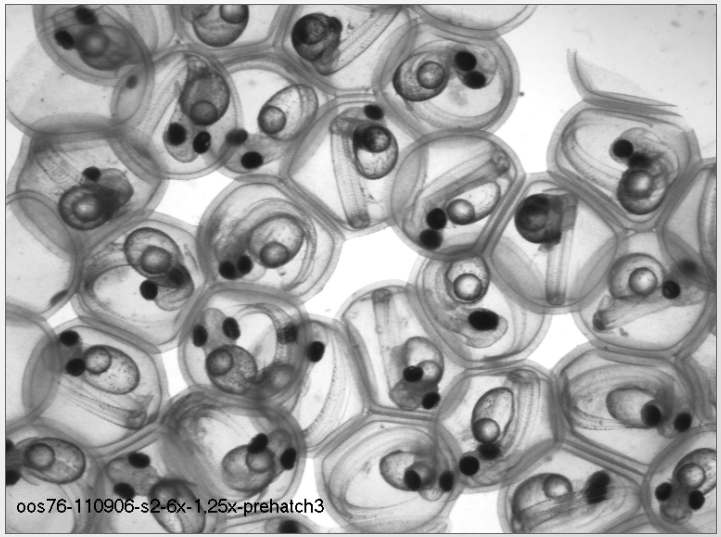

Bornholms Salmon Hatchery: Control of Out–of-Season spawning of perch

Julia Lynne Overton,
Helge Paulsen, Dariusz Kucharczyk, Andrzej Szcerbowski

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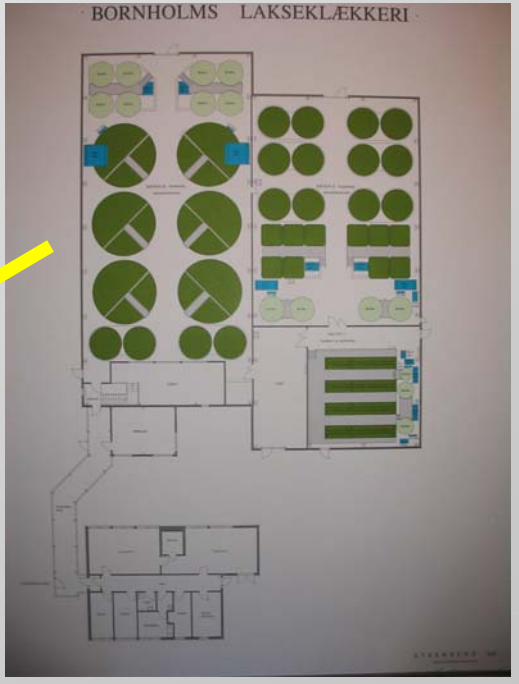
Location: Bornholms Salmon Hatchery



Pilot projects

”Optimisation of spawning period for the culture of perch” (July 2003 – June 2005). *In cooperation with Dept. of Lake & River Fisheries, Warmia & Mazury Olsztyn, Poland and Inland Fisheries Institute, Olsztyn, Poland.*

”Development of perch culture: an alternative species for freshwater aquaculture” (March 2005 –February 2007).

Both funded by the Financial Instrument for Fisheries Guidance (FIFG),under pilot and demonstration projects (Ministry og Food and Agribusiness).

And

PERCATECH (October 2004 - September 2006) – EU-CRAFT programme

Main Objective

To investigate the possibility to alter the spawning season for Eurasian perch (*Perca fluviatilis*).

Introduction

In the wild,

Perch spawn once a year with a single batch of eggs per female (produced as a ribbon).

They are highly synchronized to spawn around the same time (2-6 weeks in the spring where water temp increases over 10 degrees and daylight is over 12 hours).

At start of perch project (2003),

Commercial production of Eurasian perch relied egg strings from wild caught broodstock spawning at the natural time

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Limitations with natural spawing period

- There is a limited period where juveniles are available for grow out.
- Production of perch based on season and could compete with captured perch market.
- Utilise hatchery and grow out facilities in a sub-optimal way.

Advantages with altering spawning season

- Focus production to specific market demands
- Have a more effective/economically sustainable production
- Juveniles available all year round
- Whole fish are available all year round (providing a more stable market)
- Able to shorten the production period (to utilise the warm summer months in outdoor facilities when fish are larger).

Seasonal control of spawning

Stimulation of maturation of perch gonads is primarily reliant on two environmental cues

Temperature and photoperiod

Males: Sperm production is stimulated by reduction of daylength and temperature (autumn)

Females:

1. Ova development is stimulated by reduction of day length and temperature.

2. Vitallogenesis (yolk deposition in the egg) takes place during the winter with cold temperature (< 6ºC) and short day length (under six hours daylight).

3. Ovulation, spawning success and egg quality is determined by the length of the warming period

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Trial 1: 2003/04

Broodstock: Wild fish (Lake Tange)
20 females (230 -800g)
50 smaller fish (mixed) 20-250g

Tank: 1 x 7m^3 circular tank.

