, Marine Science & Technology Board; Chair, Science Management Audits of NERC's Marine Research Institutes (Marine Biological Association, Plymouth Marine Laboratory, Scottish Association Marine Sciences). 2009-13, EMBRC steering committee member; 2014-5, EMBRC Implementation Board as UK scientific representative.

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Abstract

EMBRIC (European Marine Biological Research Infrastructure Cluster to promote the Blue Bioeconomy) is an EU H2020 "Research and Innovation action" (Grant agreement no 654008) which has funding of €9.041.611 over the period 1st June 2015 to 31st May 2019. The project is co-ordinated by the Université Pierre & Marie Curie, Paris, France and has 27 partners from 9 countries.

EMBRIC is designed to propose integrated multidisciplinary value chains of services for the exploration of marine bioresources and their sustainable exploitation as sources of biomolecules and/or as whole organisms for food. The cluster unites RIs that provide access to the full spectrum of diversity of marine organisms (EMBRC) or are specialized in the provision of specific groups of organisms (MIRRI: prokaryotes and fungi; AQUAEXCEL: finfish). Using these biological resources as raw materials, the cluster will develop service-oriented workflows for natural products discovery and for genetic selection in aquaculture. EU-OPENSCREEN contributes its services and expertise in the area of natural product discovery, while AQUAEXCEL does likewise in the aquaculture domain. ELIXIR provides cross-cutting expertise on data services and management. The cluster also includes the coordinator of the social sciences Integrating Activity project RISIS, specialized in the analysis of innovation ecosystems across Europe, which will be involved in establishing the technology transfer identity of EMBRIC. Case studies are designed to help testing and refining these workflows through Joint Development Activities (JDAs). This internal testing will be complemented by providing access to EMBRIC services to external user communities in the second half of the projects lifetime.

Work package 8 is concerned with the genetics of selective breeding in finfish and shellfish (WP leader is Prof. Ian A. Johnston). The partners are the University of St Andrews (Scotland), INRA-Ifremer Fish Genetic Improvement group (France) the Hellenic Centre for Marine Research (Greece), Marine Science Scotland (Scottish Government) and 3 SMEs (Xelect Ltd, Scotland; Scalpro A/S, Norway and TunaTech GmbH, Germany). The WP activities include the production of standards and ontologies for trait measurements, the generation of genomic resources for key species and the development of pipelines and workflows for genetic marker discovery. Knowledge exchange and interaction between the RI cluster and industry is being achieved through a Company Forum. The Company Forum is free to join and has already more than 30 members. Examples of the work being undertaken in EMBRIC will be presented along with the opportunities for the Percid aquaculture community. We welcome discussion on how the Company Forum (coordinator Prof. Chris Bridges, University of Dusseldorf and TunaTech GmbH) could be of most service to its members.

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1.2 Costs and benefits of applying genetic selection in Percid aquaculture

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Costs and benefits of applying genetic selection in Percid aquaculture

Author(s)

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Founder & CEO Xelect Ltd December 2012-present

Research on the genetic basis of muscle growth and quality led to the discovery of genes with a large effect on fillet yield and texture (patent number PCT/GB2012/052509). I was successful in obtaining Follow-on funding from BBSRC (2012-13) to commercialise the research. Following an investment from the Norwegian Company SalmoBreed A/S I co-founded Xelect Ltd, a company registered in Scotland no. SC438223, with Dr Thomas Ashton in December 2013. Xelect provides specialist genetics support to the aquaculture industry worldwide. The company offers a fast and cost-effective "one stop shop" for the genetic management of breeding programs including parentage assignment, control of inbreeding and combined selection. Xelect is a leader in marker assisted selection. Markers for superior production traits in Atlantic salmon and Nile tilapia have been licensed worldwide. Our customers for selection markers for carcass quality traits include Marine Harvest, Cermaq Canada, Loch Duart Salmon, GenoMar, SalmoBreed and Landcatch Natural Selection. Xelect has a strong research and development pipeline of genetic markers for other traits and species including rainbow trout, sea bass and sea bream. Our current customers for broodstock management including leading producers of Atlantic salmon, rainbow trout, sea bass and sea bream. Xelect has a well established pipeline for validating SNP panels for pedigree assignment in any fish species. Our well-equipped laboratories also carry out service work including DNA extraction and normalisation, genotyping, DNA-based sex determination, flesh quality consultancy and "next day" triploidy testing of live eggs. Xelect currently occupies incubation space at the Scottish Oceans Institute, but will move to independent purpose built premises nearby in October 2016. The company had a successful investment round in March 2016 to fund future expansion.

