Why aquaculture?

1. A controlled production of healthy food with the potential to balance the need of the market and the availability of sustainable caught wild fish

2. May be located in urbane and peri-urbane areas and thereby play a vital role in future cities recycling based food systems

3. New work opportunities within a shrinking agro sector and at the same time add to local food security

4. Perform Eco-services in e.g. blue catch crops like feed mussels and bio generators including microbes as yeast, micro algae etc. resulting in:
    1. Food
    2. Feed components
    3. Bio energy

5. Fair trade. Without aquaculture fish as food runs the risk to be a class issue where fish on the table depends on your salary in parity with game meat

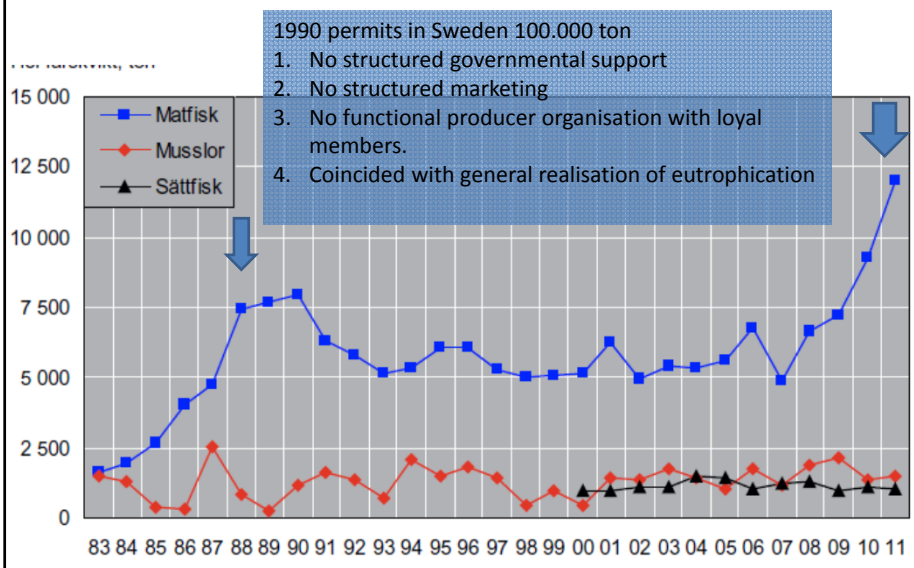
6. In conclusion: Aquaculture has the potential to lead the transformations from todays linear food systems into a future circular one. However, in the process we need to solve:
    1. Feed (FAOs prognoses a need of **30 million ton** pure high quality feed protein at 2030)
    2. Functional tools for open system localisation
    3. Technology development and cost reduction of closed and semi closed systems

Ny rapport kring svenskars konsumtion av sjömat

7 av 10 svenskar äter fisk varje vecka.

Men det finns tydliga regionala skillnader. Västsvenskar är de som är mest förtjusta i fisk som lunch och middag, medan norrlänningarna är desto mer skeptiska.

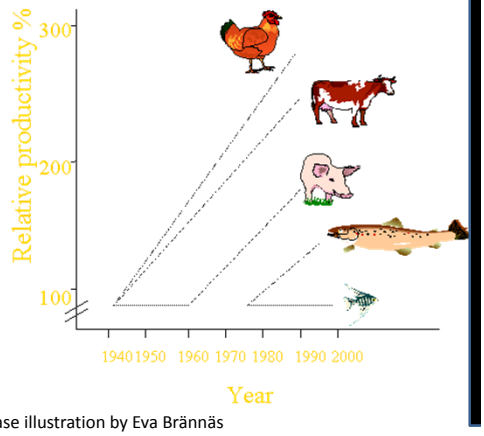
Smaken varierar även vad gäller fiskrätter. Stockholmarna är de som tycker bäst om sushi, smålänningarna har en förkärlek till panerad fisk medan fiskgratängen går bäst hem i mellersta Norrland.




SLU
Photo A.Kiessling
Photo A.Kiessling
Bild A.Kiessling

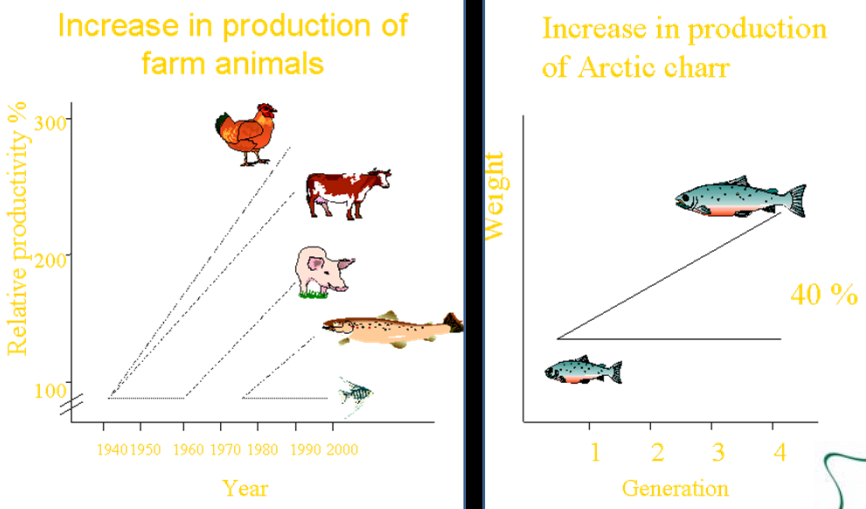

SLU
Open net cage farming in nutrient poor hydro power dams.
50 – 70.000 ton ?
The Baltic project Aquabest , with SLU as one lead partner, Is now developing tools for localisation of both cage and mussel farms as support to authorities and industry
www.aquabestproject.eu
AQUABEST

