Post-smolt welfare, performance and water quality in commercial scale, floating, semi-closed containment systems: Preline, Neptune and Eco-Cage.

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uni Research

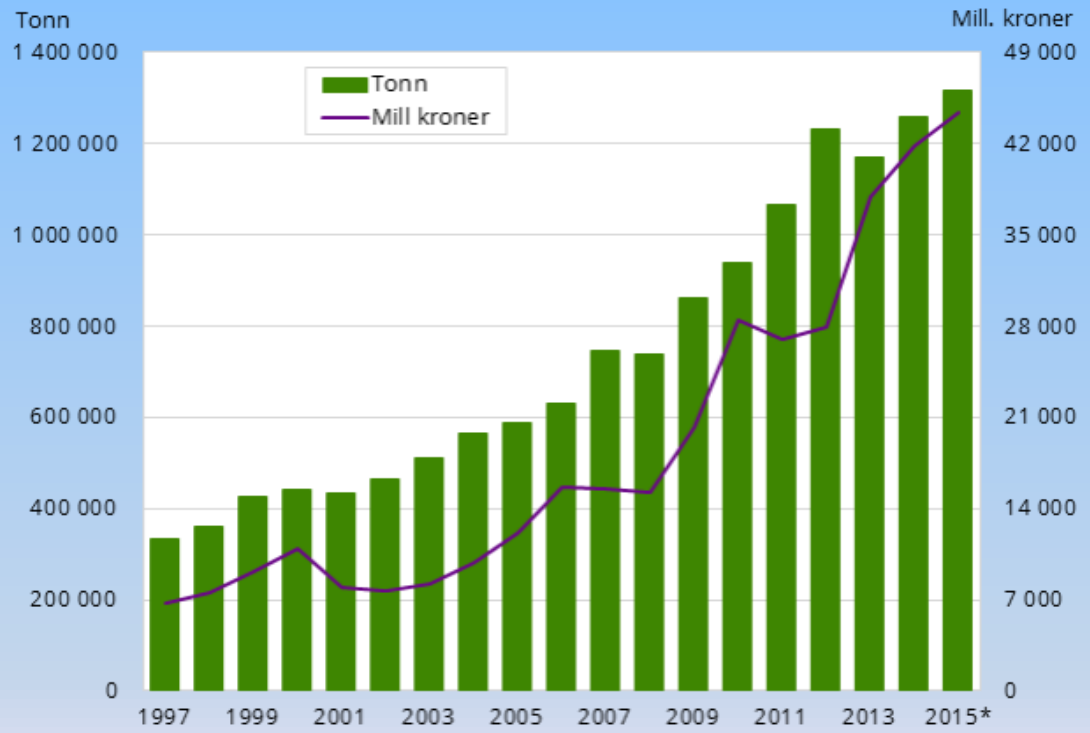
Sigurd Handeland
Senior scientist, prof. II

UNIVERSITAS BERGENSIS

sfi Senter for forskningsdrevet innovasjon
Norges forskningsråd

Production of av salmon and trout in Norway

Figur 1. Solgt mengde og førstehåndsverdi av laks



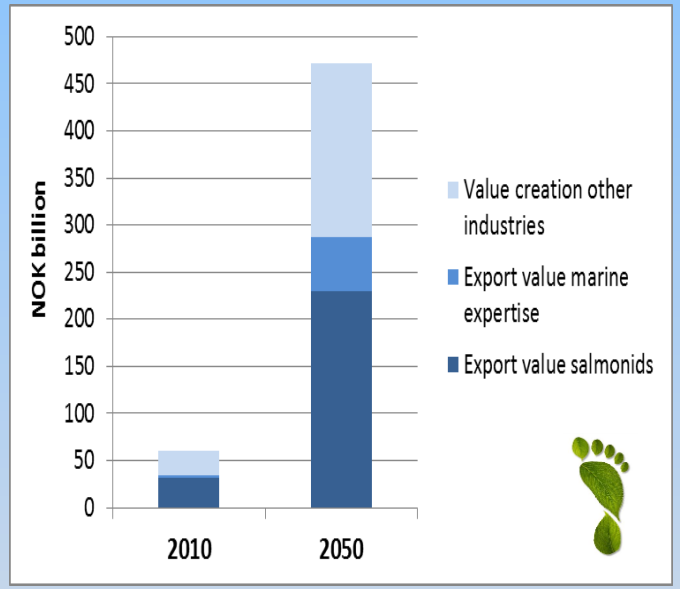
Kilde: Statistisk sentralbyrå.

Status Norwegian aquaculture industry:

1.000 fishfarms for trout and salmon in sea
7.000 people working in aquaculture

Norwegian salmon production in the period 2010-2050

- Governmental report. 22 (2012-13) "The world's leading seafood nation"
- Estimate that Norway can produce 5 mill. ton salmon i 2050.
- 5x increase in biological production and 8x increase in the economical value creation
- **Assumes a sustainable production with a low 'environmental foot print'**



Envisioned value generation provided limiting factors for growth in the aquaculture value chain are addressed. Value estimates from Olafsen et al (2012)

Challenges related to continous growth in Norwegian aquaculture industry

Sealice

Typical newspaper articles :

1. Aquaculture cause to a multiplication of sealice.
2. Salmonlice kill wild smolts.

Escape's

'A report from 'Fiskeridirektoratet' shows that the storm «Nina» caused an escape of 127 000 salmon and trout in Hordaland in 2014'

