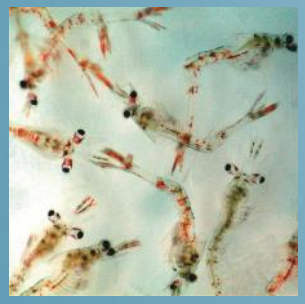
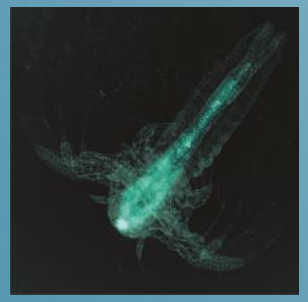
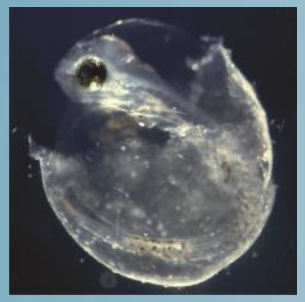
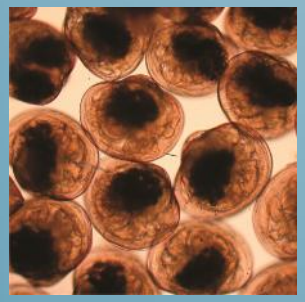




larvi 2013

6th fish & shellfish larviculture symposium

Control of the selective pressure on microbes in rearing tanks through manipulation of the incoming water increases survival of marine fish larvae

Kari Attramadal

ghent university, belgium, 2-5 september 2013

Control of the selective pressure on microbes of the incoming water increases survival of marine fish larvae

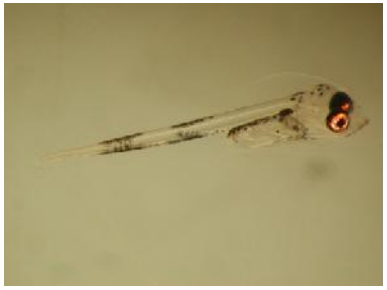
Attramadal, K.[a], Øie, G.[b], Kjørsvik, E.[a], Minniti, G.[a], Skjermo, J.[b], Bakke, I.[c], Østensen, M-A.[b], Olsen, Y.[a], Vadstein, O.[c]

[a] Department of Biology, NTNU, 7491 Trondheim, Norway
[b] SINTEF Fisheries and Aquaculture, Department of Marine Resources Technology, 7465 Trondheim, Norway
[c] Department of Biotechnology, NTNU, 7491 Trondheim, Norway

Marine fish larvae

- Period of rapid growth and development of organs
- The specific immune system not fully functional until after metamorphosis
- Sensitive to infections

Common (microbial) problems in larviculture?



- Often large tank to tank variations in survival despite same egg group, feed and physicochemical conditions
- Antibiotics increase reproducibility of survival
- The rearing water is an important source of bacteria for the larvae

→ Microbial control of rearing water!

Microbial control: Specific pathogens and opportunists

- Specific pathogens may be stopped by **strong hygienic barriers** into the system: **BIOSECURITY!**

- A lot of the problems in aquaculture caused by naturally occuring opportunistic bacteria that become pathogenic when the host is weakened by environmental stress

- It is possible to set up selection to **outcompete the opportunists!**

Generally one out of two different strategies favoured:
Ecological r/K-theory

Carrying capacity (CC)
= Max biomass/number of bacteria that can be maintained in the system over time

Depends on:
Supply of available organic matter

Selection	Environment	Substrate supply per bacteria	Favoured ability
r-selection	Unpredictable/unstable, Empty niches	High	Rapid reproduction, Fast growth → Opportunist
K-selection	Stable or predictable, crowded	Low, Close to CC	Competing on limited resources → Specialist