Effects of breeding programs

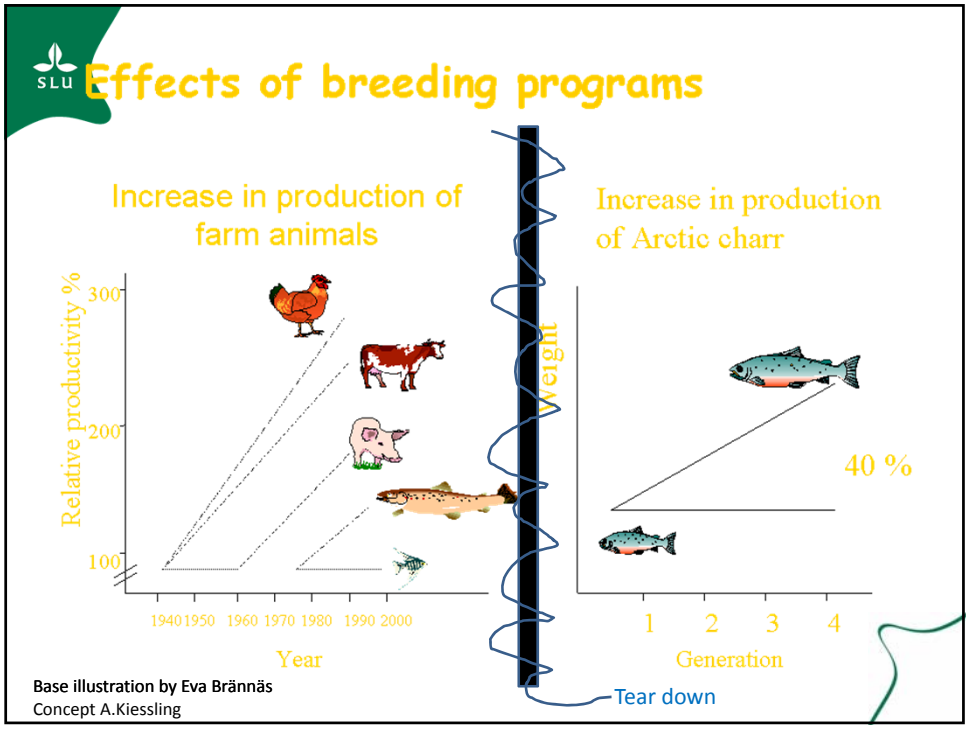


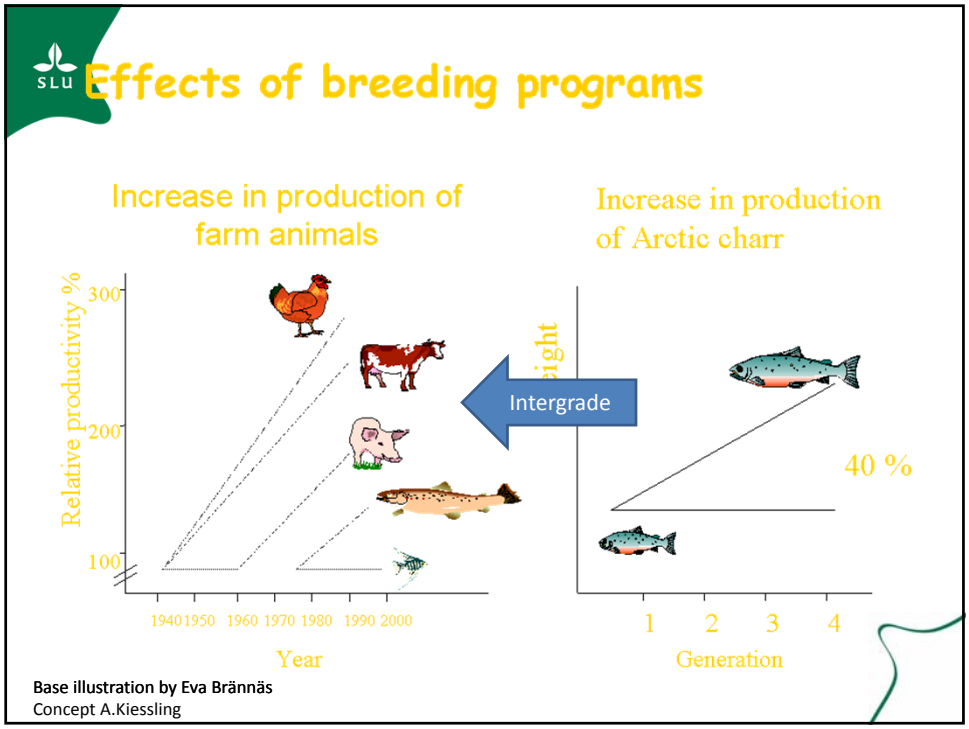
Base illustration by Eva Brännäs
Concept A.Kiessling