A biological, economical and public reputation challenge

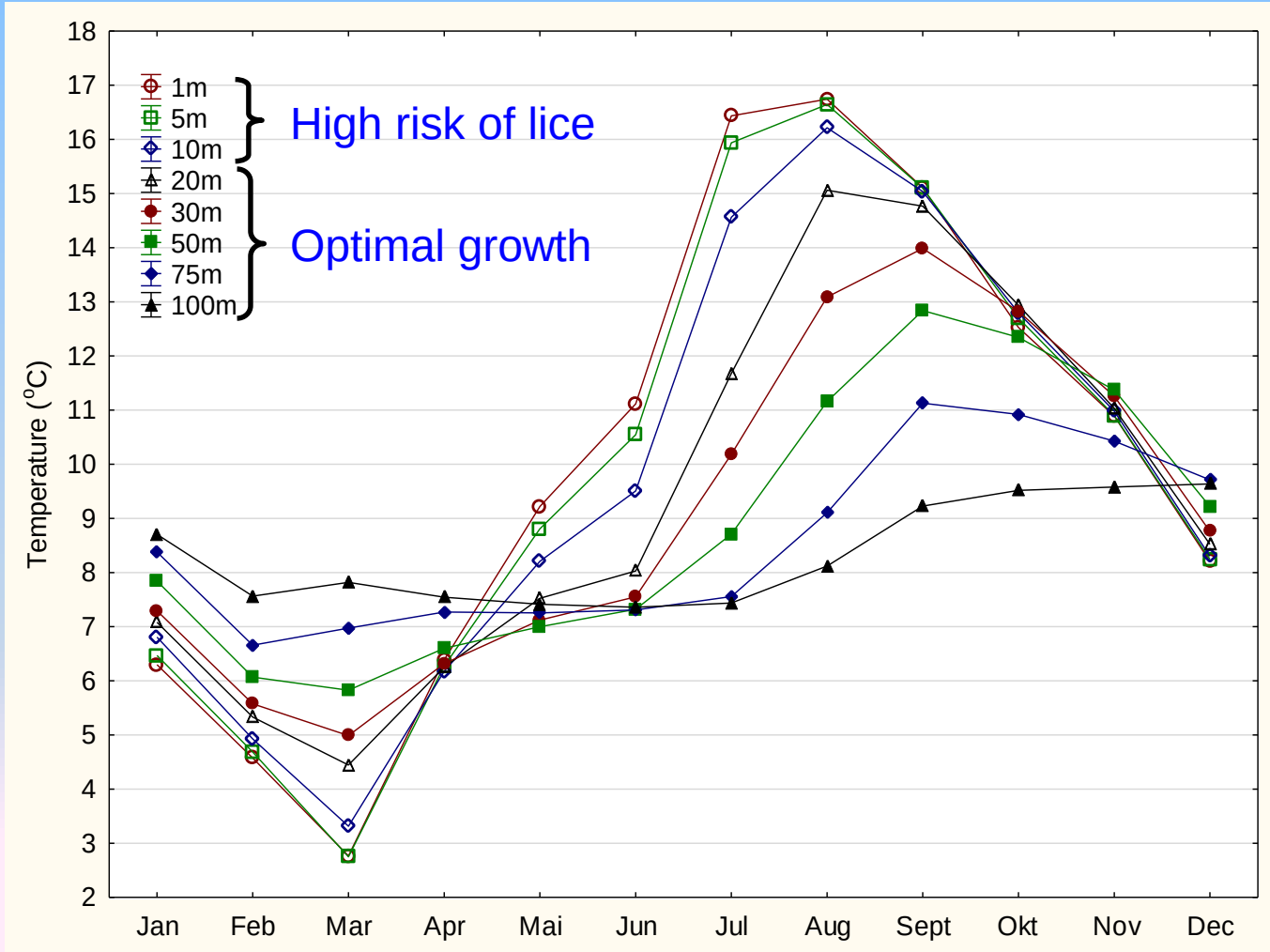
What can we expect in the use of closed containment systems in the biological production of Atlantic salmon postsmolts?

- Protect against lice and algie
- Feed waste and firm can be collected
- Reduced risk of infection from neighbor sites
- Reduced risk of escape
- Stabile temperature will cause improved growth

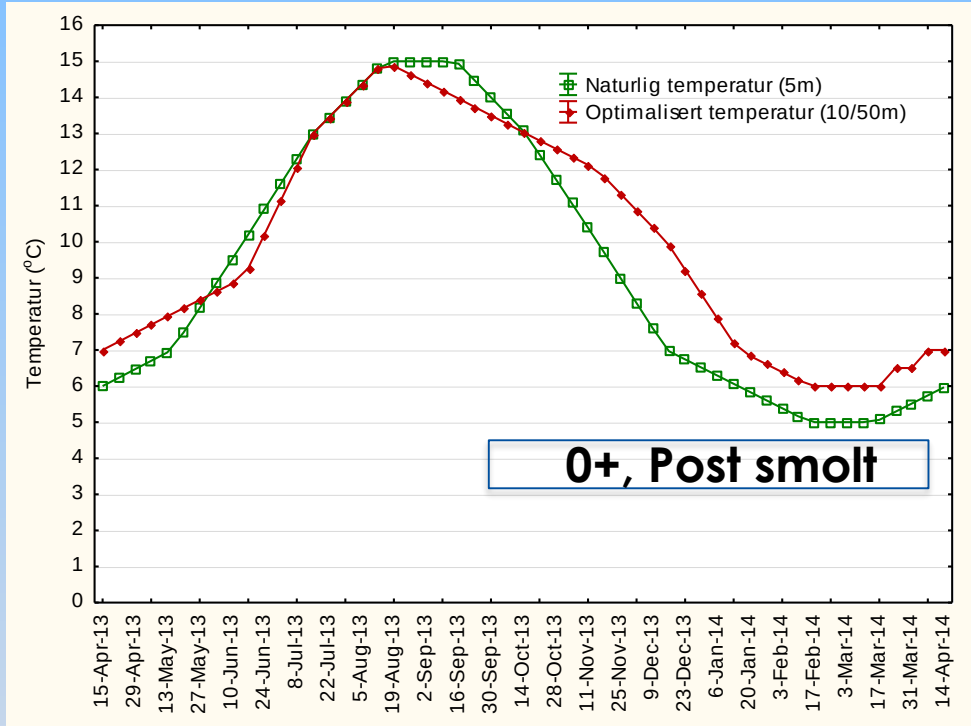
Question: Do closed containment systems have the same biological production potential as traditional open pen ?