Abstract

A brief introduction will be given to the principles of genetic selection in fish breeding and how these might be applied to the pike-perch industry. The indicative costs of operating a genetic selection program will be discussed along with breeding goals and the modeling approaches we use to estimate the cost-benefit ratio of particular schemes.

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1.3 Recent advancements in hormonal stimulation of reproduction in Eurasian Perch, *Perca fluviatilis*

Download presentation here:

Recent advancements in hormonal stimulation of reproduction in Eurasian Perch, *Perca fluviatilis*

Author(s)

Daniel Żarski*, Katarzyna Palińska-Żarska, Sławomir Krejszeff, Zoltán Bokor, Sylvain Milla, Pascal Fontaine, Bela Urbányi

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*Since over 10 years I am working scientifically on different aspects of freshwater aquaculture where intensive production systems, controlled reproduction and larviculture are among my main fields of interest. Since the very beginning I have been working on the development of reproductive and rearing protocols for percids (Eurasian perch and pikeperch). I have been mostly focusing on the improvement of controlled reproductive protocols from the perspective of synchronization of ovulation, factors affecting gametes quality as well as gametes biology. I have been participating in several percid-related research projects (LUCIOPERCIMPROVE, PERCAHATCH, TRANSANDER) as well as one project where Eurasian perch aquaculture was a very important part of the research activities (INNOVAFISH). I am the author and co-author of over 70 scientific articles from among which 19 are strictly related to different aspects of reproduction in percids. I am also the author of first 'Hatchery Manual' for Eurasian perch, which is going to be published by Springer in the coming months.

Abstract

Introduction

One of the main challenge in percids aquaculture is to acquire high quality gametes at precisely planned time. To this end hormonal therapy is highly perspective method allowing precise control over the final oocyte maturation (FOM) process and spawning (Żarski et al., 2015).

The FOM process in percids is highly desynchronized, what turns into prolonged spawning season whenever fish are left to spawn spontaneously. In effect, particular females are spawning at barely predictable time. One of the most plausible method allowing synchronization is the application of hormonal therapy at the very first maturation stages (stage I of classification given by Żarski et al., 2011) when fish just entering FOM, being relatively synchronous process. However, in such a case the application of typical hormonal therapy may affect egg quality negatively (Żarski et al., 2011).

In the case of percids usually human chorionic gonadotropin (hCG) is applied. Due to its long (several days) half-life in the blood stream the multiplication of injection is not necessary (see Zakęś and Demska-Zakęś, 2009). In percids it was accepted that a single injection is fully suitable to promote ovulation (Żarski et al., 2015). This has led to perform tests on the application of gonadoliberines (GnRHa) in a single injection, as well. It was found to be successful only when high doses (over 100 μg kg^{-1}) of this spawning agent were applied. Because the half-life of GnRHa is much more shorter the tests on its application in two doses were performed. The first dose (stimulatory) is usually lower and should slightly promote the FOM, whereas the second one (resolving), being at least two fold higher is given to trigger the final process of ovulation (Kucharczyk et al., 2008). In this study we have tested the application of salmon GnRHa (sGnRHa) alone (without dopamine antagonists - never tested before) given in two doses at the very first phases of the FOM process.