Feed: Shrimp and dryfeed mix

Water quality: Temperature, oxygen, pH measured daily. Ammonia, Nitrites and nitrates tested three times weekly.

Fish were individually tagged.

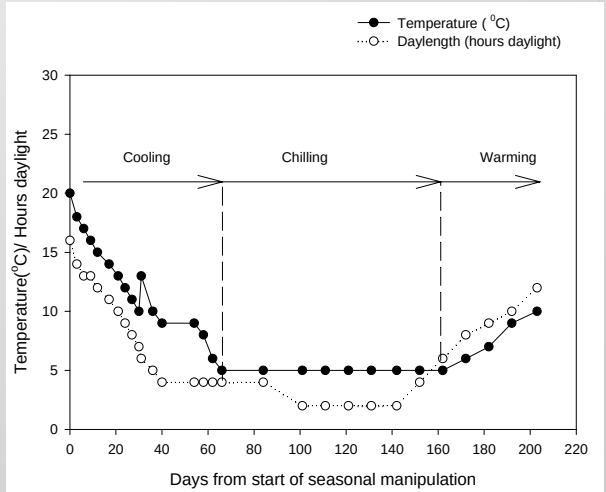

Figure 3: Thermophotoperiodic regime used to alter spawning period of Eurasian perch, Bornholms Lakseklækkeri, 2003/04.

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Monitoring maturation of fish

Sampling of eggs for mature female perch (Jan 2004)

Sampling of sperm from mature male perch (Jan 2004)

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Hormonal induction

	Injection I (primer) t: 0 Temp: 12,6°C	Injection II (stimulator) (10,5 hours after injection I) Temp: 12,8°C	Injection III (resolving) (13,5 hours after injection II) Temp: 13,1°C
Females ind 1, 13	Ovopel 0,2 pellet/kg fish	Ovopel 0,4 pellet/kg fish	Ovopel 1,0 pellet /kg Fish
Females ind 2-12	Ovopel 0,2 pellet/kg fish	CPE 0,4mg/kg fish	CPE 3,6mg/kg fish
Females ind. 14, 15			Ovopel 1,0 pellet /kg Fish
Females ind. 16,17			CPE 3,6mg/kg fish
Males	Ovopel 0,2 pellet/kg fish	Ovopel 0,4 pellet /kg fish	Ovopel 1,0 pellet /kg Fish

Results

- Seven fish increased weight after first injection (minimum 13% increase in weight)
- After second injection the female fish continued to increase weight (29%) and spawned 4 days later.
- However: Eggstrings were fragmented and the eggs died after a couple of days
- All males produced spem with a motility over 90% and concentration that was similar to that found in normal spawning (64-73 billion ml $^{-1}$)
- Mortality 45.7% of broodstock over trial period.

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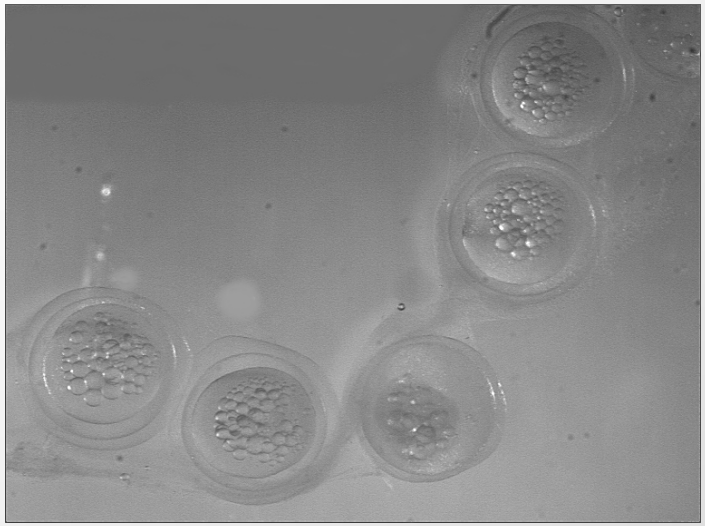
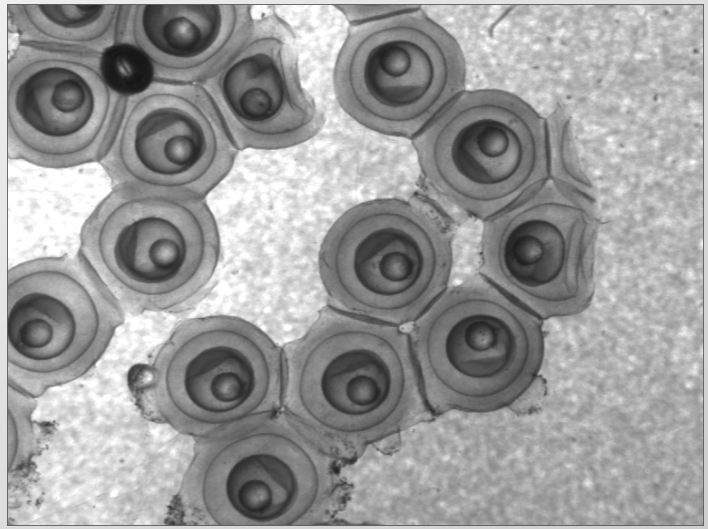