Colonising bacteria typically r-strategist

Succession: bacteria with increasing ability to compete

Opportunists gradually replaced by K-strategists

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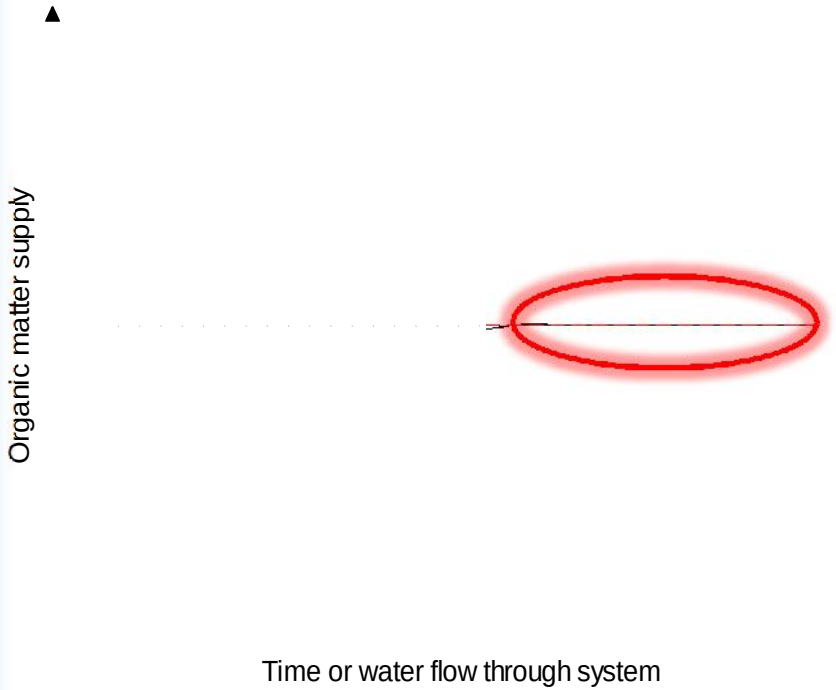
K-selection: Microbial maturation

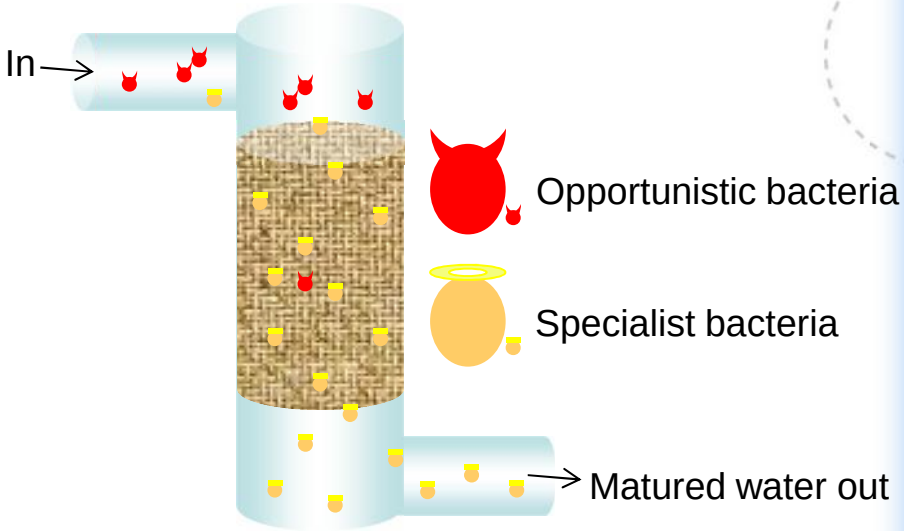
How?