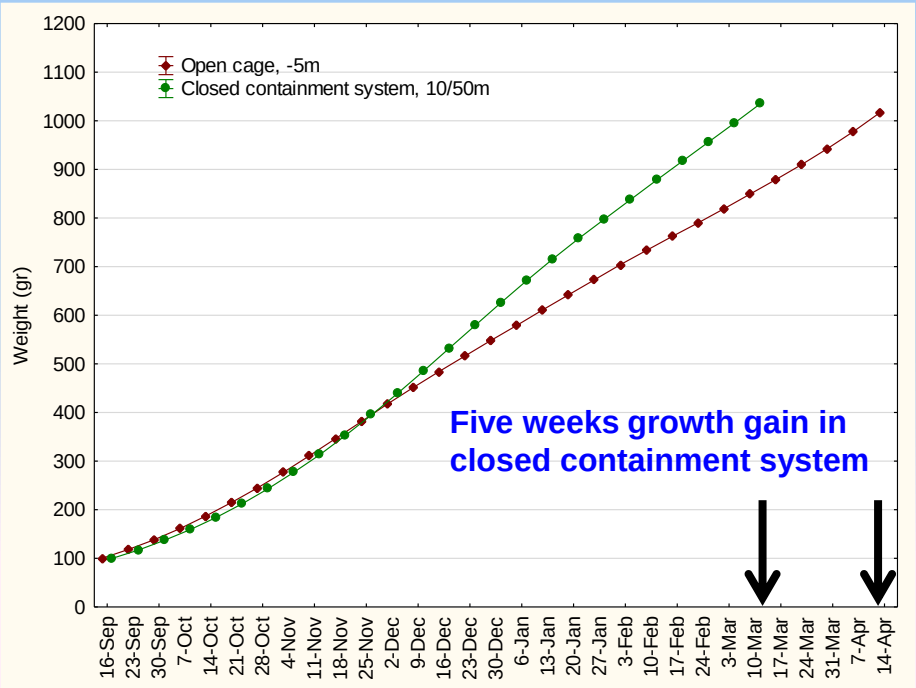
Annual seawater temperatures at different depths in fjords in Western Norway

(Data from 2006-2010, ref. IMR)



Annual surface sea temperature (Western Norway) compared with optimized temperature (-10/50m)



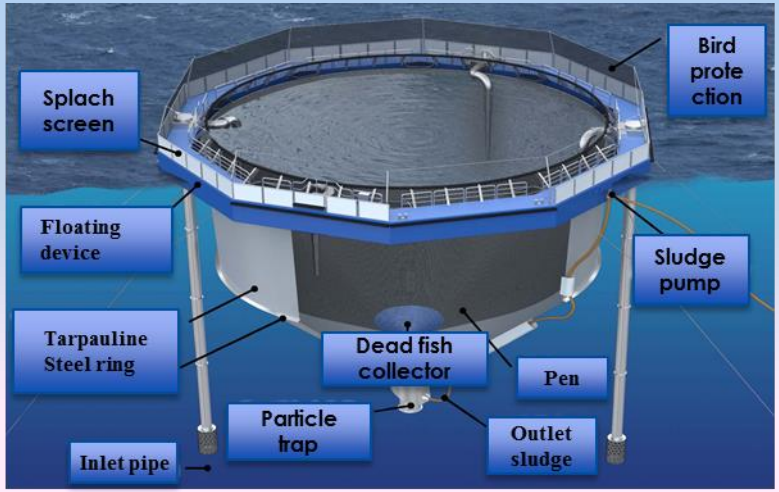


Can we expect to see the same results in large scale in the field ?

The Neptun tank (Marine Harvest)

Volume: 21 000 m^3
Material: Circular tank, GRP
Site: Skånevik, W. Norway

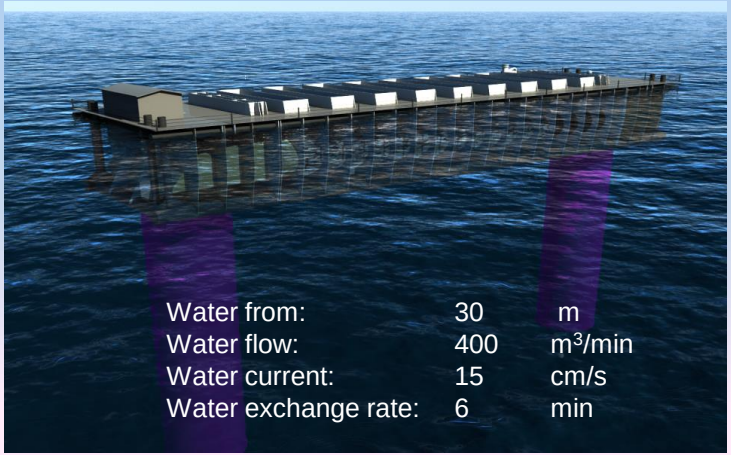
EcoMerd (Sulefisk)



Volume: 5000 m^3
Material: Ferrari tarpauline
Site: Sogn og Fjordane, W. Norway

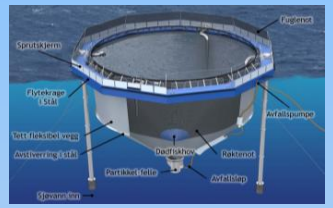
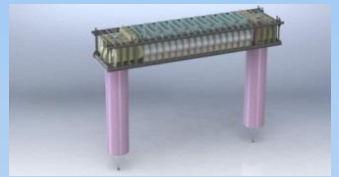
Preline (Lerøy Seafood Group ASA)

Volume: 2000 m^3
Material: PE, raceway
Site: Samnanger, W. Norway



Large scale post-smolt experiment (protocol)

Group size:	300-400 000
Quality:	0+ smolt
Initial size:	100 gr (final: 1000g)
Growth period:	20-36 weeks

Semi closed facility		Control (open pen)	
	+		Neptun; Two production cycles <u>October 2013</u>
	+		EcoMerd; Two production cycles <u>October 2015</u>
	+		Preline; Five production cycles <u>November 2015</u>

Samples collected in fresh water:

Growth (length and weight), condition
Gill tissue (NKA og gill metals)
Fish health screening (11 pathgen)
Welfare index (Fin status, cataract etc.)