Out of season eggs



Eggs spawned in season

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Reasons for not using wild broodstock

- Wild caught broodstock had already spawned in spring. Therefore fish could have exhausted resources and were unable to spawn in a shortened period.
- Fish are already primed to a particular spawning period
- Wild caught broodstock were difficult to wean to dry feed.
- Wild fish were affect by stress of handling
- Quarantine facilities are required to hold broodstock away from other production facilities to minimise spread of disease.

Trial 2: 2004/05

Broodstock: 267 F1 one-year old fish produced at BL (20g to 373g).
Reared in constant temperature (20ºC) and Photoperiod (16 hours daylight).

Tank: 2 x 7m³ circular tank (3m diameter).

Feed: Dan-Ex 1549
(0.5% body weight day $^{-1}$ over three days per week). Feeding ceased during the chilling period.

Light: Introduced a light dimmer system to simulate dawn/dusk.

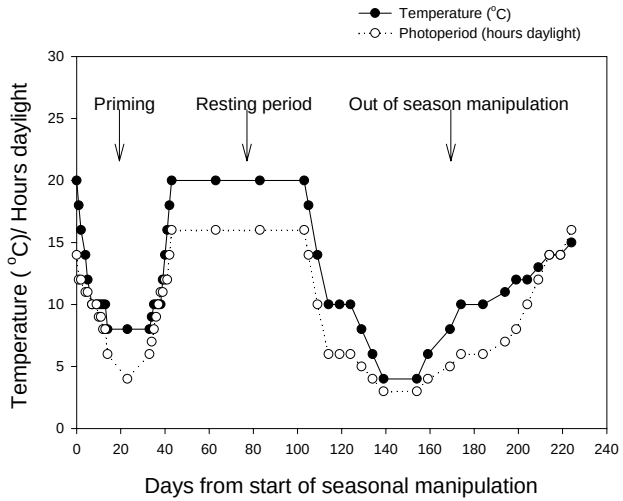

Figure 6: Thermophotoperiodic regime used to alter spawning of Eurasian perch, Bornholms Salmon hatchery, 2004/05.

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Hormonal induction

Treatment	No. of fish (tank 4)	No. of fish (tank 5)	Primary dose (per kg. fish)	Resolving dose (per kg. fish)
hCG	9m 14 f	11m 5f	150 IU	1000 IU
Ovopel	11m 10 f	8m 6f	0.2 pellet	1.0 pellet
Control	10m 12 f	9m 5f	Only saline	Only saline

IU = International units
Saline = 0.9% sterile NaCL solution
m = males
f = females

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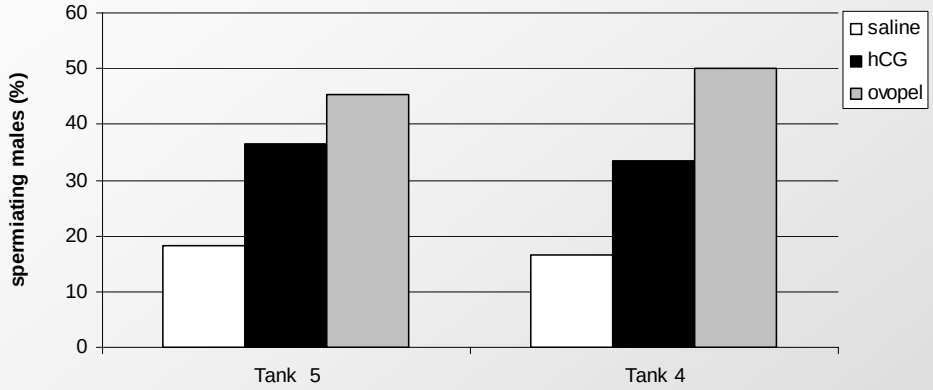
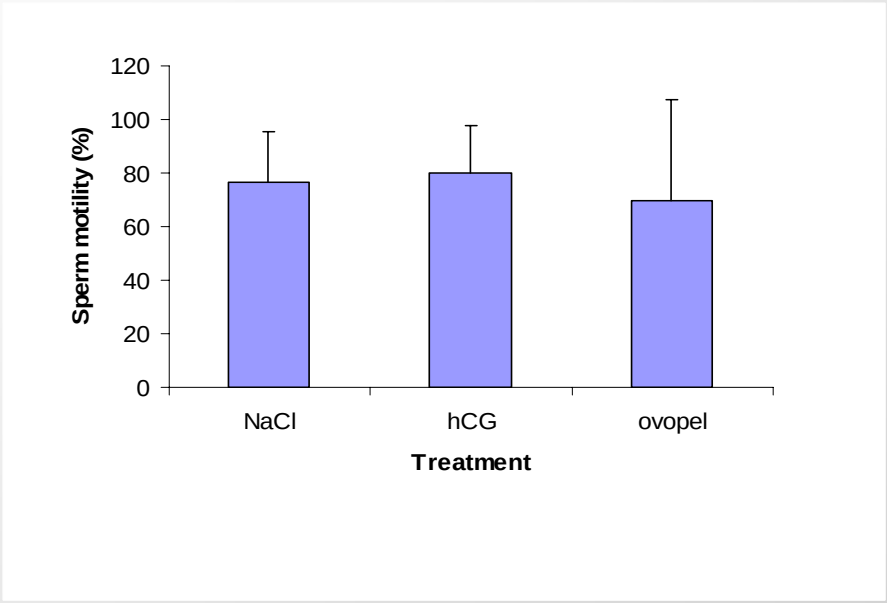
Females

