Food is second to drinking water the most central priority to man

1. Global food security is based on wheat, soy, corn, rice.
2. We loose arable land due to present farming practices and human activities.
3. We treat our fresh water as waste baskets and in the same time is many rivers dry even before reaching the sea due to irrigation.
4. I.e. We need to invest in next generation feed systems capable of producing food independent of large land areas, massive input of artificial fertilizers and huge fresh water resources.
5. One health is as relevant to man as animal. Algae lipids are necessary for normal mental development in juveniles and maintained mental health in seniors. Fish, be it farmed or wild is our best source of these lipids.

Photo courtesy of Aquabest

Todays linear flows of nutrients

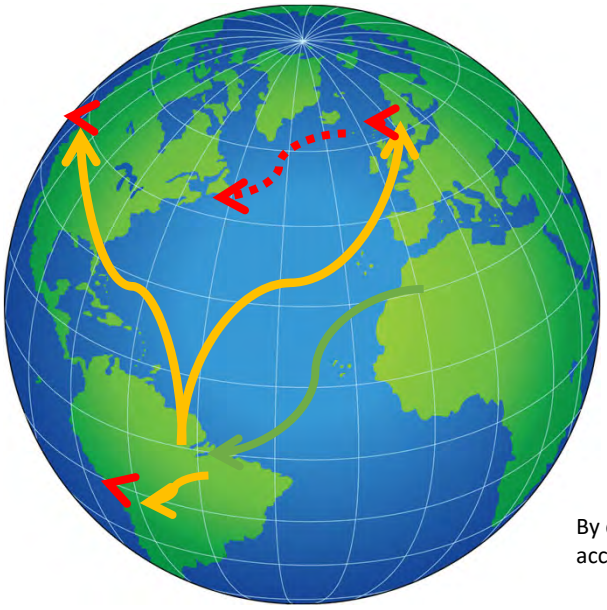


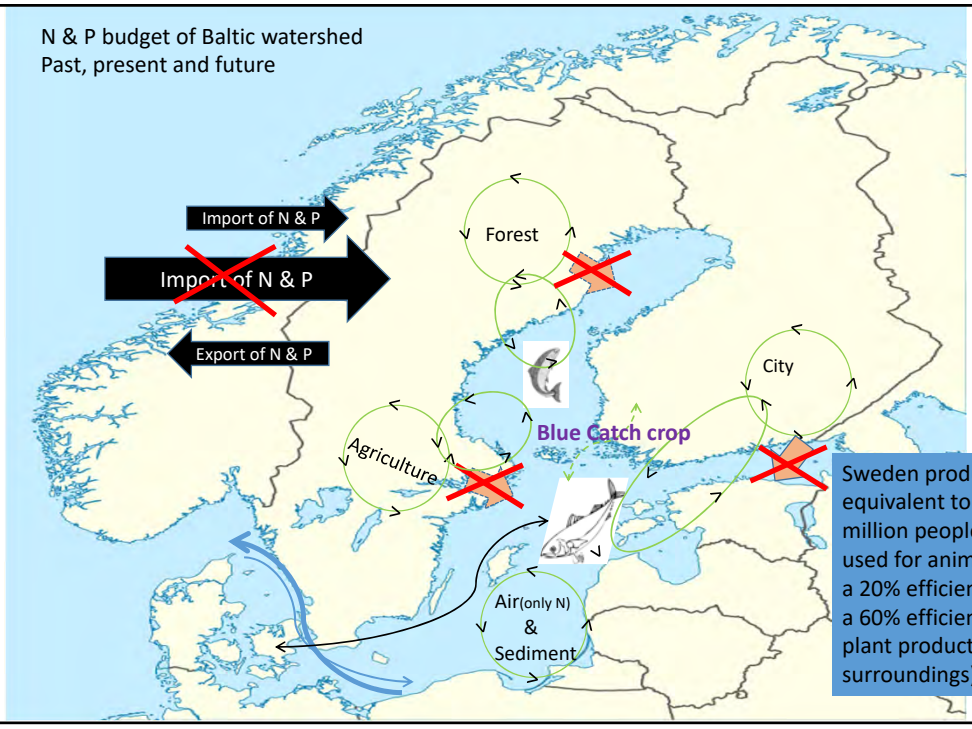
Illustration A.Kiessling

By default deprivation at one end and accumulation at the other

Bild Fiskeriverket

AK2

N & P budget of Baltic watershed
Past, present and future



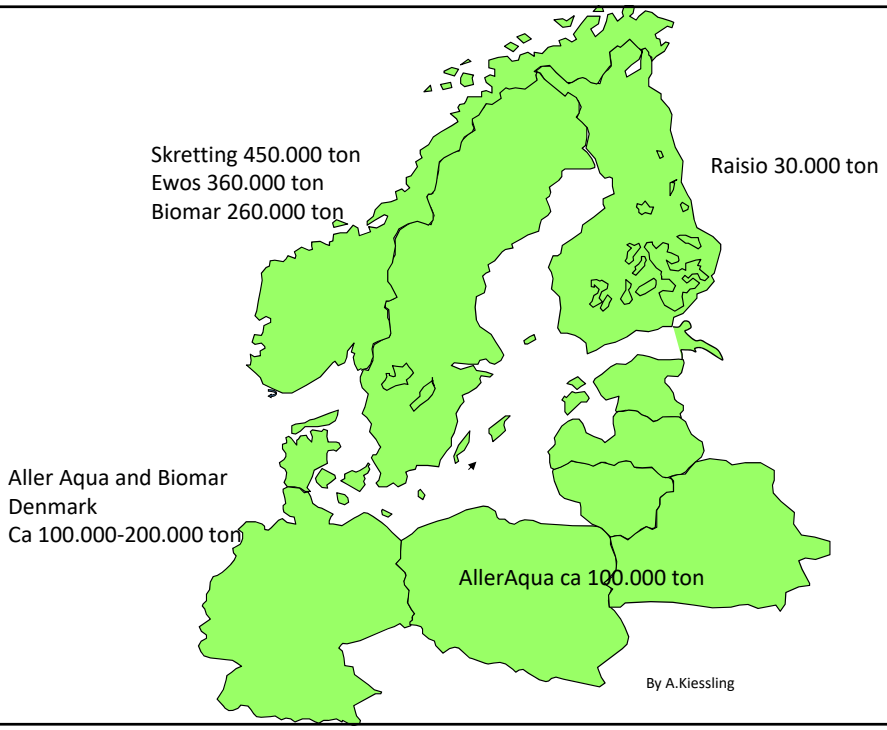
Sweden produce protein equivalent to food for 25 million people, but most is used for animal feed with a 20% efficiency and with a 60% efficiency during plant production (loss to surroundings).

By A.Kiessling

AK2 Förklara vad som måste göras

Anders Kiessling; 2019-06-20

Aqua Feed A Baltic Possibility



By A.Kiessling

The paradox of fish farming

(Most effective protein transformer but do so in water)

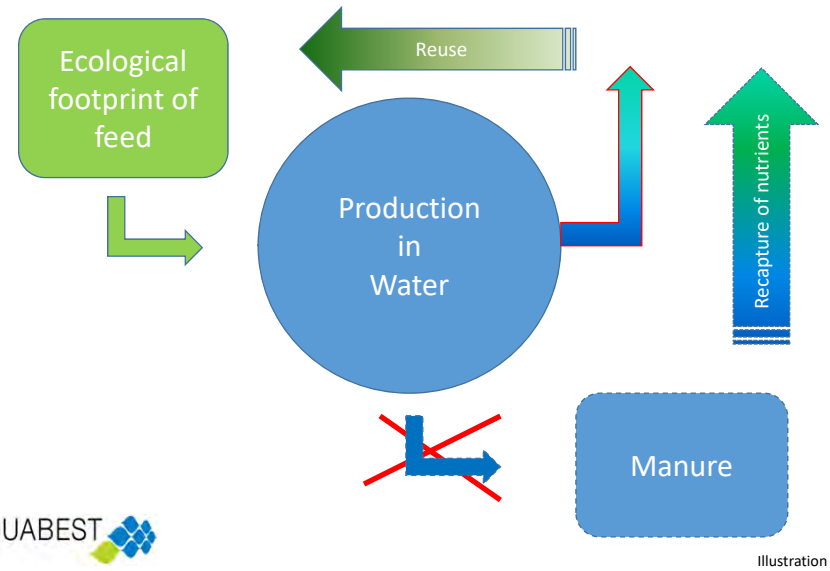
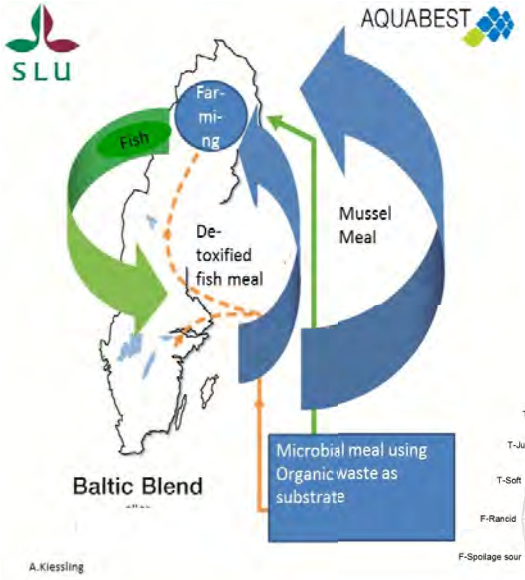
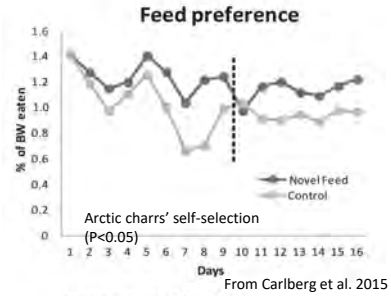