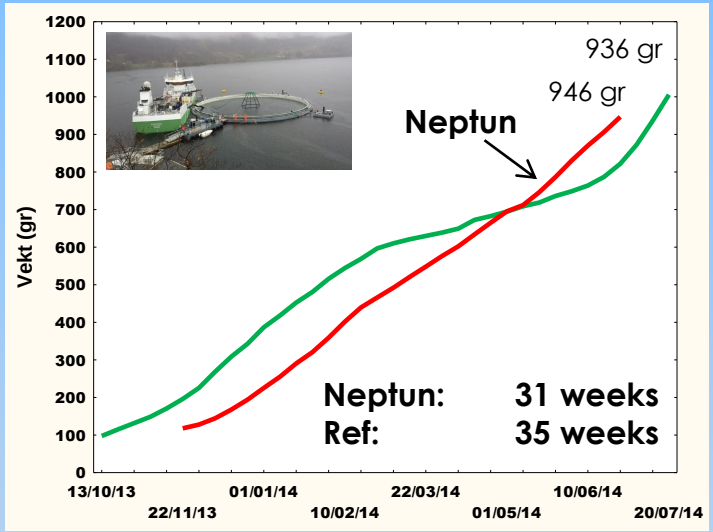
Water quality (Temp, CO_2, TAN, O_2)

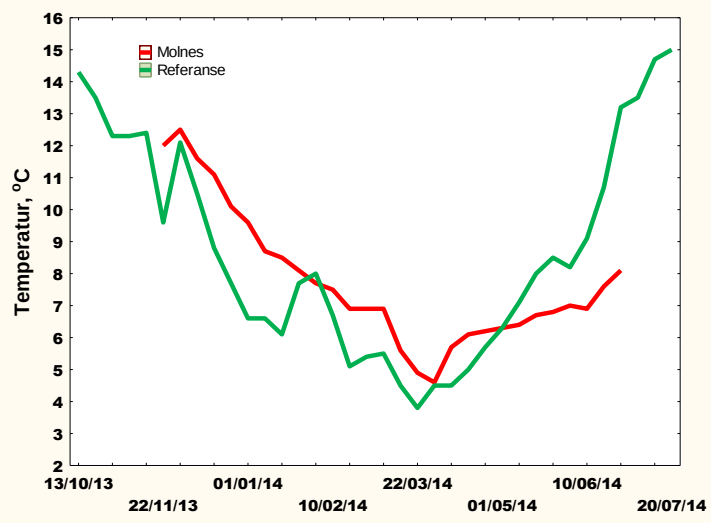
Samples collected in sea water:

<u>Growth</u> (length and weight), condition, <u>FCR</u>
Gill tissue (NKA og gill metals)
Fish health screening, <u>lice infection</u>
Welfare index (Fin status, cataract etc.)
<u>Mortality</u>

Water quality (Temp, CO_2, TAN, O_2, salinity)