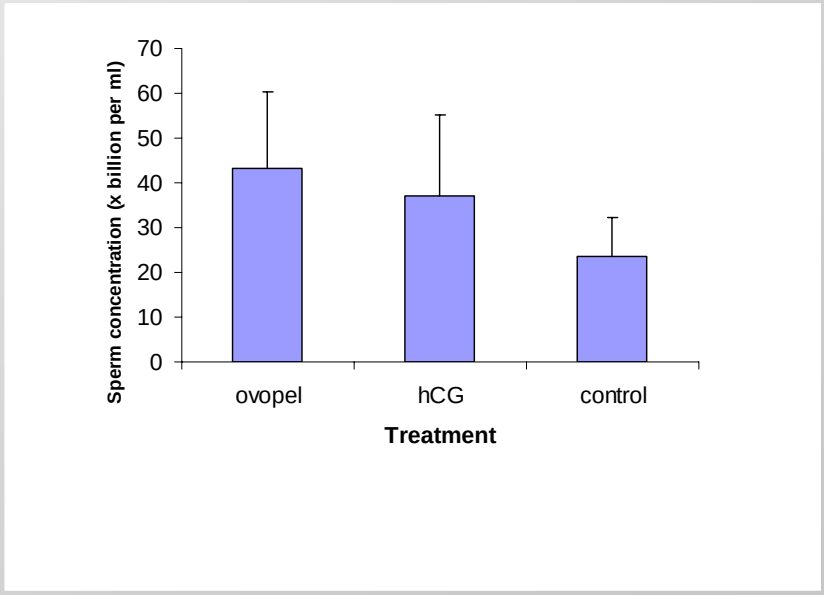

6
5
4
3
2
1
0
spawn individuals
3,5
4
4,5
5
5,5
days after last injection
hCG
Ovopel
Saline



a) Percentage spawning males



b) Sperm motility



c) Sperm concentration

Results

- 41.3 - 43% of fish had matured.
- Females spawned both spontaniously and were stripped.
- All females which increased in weight afer the first injection also spawned.
- % female that spawned hCH 45% , Ovopel 41%, Contol 18%
- GSI between 8 -16%
- Eggs were fragmented or loose.
- All eggs died after a few days.
- Males performed as well as previous year.
- Mortality after spawning was limited (under 10% mortality experienced)

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Reasons for poor results

- Females were young (1 year old fish) and first time spawners.
- Feed possibly not optimal
- Temperature/photoperiod protocol not optimal
- Stress from handling the fish
- Fertilisation process not optimal

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Trial 3: 2005/06

Broodstock:

200 F1 one - year old fish (mean = 216g) (first time spawners expected to spawn in november/december 2006 after second out of season manipulation).

+ 112 F1 two - year old fish (mean = 293g).

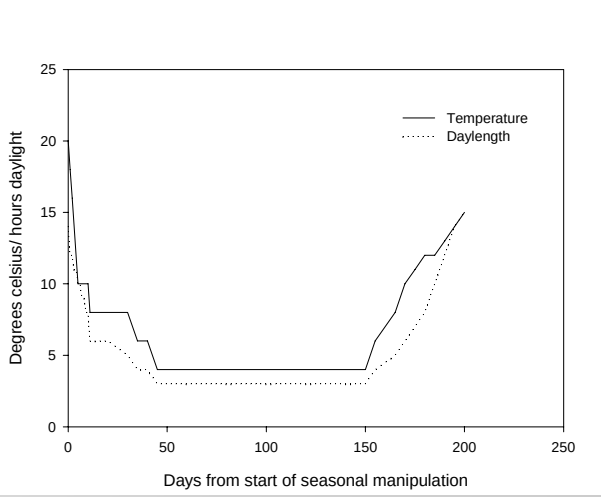
Tank: 4 x 7m³ circular tank.