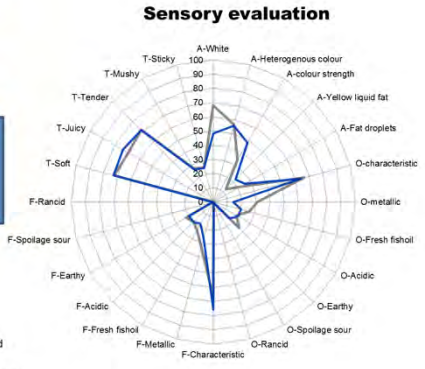
Illustration A.Kiessling





Arctic charrs' self-selection (P<0.05)

From Carlberg et al. 2015



The principle of Robin Hood

Preference test:

C: 6.19 out of 9

BB: 6.35 out of 9

From Carlberg et al.

Phosphorus in sediment is more or less very tightly bound together with Al or Fe

Fish farming as an eco service

1 kg farmed fish reduce nitrogen (N) in Southern Baltic with 77 g N=> 45 g fertilize the hydro power dam and 32 g N is turned in to food.

100.000 ton farmed fish reduce N in Southern Baltic with 7.700 ton =>

- 3.200 ton in to food
- 4.500 ton fertilize

- Total recapture of N by the Baltic fishing 1999 was 7.500 ton

Bild A.Kiessling

A production of 500.000 ton (60% slaughter yildis enough to supply the complete Swedish population with daily animal protein for a full year


Bild Vattudal Fisk
Bild A Kiessling
Bild Vattudal Fisk
Bild Vattudal Fisk
Illustration A.Kiessling


Bild Vattudal Fisk

Slamoppsamling i ferskvann Vattudalens Fisk AB 2019

- Fjord Solutions (ide)
- Markleen (duk og pumpe)
- Egersund Net (not)
- Vattudalens Fisk AB (testfasiliteter)
- SLU (Sveriges lantbruksuniversitet)
- SWECO

Markleen Oil Spill Technology

VATTUDALENS FISK AB

SLU

Egersund Net PART OF EGERSUND GROUP

Fjord Solutions

Effects of chemical fertilizers or/and organic fertilizers on Tomato photosynthesis

Jean W. H Yong (jean.yong@slu.se)

Swedish University of Agricultural Sciences

What is a GOOD Fertilizer?

- Essential nutrients (Marco & micro nutrients, trace elements)
- Improves substrate/soil structure & holds water
- Promote plant cell division leading to cell proliferation (hormones, etc - biostimulants)

Courtesy of Jean Yong, SLU

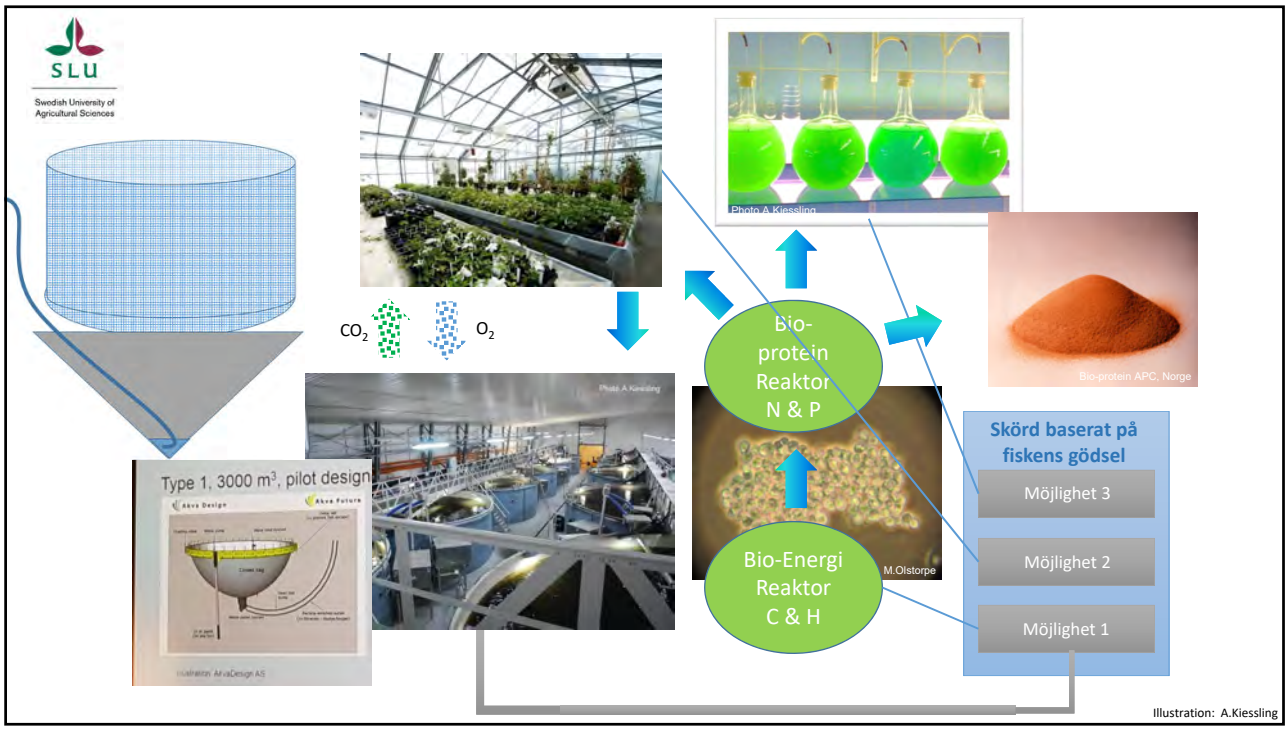
Swedish University of Agricultural Sciences