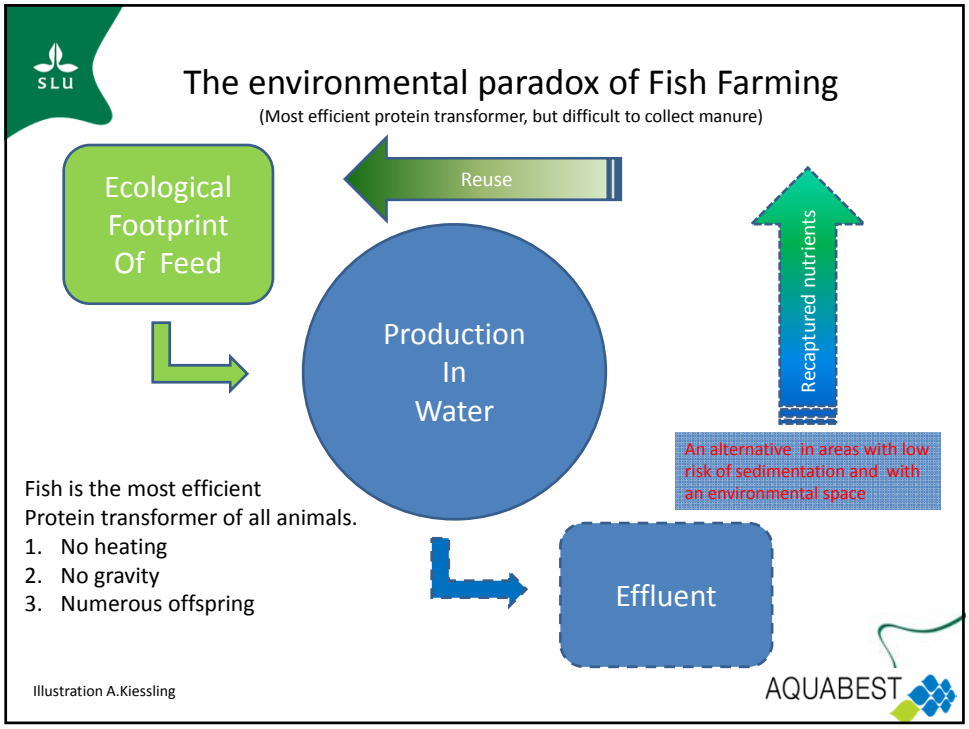
Effects of breeding programs

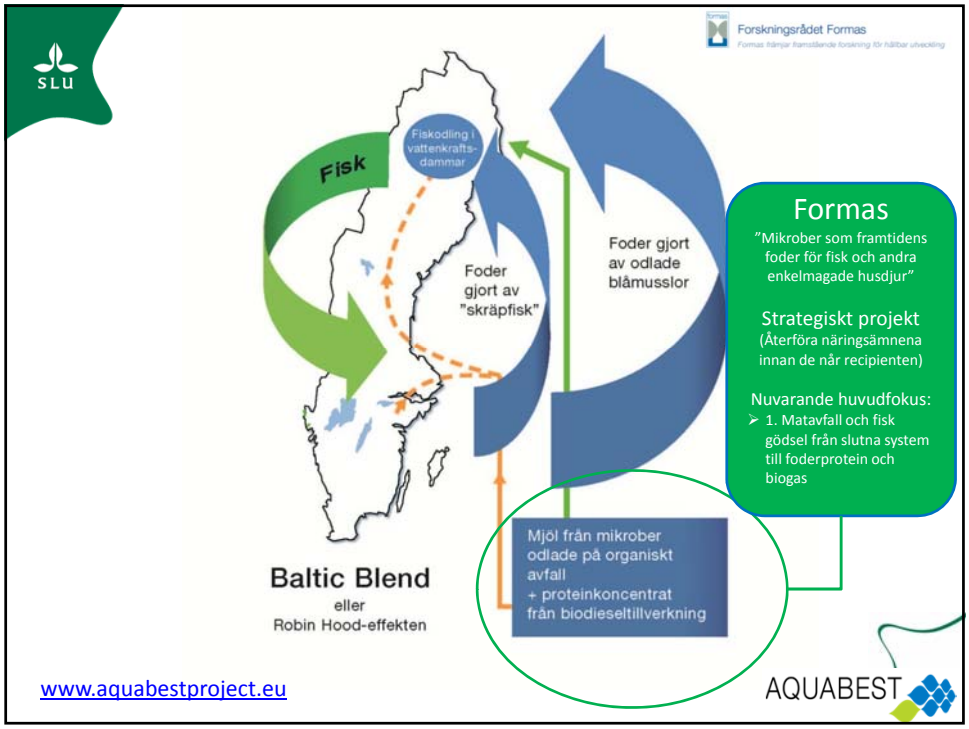


Base illustration by Eva Brännäs
Concept A.Kiessling

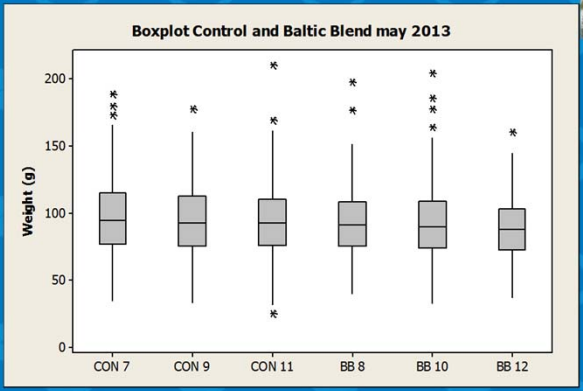

Effects of breeding programs
Increase in production of farm animals
Relative productivity %
300
200
100
1940 1950 1960 1970 1980 1990 2000
Year
Weight
Increase in production of Arctic charr
40 %
1 2 3 4
Generation
Tear down
Base illustration by Eva Brännäs
Concept A.Kiessling


Effects of breeding programs
Increase in production of farm animals
Relative productivity %
300
200
100
1940 1950 1960 1970 1980 1990 2000
Year
Intergrade
Increase in production of Arctic charr
40 %
1 2 3 4
Generation
Base illustration by Eva Brännäs
Concept A.Kiessling


The environmental paradox of Fish Farming
(Most efficient protein transformer, but difficult to collect manure)
Ecological Footprint Of Feed
Reuse
Production In Water
Recaptured nutrients
An alternative in areas with low risk of sedimentation and with an environmental space
Fish is the most efficient Protein transformer of all animals.
1. No heating
2. No gravity
3. Numerous offspring
Effluent
Illustration A.Kiessling
AQUABEST


Forskningsrådet Formas
Fisk
Fiskodling i vattenkrafts-dammar
Foder gjort av "skräpfisk"
Foder gjort av odlade blåmusslor
Baltic Blend
eller
Robin Hood-effekten
Mjöl från mikrober odlade på organiskt avfall
+ proteinkoncentrat från biodieseltillverkning
Formas
"Mikrober som framtidens foder för fisk och andra enkelmagade husdjur"
Strategiskt projekt
(Återföra näringsämnena innan de når recipienten)
Nuvarande huvudfokus:
1. Matavfall och fisk gödsel från slutna system till foderprotein och biogas
www.aquabestproject.eu
AQUABEST

Kälarne 2013 Growth – May 2013 status



CON = control feed
BB= Baltic Blend

No significant differences between the feeds

Illustration H. Carlsberg

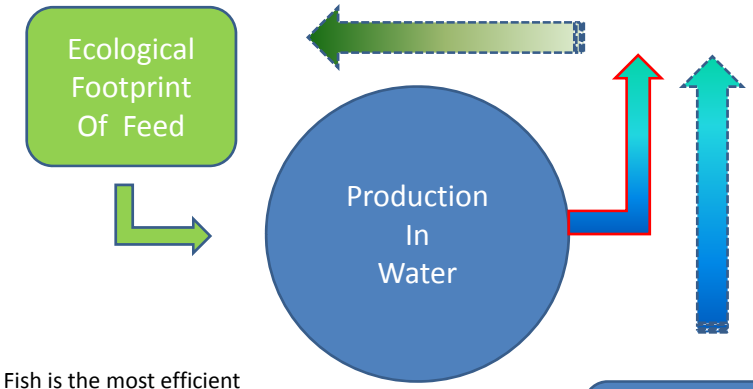
Baltic Sea Region Programme 2007-2013
Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