Feed: 80% Aller Aqua and 20% Aller Aqua Rep Helse, 7mm pellets)

Fish fed *ad libitum*

Three groups:

1. ***fish with reduced handling***
2. ***fish treated with ovopel, hCG and saline as in 2004/05***
3. ***12 fish investigated for gross stage of maturity***



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Results

- Only one female spawned in January 2006, of which eggs fragmented and poor quality.
- No spawning from one year old fish as expected.
- No benefit from induction of fish.
- Mortality low (under 5%)

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Therefore under final attempt……

- Improve regime of temperature and photoperiod by includein a summer period of increased temperature and light prior to cooling and chilling period. This will maximise food consumption and allow necessary storage of nutrients before next spawning attempt.
- Handling was reduced to a minimum
- Induced spawning dropped in favour for spontaneous spawning.
- Investigate the effect of nutrition on quality of eggs produced. (a study carried out in cooperation with the University of Namur, Belgium (Emilie Henrotte, Patrick Kestamont).

Trial 4/5: Feb 2006 –Oct 2006

Broodstock: F1 100 3 - year old fish
+ 120 F1 2- year old fish

Tank: 3 x 7m³ circular tank. (nutrition trial)

+ 1 x 30m³ circular tank (remaining fish)

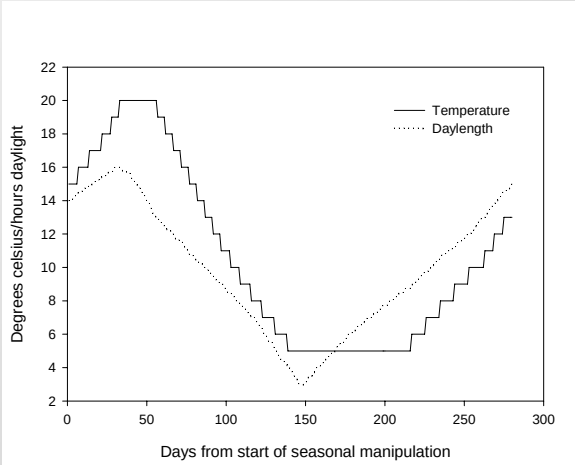
Feed: Dan-Ex 1549 (7mm pellets)
Fed *Ad libitum*

Plus: 2 experimental diets

Spawning substrate:

Spawning substrate was added to the tanks Prior to spawning.

No hormonal induction used.
No pre spawn handling



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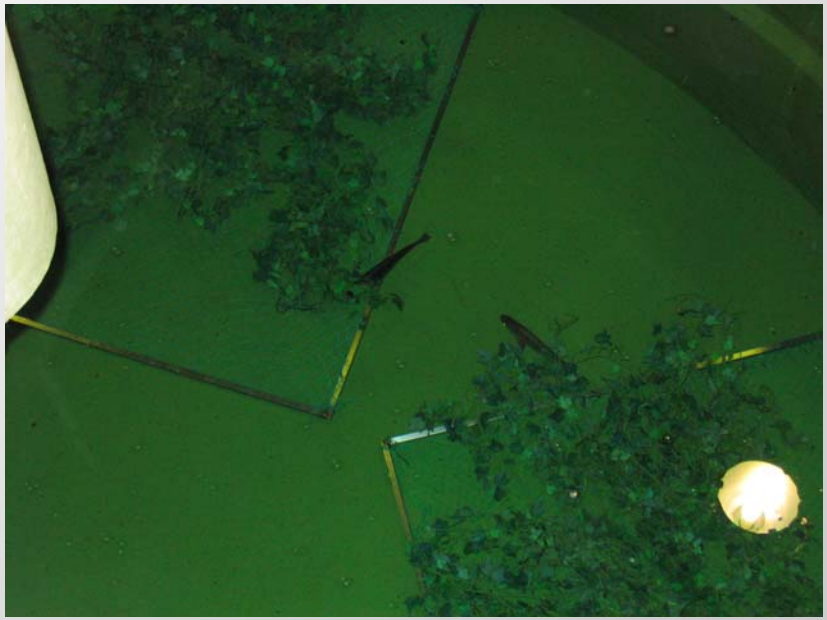
Fatty acid profile for a commerical diet (R3) and two experimental broodstock diets (R1 and R2)