Wait for succession at a given CC



Maturing unit = biofilter

Low substrate supply per bacteria, favouring the specialists over the opportunists



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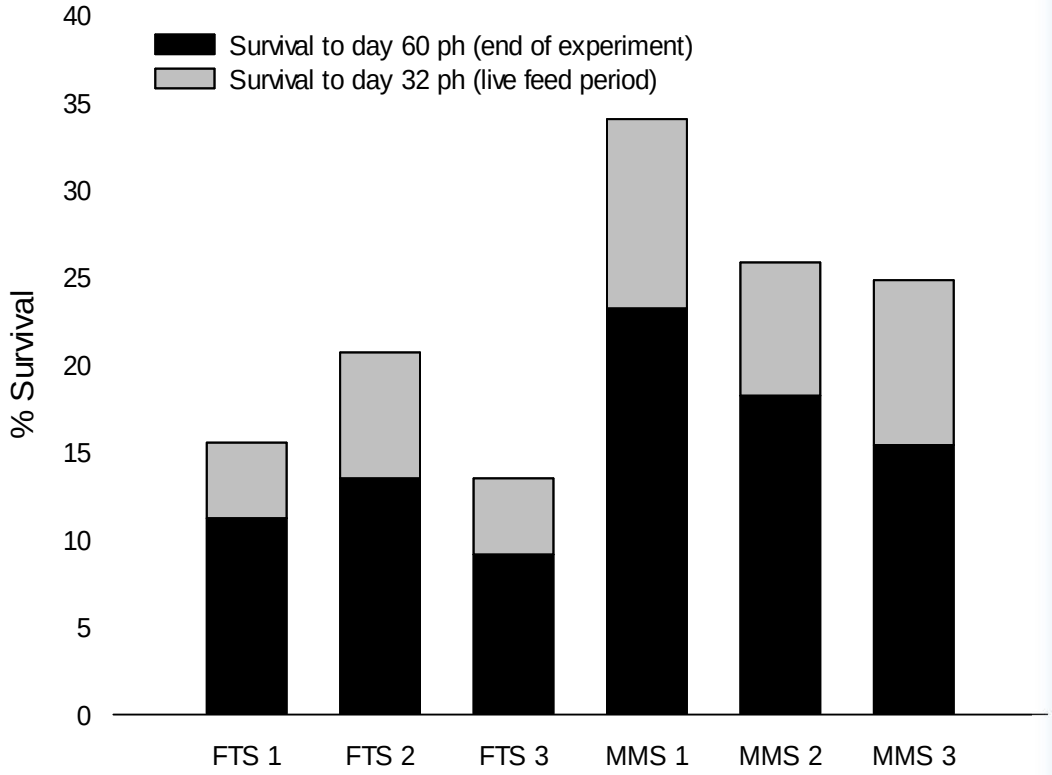
K-selection: Microbial maturation

Effects on the microbial community composition of the incoming water:

A more stable, even and diverse community dominated by slow-growing specialists

Effect on the fish: Significantly higher survival



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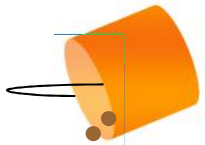
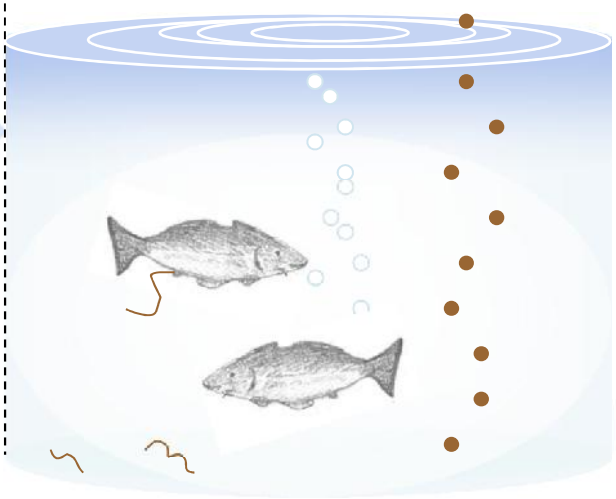
Incoming water ≠ Tank water