Biostimulant(s) signals influencing plant growth

Courtesy of Jean Yong, SLU

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Wong et al. (2015) Springer,
Wong et al. (2016) Acta Horticulturae



SLU

Reed (Phragmites australis) grows on soft bottoms in sweet and brackish water not deeper than 2 meters and to some extent on very wet solid

- Granéli & Björk estimated the total reed area to about 100 000 ha. Then only one had contiguous surfaces over 0.5 ham being is in line with the NILS inventory (J.Svensson, 2010) with a **reed area in Sweden of 230.000 ha** with ca 9-54 kg P and 100-600 kg N / ha pending nutrient availability.
- The feed value for summer harvested reeds is like straw when it comes to the energy content. A little better than straw when it comes to protein value and can serve as feed for non-producing cows, mainly suckler cows during the 4-5 winter months or horse.

Market			
Dry cows	Kg reed / cow / year (Dm)	Total ton reed available (wild harvest)	Total value (0.8 kg Dm)
207 000	750	155 000	124 milj sek

Estimation by Rolf Spörnly, HUV SLU

(Granéli & Björk, 1980)	Ash, g/kg DM ±s.d.	P, g/kg DM s.d.	K, g/kg DM ±s.d.	N, g/kg DM ±s.d.	Cp, g/kg DM ±s.d.
Straw	31 (11)	0,6 (0,3)	5,5 (3,5)	3,4 (1,9)	21
Leaf	84 (23)	1,7 (0,4)	9,7 (3,3)	25,7 (4,5)	161

Bild A.Kiessling

We work along two lines.

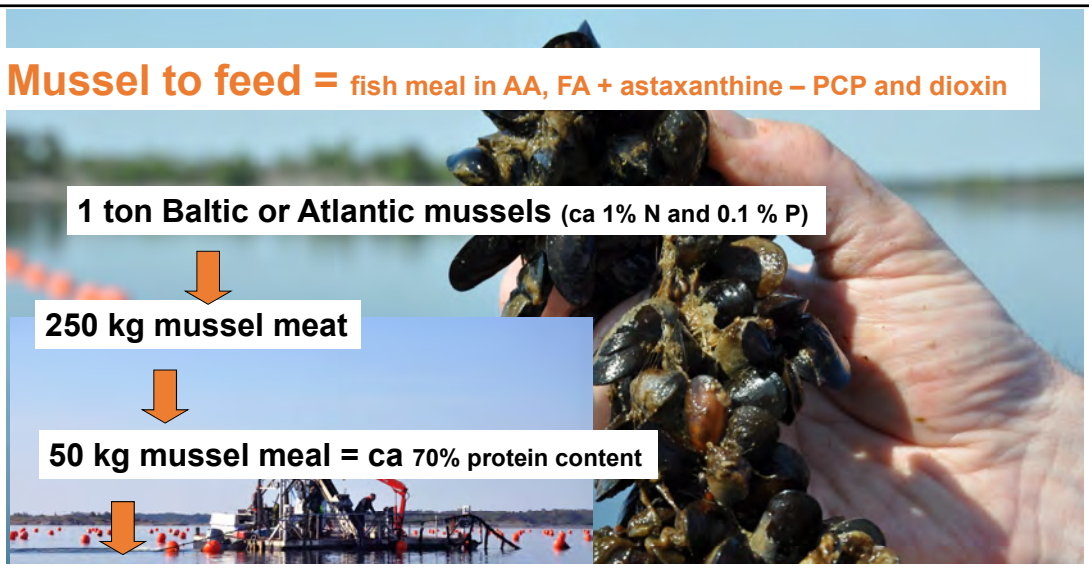
- Two harvests of reed as catch crop, mainly for silage (enzymatic treatment to increase digestibility), Suckler cows and **horse**
- Wild harvest for environmental service at harvest site and soil improvement (carbon/ash)

Foto: Terhi Ajosenpää (FIN)

Foto: Henri Vaarala (FIN)

Foto: Erik Gregeby (SWE)

