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v Českých Budějovicích
University of South Bohemia
in České Budějovice
Czech Republic



MINISTRY OF AGRICULTURE OF THE CZECH REPUBLIC



MINISTERSTVO ZEMĚDĚLSTVÍ

Production of juveniles for RAS ongrowing farms with a combined system using POND / RAS



T. Policar, J. Kříšťan, M. Blecha, O. Malinovskiy



Národní agentura
pro zemědělský výzkum
MINISTERSTVO ZEMĚDĚLSTVÍ



Traditional Food Network to improve the transfer of knowledge for innovation



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Team introduction

Laboratory of Intensive Aquaculture

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Research interest related to pikeperch:

Controlled reproduction: spawning from Jan. – June, around 5 – 7 millions of high quality larvae;

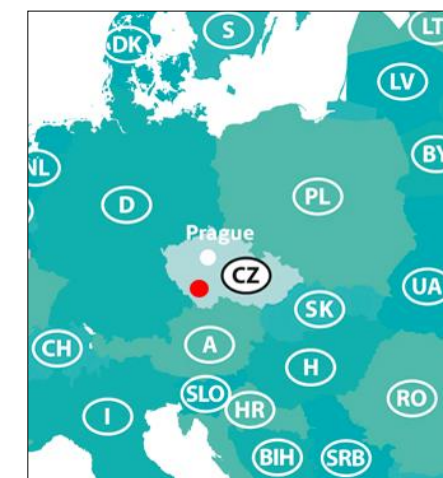
Oocyte quality: cellular and molecular changes associated with oocyte ageing during their incubation;

Induction of polyploidy level for production of triploids: effective pond ongrowing production;

The first larval feeding: with using of rotifers *Brachionus plicatilis* under RAS – increasing survival around 25 – 30 %;

Adaptation of autumn and spring juveniles: more batch production;

Optimization of ongrowing phase under RAS.





History of POND /RAS production system development and using

Getting of experience from literature 2004 (e.g. Zakes 1997; Ljunggren et al., 2003);

Using and development POND / RAS system for Eurasian perch (2005 – 2008);

Adaptation of POND / RAS system for pikeperch (2009 – 2010);

Using of POND / RAS system for mass pikeperch juvenile production (2011 – present);

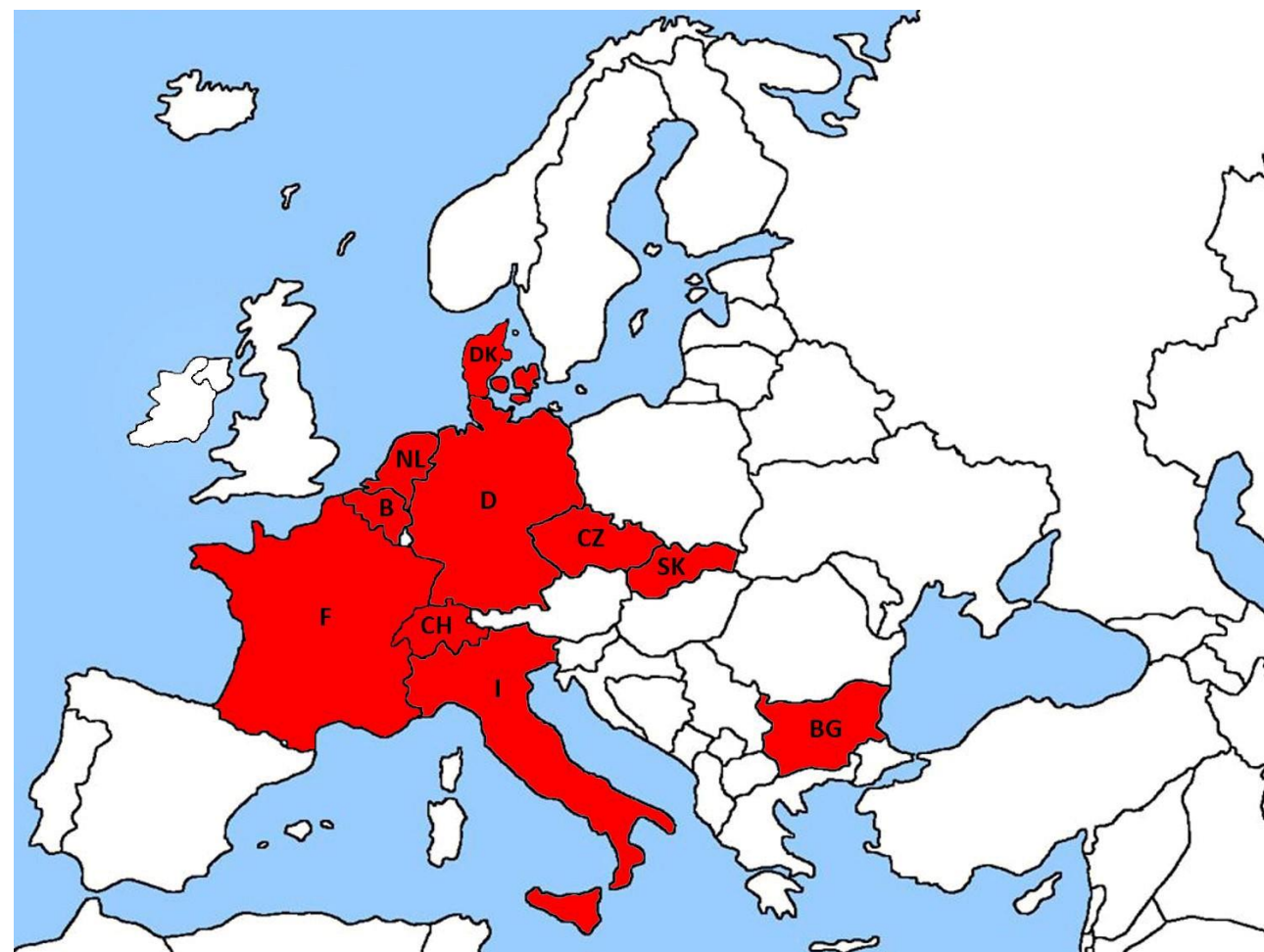
The aim: getting of high quality experimental fish for our experiments and develop effective system for pikeperch juvenile for ongrowing farms in mainly in Central and Eastern Europe.