Selection pressure

- Intake bacteria
- Disinfection
- Intake org.matter
- Particle removal

- Water exchange rate
- Feeding
- Faeces





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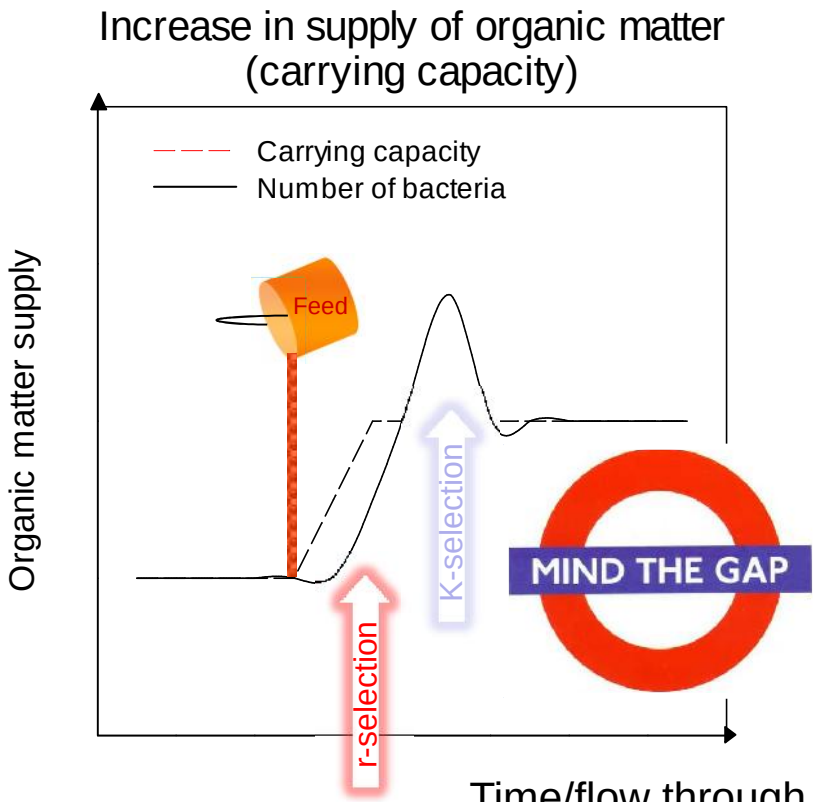
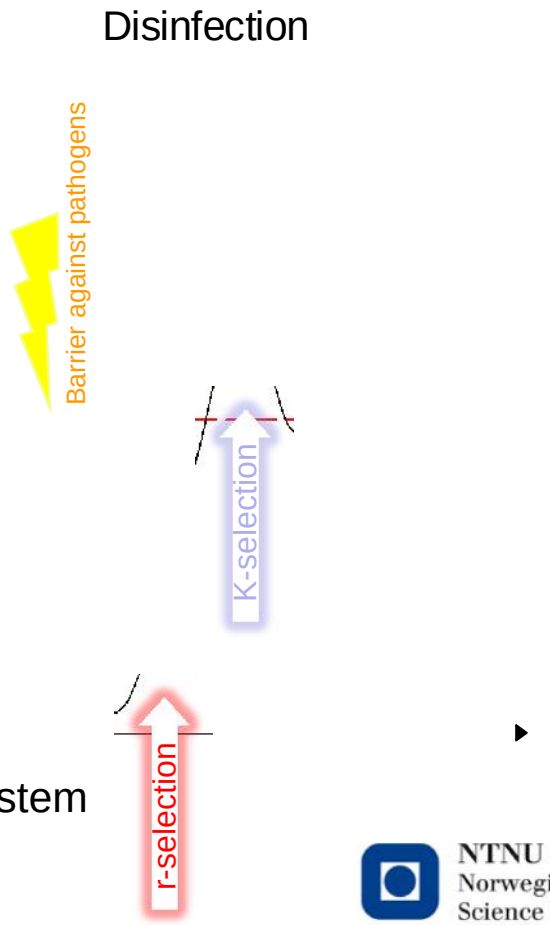
Perturbances promoting r-selection in intensive aquaculture