Mussel to feed = fish meal in AA, FA + astaxanthine – PCP and dioxin



1 ton Baltic or Atlantic mussels (ca 1% N and 0.1 % P)

↓

250 kg mussel meat

↓

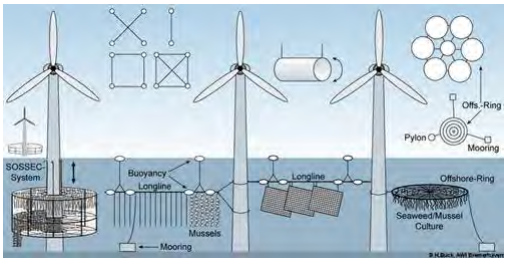
50 kg mussel meal = ca 70% protein content

↓

1 ton feed

(5%, planed for poultry, while up to 15% in fish feed, also interesting for pet animals and as manure)

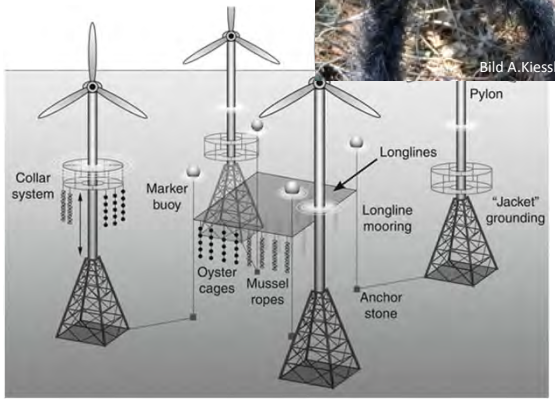
Bilder Lena Tasse



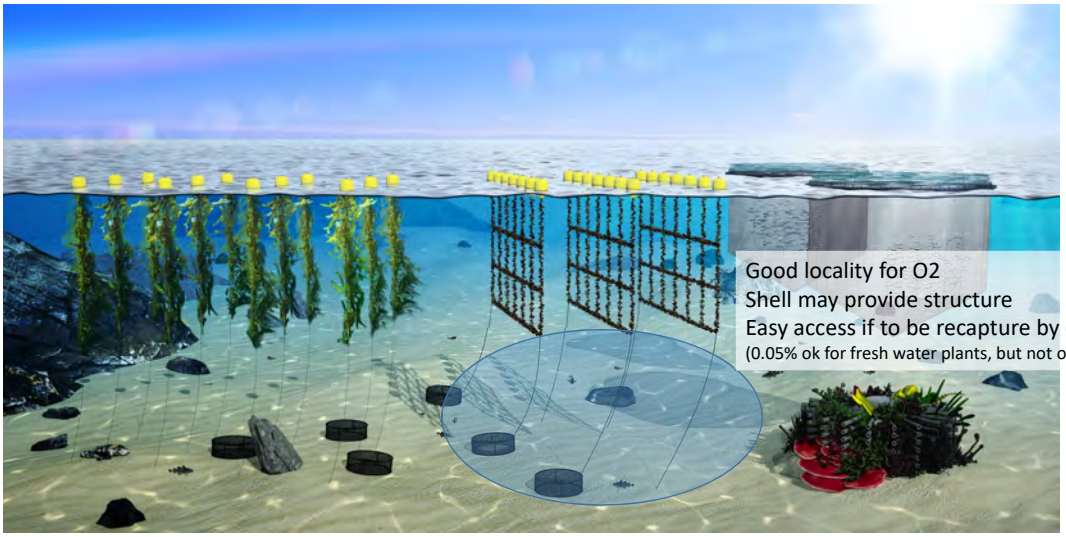
Present status, but technology in infancy:
1 ha = 100 ton/ cycle => 10.1 g N/Kg and 0.9 g P / Kg =>
Ca 1,01 Ton N and 0,09 ton P

Cost 0.13 Euro/kg
+ labour => 0.5 Euro/Kg

Present 5 kg /m substrate as far north as Norrtälje.
Grove down to 12 m i Baltic
Haven't seen final technology yet => a mix of net and settler rope ?



Ocean Farmin, IMTA

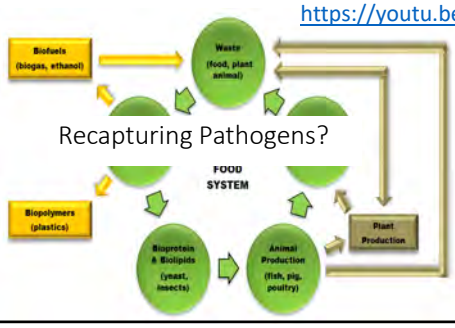


Good locality for O2
Shell may provide structure
Easy access if to be recapture by dredging
(0.05% ok for fresh water plants, but not optimal)