Forskningsrådet Formas

AQUABEST

The environmental paradox of Fish Farming

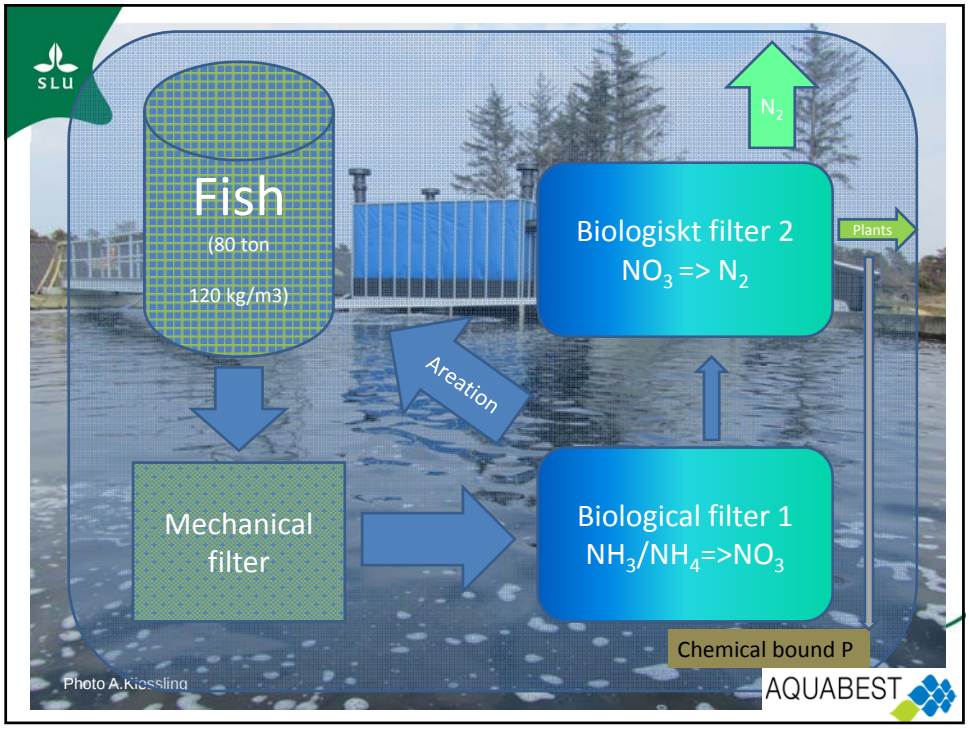
SLU



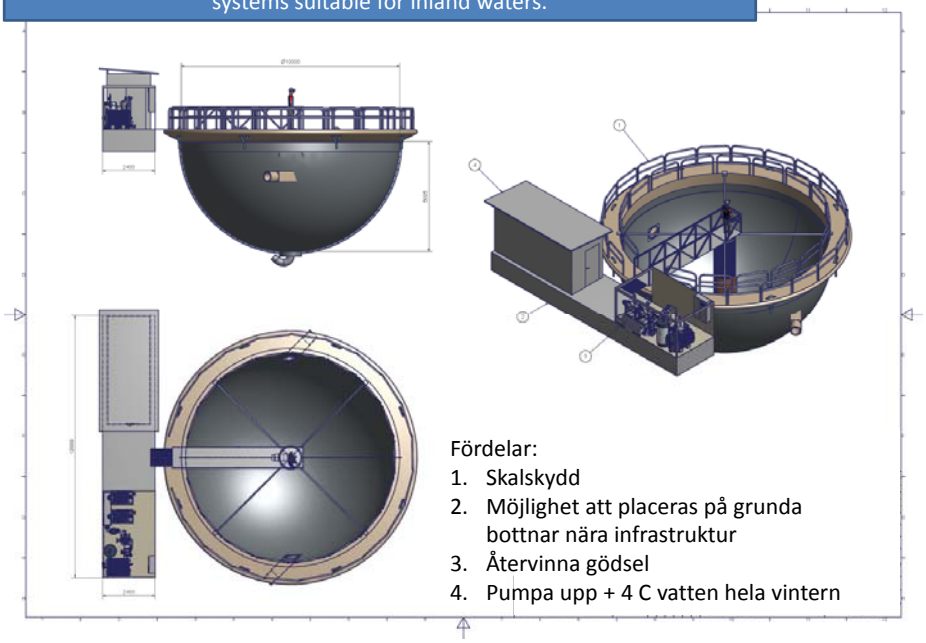
Fish is the most efficient Protein transformer of all animals.

1. No heating
2. No gravity
3. Numerous offspring

Illustration A.Kiessling



An example on one possible technology development for semi closed systems suitable for inland waters.

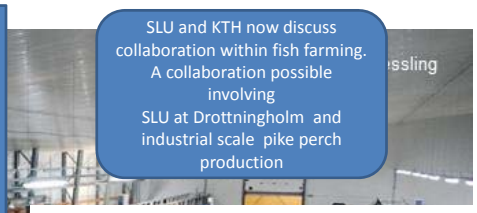


Fördelar:

1. Skalskydd
2. Möjlighet att placeras på grunda bottnar nära infrastruktur
3. Återvinna gödsel
4. Pumpa upp + 4 C vatten hela vintern

This is a production form in rapid development driven by the industry because:

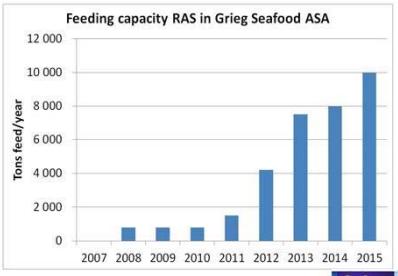
1. Temperature (production time)
2. Control of infectious diseases
3. Control of feed use and effluents



SLU and KTH now discuss collaboration within fish farming. A collaboration possible involving SLU at Drottningholm and industrial scale pike perch production