	R1	R2	R3
Saturated FAs	13.18	31.05	40.91
14 :0	0.71	7.52	8.47
16 :0	8.66	19.70	23.45
18 :0	3.80	3.83	8.99
20 :0			
Monounsaturated FAs	26.80	26.48	15.41
16 :1n-7	0.92	10.46	4.08
18 :1n-9	23.95	10.25	7.47
18 :1n-7	1.15	3.80	1.39
20 :1n-9	0.78	1.97	2.47
Polyunsaturated FAs	60.02	42.47	44.08
16 :2n-4	0.12	1.48	0.16
16 :3n-4	0.07	0.26	0.63
18 :3n-4	0.04	0.10	0.80
16 :4n-1			0.86
18 :4n-1			0.10
n-6 total	52.68	1.11	9.27
18 :2n-6	50.63	0.08	8.45
20 :4n-6	2.06	1.02	0.82
n-3 total	7.09	39.52	32.25
18 :3n-3	0.28	1.51	
18 :4n-3	0.26	3.54	2.96
20 :4n-3	0.09	1.96	0.37
20 :5n-3	2.05	12.43	13.70
22 :5n-3	0.29	2.65	2.18
22 :6n-3	4.12	17.42	13.03
n-3/n-6	0.13	35.54	3.48

Examples of spawning substrate



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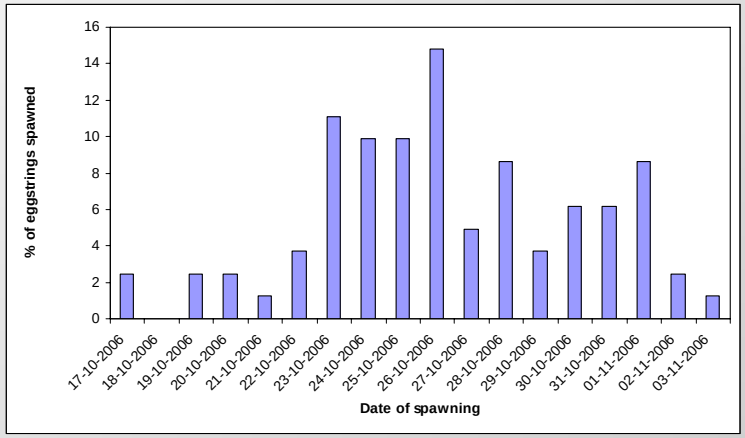
Results

- Successful spawning with 81 eggstrings produced (46% females).
- Eggstrings weighed between 12g and 152g (mean =69.8g).
- Individual eggs weighed 2.1mg (= 70.000 eggs largest eggstring).



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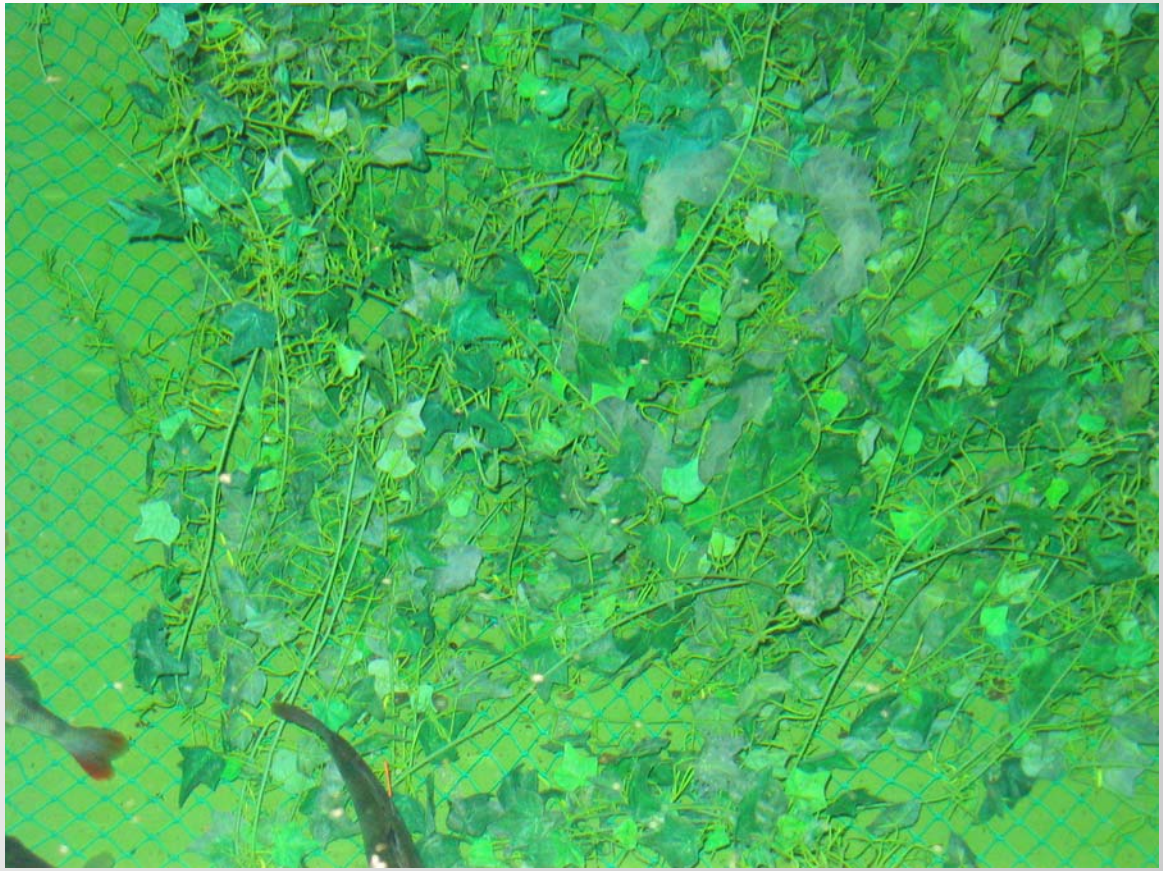

Reproductive success for out of season perch fed three test diets (R1,R2 and R3), november 2006.