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Material and methods

The fish were obtained from the earthen ponds during Autumn and were subjected to the vernalization period (water below 10°C) in dimness for 70 days. After the temperature was raised to 10°C females (n=10 for each group) were subjected to a 1st injection with various hormonal stimulation protocols (Tab. 1) and next they were placed to a 300 l tanks (separated by the groups). After 7 days fish were subjected to the second injection (Tab. 1) and temperature was raised to 12°C. At that time to each tank 10 males (injected 4 days in advance with the hCG at a dose of 500 IU kg^{-1}) were placed. Before first injection maturation stage of each female was checked by catheterization (Żarski et al., 2015). The fish were left to spawn spontaneously. The eggs were collected for the next 10 days and were incubated at 14°C. At the eyed-egg stage survival rate of embryos was determined. After hatching larvae were reared (from each group separately) with the same protocol for 10 days, after which swim bladder inflation effectiveness (SBIE) and spawning efficiency index (SEI) (representing number of larvae with inflated swim bladder obtained form 1 kg of spawned females,. Żarski et al. 2015b) was determined.

Results

At the moment of first injection all the females were at stage I. Ovulation rate was very high in all the groups. After the second injection fish from the control groups (hCG and GnRH) ovulated after over 6 days, whereas in the experimental groups between 2nd and 4th day. The highest SR was recorded in group GnRH-10, whereas the lowest after application of hCG and GnRH-100 (Tab. 1). After application of hCG no viable larvae were found at 10 day post hatch (DPH). Among the remaining groups the highest SBIE and SEI was recorded in group GnRH-25. The lowest values were always recorded in group GnRH-100 (Tab. 1).

Tab. 1. The results of out-of season (advanced) spawning of wild Eurasian perch after application of double injection protocol with sGnRHa in comparison to 'typical' single-dose treatments with hCG and sGnRHa. OR – ovulation rate; SR - survival rate of embryos at eyed-egg stage; LT – latency time (between second injection and ovulation); SEI – spawning efficiency index expressed in number of larvae with inflated swim bladder at 10 DPH.

Group	hCG	GnRH	GnRH-10	GnRH-25	GnRH-50	GnRH-100
1st injection	NaCl	NaCl	10 µg kg^{-1}	10 µg kg^{-1}	10 µg kg^{-1}	10 µg kg^{-1}
2nd injection	500 IU kg^{-1}	100 µg kg^{-1}	10 µg kg^{-1}	25 µg kg^{-1}	50 µg kg^{-1}	100 µg kg^{-1}
OR (%)	80	80	80	100	90	100
LT (h)	182 ± 29^{b}	180 ± 13^{b}	76 ± 24^{a}	56 ± 25^{a}	75 ± 39^{a}	84 ± 43^{a}
SR (%)	72.3 ± 25.7^{b}	79.5 ± 35.1^{ab}	92.3 ± 8.3^{a}	86.3 ± 15.7^{ab}	88.5 ± 17.8^{ab}	58.7 ± 22.8^{b}
SBIE (%)	-	27.3 ± 6.4^{b}	31.3 ± 5.6^{ab}	36.3 ± 2.7^{a}	32.0 ± 5.2^{ab}	29.1 ± 1.8^{b}
SEI ($\times10^3$)	-	21.7 ± 5.1^{b}	28.9 ± 5.1^{ab}	31.3 ± 2.3^{a}	28.3 ± 4.6^{a}	17.1 ± 1.0^{c}

Discussion

The results obtained in our study has revealed that a single dose of hCG was less effective than a single injection of GnRH, in terms of larvae quality. From none of the fish treated with hCG we were able to grow the larvae, although the same husbandry protocol was applied. It could stem from the negative effect of hCG on the fatty acid profile of the eggs, as reported by Żarski et al., (2016). However, it should be more closely studied before any conclusion can be given.