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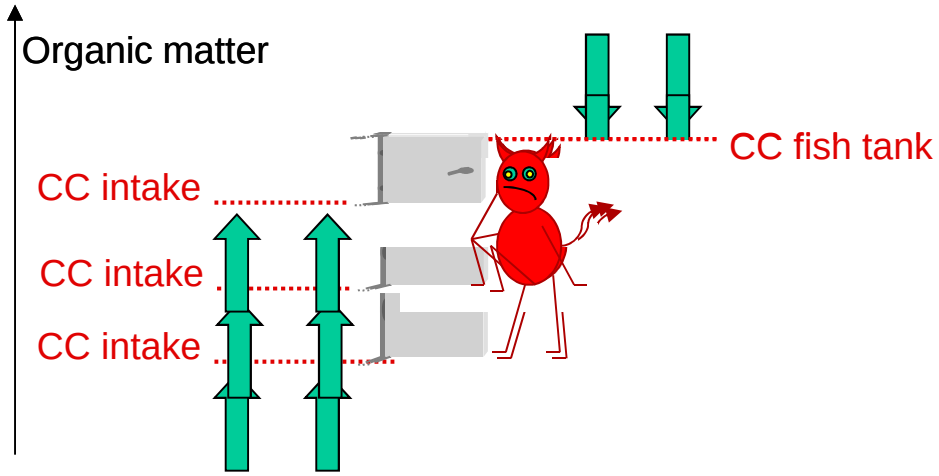
Closing the gap:

K-selection/maturation should be carried out at a carrying capacity (CC) (organic matter supply) similar to that of the rearing tanks

Increase CC in the matured inflowing water

Reduce CC in the rearing tanks



1. Recirculation (RAS)
2. Feed the maturation filter (flow through)

1. High water exchange rates
2. Efficient cleaning
3. Addition of clay instead of algae

Closing the gap - gaining control

K-selection/maturation of the microbial community of incoming water at a carrying capacity (CC) similar to that in the tanks