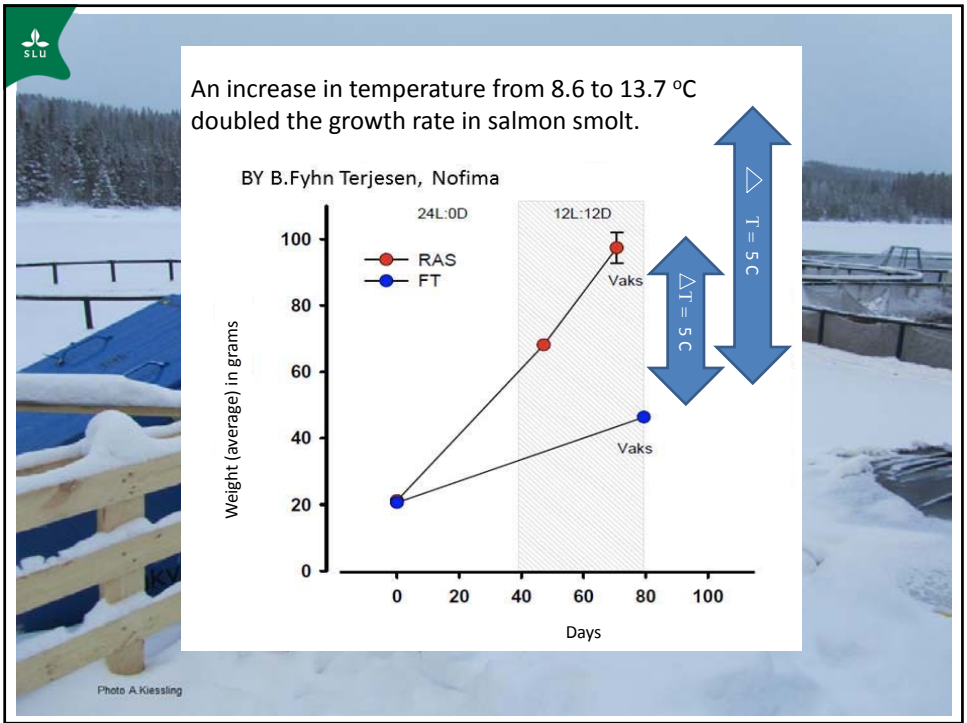
The issue is if Sweden should try and head the technical race or follow the development in order to optimise our resources?

The use of RAS in Grieg Seafood ASA is illustrative for the general RAS development



By Frode Mathisen

Grieg Seafood



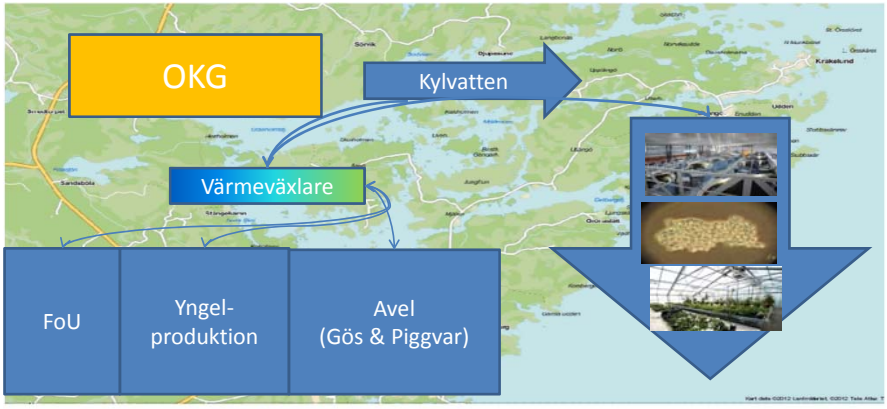
Low grade Surplus Heat

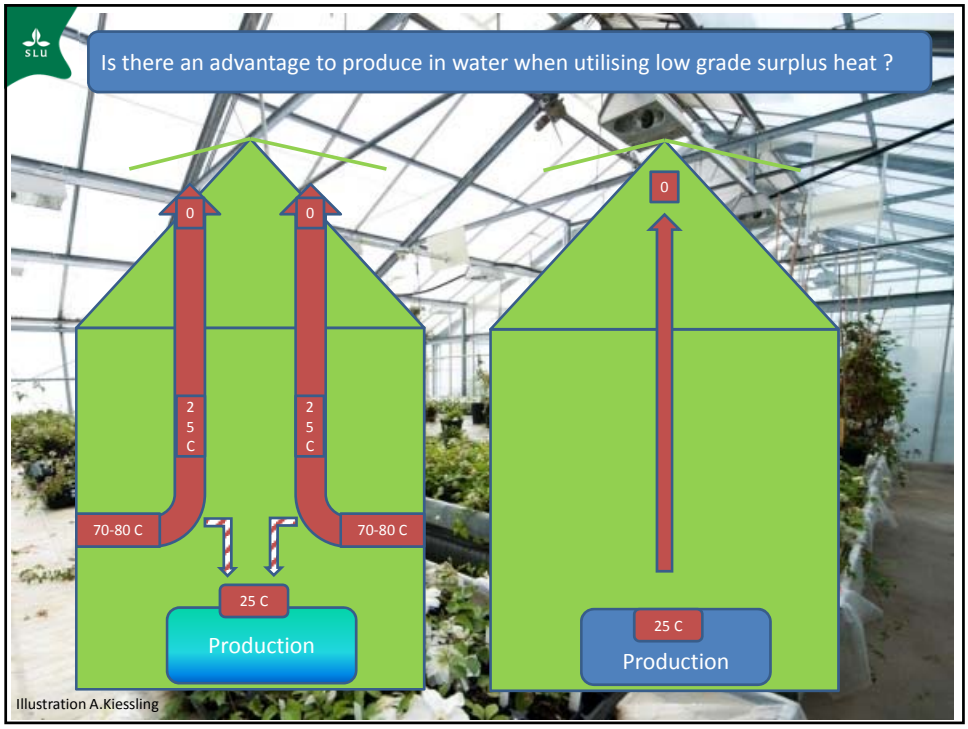
1. Enormous amounts of heat < 60 °C is lost as cooling, ventilation or insufficient insulation.
2. In Sweden it is estimated to 150 TWh => ¼ of Swedish energy use.
3. In EU it is estimated to 500 billions Euro in petrol equivalents.
4. **Growth of fish, plants, algae are all stimulated by a moderate increase in temperature.**