The application of GnRH in two doses allowed to obtain highest spawning rate and larval performance. However, too high dose of GnRH given in second injection had negative impact on the final reproduction outcome. This suggest an overdosage of the hormone. A lowered egg quality after application of the highest dose of mGnRHa was also reported in pikeperch (Křišťan et al., 2013). This highlights the need for precise determination of the most effective dose when GnRH-based hormonal preparations are intended to be used.

Thermal manipulation during the hormonal therapy is a common practice in freshwater species. Lower temperature after the initial injection allows to slightly promote the first phases of FOM. Then, together with the resolving injection simultaneous thermal and hormonal stimulation have strong effect on the ovulation process (Kucharczyk et al., 2008). By following this approach, we have proposed a novel hormonal stimulation protocol in percids which combines thermal and hormonal manipulation. We have found, that application of 10 and 25 µg kg^{-1} of sGnRHa allowed to obtain high quality larvae fully suitable for culture purposes, what was never reported before in any of the studies on induced spawning of Eurasian perch. However, one must be

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highlighted, that the application of this protocol in commercial production should be first verified under the local conditions considering potential alterations stemming from domestication process and genetic background of the stock.

Acknowledgements
This study was supported by the EUREKA project (E! 8028 PERCAHATCH).

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1.4 Reproduction of pikeperch at Inagro 2016: food for thought

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Reproduction of pikeperch at Inagro 2016: food for thought

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Abstract

In order to be successful Inagro leaned on his reproduction experience with wild pikeperch (*Sander lucioperca*) from 2015 and followed the same reproduction protocol in 2016: to getting wild broodstock, induce the spawning by raising temperature, collect the eggs on artificial grass, disinfect the eggs with peroxide and raise the larvae. The detailed protocol was written out with input from Andreas Müller-Belecke, Gregor Schmidt, Jiri Bossuyt and Thomas Janssens through visits and email.

Inagro succeeded in 2015 in collecting 220.000 hatched larvae in 2 days from approximately 40 females, 30 males (housed in one group) and ended on day after hatching (DAH) 30 with 40% larvae feeding for 5 days on dry feeds. The larvae where raised in 12 tanks (220l) at 4 different feeding regimes in triplicate. We had larvae fed from DAH 8 with enriched instar 2 artemia, enriched instar 2 artemia and Orange (INVE), not enriched instar 1 artemia and Orange and not enriched instar 1 and Micro-Gemma (Skretting). Until DAH 18 no significant difference was seen in dry weight or length. At DAH 30 the group fed Micro Gemma was significantly bigger. Gill, tail and spine deformations where low in all treatments (< 5%, 0,5% and 3%) and had no significant difference between treatments. With the second diet we did see a higher probability for protruding lower jaw deformation,

In contrary it took Inagro in 2016, 24 days to collect 202.000 hatched larvae out of a similar group of newly bought wild parent animals. Resulting in bigger workload and no homogeneous (in age and parents) population in the 12 larval production tanks.

On top of that when the eldest larvae where on DAH 36 and the youngest on DAH 12 we seen sudden dead in one tank. After 4 days no larvae where left alive in this tank. Meanwhile this symptom was seen in almost all of the tanks, a viral infection was suspected. When the oldest larvae where on DAH 43 we decided to stop the production and disinfect the whole hatchery.

In 2016 we also had 3 tanks with larvae coming from broodstock F1, fed only dry diets and second year spawners (first year without success). Due to the disease we could only monitor 1 tank (these where the oldest larvae) on their growth (data to be monitored until presentation).

Lots of food for thought: why was it so difficult to get eggs and larvae in 2016? what kind of disease or mistake did we have/make?

One conclusion: if you want to secure your larval production you need to cut through all connections with nature. Prelemanary results at Inagro show possibilities to grow larvae out of broodstock fed dry diets resulting in larvae with the same length as recovered from wild broodstock on DAH 30.

