

## *Water quality in freshwater production - is there a link to skeletal deformities?*

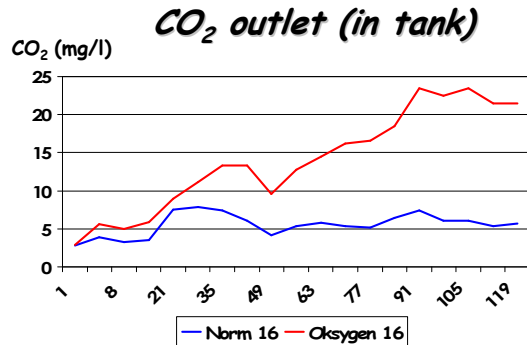
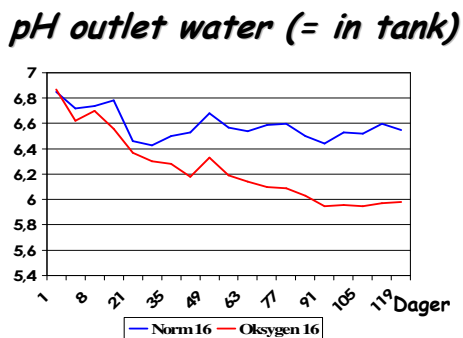
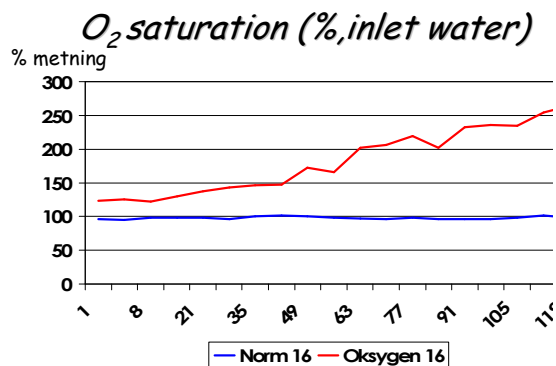
- Increased production of smolts (higher numbers, bigger smolts) at fewer sites
- Available water resources do not increase correspondingly
- Water flow (l/kg/min) is decreased
- Oxygen is added
- CO<sub>2</sub>-accumulation and low pH in tank water
  
- ...any effects on skeletal deformities ?

- High density, low specific waterflow, high CO<sub>2</sub> and low pH
  
- High density, low specific waterflow, high CO<sub>2</sub> and low pH  
*in combination with  
restricted dietary mineral supply*
  
- O<sub>2</sub> supersaturation

# Water quality monitoring and control in commercial production

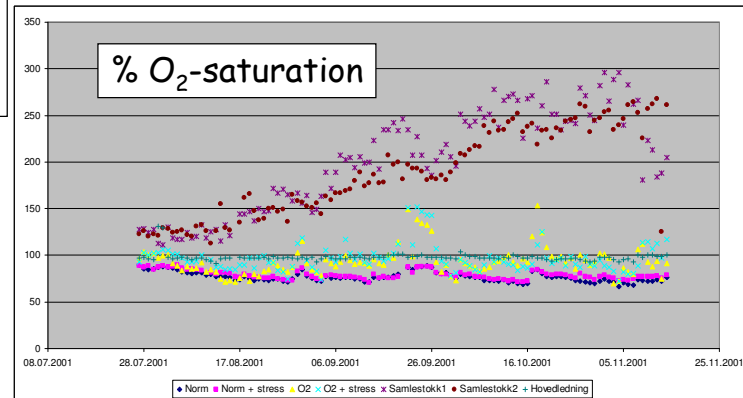
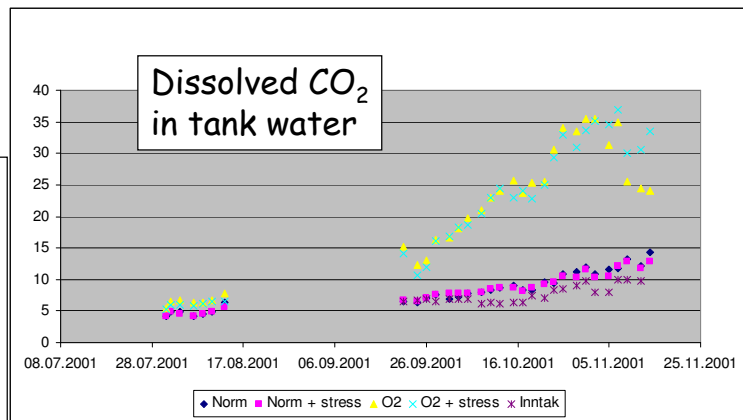
- ..... requires skills, scientific knowledge and technical solutions
- Too many hatcheries are "old" and were built in different times and for far less fish
- Hatchery personell may have skills, but are they listened to?
- Scientific knowledge is building gradually, but too much is still unclear
- High intensity systems are more vulnerable
- Small or big tanks?
  - Small tanks are low-tech, but allow for human control
  - Big tanks more difficult to control subjectively
- Use of new technology costs money
  - Smolts should be big, but also cheap to produce!