Test diet	Spawning rate %	No. of egg strings fertilised/ No. of eggstrings produced	Mean fertilisation rate (%)	Larval robustness (% survival)
R1	85.7	7 / 18	88.6 ± 10.4	74.2 ± 25
R2	33.3	3 / 12	90.7 ± 10.7	nd
R3	95	14 / 20	87.4 ± 15.1	69.0 ± 24.2

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Food

	R1	R2	R3
Saturated FAs	13.18	31.05	40.91
14 :0	0.71	7.52	8.47
16 :0	8.66	19.70	23.45
18 :0	3.80	3.83	8.99
20 :0			
Monounsaturated FAs	26.80	26.48	15.41
16 :1n-7	0.92	10.46	4.08
18 :1n-9	23.95	10.25	7.47
18 :1n-7	1.15	3.80	1.39
20 :1n-9	0.78	1.97	2.47
Polyunsaturated FAs	60.02	42.47	44.08
16 :2n-4	0.12	1.48	0.16
16 :3n-4	0.07	0.26	0.63
18 :3n-4	0.04	0.10	0.80
16 :4n-1			0.86
18 :4n-1			0.10
n-6 total	52.68	1.11	9.27
18 :2n-6	50.63	0.08	8.45
ARA → 20 :4n-6	2.06	1.02	0.82
n-3 total	7.09	39.52	32.25
18 :3n-3	0.28	1.51	
18 :4n-3	0.26	3.54	2.96
20 :4n-3	0.09	1.96	0.37
EPA → 20 :5n-3	2.05	12.43	13.70
22 :5n-3	0.29	2.65	2.18
DHA → 22 :6n-3	4.12	17.42	13.03
n-3 / n-6	0.13	35.54	3.48