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2 Production in RAS

2.1 Exploring Biostability in RAS with Aquapri's new pikeperch facility

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Exploring Biostability in RAS with Aquapri's new pikeperch facility

Author(s)

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* Tahi finished his Master of Science in Aquaculture at James Cook University, Townsville, Australia in June 2015 and is now working at Aquapri's new pikeperch recirculation farm in Vejen. During his studies, he gained practical experience with Asian seabass larvae, RAS, aquaponics and other relevant topics. Before his MSc, he obtained his BSc from University of Auckland, New Zealand and worked on the effects of hypoxia on a variety of Triplefin fish species with emphasis on physiology and behaviour.

Abstract

AquaPri
- Focus on the new pike perch facility in Gamst, Denmark
- Annual production of 600t
- Divided into 3 systems
  - A) 20g - 400g
  - B+C) 400g - Market size (>600g)

"Achieving biostability in RAS"
- restrict/isolate biological activity to biofilters / denitrification reactors
- consider production cost, labor, flow on effects from implemented strategies
- be aware of energy equilibrium (energy input vs output)

Our goal at Aquapri
-treating the system as a dynamic environment
  - an "ecosystem" approach
- Use bacteria monitors from Grundfos to monitor bacteria levels
  - provides data to help make water quality management decisions
- consistent improvement and optimization of farm components to help improve water quality.

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2.2 The effect of carbon dioxide on metabolism and growth in adult pikeperch *Sander lucioperca*

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The effect of carbon dioxide on metabolism and growth in adult pikeperch *Sander lucioperca*

Author(s)

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* Kathrin Steinberg holds a B.Sc. in Marine Technologies (University of Applied Sciences, Bremerhaven) and a M.Sc. in Sustainable Aquaculture (University of Stirling) and is currently doing her PhD at Christian-Albrechts-Universität zu Kiel and the *Gesellschaft fuer marine Aquakultur* in Buesum, Germany. Her research is focused on the effect of relevant RAS ongrowing parameters on the growth rates, metabolism and health of the later life stages of pikeperch. She also worked for the German Development Agency GIZ as a Junior Advisor in the project 'Promotion of Sustainable Fisheries and Aquaculture' and as a Consultant in Kenya and Ethiopia.

Abstract

Introduction

Partial pressure of CO_2 (pCO_2) in open water bodies is roughly that of the atmosphere but fish grown in RAS systems may be exposed to substantially higher carbon dioxide concentrations and it is one of the limiting factors of land-based aquaculture. Most studies of the impact of hypercapnia on fish have focused on acute hypercapnia. Only little is known on the chronic effects. Carbon dioxide has direct physiological effects on the fish as it increases plasma pCO_2 which reduces oxygen transport. Additionally reduced growth and feed conversion efficiency as well as nephrocalcinosis have been observed in longterm exposure of carbon dioxide to turbot, rainbow trout and Atlantic Salmon (Fivelstad, 2013; Smart et al., 1979; Stiller et al., 2015).

Materials and Methods

The trial was conducted in a recirculating aquaculture respirometer system (RARS) as described in detail by Stiller et al. (2013). The systems consists of 10 tanks (volume of 250 L each), one of which is kept empty of fish. The RARS (4 m^3 volume) has its own water treatment system and consists of an online water chemistry analysis unit measuring oxygen, water temperature and pH, dissolved CO_2 and total NH_3-N. Ten fish were stocked in each tank with an average weight of 251.9 g and fed daily until apparent satiation with a commercial diet (ALLER Metabolica). Food grade CO_2 was added to the medium (~15 mg L^{-1} CO_2) and high (~ 30 mg $^{L-1}$ CO_2) hypercapnia level tanks using ceramic diffusers while three tanks were left without additional CO_2 ingassing to represent the low hypercapnia regime. Individual body wet weight [g] and length [cm] of three individuals per tank and wet fish group weight [kg] were determined at the start and end of the experiment. Blood was taken

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from the caudal vein of three fish per tank to evaluate haematocrit. Data of oxygen consumption and ammonia excretion were used to calculate the ammonia quotient (AQ) on a biweekly basis.