**Production exp.# 1**  
 Low density, unlimited water supply,  
 compared to  
 High density, low water supply, oxygen added



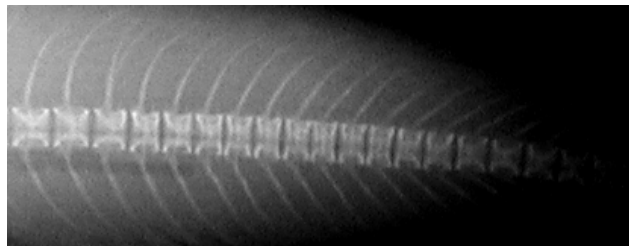
## Production exp. # 2

Low density, unlimited water supply, compared to High density, low water supply, oxygen added, in fish given diets with different levels of available phosphorus



## Downgrading of fish at harvest in tanks with unstable conditions: **22%**

- In particular, increase in number of fish with **platyspondylia**



### These tanks were characterized by

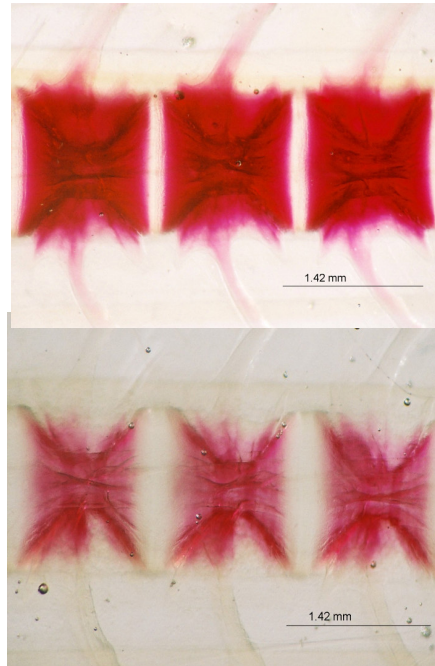
- Rearing temperature 3-60g: 16°C
- Fluctuating O<sub>2</sub>-saturation, periods with supersaturation (>100%)
- Periods with high levels of CO<sub>2</sub> (>30mg/l)
- Periods with low pH (<5,8)
- A "near death" experience with stop in water supply and hypoxia

**Unstable conditions, fluctuations, stress**

## Interaction between reduced water quality and dietary mineral supply:

**Mineral balance and bone formation in fast-growing Atlantic salmon parr in response to dissolved metabolic CO<sub>2</sub> and restricted dietary phosphorus supply**

Bone mineralisation strongly affected by diet, much less by water quality



*Helland et al., Aquaculture, 2005*

## Project "Water quality- smolt quality"

O<sub>2</sub>-supersaturation in freshwater:  
Effects on health condition and seawater performance

AKVAFORSK, NIVA, UMB, NIFES, UiB

- Limited water supply, oxygen added
- **What happens if fish are reared in hyperoxic conditions, i.e. with O<sub>2</sub> saturation > 100% ?**
- Exposure in two periods
  - From 40 to 80g size, growth under continuous light
  - From 80g to smolt, through smoltification, 6 weeks of 12D:12L, 6 weeks of continuous light
- Examination of fish after 16 weeks of communal rearing in seawater