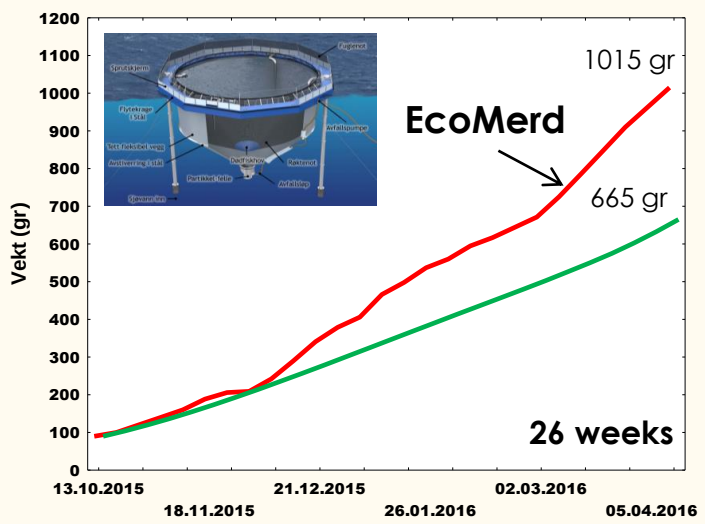
Growth results – field study

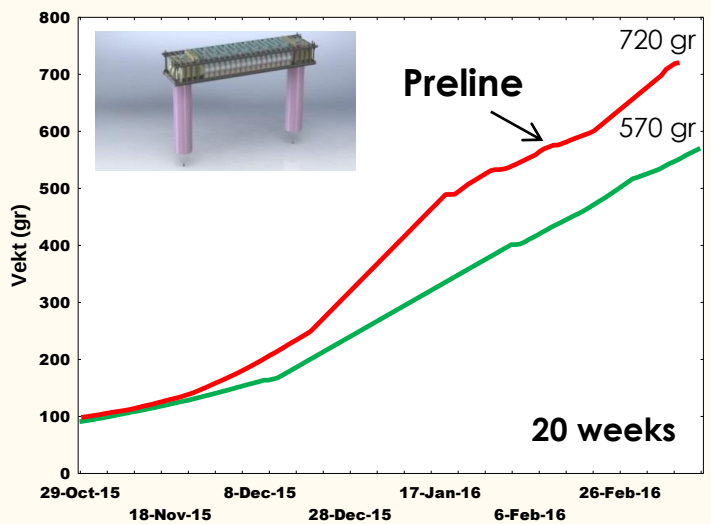




FCR (bio):
Neptun : 0,95
Ref : 1,17

11 % improved FCR in closed system





FCR (bio):
Preline :1.07
Ref. :1,24

14 % improved FCR in closed system

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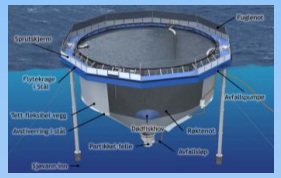
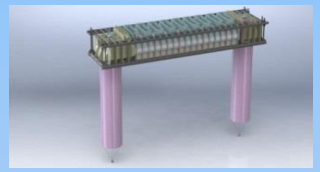
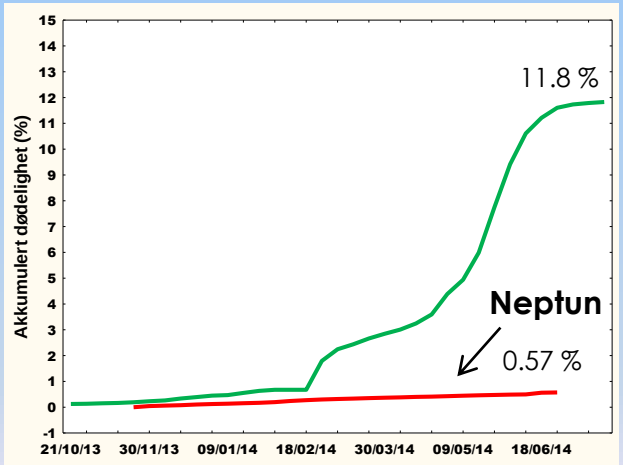
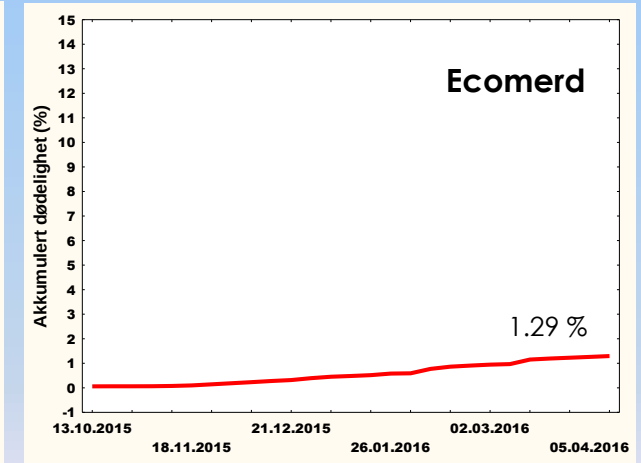
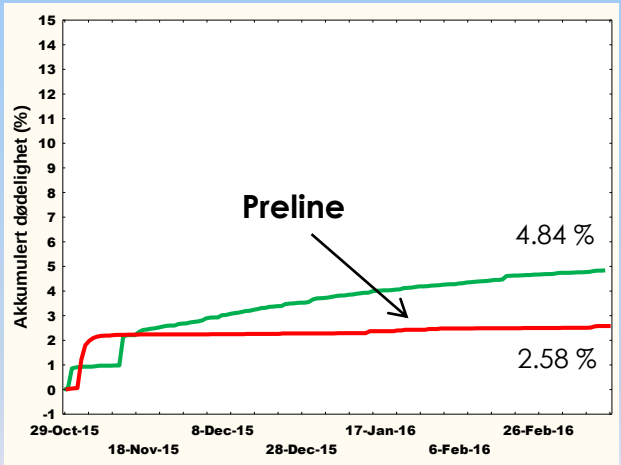
Accumulated mortality – Field study











Low accumulated mortality in CCS

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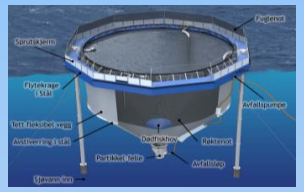
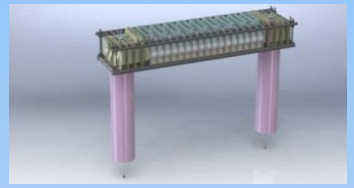
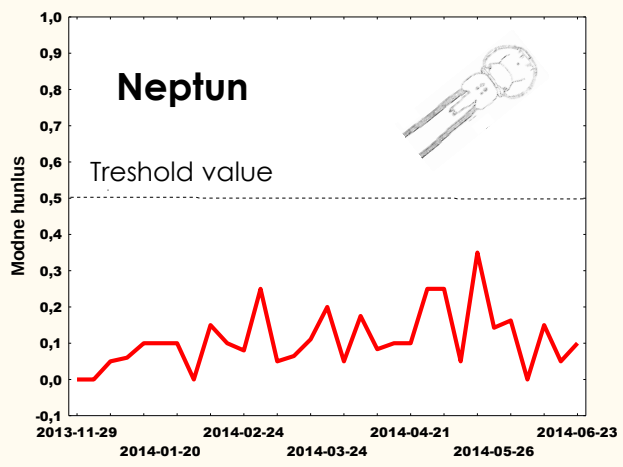
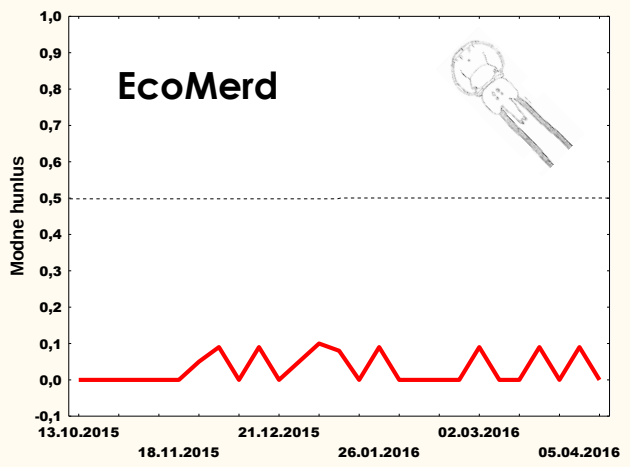
Salmon lice – field study