Results

Fish showed a decreasing dose responded trend in the daily feed intake with a DFI of 0.97±0.0 % for the low hypercapnia regime, 0.92±0.08 % for the medium regime and 0.86±0.02 % for the high regime. The SGR was 1.05±0.06 %, 0.97±0.17 % and 0.88±0.10 % accordingly. FCR's increased from 0.93±0.04 (low) to 0.97±0.11 (medium) and 0.98±0.04 (high). The condition factor was similar through all groups and treatment with a mean CF of 0.84±0.12. The AQ increased from 0.12±0.01 (low), 0.13±0.01 (medium) and 0.14±0.01 (high) in week 1 to 0.16±0.01 (low), 0.18±0.02 (medium) and 0.18±0.02 (high) in week 4 without significant differences between the treatments. Haematocrit showed a linear correlation with values of 33±4% (low), 28±9% (medium) and 25±3% (high). The calculation of energy budgets did not show any significant differences between the treatments. An average of 68.4±2.2% of gross energy intake remained in the fish within all treatments.

Discussion and Conclusion

The fish were fed till apparent satiation for a limited amount of time (10 minutes). The data retrieved for SGR, DFI and FCR suggest a reduction in appetite in correlation with the CO_2 concentration. This effect was also described in other fish species such as turbot (Stiller et al., 2015) or Atlantic salmon (Fivelstad, 2013). Reduction in haematocrit with increasing CO_2 levels indicate that red blood cells were affected by the increase in CO_2. This has also been seen in Atlantic Salmon, were the reason seemed to be erythrocyte shrinkage (Fivelstad et al., 2007). The determination of AQ in this trial showed an increase in protein catabolism with increasing time and weight but no correlation with CO_2 dosing. Therefore these results are not in line with hypercapnia trials on other species were an increased protein catabolism and reductions in protein anabolism were demonstrated under hypercapnic conditions but correlate with the results for energy metabolism which indicate that 30 mg L^{-1} of CO_2 do not have an effect on the metabolism of pikeperch (Methling et al., 2013; Stiller et al., 2015). The research provides new data in terms of adaptive mechanisms of pikeperch to hypercapnia conditions as well as detailed baseline data on the energy metabolism of pikeperch.

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2.3 Improving juvenile production in RAS – Progress and challenges

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Improving juvenile production in RAS – Progress and challenges

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Abstract

This presentation will mainly focus on some of the production techniques and the successes/challenges that were faced at Keywater fisheries in the out of season spawning and juvenile production of perch in a fully RAS system.

Topics to cover include: swimbladder inflation, Artemia production, weaning to dry diet etc.

3 Snapshot into Science

3.1 Egg quality in pikeperch (*Sander lucioperca*): Effects of year-round reproduction and broodstock characteristics

Download presentation here:

Egg quality in pikeperch (*Sander lucioperca*): Effects of year-round reproduction and broodstock characteristics