## Exposure levels:

- First period

Inlet	Outlet
100	75
150	105
175	130

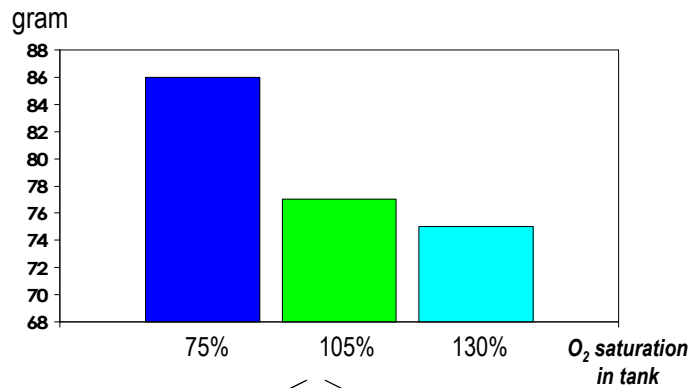
- Second period

Inlet	Outlet
100	85
170	125

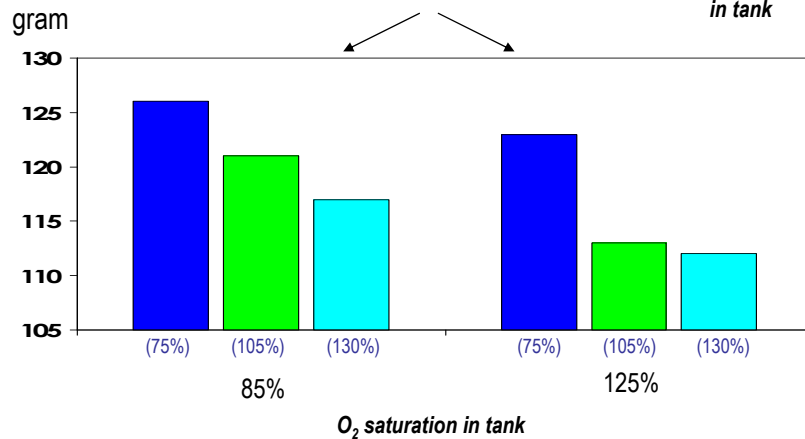
Corresponding to O<sub>2</sub> saturation in tanks