1. RAS
2. Feed the maturing unit (flow through)

Reduce the use of disinfection inside the RAS

1. In the recycling loop
2. Before tanks

Closing the gap 1

RAS

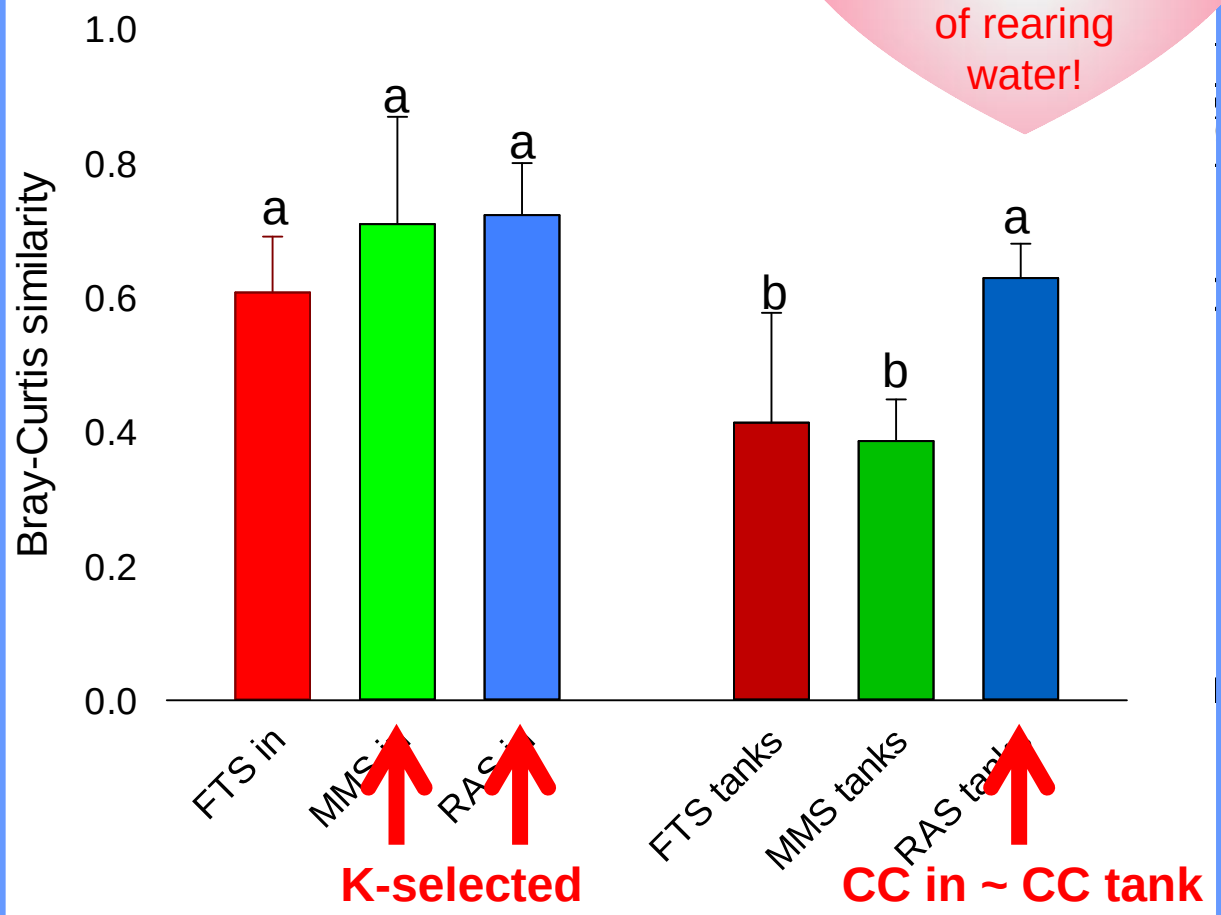
System	RAS
# bacteria in	65 ± 4
Bacterial bio	29 ± 6

FTS: no … of tanks lea…

MMS: ma… may open for …

RAS: ma… onger buffer ag…

Stability of microbial commu…
(moving window an…



Sign. higher stability of MC of rearing water!