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Abstract

The year-round production of high quality eggs is paramount for reaching and maintaining a constant and reliable availability of stocking material. In pikeperch, photothermal protocols are used to control gonad maturation and allow for out-of-season reproduction. However, the effects of this practice on the quality of the eggs have not been determined. We hypothesized that such manipulation of environmental cues may interfere with the endogenous control of reproduction subsequently affecting gamete quality. In addition to out-of-season spawning, it presently remains unknown to what extent maternal characteristics (length, spawning experience) affect specific egg traits (morphology, biochemical and molecular composition) and – in turn – how these traits are related to developmental success in pikeperch. Identifying critical egg components would allow for the implementation of predictive biomarkers further promoting improvements of current hatchery practice. Over a three-year period we sampled eggs from 41 pikeperch spawners covering six independent spawning seasons originating from four separated commercial broodstocks (AquaPri, Denmark). Protocols for broodstock rearing and reproduction were similar for all seasons. Spawning history, day of spawning, female length and fecundity were documented. To assess egg quality, rates of fertilization, embryo survival at time (24, 28, 48 h) and hatching were determined. In the lab, a variety of egg traits (egg size, markers of oxidative stress, fatty acid (FA) profiles, cortisol, protein and dry-weight content) were quantified in sub-samples of unfertilized eggs. Developmental rates were analyzed against maternal characteristics, as well as egg traits.
No substantial effects of out-of-season spawning on fertilization, rates of embryo development and hatching success could be identified. Increased spawning experience and larger fish size was not associated with higher egg quality. To the contrary, reproductive performance (fecundity, egg quality) decreased for large fish revealing an optimal fish length of ~65 to 70 cm. Variability in egg quality was higher in successively stripped, large females compared to smaller spawners stripped for the first time. Interestingly, rates of egg and embryo development were largely independent of egg cortisol content and markers of oxidative stress (antioxidant capacity, mtDNA fragmentation). However, specific (neutral and polar) FA, including highly unsaturated FA (HUFA) were correlated with fertilization, embryo development and hatching highlighting the major role of FA during early development. In addition, egg size proofed to be a useful biomarker being associated with late embryo development and egg size. Interestingly, smaller eggs revealed a higher quality. By using both,

maternal characteristics and egg traits, significant amounts of variability (43.9 to 58.2%) in developmental rates could be explained.

Conclusively, out-of-season reproduction can fully be recommended in pikeperch. Attention should be paid towards the selection of breeders regarding the optimal size for reproduction. Oocyte-based observations highlight the potential for further optimization of hatchery practice. For example, correlations between cortisol levels and specific FA possibly indicate a relationship between handling stress and the mobilization of nutrients during reproduction, which could potentially be counteracted by prolonging resting times in-between successive spawning seasons. The results should be considered to establish a species-specific broodstock diet to further increase reproductive performance.

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3.2 Development of techniques to promote gas bladder inflation of walleye (*Sander vitreus*) larvae in intensive recirculating aquaculture system

Author(s)

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Abstract

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3.3 Integration of the narrow-clawed crayfish (*Astacus leptodactylus*) into an operating pike-perch aquaculture system

Download presentation here:

Integration of the narrow-clawed crayfish (*Astacus leptodactylus*) into an operating pike-perch aquaculture system

Author(s)

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*Tanja Soukup received her Master of Science at the TU Munich in 2013 after finishing her thesis about the influence of anthropogenic introduced hard-bottom substrata (tetrapods) on decapod crabs and demersal fish. Afterwards she started working at the imare GmbH (now introduced to AWI) writing the proposal for the recent project "InSuZa" and is now, after the project was granted, working on the realization of an IMTA of pike-perch and the narrow-clawed crayfish.

Abstract

Introduction
Aquaculture systems for fish species like Pike-perch (*Sander lucioperca*) farming could benefit from integrated multitrophic aquaculture (IMTA) methods in terms of cost-efficiency and sustainability. With similar environmental requirements to pike-perch, the narrow-clawed crayfish (*Astacus leptodactylus*) may function as a "tank-cleaner" at the bottom of the fish tanks, feeding on fish faeces and otherwise wasted fish feed.

Materials and methods
In commercial production, culture conditions cannot be significantly changed and thus the suitability of the narrow-clawed crayfish to farm conditions must be investigated.