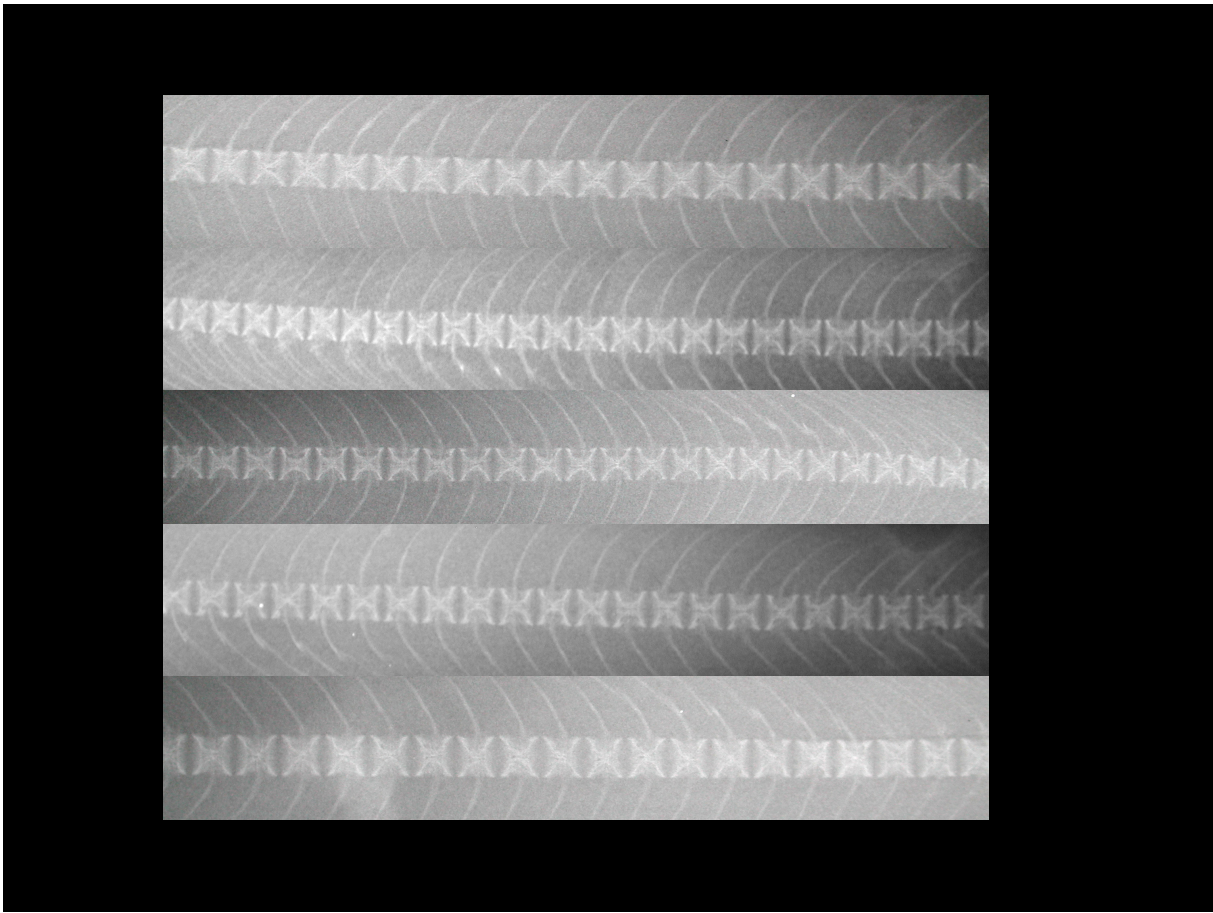
Weight at start:  
43g

Weight at end of  
first exposure period  
(40-80g, parr):



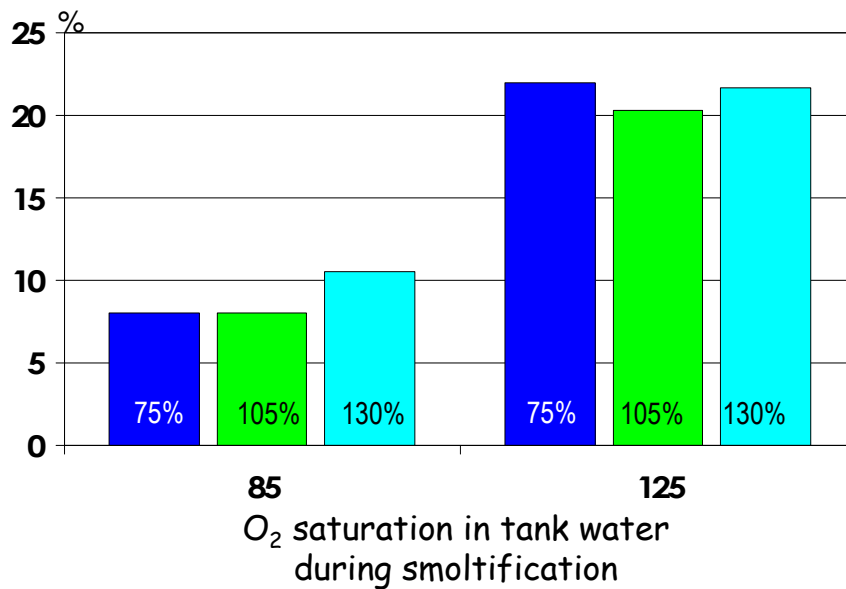
Weight at end of  
second  
exposure per.  
(80g-smolt):