Production during 8 years (2010-2017)

Final product: pikeperch juveniles for RAS culture with BW 10 – 25 g

Year	Produced fish (pcs)
2010	18 000
2011	30 000
2012	55 000
2013	40 000
2014	37 000
2015	80 000
2016	50 000
2017	80 000
Total	390 000
Avg.	48 750



- 30 – 50% of production was used for our experiments
- the rest was sold to production and research partners in the Czech Republic, Netherlands, France, Belgium, Italy, Bulgaria, Germany, Switzerland, Denmark and Slovakia.



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Detailed technology steps of POND/RAS system



Broodstock management under pond/RAS conditions



Reproduction and egg incubation under controlled conditions



Stocking of larvae into prepared ponds



6-weeks pond culture of larvae and juveniles under pond conditions



Harvest of pikeperch juveniles from ponds



Weaning and adaptation of juveniles under RAS



Following juvenile culture under RAS to BW 25 grams





Broodstock management and reproduction



Size of broodstock

Pond cultured broodstock with TL= 520 – 570 mm, W= 1200 – 1800 g not bigger;

Better and easier manipulation;

Lower egg fecundity and better egg distribution on the artificial nests providing good incubation conditions and high hatching rate and larval production;

Lower demanding for tanks capacity and culture place;

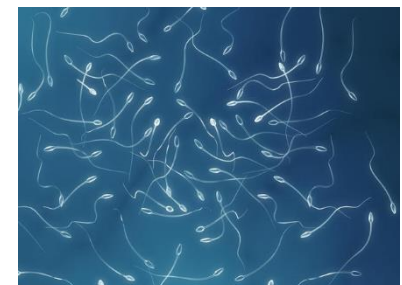
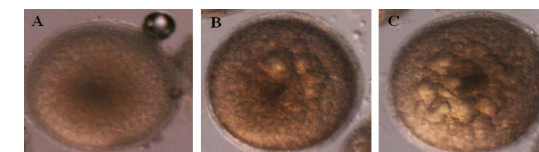
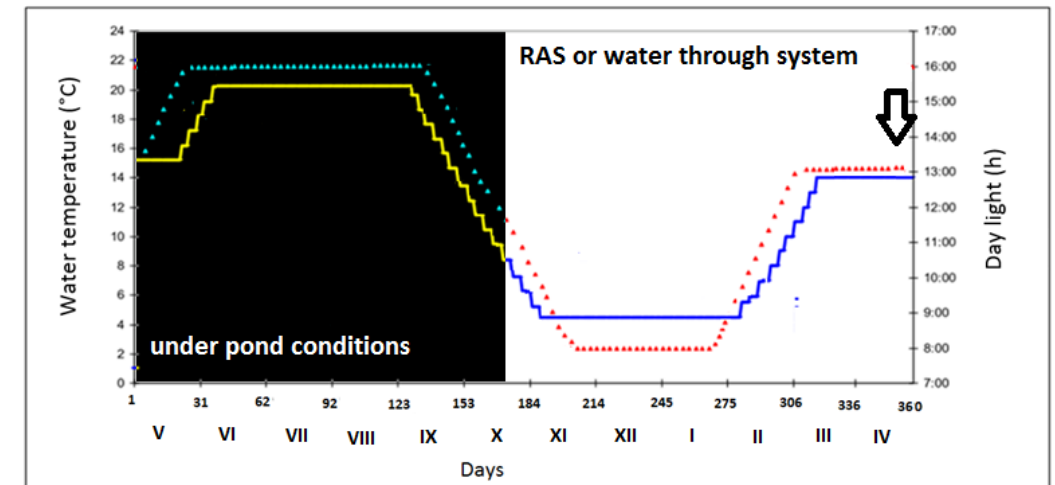
We can use higher number of fish for higher genetic diversification.