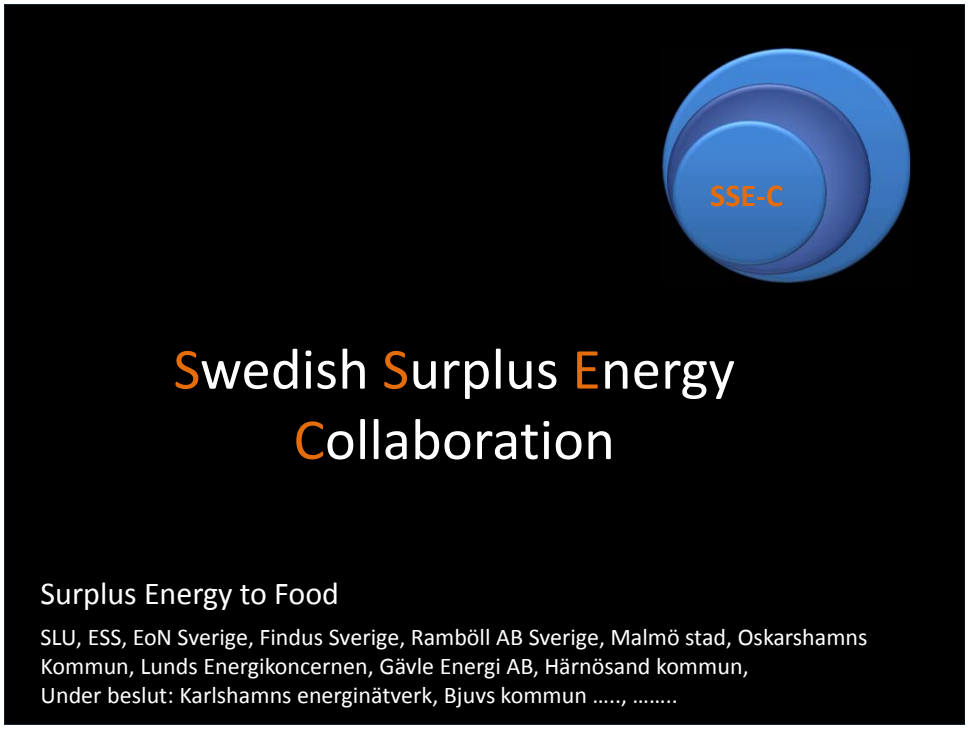
BIC, *Baltic Aquaculture Innovation Center,*
Oskarshamn

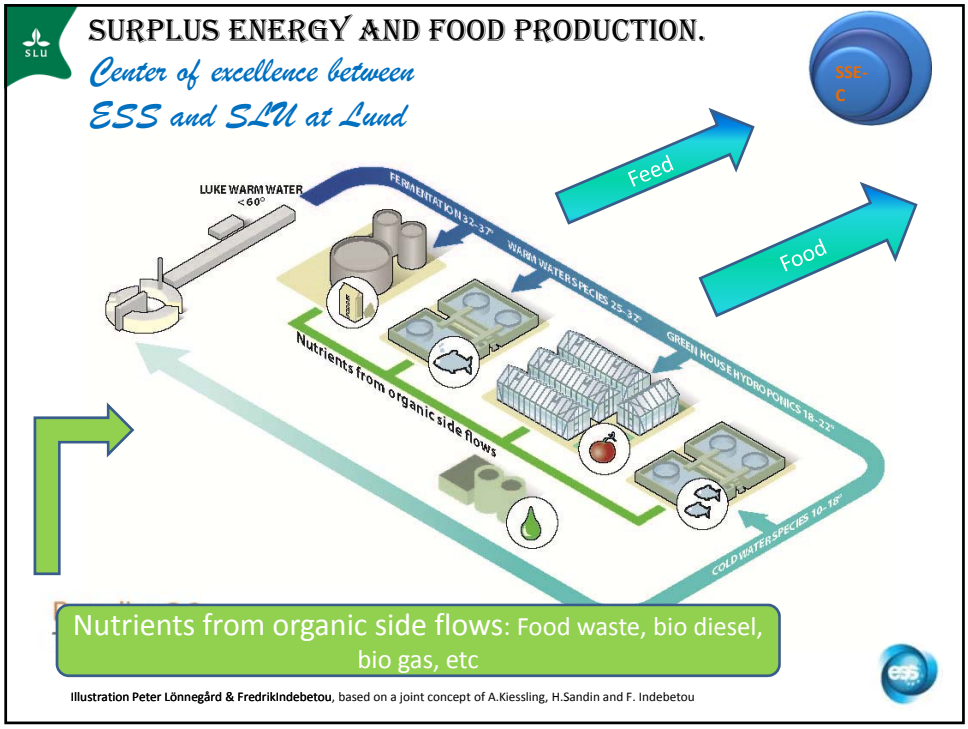
Är ett FoU center med övergripande mål att bedriva utveckling av framtidens miljövänliga matproduktion

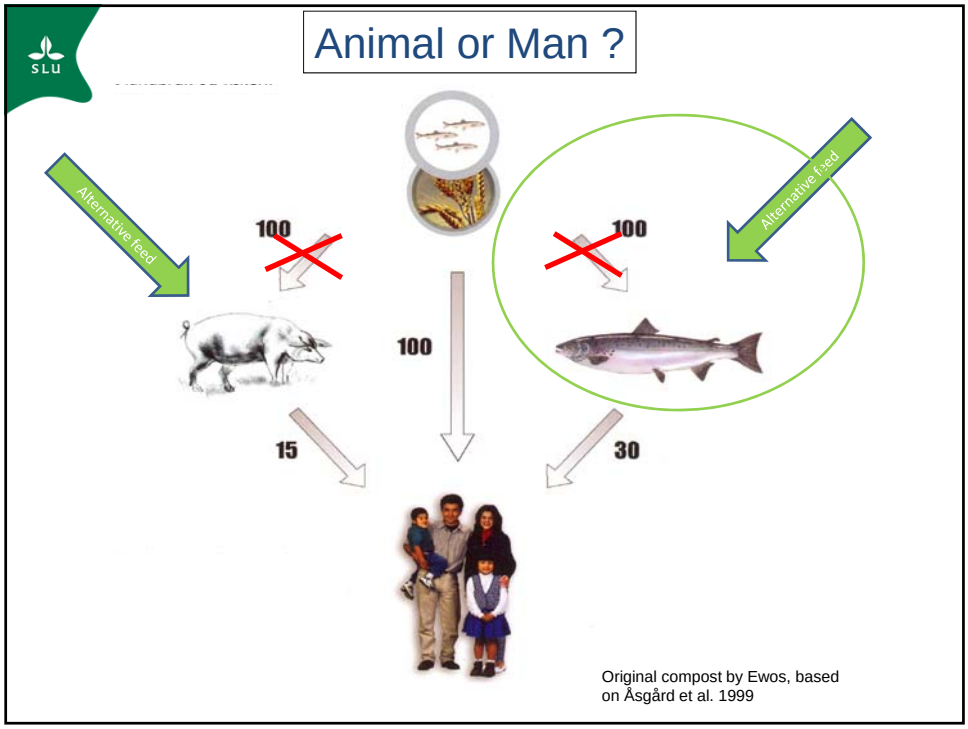
Delmål 1: Att säkra näringens framtida behov av kunskap.
Delmål 2: Att i samarbete med andra aktörer säkra näringens tillgång på högkvalitativt genetiskt material