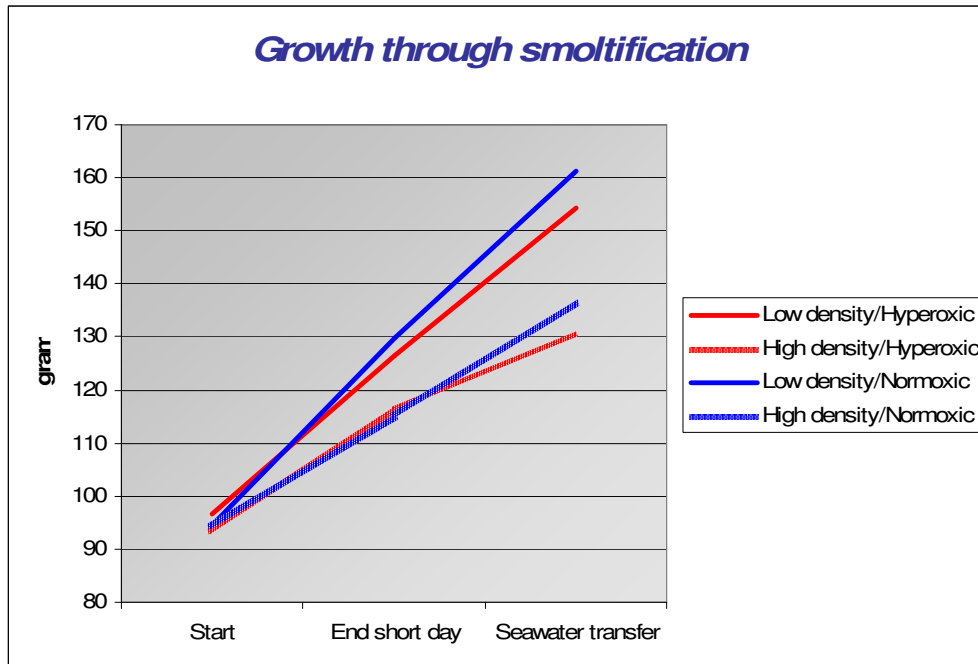
### *"Irregular vertebrae"*

Effect of oxygen supersaturation prior to seawater transfer  
Radiography after 16 weeks in seawater



## ***Production exp.# 4***

Effects of hyperoxia and fish density (kg fish/m<sup>3</sup>)



## ***Summary, water quality and deformities***

- No simple correlation between high CO<sub>2</sub>/low pH and vertebral deformities
- No simple correlation between O<sub>2</sub> supersaturation and vertebral deformities
  - *Indications that both CO<sub>2</sub> and O<sub>2</sub> are of importance*
- O<sub>2</sub> saturation >100% affects growth!
  - *Improve control with O<sub>2</sub> supplementation*
- Results indicate that **unstable conditions** and water quality fluctuations are as bad as high levels *per se*
- Water temperature is the most important water quality parameter
- There is a fish density effect on growth!

# Kan vi oppnå bedre kontroll med vannkvaliteten i resirkulering?

- Vannkvalitet er mistenkt som årsaksfaktor til deformiteter
- "Vannkvalitet" et sammensatt begrep, mange parametre
- Usikre grenseverdier for hver av parametrene, enda mindre kunnskap om samspill
- Er det bedre å ta kontroll over den helhetlige vannkvaliteten fra starten av gjennom resirkulering?
  
- Resirkulering har vært et "fy"-ord i norsk oppdrett
- Internasjonalt er resirkulering mye brukt, også for eksempel til ørret i Danmark og laks på Færøyene

## Oppdrettsindustrien er interessert i resirkulering (pre-finanskrisen)

Kyst.no 29/02/08

### Vi må bygge store smoltfabrikker

Sunnalsøra: Daglig leder for Marine Harvests resirkulerings-settefiskanlegg på Flø, Knut Hofseth, tar til orde for gå over fra små og middels store settefiskanlegg til det han kaller store smoltfabrikker på fem millioner individer og oppover.

Kyst.no 29/02/08

### Resirkuleringsøyene i vest

Sunnalsøra: På Færøyene har all smoltproduksjon siden 2002 vært i resirkuleringsanlegg. – Dette har gitt oss svært gode resultater, sa daglig leder ved Marine Harvest Laxa, Ragnar Joensen på resirkuleringskonferansen.

Kyst.no 25/02/08

### Første resirkulerings-anlegget i nord

Fjordsmolt AS i Grovfjorden bygger et helt nytt resirkuleringsanlegg for laksesmolt. De kommer til å øke sin årlige produksjonskapasitet fra 1 til 4 millioner smolt.

Kyst.no 15/09/08

### Aquaoptima vokser

Oppdragsmengden har økt betydelig for Aquaoptima AS i Trondheim og de har ansatt flere nye medarbeidere.

Nordjyske 04/06/08

### Læsø Laks sikrer 25 job

Læsø Laks bygges i Tørkøret på den sydlige del af øen. Et stortilet oppdrætsprosjekt på Læsø stiller mod årsomsætning på 100 mio. kr.



IntraFish 19/08/08

### Tørr sommer kan gi smoltutfordringer

Oystein Ingliæ

Publisert - 19. august 2008

Strekningen Sør-Trøndelag til nordre del av Nordland har hittil i år vært svært tørr. Det kan gi store utfordringer for settefiskselskapene.