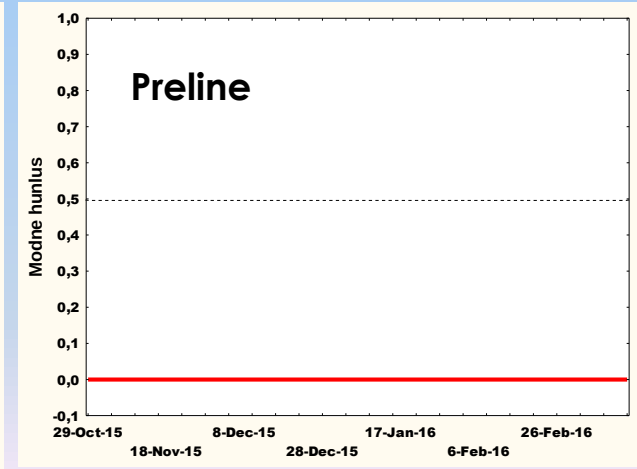
Number of mature lice per fish







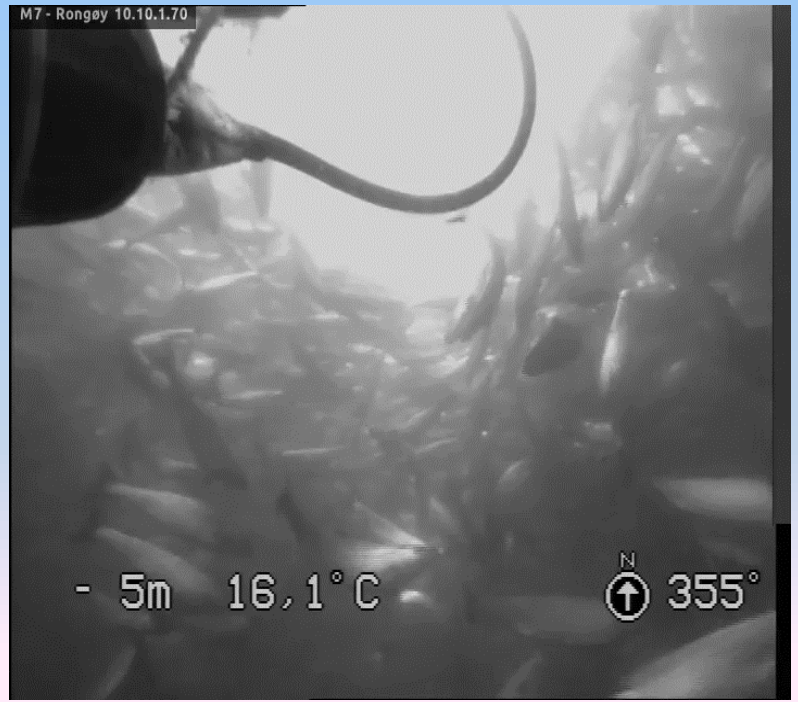




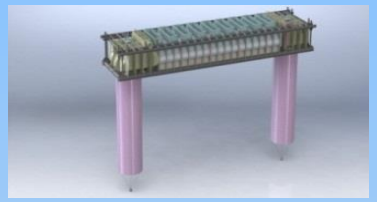
Salmon lice level below treshold value in CCS

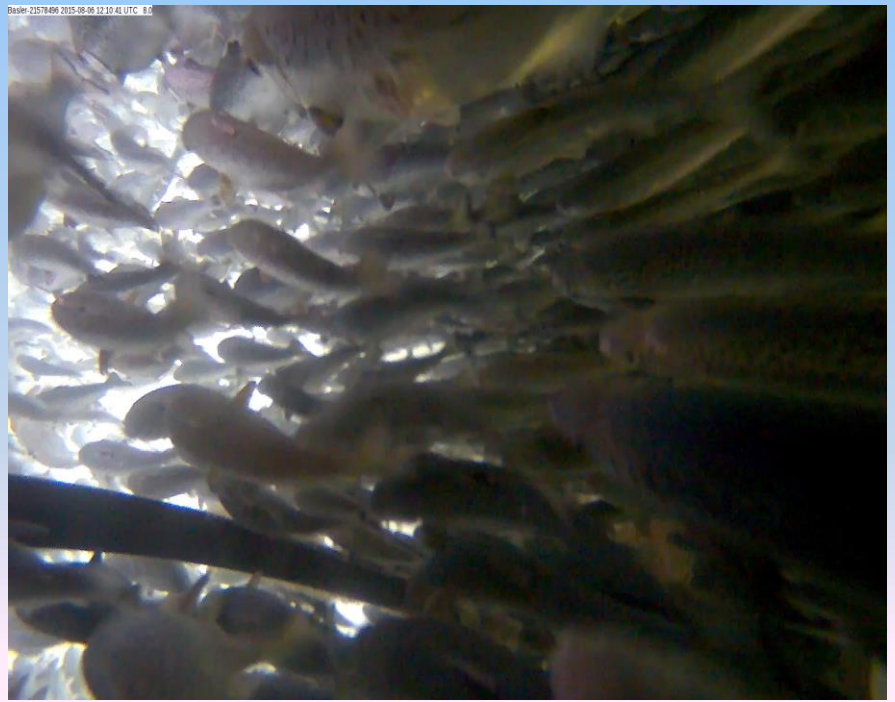
Swimming behaviour

Referanse



Preline





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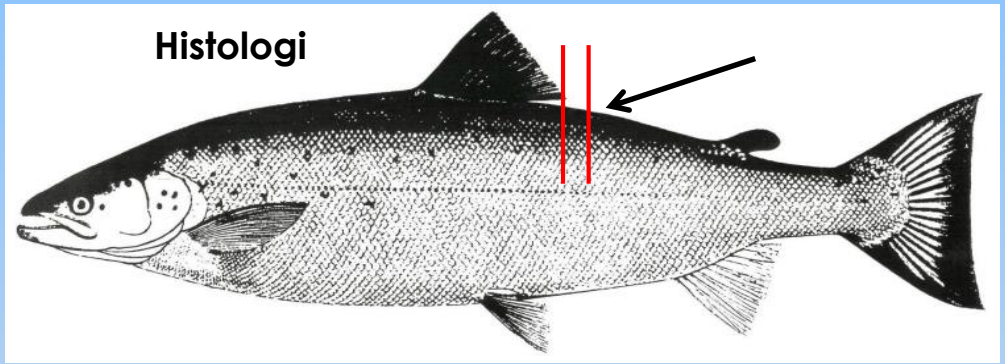
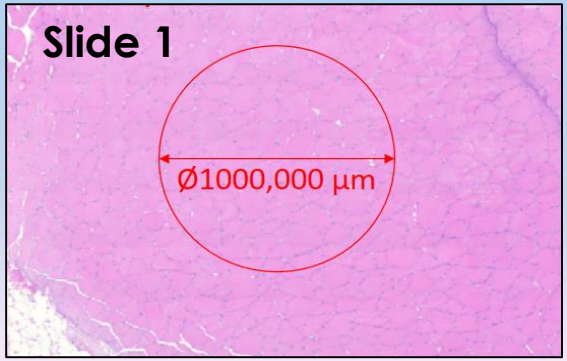
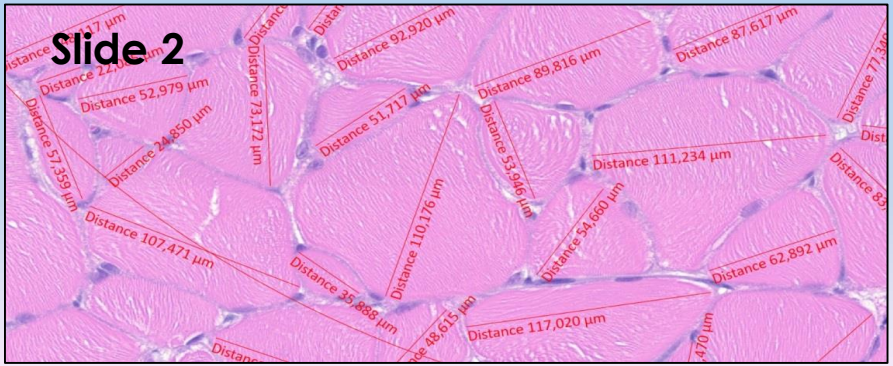
Effect of training; Measurement of the white muscle cells (number and size, Sveier et al. 2015; Moe 2017)