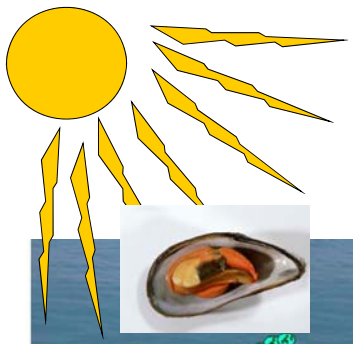



Is there an advantage to produce in water when utilising low grade surplus heat ?
0
0
0
25 C
25 C
70-80 C
70-80 C
25 C
Production
25 C
Production
Illustration A.Kiessling


SSE-C
Swedish Surplus Energy Collaboration
Surplus Energy to Food
SLU, ESS, EoN Sverige, Findus Sverige, Ramböll AB Sverige, Malmö stad, Oskarshamns Kommun, Lunds Energikoncernen, Gävle Energi AB, Härnösand kommun,
Under beslut: Karlshamns energinätverk, Bjuvs kommun ….., ……..

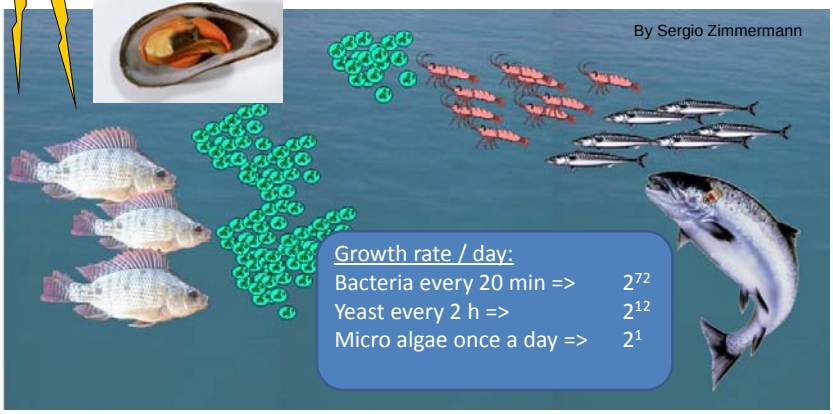

SURPLUS ENERGY AND FOOD PRODUCTION.
Center of excellence between
ESS and SLU at Lund
SSE-C
LUKE WARM WATER
<60°
FERMENTATION 32-37°
WARM WATER SPECIES 25-32°
GREEN HOUSE HYDROPONICS 18-22°
COLD WATER SPECIES 10-18°
Feed
Food
Nutrients from organic side flows
Nutrients from organic side flows: Food waste, bio diesel, bio gas, etc
Illustration Peter Lönnegård & FredrikIndebetou, based on a joint concept of A.Kiessling, H.Sandin and F. Indebetou


Animal or Man ?
Alternative feed
100
100
100
Alternative feed
15
30
Original compost by Ewos, based on Åsgård et al. 1999



Microbes are the base of the food web evolution of all higher animals including ruminants.

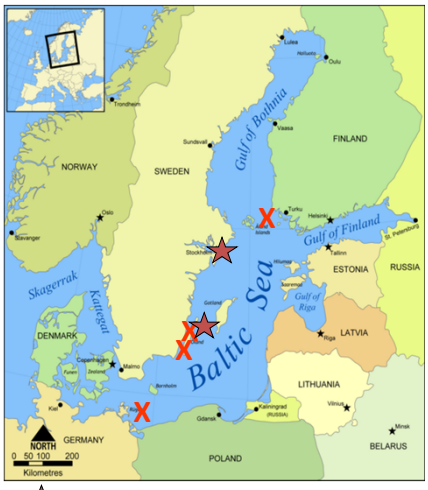
FA & AA = our need



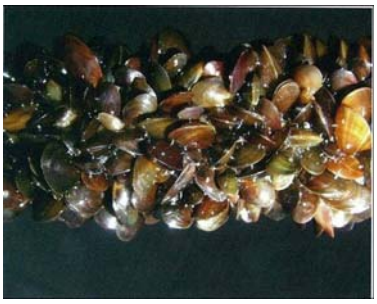
Mussel farming in Southern Baltic

-Alternative to Fish Farming (socio economics)
-A Tool in a Nutrient Emission Trading System
-Low in natural feed chain

-Recapture Nutrients as **Mussel meal**

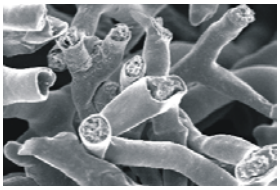


★ & X =Experimental mussel farms

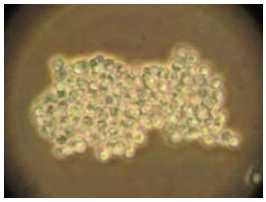


BALTIC SEA 2020

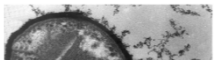
Microbial protein / Bio-protein meal



Micro fungi

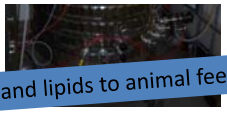


Yeast



<u>Need low temp drying</u> (otherwise reduced quality)
10% DM in bio-generator
90% DM in protein meal

Need 30 mil. ton protein to aquaculture alone 2030
=> Dry 48 mil. ton water



SLU Formas centre of excellence in lipids and lipids to animal feed by microbial transformation