IntraFish 07/07/08

### Har nådd taket

Oystein Ingliæ

Publisert - 07. juli 2008

Smoltelskapet Laksefjord AS har nådd taket og produserer nå fem millioner smolt årlig.

– Dersom smoltbehovet til Lerøy blir større i nord, må vi bygge nytt anlegg, sier daglig leder Bjørn Hovrud i Laksefjord AS.

IntraFish 25/03/08

### Millionkontrakt til AKVA group

Joar Grindheim

Publisert - 25. mars 2008

Bergen: AKVA group Chile har undertekna ein kontrakt med Sealand Aquaculture S.A. om å bygge eit resirkulerings klekkeri for laks i region 10 i Chile.



Egersund Aqua  
fish farming



Egersund (nov 08, i finanskrisen): store planer om resirk for settefisk torsk. Se [www.eaqua.no](http://www.eaqua.no)

### Settefisk-produzent anmeldt

IntraFish Media

Publisert - 10. oktober 2008

Settefisk-produzent er anmeldt av grunneier på Otterøya i Trøndelag for nedtapping av vann.





## Nofima Senter for resirkulering i akvakultur, Sunndalsøra

### Visjon:

Gjennom forskning bidra til en kunnskapsbasert bruk av resirkulering i norsk akvakultur

### Mål 2007-2009:

Planlegge, bygge og starte et forskningsanlegg basert på resirkulering av ferskvann og sjøvann