Broodstock culture

- Natural environmental stimulation for gonadal development and maturation (6 periods before spawning) – control and cutting of summer or wintering periods for different terms of spawning (from January till June);
- Broodstock culture under POND and RAS conditions with stable and good supply of prey fish (15 kg of prey fish. kg^{-1} of broodstock per year);
- Broodstock protection in ponds against otters and cormorants;
- Selection of the best broodstock 40 days before spawning according conditions;
- Checking of maturation stages of oocytes and selection of matured broodstock for final hormonal stimulation.





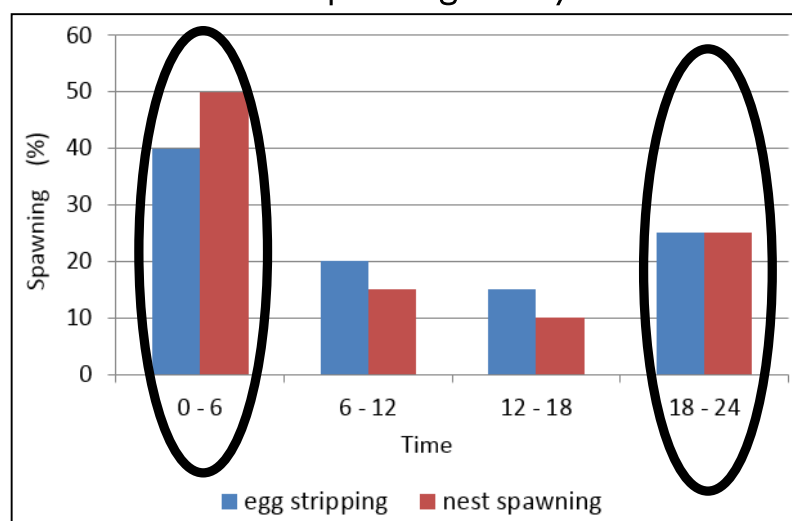
Spawning

Final hormonal treatment : HCG (Chorulon) - one dose 500 IU.kg^{-1}
of both sexes
GnRa (Supergestran) – one dose 25 mg.kg^{-1}

Spawning technique: Preferred is nest spawning — less time consuming, easier way and higher hatching rate



Diurnal spawning activity



Parameter	Egg stripping (artificial fertilization)	Nest spawning (natural fertilization)
Spermatation rate (%)	100 _a	100 _a
Ovulation rate (%)	78.0 ± 11 _a	95.0 ± 5.0 _b
Spontaneous spawning without fertilization (%)	35 _b	0 _a
Fertilization rate (%)	78.7 ± 5.5 _a	91.5 ± 3.0 _b
Hatching rate (%)	63.5 ± 4.5 _a	75.6 ± 2.7 _b
Production of larvae per female (thousands of pcs)	81.6 ± 19 _a	97.3 ± 23.8 _b

Broodstock post-spawning care and mortality

Tanks within RAS (clean and filtrated water, with constant water parameters;

Removal of female from tanks immediately after spawning;

Long salt bath during 48 hours (7.5 – 10 g NaCl per liter);

Intensive feeding with prey fish (5 prey fish per one broodstock);

Water temperature 16 – 18 °C and light 10 – 12 hours;

Fish density 30 – 40 kg.m⁻³.