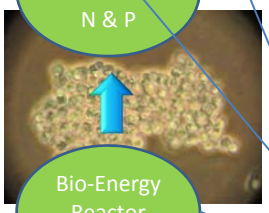
Photo A.Kiessling

Food for thought

CO_2 O_2

Photo A.Kiessling

Bio-protein Reactor N & P



Bio-Energy Reactor C & H

Harvest Station

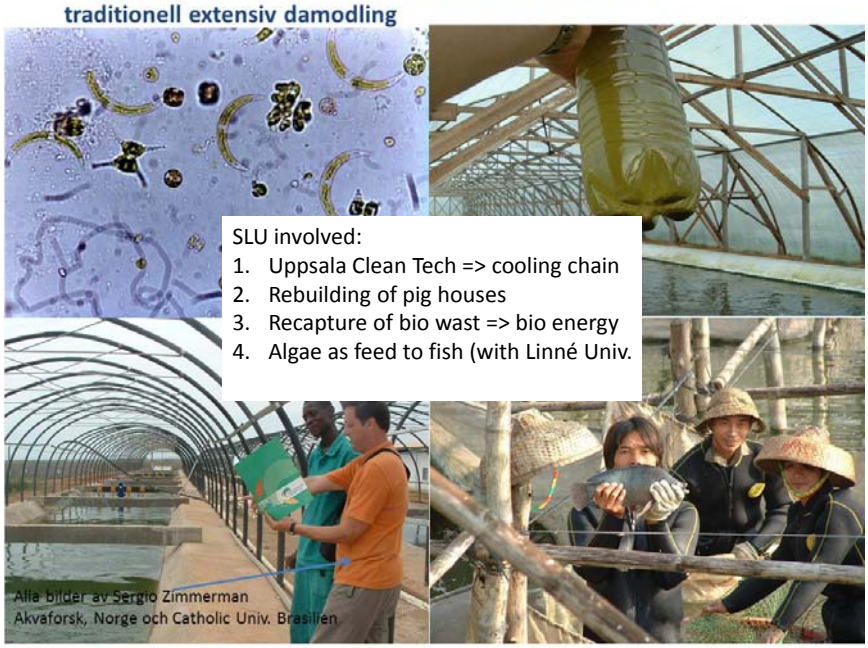
Utilisation model 3

Utilisation model 2

Utilisation model 1

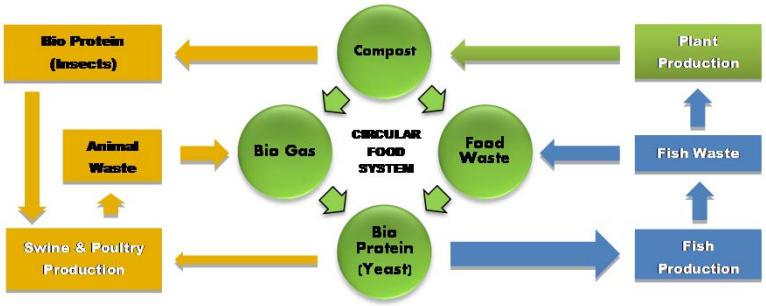
By A.Kiessling

Mikrober som levandefoder: Nutidens svar på traditionell extensiv damodling

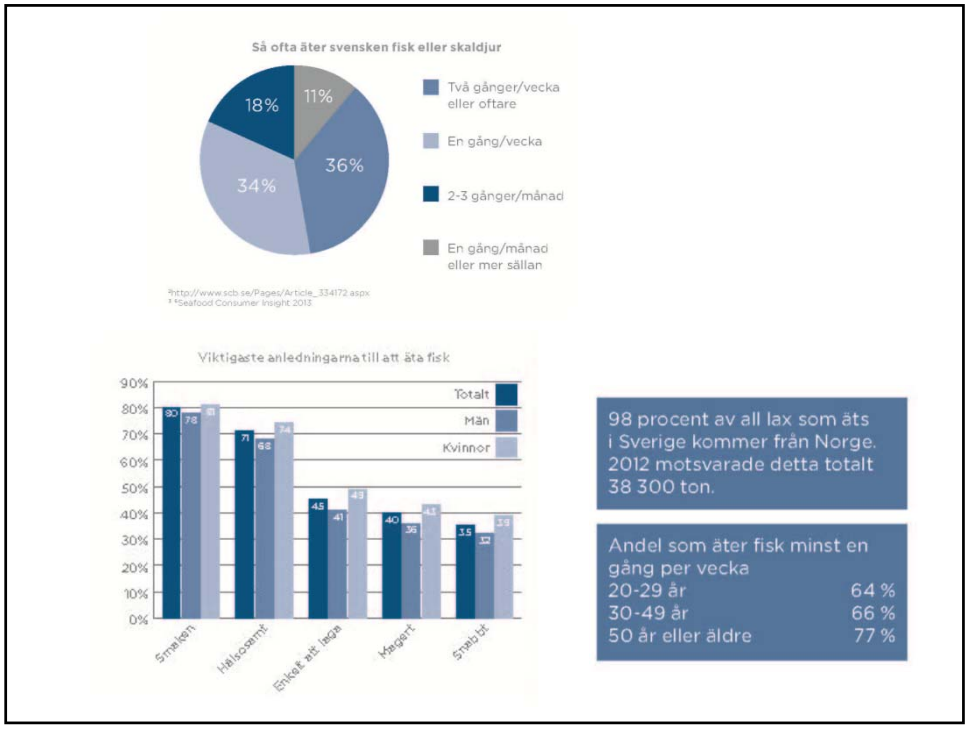


Biosecurity risks when recapturing nutrients for sustainable agri-food and biogas production

Anders Kiessling, Ivar Vågsholm, David Huyben, Jakob Babul, Sofia Boqvist



Supported by SLUMat


Så ofta äter svensken fisk eller skaldjur
18%
11%
36%
34%
Två gånger/vecka eller oftare
En gång/vecka
2-3 gånger/månad
En gång/månad eller mer sällan
Viktigaste anledningarna till att äta fisk
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Totalt
Män
Kvinnor
Smaken
Hälsosamt
Enkelt att laga
Mångsidigt
Snabb lit
98 procent av all lax som äts i Sverige kommer från Norge. 2012 motsvarade detta totalt 38 300 ton.
Andel som äter fisk minst en gång per vecka
20-29 år 64 %
30-49 år 66 %
50 år eller äldre 77 %


SLU
Whom is the future fish farmer?
Traditionally aquaculture been organised under fishing, but is this logic ?
A fisherman is used to receive economic gratification in connection with ones work. A farmer normally gets paid at harvest after year/years of preparatory work.
I.e. is there a socio economic oxymoron in todays organisation?
Do development of aquaculture demand a separate organisation as a production system in its own right and if so how should one approach the issue of aquaculture as a side income to other production forms like fishing, forestry and terrestrial farming?
Today´s Swedish fish farmer is a 50+ man, with more than 20 years of experience.
From a socio economic perspective is this the person that also will develop next generation aquaculture or is this the person that will be the driver of expanding present systems?
Photo A.Kiessling
Baltic Sea Region Programme 2007-2013
Part financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)
AQUABEST