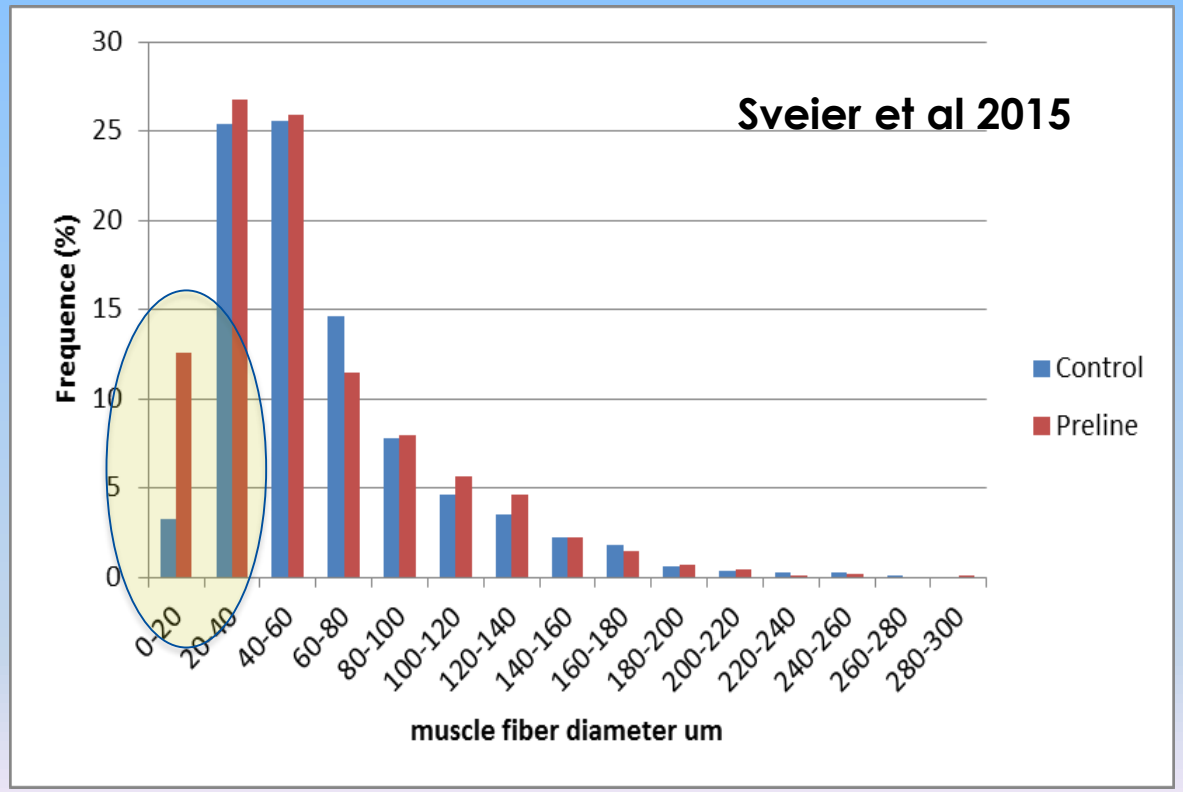
Collected white muscle fibres in trained (Preline) and untrained (ref) fish.

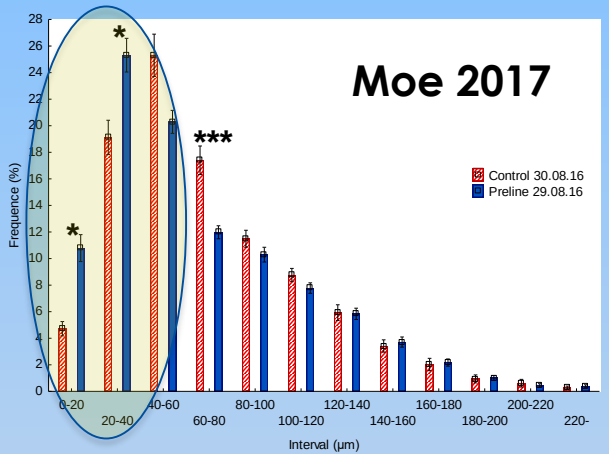




In a pre-defined area (slide1), all fibres were measured for the greatest possible distance/diameter (slide 2).

Distribution of muscle fibre in trained and untrained groups of salmon



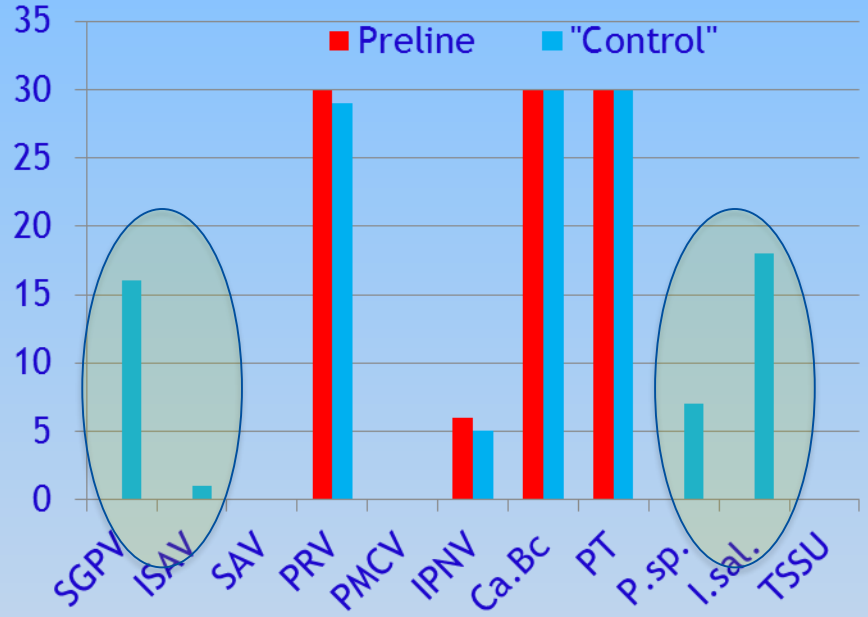


3.8 times higher frequency of small muscle fibres at the end of the post-smolt phase in trained group (Preline).