## Milepæler i prosjektet fram til i dag

**Juli 2009:** Forventet ferdigstillelse

**Sept-Nov 2008:** Kulverter, sumper og gulv

**Juni-Aug 2008:** Hallmontasje

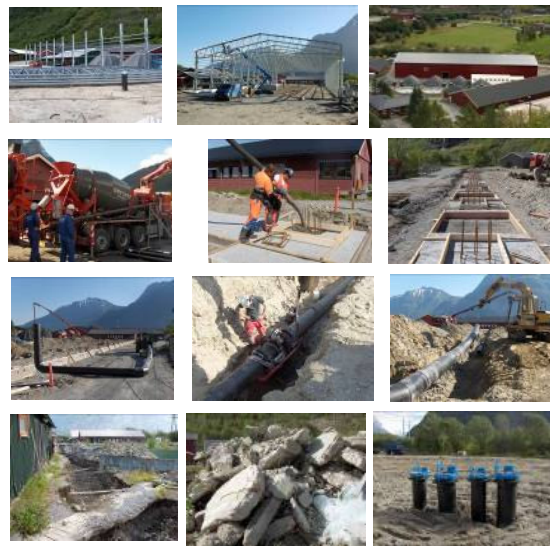
**Juni 2008:** Fundamentering

**Mai-Juni 2008:** Rørarbeider grunn

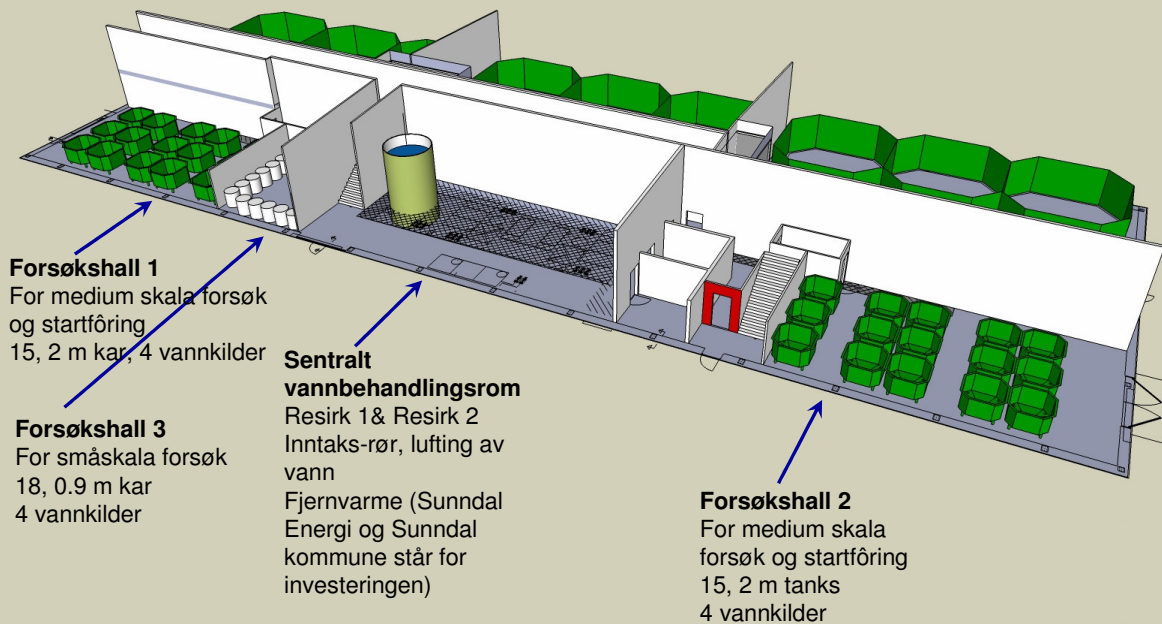
**April 2008:** Kontrahering AquaOptima

**Juli-Aug 2007:** Grunnarbeider og rør

**Mai 2007:** Vedtak i Akvaforsk styre



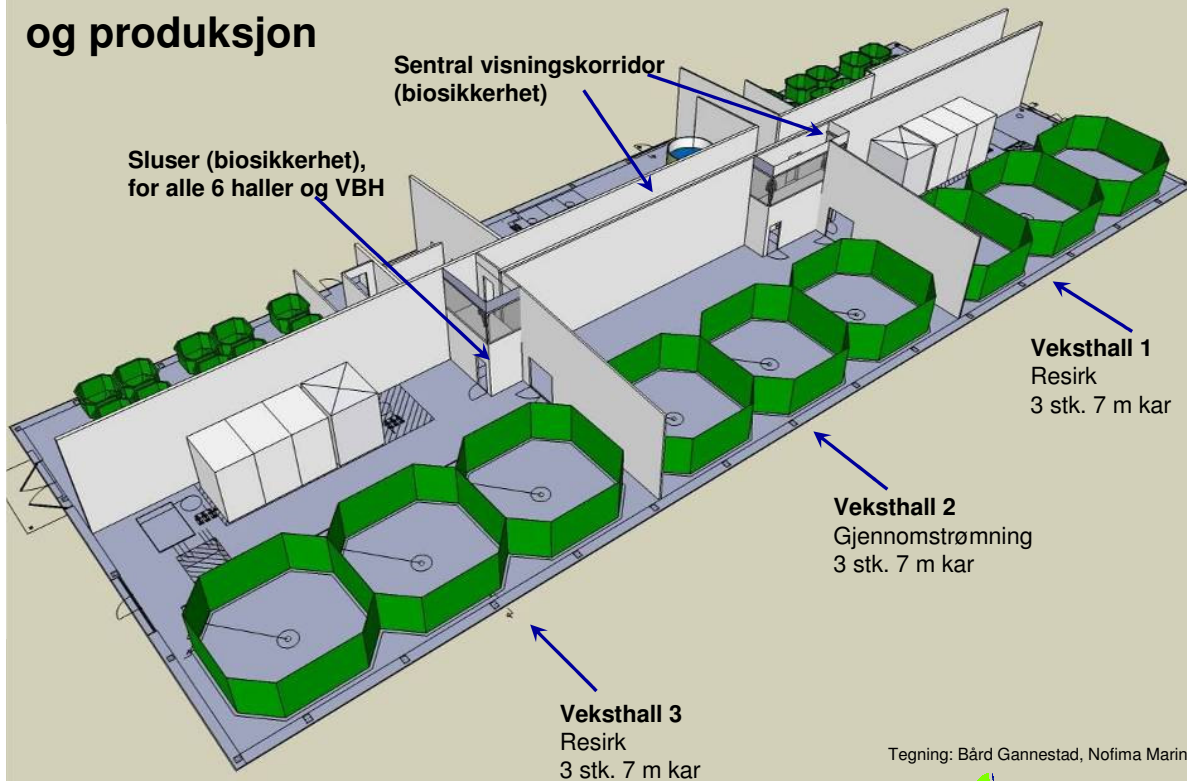
## Forsøkshaller



Tegning: Bård Gannestad, Nofima Marin



## Haller for semi-kommersiell skala forsøk og produksjon



Tegning: Bård Gannestad, Nofima Marin