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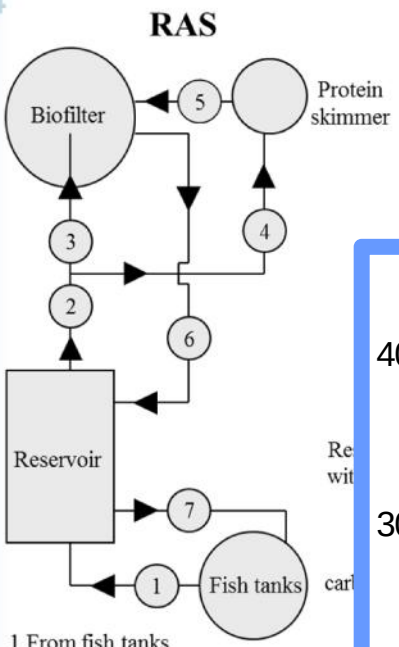
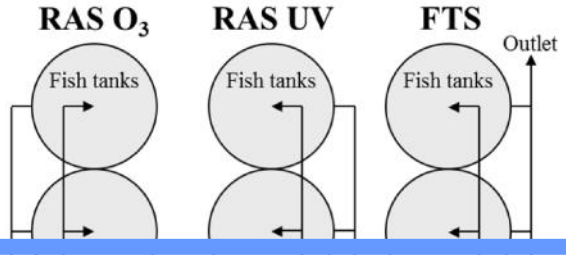
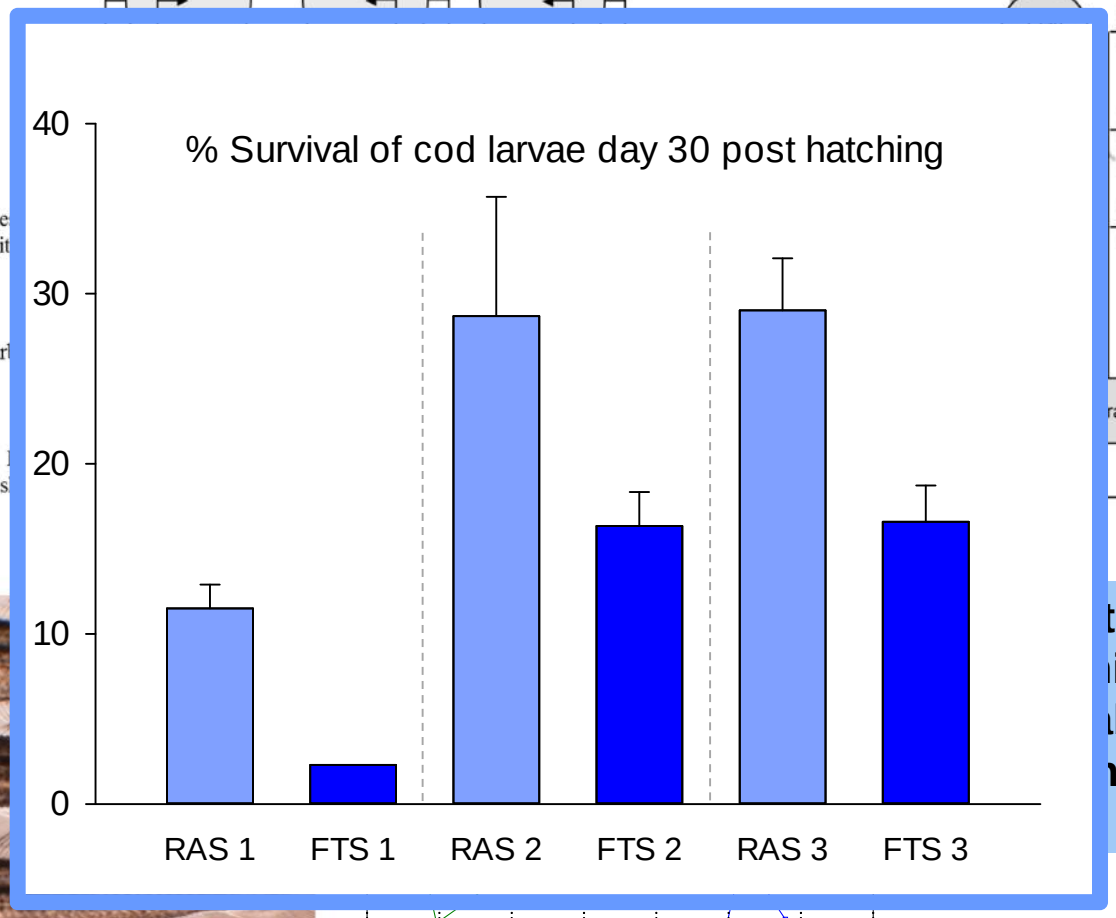
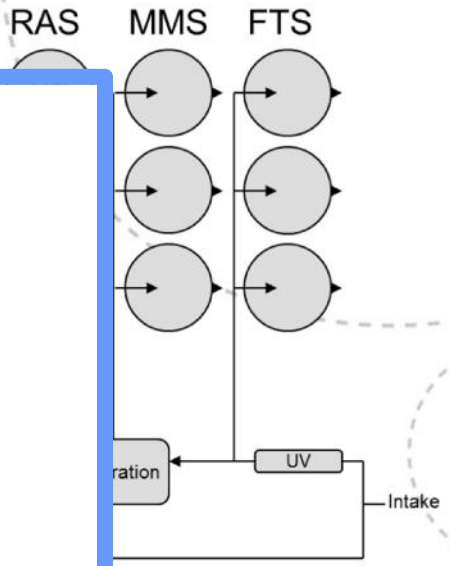
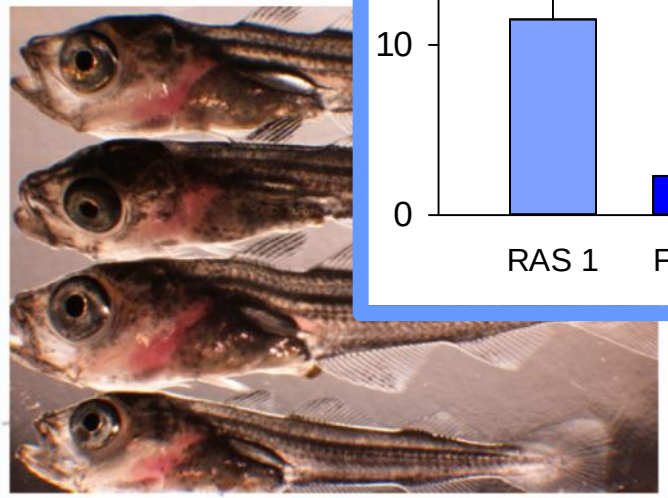
RAS