Mortality	Female	Male
During spawning	8 %	5%
10 days after spawning	10 % (90%)	8% (95 %)
100 days after spawning	25 %	25%



Preparation of ponds for larval stocking

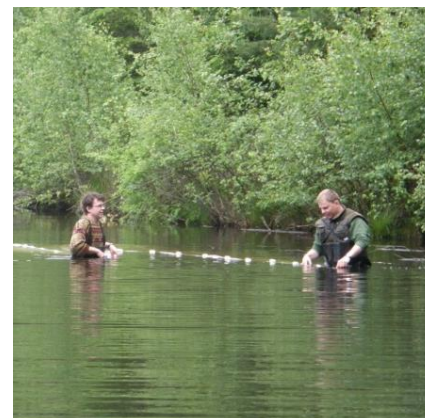


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Choice and preparation of ponds

- Small ponds – maximum area 1.5 - 2 ha
- Pond with maximum hatching time about 18 – 24 hours,
- Pond wintering – elimination of weeds, leech and beetle larvae
- Littoral vegetation provides better feeding supply in ponds for later juvenile culture,
- No fertilization of ponds is used,
- Pond must be filled by water 10 days before stocking of larvae,
- Good supply of cladoceran, copepods and rotifers must be indicated in ponds before stocking of larvae.





Stocking of larvae to ponds



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Stocking of larvae to ponds

- Larvae are collected 3 - 4 days post hatching (DPH) from nests,
- Larvae are transported in polyethylene bags under density 100 000 larvae per 5 – 7 liters of water (maximum 3 hours),
- Larvae are stocked to ponds under initial stocking density 150 - 300 000 larvae per 1 hectare of pond area.
- Initial density is dependend on pond size and its trophy level and littoral vegetation.





Larval and juvenile culture under pond conditions



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Pond juvenile production

Advantages

- Natural food supply and high sustainability of culture;
- Excellent fish growth ($\text{SGR } 20 - 23 \% \cdot \text{d}^{-1}$);
- Elimination of poor-quality fish during culture;
- Good fish survival $25 - 30\% =$ good production efficiency;
- High-quality fish production without any deformity;
- Low production cost;
- Low demand for labor;
- Using of small unused ponds.



Disadvantages

- Uncontrolled and unexplainable production;
- Dependence on the weather and countryside;
- Complicated and hard harvesting way;
- Potential transmission of diseases;
- Seasonal production.



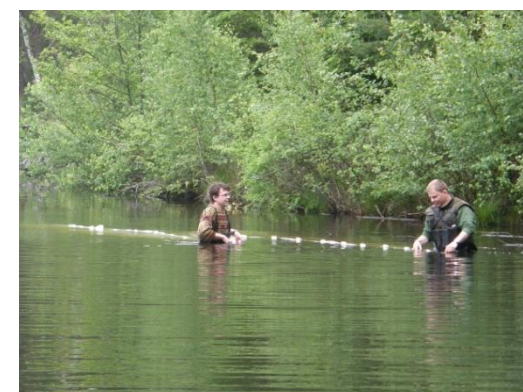


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Larval and juvenile culture under pond conditions

- Duration of culture: 42 ± 2 days,
- Needed periodical checking water quality and food supply during culture at one week interval
- Initial fish size: TL= 5.2 – 5.7 mm, W=0.85 – 0.9 mg
- Final fish size: TL= 35 – 50 mm, W=0.3 – 0.8 g
- SGR: 20.3 – 22.5 % \cdot d⁻¹
- Survival rate: 27.4 ± 10.5 % (in total 75 ponds: 0,5 – 70%)
- Cannibalism rate: 1.0 - 20,5 %.





Natural food supply for larvae and juveniles of pikeperch during pond culture

Larval food:

- 85 % copepods and cladoceran species and 15% rotifers
= 100 % zooplankton



Juvenile food:

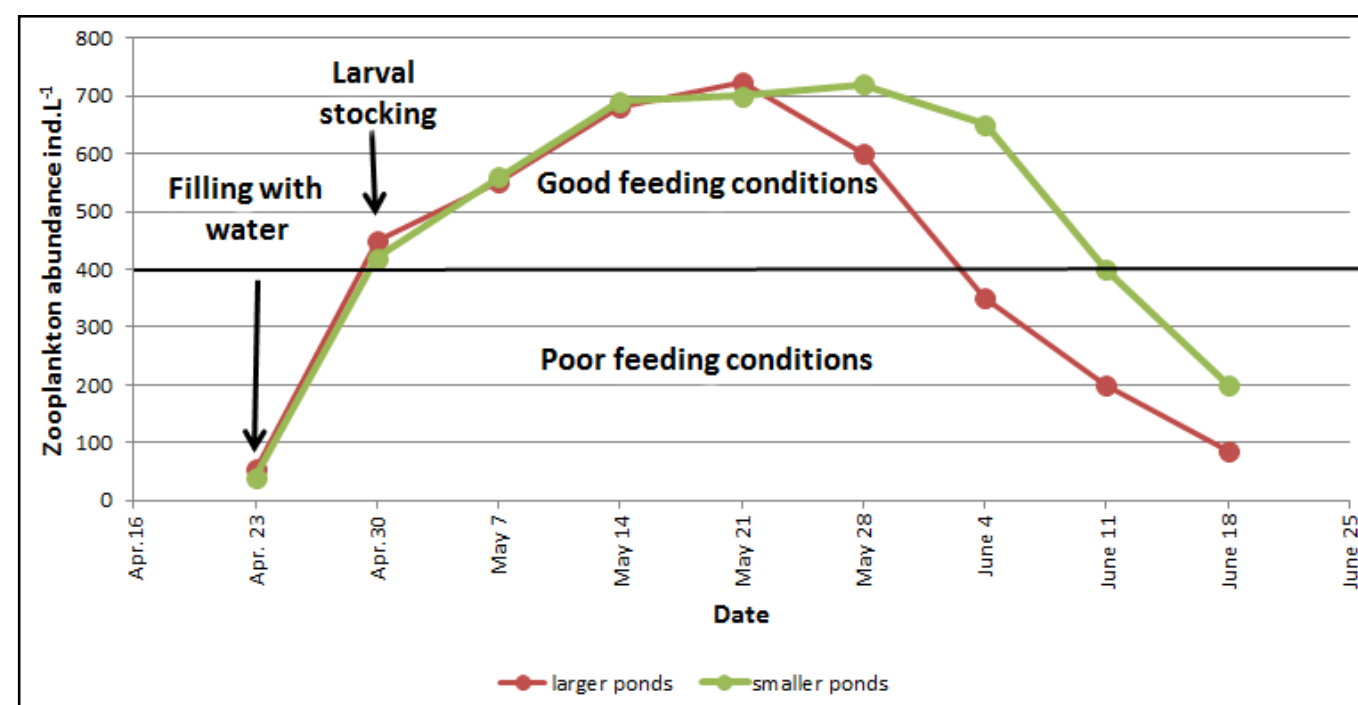
- 72% zooplankton = copepods and cladoceran species,
- 20% zoobentos = larvae of insects
- 8% phytophilous invertebrates = larvae of insect



Zooplankton is the most important food
for larvae and juvenile

Zooplankton abundance effects efficiency
of pond production

Zooplankton abundance below 400 ind.ml⁻¹
– harvesting of juveniles must be quickly
organized





Harvest of pikeperch juveniles from ponds



Harvest of pikeperch juveniles from ponds

- In outlet channel below pond,
- Special nets or cages have been used,
- Final harvesting must be quick (4-6 hours),
- Final harvesting during morning,
- Acceptable summer weather:
 - air temperature (max. 22 – 24 °C),
 - water temperature (max. 20°C),
 - cloudy or rainy,
 - no large change of water temperature,
- After harvesting prophylactic bath during or after fish transport.





Adaptation and weaning of juvenile under RAS



Juvenile adaptation in RAS

- For controlled conditions in RAS
- For artificial food – weaning of larvae



Conditions during adaptation:

- Same sized fish – after careful grading
- Stocking density – 8 fish per 1 liter
- Light regime – 16 L/8 D , 100 - 200 lx
- Water temperature 23.0 ± 0.5 °C
- Oxygen saturation 100 %





Weaning of pond-cultured pikeperch juveniles

Stocking of juveniles to RAS (day 1)



Set-up environmental conditions: $t = 23^{\circ}\text{C}$, $\text{O}_2 = 80\text{-}100\%$, 18L/6D (day 2)



Starvation of stocked juveniles (day 1 – 2)



100 % feeding rate with frozen chironomids (red worms)
(day 3 – 4)



Feeding with 75% red worms : 25% artificial food 0.8-1.1 mm (day 5 – 6)



Feeding with 50% red worms : 50% artificial food 0.8-1.1 mm (day 7 – 8)



Feeding with 25% red worms : 75% artificial food 0.8-1.1 mm
(day 9 – 10)



Feeding with 100% artificial food 0.8-1.1 mm (day 11 – 12)





Juvenile weaning and adaptation in RAS

Results:

- Duration of adaptation: 12 days
- Initial fish size: TL= 35 – 50 mm, W=0.3 – 0.8 g
- Final fish size: TL= 37 – 52 mm, W=0.45 – 1.0 g
- SGR: 2 - 3.8 % \cdot d⁻¹
- Survival rate: 72.5 – 84.0 % (cumul. s. 21.5 %)
- Canibalism rate: 3.0 - 5.0 %
- Initial feeding rate: at libitum (0.8 mm)
- Final feeding rate: at libitum (0.8 mm)
- Feed Conversion Ratio FCR: 4.2 - 5.0





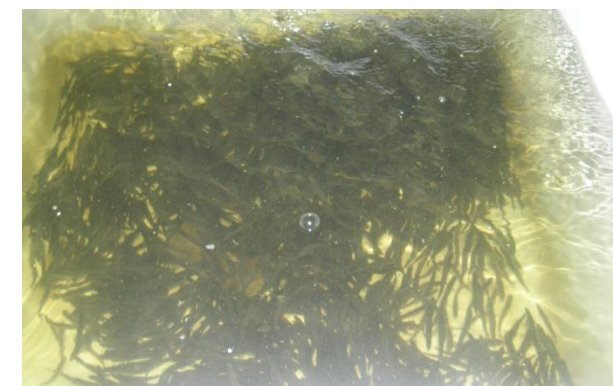
Juvenile culture under RAS up
to BW 25 grams



Juvenile culture under RAS up to 25 g

Conditions:

- Directly after weaning and adaptation
- Water temperature 22.5 ± 0.7 °C
- Oxygen saturation 100 %
- Light regime 16L/8D, 100 - 200 lx
- Initial fish density: 8 fish.L⁻¹ (5kg.m⁻³)
- Final fish density 2 fish.L⁻¹ (49.2 kg.m⁻³)
- Initial feeding rate 10 % (1.1 mm)
- Final feeding rate 5 % (2 mm)
- Fish grading at 14-21days interval
- Duration of juvenile culture 90 days





Juvenile culture under RAS up to 25 g

Results:

- Initial fish size: TL= 37 – 52 mm, W=0.45 – 1.0 g
- Final fish size: TL = 141 ± 10 mm, W= 24.6 ± 5.6 g
- Survival rate: 87.5 - 90.0 % (cumul. s from larvae 19 - 20%)
- Canibalism rate: 2.0 – 3.0 %
- SGR= 3.0 – 4.0 % \cdot d⁻¹
- Feed Conversion Ratio (FCR) = 1.3 – 1.6





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Already presented information about our POND/RAS production system



EPFC 2012 Policar, T., Overton, J., Toner, D., Mandiki, S.N.M., 2012: How to stabilize supply of larvae and juveniles in Eurasian perch and pikeperch;



AQUA 2012 Policar, T., Kristan, J., Stejskal, V., Blaha, M., 2012: Juvenile production in pikeperch for ongrowing culture;



EPFC 2013 Policar, T., Blecha, M., Kristan, J., Stejskal, V., Blaha, M., 2013: Combination of intensive and extensive aquaculture for juvenile pikeperch production (*Sander lucioperca*);



AE 2013 Policar, T., Blaha, M., Kristan, J., Stejskal, V., Blecha, M., 2013: Juvenile production of pikeperch (*S. lucioperca*) under pond conditions – experience for three years;



AE 2014 Blecha, M., Křišťan, J., Policar, T., 2014 Adaptation of the intensively cultured pikeperch (*Sander lucioperca*) juveniles to pond culture during winter and their following adaptation and culture under RAS



EPFC 2015 Policar, T., Blecha, M., Křišťan, J., Svačina, P., 2015: Broodstock management of pond cultured pikeperch for effective larval production;



AE 2015 Policar, T., Šetlíková, I., Bláha, M., Blecha, M., Svačina, P., Křišťan, J., Żarski, D., Kucharczyk, D., 2015: Effect of periphyton support on the production of pikeperch *Sander lucioperca* L. juveniles in ponds;

AE 2017 Malinovskyi, O., Křišťan, J., Blecha, M., Veselý, L., Policar, T., 2017: Foraging behavior of pikeperch, *Sander lucioperca* (L., 1758) broodstock;

AQUA 2018 Policar, T., Malinovskyi, O., Blecha, M., Kristan, J., Samarin, A.M., 2018: Post-spawning treatment and mortality elimination after two different spawning techniques in pond-cultured pikeperch *Sander lucioperca* broodstock.