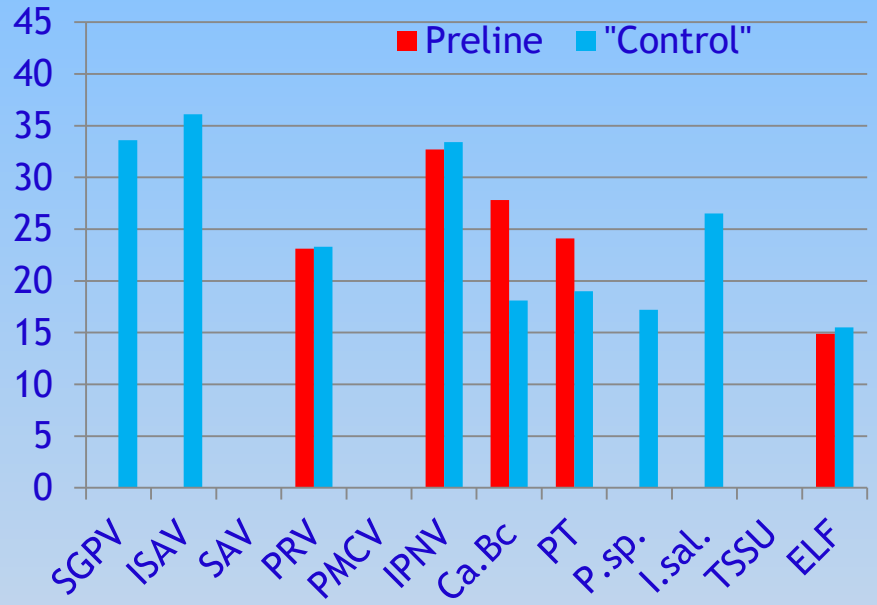
Increased recruitment of small muscle fibres ?

Fish health; Results from the screeningprogram

Prevalence



Mean ct values



SGPV = Salmonid gill poxvirus, ISAV = ILA virus, SAV = PD virus, PRV = Piscine reovirus,

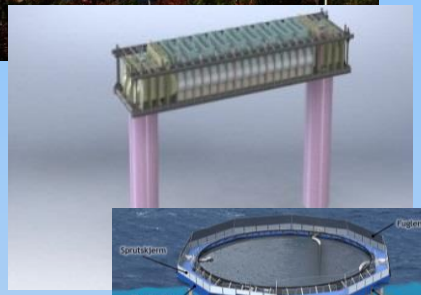
PMCV = Piscine myocarditis virus, IPNV = IPN virus, Ca. B.cyst. = Branchiomonas cysticola (epitheliocystis),

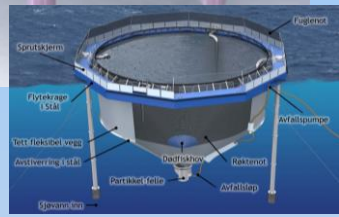
PT = *Paranucleospora theridion*, **P. sp. = *Paramoeba perurans*,** **I.sal. = *Ichthyobodo salmonis*,** Tssu=Tetramitus sp.

ELF = elongationfactor (Control gen, n=30)

Ref: Are Nylund

Conclusions field study





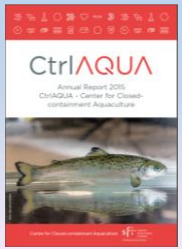
Question: Do closed containment systems have the same biological production potential as traditional open pen ?

1. Good performance and high growth in semi-closed systems for fish up to 1 kg.

2. Survival above 98 % during the postsmolt phase.

3. Good fish health, but some lice infestation during the postsmolt phase.

4. Training may increase muscle cell recruitment.

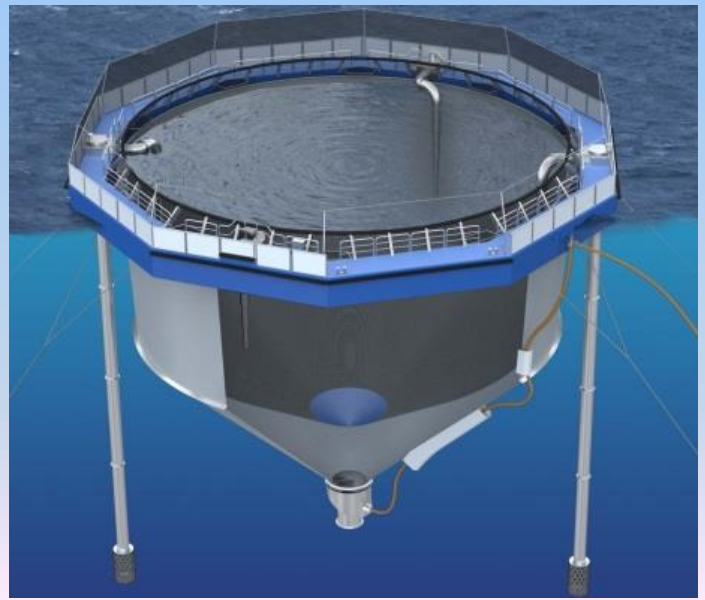


Answer: Yes, there is a potential

Senter for forskningsdrevet innovasjon

Norges forskningsråd

Thank you for your attention



New strategies and technologies

Technology of today

LANDBASED SMOLT PROD. → OPEN SYSTEMS (PEN)

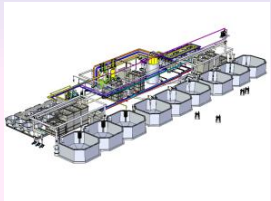
New Innovations

I) LANDBASED SMOLT PROD. → LANDBASED POSTSMOLT → OPEN SYSTEMS (PEN)

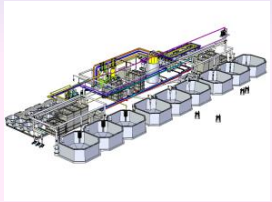
II) LANDBASED SMOLT PROD. → CLOSED POSTSMOLT-PROD IN Sea → OPEN SYSTEMS (PEN)

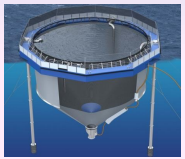
III) LANDBASED SMOLT PROD. → CLOSED PRODUCTION ON LAND OR IN SEA

0-80 g



80 g-1 kg





1-5 kg