1. The critical factor of the continuous high temperatures (ca. 26 – 28°C) in pike-perch farming compared to optimal temperature of the narrow-clawed crayfish (22 – 24°C) must be investigated. Thermal stress can cause crayfish to react with higher oxygen consumption and therefore higher respiratory rates. Respiratory rates of single crayfish were measured using flow-through respirometry at different temperatures.
2. Another critical factor is almost complete darkness at the bottom of the pike-perch tank, where the crayfish are held. Continuous lack of light can confuse parts of the circadian rhythm within different crayfish species like activity and heart rate and some metabolic processes.
3. It is known that the diet of the narrow-clawed crayfish includes fish-faeces but there is no information if they can feed only on fish-faeces and specifically pike-perch faeces. Investigating the RNA-DNA ratio of different fed crayfish with commercial feed and faeces will show, whether pike-perch faeces are sufficient for health and growth of the narrow-clawed crayfish.
4. In order to avoid recurring handling stress by periodic grading of crayfish and pike-perch, the crayfish will be held in pike-perch tanks within cages or will be otherwise separated at the bottom of the tank. The design must be adjusted to meet requirements of both species to avoid stress.

Results
Preliminary results indicate that crayfish can adapt to higher temperatures and can deal with complete darkness over a period of several weeks. In addition, noble crayfish (*Astacus astacus*) fed only on tilapia faeces

in the IMTA project “Aquamona” over longer periods, have exhibited strong growth performance. It remains unclear whether growth rates, moulting or stress are significantly impacted by one of these factors.

Discussion and Conclusion

Optimal temperature of the narrow-clawed crayfish is cited widely as 22 – 24°C (Harlioğlu 2009, Malev et al 2010), however it is clearly able to cope with higher temperatures up to 29°C over a mid-short time period (Mazlum et al 2011). Furthermore, the narrow-clawed crayfish is able to manage complete darkness during the mating period (Harlioglu and Duran 2010), seems to adapt to a missing light-dark cycle (Ulikowski et al 2006) and activity patterns, one element of the circadian rhythm, can be entrained by food provision (Fernandez de Miguel and Arechiga 1994). Pike-perch faeces will be available to crayfish continuously, but it is necessary to investigate whether the remaining nutrients are sufficient for viable growth. As a minimum, an appropriate tank and cage design is essential for reducing stress, because pike-perch as well as the narrow-clawed crayfish are stress-susceptible (personal observation). The narrow-clawed crayfish for example appears to react to stress with moulting which reinforces cannibalism and an unintended reduction of the stocking density.

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3.4 Research and practice: First steps to establish perch aquaculture in Northeastern Germany

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Research and practice: First steps to establish perch aquaculture in Northeastern Germany

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Abstract

The Institute of Fisheries and Aquaculture of the State Research Center has been given the task to experiment with scientific results made in the aquaculture sector. The main purpose of this is converting science in usable practice and as a result to establish aquaculture operations with potential partners and investors in the federal state Mecklenburg-Vorpommern. For this reason the Ministry of Agriculture and Fishery started several projects (pikeperch production, whitefish production, animal welfare, perch production) in the last years.

The aquaculture research facility is situated in Northeastern Germany between the Baltic Sea and inner coastal waters. The research mostly takes place in different RAS. Since 2013 we are working with European perch (*Perca fluviatilis*).
One of our main tasks is optimizing the fingerling production in our facility. We tested different approaches to improve the survival rate and fingerling quality. Another issue is an improvement of our regional broodstock. For this we are comparing perch populations (German coastal waters, several populations from different waterbodies) to gain information about their value as potential broodfish in the future. Furthermore we are trying to determine genetic differences in our perch stock from different locations. Another aspect of our work is to improve the reproduction of perch without the usage of hormones, to increase the survival rate while larval rearing and to simplify the handling of perch in all stages especially in the first month after hatching. Currently we are working on the improvement of our off season reproduction. This will be a key position for the next years. Recently we started cooperating with different institutes to use for example methods for cryopreservation of perch sperm in our facility.

In summary it can be stated that we were able to improve different issues in our perch production and as a result made the first steps to awake some interest in perch aquaculture in Northeastern Germany. We are receiving requests for information about perch and especially for perch fingerlings in increasing intervals.

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