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thanks to EU project:



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Adaptace a chov juvenilních ryb candáta obecného (*Sander luciperca* L.) v recirkulačním akvakulturním systému (RAS)

T. Policar, J. Křišťan, M. Blecha, J. Vaniš



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Adaptation and Culture of Pikeperch (*Sander lucioperca* L.) Juveniles in Recirculating Aquaculture System (RAS)

T. Policar, J. Křišťan, M. Blecha, J. Vaniš



Scientific papers about POND/RAS production system

Policar, T., Blecha, M., Křišťan, J., Mráz, J., Velíšek, J., Stará, A., Stejskal, V., Malinovskyi, O., Svačina, P., Samarin, A. M., 2016. Comparison of production efficiency and quality of differently cultured pikeperch (*Sander lucioperca* L.) juveniles as a valuable product for ongrowing culture. Aquaculture International, 24: 1607 – 1626

Blecha, M., Kristan, J., Policar, T., 2016. Adaptation of intensively reared pikeperch (*Sander lucioperca* L.) juveniles to pond culture and subsequent re-adaptation to a recirculation aquaculture system. Turkish Journal of Fisheries and Aquatic Sciences, 16: 15 – 18.

Policar, T., Stejskal, V., Kristan, J., Podhorec, P., Svinger, V., Blaha, M., 2013. The effect of fish size and density on the weaning success in pond-cultured pikeperch (*Sander lucioperca* L.) juveniles. Aquaculture International 21 (4): 869 – 882.

Aquacult Int (2015) 23:869–882
DOI 10.1007/s10691-015-9350-4

The effect of fish size and stocking density on the weaning success of pond-cultured pikeperch *Sander lucioperca* L. juveniles

Tomáš Polcar · Vlastimil Stejskal · Jiří Kristan · Petr Podhorec · Viktor Svinger · Martin Blaha

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Abstract The effect of initial fish size (small with TL = 40.3 ± 2.3 mm and W = 0.42 ± 0.15 g, medium with TL = 56.2 ± 2.7 mm and W = 1.66 ± 0.4 g, and big with TL = 71.0 ± 3.2 mm and W = 2.95 ± 0.65 g) and stocking density of identical fish with TL = 40.3 ± 2.3 mm and W = 0.42 ± 0.15 g (1; 2; 4; 8 fish l⁻¹) on weaning success was evaluated in pond-cultured pikeperch. The trial was divided into weaning (12 days) and post-weaning (16 days) periods. Small juveniles reached significantly higher specific growth rate (SGR = 1.6 ± 0.2 % day⁻¹) and survival rate (S = 81.7 ± 2.7 %) and lower cannibalism (C = 3.0 ± 0.75 %) compared to medium and large juveniles (SGR = 0.3–0.5 % day⁻¹, S = 65.3–76.5 %, C = 6.5–7.5 %) during the weaning period. The higher survival rate was found at the two higher densities (S = 72.6–79.1 %) during the weaning period. The lowest survival rate (S = 30.9 ± 2.7 %) was observed at the lowest fish density. Fish stocking density did not affect growth, condition, or cannibalism rate during the weaning period. Similar trends of growth, condition, and cannibalism in juveniles were observed during the post-weaning period. Experimental results showing small pikeperch juveniles (SGR = 1.4 ± 0.1 and 7.2 ± 0.2 % day⁻¹, 97.6 ± 1.0 %), and cannibalism (C = 4.0 ± 1.5 % weaning and post-weaning periods; No body or fin observed).

Keywords Artificial food · Growth · Pikeperch · Recirculation aquaculture system · Survival

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Aquacult Int (2016) 24:1607–1626
DOI 10.1007/s10691-016-9405-9

Comparison of production efficiency and quality of differently cultured pikeperch (*Sander lucioperca* L.) juveniles as a valuable product for ongrowing culture

Tomáš Polcar^a · Miroslav Blecha^a · Jiří Křišťan^a · Jan Mráz^a · Josef Velíšek^a · Alžběta Stará^a · Vlastimil Stejskal^a · Oldřich Malinovskyi^a · Petr Svačina^a · Arin Mohagheghi Samarin^a

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Abstract Production efficiency, frequency of fin erosion, skeletal and gill covers deformities, proximal composition of fish body with special emphasis on fatty acid contents in liver and muscle, oxidative stress and antioxidant response in gill, liver, muscle and intestine were analyzed and compared in exclusively RAS- and POND-cultured juveniles and juveniles produced with the combination of POND and RAS aquaculture in pikeperch (*Sander lucioperca* L.) with final body weight between 8.5 and 9.5 g. Higher production efficiency, lower fin erosion, no morphological deformation, higher level of essential fatty acids and lower oxidative stress were found in POND-RAS- and POND-cultured juveniles compared to exclusively RAS-produced pikeperch. This study showed that intensive needs next technological innovations. On the other AS aquaculture has provided a good potential to be an facing high-quality juveniles for intensive or pond fish with large pond area.