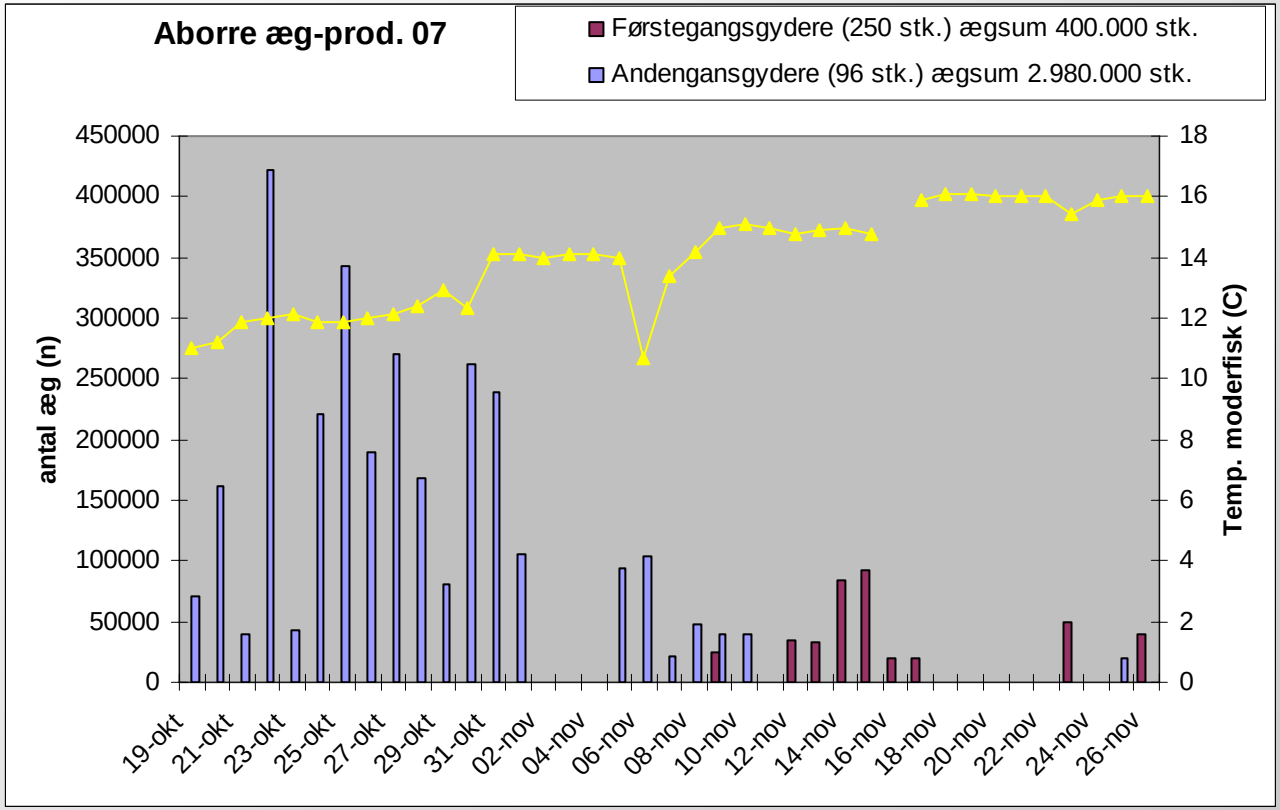
Eggs

	R1	R2	R3
Saturated FAs	$22.87 \pm 3.0_a$	$14.54 \pm 3.59_b$	$18.03 \pm 6.30_b$
14 :0	$0.54 \pm 0.19_a$	$0.90 \pm 0.08_b$	$0.88 \pm 0.14_b$
16 :0	5.06 ± 0.81	5.64 ± 0.79	5.17 ± 0.89
18 :0	$9.96 \pm 2.53_a$	$2.57 \pm 3.85_b$	$5.96 \pm 6.38_b$
20 :0	7.30 ± 1.61	5.43 ± 0.73	6.01 1.25
Monounsaturated FAs	$8.26 \pm 4.55_a$	$21.50 \pm 4.46_b$	$20.32 \pm 6.85_b$
16 :1n-7	$5.54 \pm 2.20_a$	$10.72 \pm 1.18_b$	$10.25 \pm 2.07_b$
18 :1n-9	$1.69 \pm 2.77_a$	$8.75 \pm 3.35_b$	$8.19 \pm 5.58_b$
18 :1n-7	$0.10 \pm 0.42_a$	$1.66 \pm 0.78_b$	$1.08 \pm 0.91_b$
20 :1n-9	$0.93 \pm 0.62_a$	$0.37 \pm 0.29_b$	$0.80 \pm 0.43_a$
Polyunsaturated FAs	$68.86 \pm 3.86_a$	$63.95 \pm 1.34_b$	$61.65 \pm 2.78_b$
16 :2n-4	$0.04 \pm 0.14_a$	$0.38 \pm 0.19_b$	$0.20 \pm 0.16_b$
16 :3n-4	2.67 ± 7.81	0.04 ± 0.09	0.01 ± 0.05
18 :3n-4	0.25 ± 0.32	0.16 ± 0.35	0.32 ± 0.53
16 :4n-1	$15.63 \pm 2.19_a$	$18.48 \pm 1.81_b$	$17.85 \pm 1.26_b$
18 :4n-1	$2.35 \pm 0.32_{ab}$	$2.63 \pm 0.34_a$	$2.07 \pm 0.57_b$
n-6 total	$27.06 \pm 8.04_a$	$7.20 \pm 0.77_b$	$12.33 \pm 5.37_c$
18 :2n-6	$26.05 \pm 7.95_a$	$6.37 \pm 0.87_b$	$11.78 \pm 5.27_c$
20 :4n-6	$1.00 \pm 0.32_a$	$0.83 \pm 0.22_b$	$0.56 \pm 0.23_b$
n-3 total	$20.87 \pm 5.60_a$	$35.06 \pm 2.52_b$	$28.87 \pm 3.94_c$
18 :3n-3	$0.07 \pm 0.29_a$	$0.78 \pm 0.50_{ab}$	$0.71 \pm 0.61_b$
18 :4n-3	$0.00 \pm 0.00_a$	$0.12 \pm 0.18_{ab}$	$0.17 \pm 0.18_b$
20 :4n-3	$0.04 \pm 0.16_a$	$0.59 \pm 0.12_b$	$0.30 \pm 0.18_b$
20 :5n-3	$2.22 \pm 1.13_a$	$5.51 \pm 0.87_b$	$4.28 \pm 0.86_b$
22 :5n-3	$0.92 \pm 0.31_a$	$1.83 \pm 0.36_b$	$1.41 \pm 0.22_c$
22 :6n-3	$17.62 \pm 4.16_a$	$26.23 \pm 2.04_b$	$21.99 \pm 2.76_c$
n-3 / n-6	0.77	4.87	2.34

Conclusions

- It is possible to manipulate F1 perch to spawn out of season using only temperature and photoperiod.
- Mortality is low with domesticated fish.
- Virgin fish + priming period before spawning takes place.
- Broodstock diet influences the reproductive performance of perch. In particular the n-3/n-6 fatty acid ratio infuenced spawning success, in terms of number of eggstrings produced, the fertilisation rate and the resulting robustness of the larvae.

Spawning 2008
(Danish centre for vild salmon, Randers)



Produced 19.000 2g weaned fish

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