CARBON TO FOOD

Bilder A.Kiessling

https://youtu.be/DhR2jDS2IJI

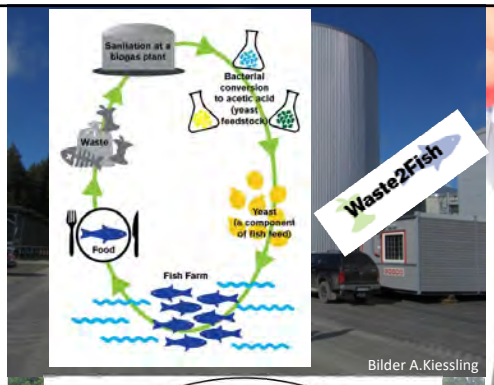


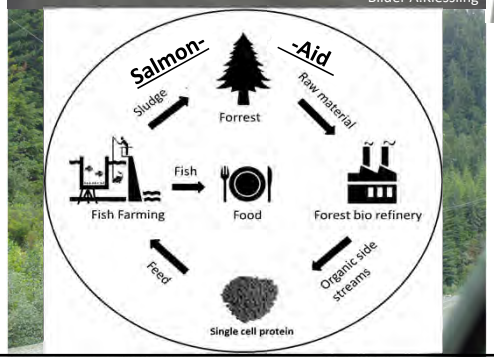
Recapturing Pathogens?

FRESH - Fish Rearing and Stress Hazards
Also
EFSA project

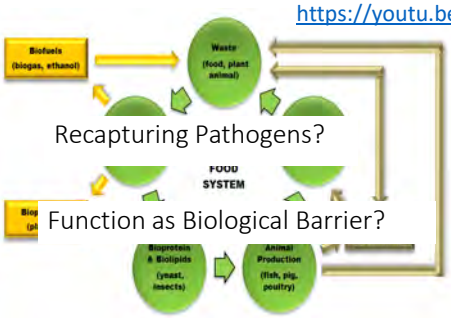
SLU

CARBON TO FOOD





https://youtu.be/DhR2jDS2IJI



Recapturing Pathogens?

Function as Biological Barrier?

FRESH - Fish Rearing and Stress Hazards
Also
EFSA project

SLU

Single chemicals and carbon chain

Sanitized Protein, lipids and vitamins

Jästbolaget, Rotebro, Sweden.
Produce 20.000 ton yeast/year optimized for producing CO_2

Good condition 10 mg of yeast => 150 ton in a week.

Growth rate / day:

Bacteria every 20 min	=> 2^{72}
Yeast every 2 h	=> 2^{12}
Micro algae once a day	=> 2^{1}

Protein of low value

Sanitized protein of high value

https://youtu.be/DhR2jDS2IJI

Yeast picture courtesy of Matilda Olstorpe

Protein composition

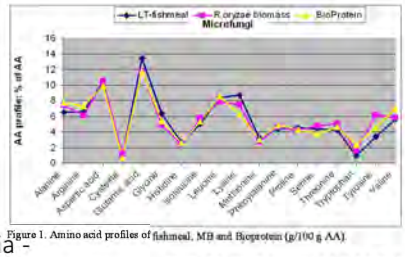
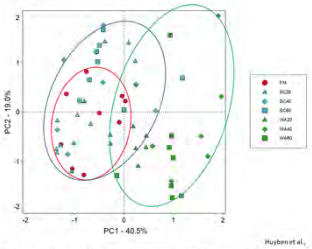


Figure 1. Amino acid profiles of fishmeal, MB and Bioprotein (g/100 g AA)

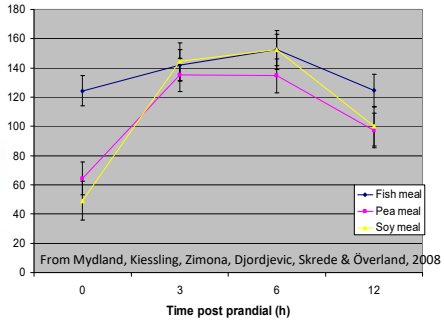
From Mydland, Kiessling, Edebo et al, in prep

Sequenced Bacteria - Intestine



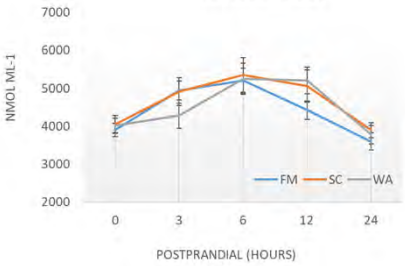
60 % replacement of fish meal with *Saccharomyces cerevisiae* (SC); or *Wickerhamomyces anomalus (Picia)* and *S. cerevisiae* mix (WA)

Lysin in plasma of Atlantic salmon



From Mydland, Kiessling, Zimona, Djordjevic, Skrede & Överland, 2008

Total Amino Acids in plasma of rainbow trout



Live insect larvae to free ranging poultry.

Hypothesis:

1. The birds rather hunt their own feed than pick at each other.
2. Found unexpected high growth rate of 25%. netP 40%, oil 15-40.