Keywords Fatty acid · Fin erosion · Oxidative stress · deformity

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Adaptation of Intensively Reared Pikeperch (*Sander Lucioperca*) Juveniles to Pond Culture and Subsequent Re-Adaptation to a Recirculation Aquaculture System

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Abstract A combination of intensive rearing and pond culture was evaluated on its benefits for pikeperch year-ovular production. Fishes hatched intensively reared juveniles (group B2) and 1000 pond-reared juvenile pikeperch in a control (group C) were divided into three batches and stocked into three ponds for 18-day long culture. Juveniles of fish in group B2 were significantly higher (P < 0.05) compared to group C (P < 0.05). SGR (group B2 = 0.1346 (0.127, 0.141) group C = 0.1016 (0.079, 0.124)) and Fulton coefficient (FC for group B2 = 1.004 (1.01, 1.01); FC for group C = 0.946 (0.97, 0.92)) did not differ at the end of pond culture which included winter and spring seasons. After harvesting, fish from group B2 were transferred to a recirculation aquaculture system and after a short adaptation period, they were fed with pellet feed. The duration of following intensive rearing in the RAS lasted 40 days. SGR was 0.1246 (0.121, 0.128), FC = 1.141 (1.12, 1.16) and survival rate was 94.64 % at the end of the 40-day rearing period. No difficulties were observed in adaptation of intensively cultured juveniles to pond conditions. During the study, it was obtained a high survival rate and excellent ability of pikeperch juveniles to overcome dry feed after their re-adaptation to recirculation aquaculture system.

Keywords: Intensive culture, pellet feed, pond rearing, survival.

Introduction Pikeperch (*Sander lucioperca*) is one of the most extensive freshwater fish for European aquaculture (Blecha et al., 2013; Kratoch et al., in press) and its diversification (Samarin et al., 2015) due to flesh palatability and attractiveness to anglers (Giblin et al., 2007; Kratoch et al., 2013). The demand for pikeperch is increasing (Vrána et al., 2009), while the wild populations in Europe are decreasing due to overfishing (DL, 2008; Müller-Belack and Ziemert 2009). The main role of pikeperch in open waters is to regulate the populations of small cyprinids (Pavlov et al., 2003). In the past, pikeperch were farmed in ponds or lakes (Ridge and Steffen, 1996), but in the last few decades they have been successfully reared in combinations of pond and recirculation aquaculture systems (RAS) (Záček and Džurina-Záček, 1998; Polcar et al., 2013). It is possible to rear the pikeperch under complete RAS conditions as well (Oblátek et al., 2006). The combination of pond and RAS rearing is based on 6–8 weeks of extensive pond rearing followed by harvesting and converting the pikeperch juveniles with TL 35–55 mm to an artificial diet and RAS conditions (Oblátek and Ryvánek, 1998; Záček and Džurina-Záček, 1998; Záček, 1997). Maximized culture technique is well described in Polcar et al. (2014). According to their experience, after hormonally stimulated semi-artificial spawning, pikeperch larvae are stocked in small (maximum 1.5 l) ponds which were wintered and fertilized before. When the pikeperch juveniles achieve the total length of 30–50 mm or rapid decrease of zooplankton abundance is observed, the ponds are drained and harvested and the juveniles are moved to RAS for the second part of the culture. To convert the juveniles from live to pellet feed a routine called co-feeding (mixtures of live and pellet feed) is applied. During 10–12 days, the live feed (fresh zooplankton) is mixed with pellet feed. The rate of live feed is being decreased in time and in contrary, rate of pellet feed goes up for 25% every two days until the fish intake the pellet feed only. This rearing method provides a viable production of high-quality pikeperch juveniles for subsequent aquaculture in countries with large pond area such as Czech Republic, Hungary, Germany, etc. (Polcar et al., 2014). The primary objective of our study was to assess





POND/RAS system for pikeperch juvenile production

Conclusion:

- Very effective and stable system for juvenile production with lower cost:
- Higher – quality fish for stocking to RAS and pond culture or for stocking to open waters (lakes, dams etc.):
 - pikeperch without morphological deformities, fin damage, high level of essential fatty acids, higher growth potential and stress resistance;
- Using in the countries with higher area of small production ponds:
 - high potential mainly for countries from Central and Eastern Europe.



Thanks for your attention