3. An additional question is if this can affect the quality of the bedding and thereby affect antibacterial medicine use

4.Legeslaition still a mess.

5. We also want to know if the diet of insect larvae eating marine substrate affect lipid and pigment composition of egg

Photo Anna Henning Moberg

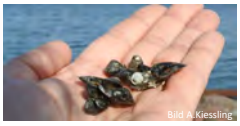
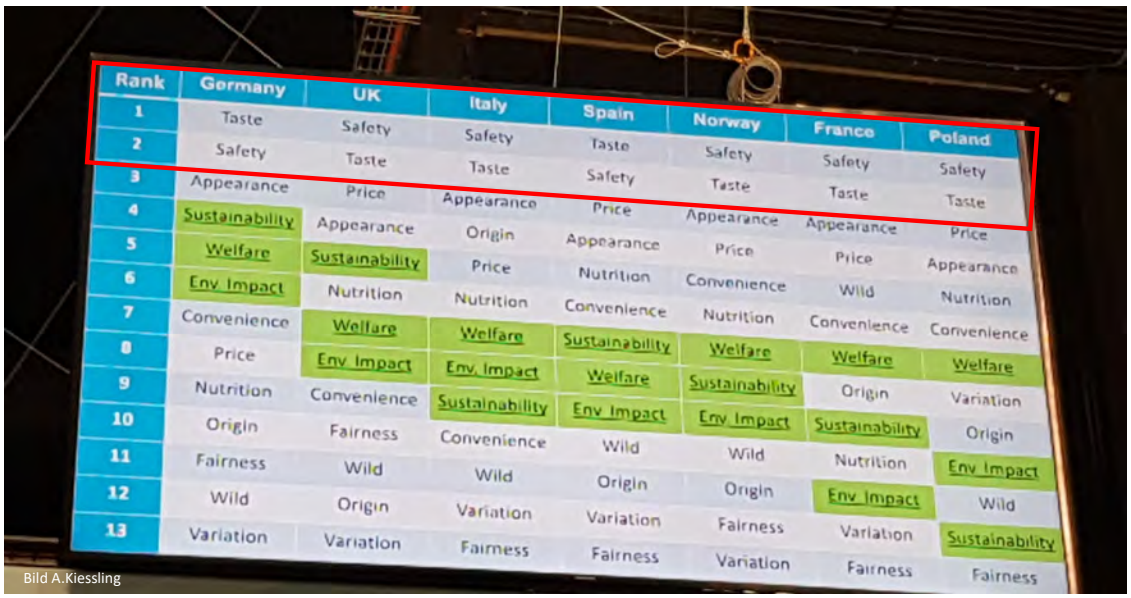
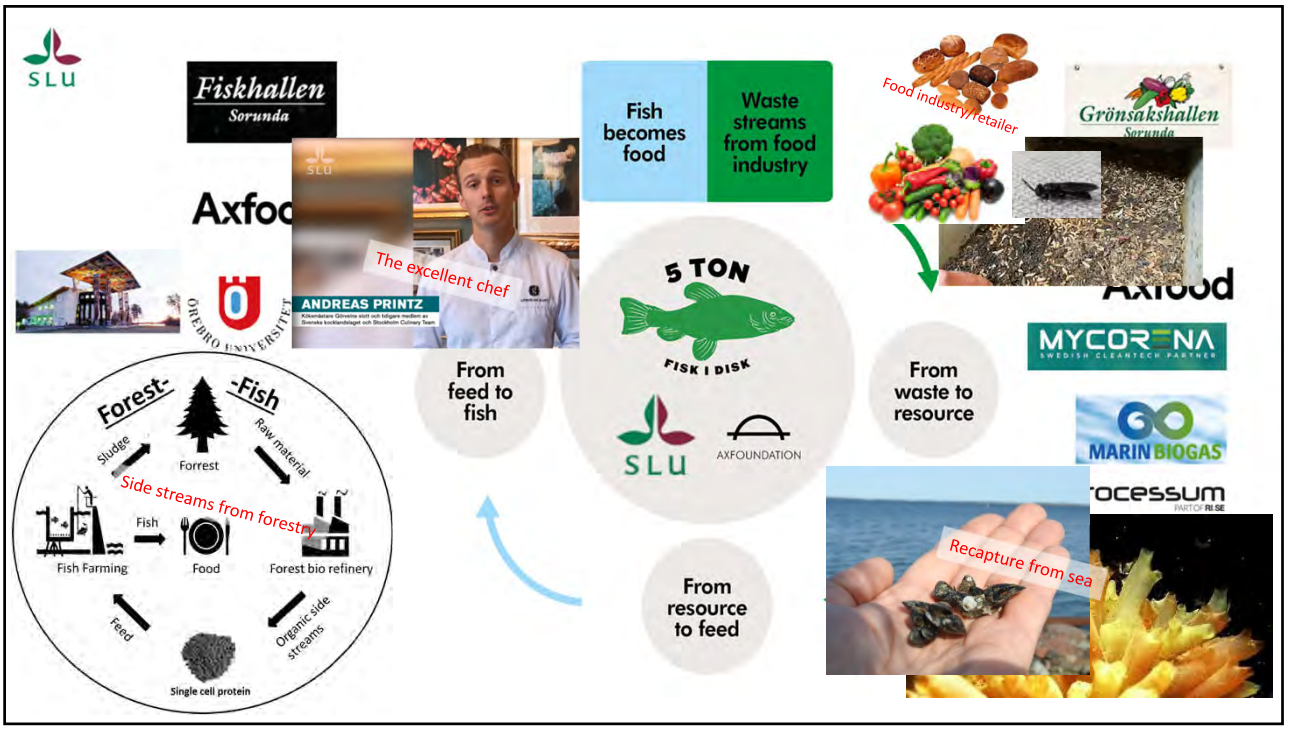


Bild A Kiessling

Insects are excellent protein to all farmed and pet animals.

Insect oil can replace some of plant oil in fish feed.


Rank
Germany
UK
Italy
Spain
Norway
France
Poland
1 Taste Safety Safety Taste Safety Safety Safety
2 Safety Taste Taste Safety Taste Taste Taste
3 Appearance Price Appearance Price Appearance Appearance Price
4 Sustainability Appearance Origin Appearance Price Price Appearance
5 Welfare Sustainability Price Nutrition Convenience Wild Nutrition
6 Env. Impact Nutrition Nutrition Convenience Nutrition Convenience Convenience
7 Convenience Welfare Welfare Sustainability Welfare Welfare Welfare
8 Price Env. Impact Env. Impact Welfare Sustainability Origin Variation
9 Nutrition Convenience Sustainability Env. Impact Env. Impact Sustainability Origin
10 Origin Fairness Convenience Wild Wild Nutrition Env. Impact
11 Fairness Wild Wild Origin Origin Env. Impact Wild
12 Wild Origin Variation Variation Fairness Variation Sustainability
13 Variation Variation Fairness Fairness Variation Fairness Fairness
Bild A.Kiessling


Fiskhallen Sorunda
Fish becomes food
Waste streams from food industry
Food industry/retailer
Grönsakshallen Sorunda
The excellent chef
ANDREAS PRINTZ
5 TON
FISK I DISK
SLU
AXFOUNDATION
MYCORENA
SWEDISH CLEANTECH PARTNER
MARIN BIOGAS
From feed to fish
From waste to resource
From resource to feed
Recapture from sea
Forest-
-Fish
Sludge
Forrest
Raw material
Side streams from forestry
Fish
Fish Farming
Food
Forest bio refinery
Feed
Organic side streams
Single cell protein

Salmon has been a favourite food fish since ice age of people of the Northern hemisphere

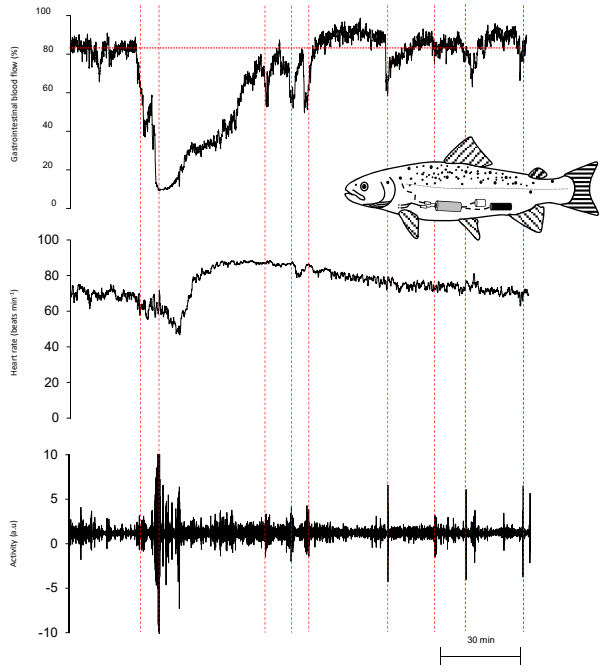


Figure 1. Representative traces collected by the multivariate implant in a rainbow trout. (A) Relative gastrointestinal blood flow, (B) heart rate and (C) activity of an instrumented trout recorded over a 5.5 h period. The red dashed lines demonstrate the relatively rapid changes in gastrointestinal blood flow and heart rate in response to a bursts of activity. Relative gastrointestinal blood flow was calculated for the individual by dividing each value with the maximum value recorded for the individual during the study (*e.g.* 100% gastrointestinal blood flow = highest value observed for the individual throughout its recordings).

Points of interest
-this figure will be used as an example figure to demonstrate the traces we get with multivariate implant as well as the fact that following a burst of activity by the rainbow trout, rapid changes occur in GBF and HR.
J Brijs et al., 2019