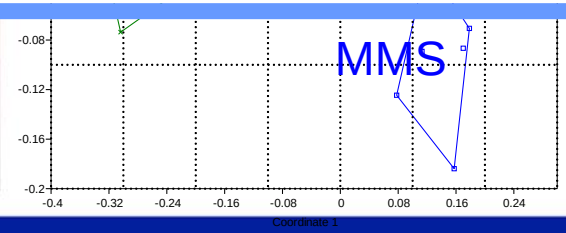








ter microbial
ity composition
able, diverse
in the RAS



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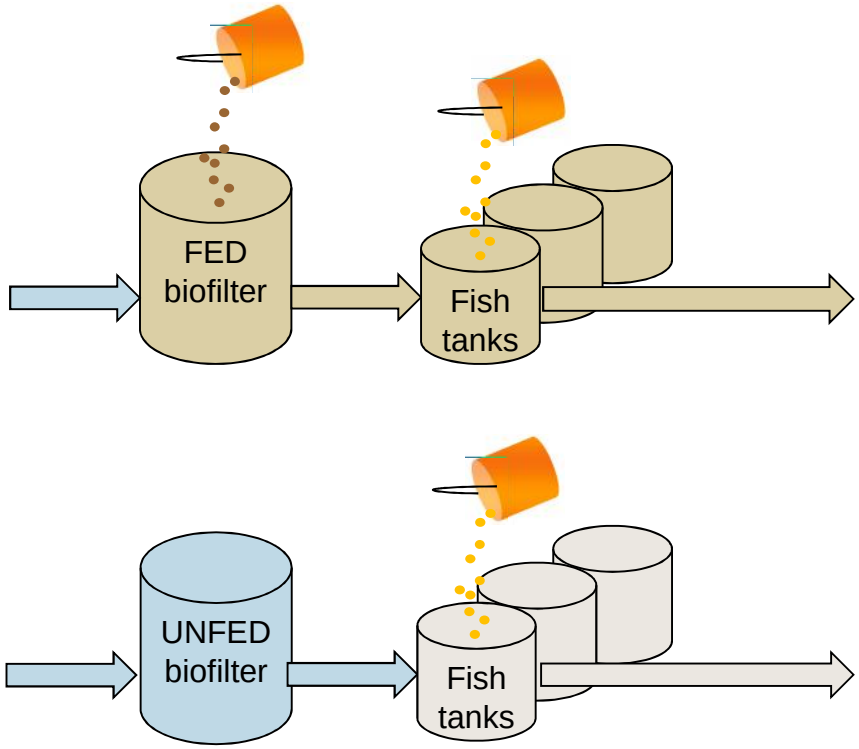
Closing the gap 2

Feed the maturation filter (flow through)



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Closing the gap 2

Feed the maturation filter (flow through)

Microbial growth potential in tank water (3 days)

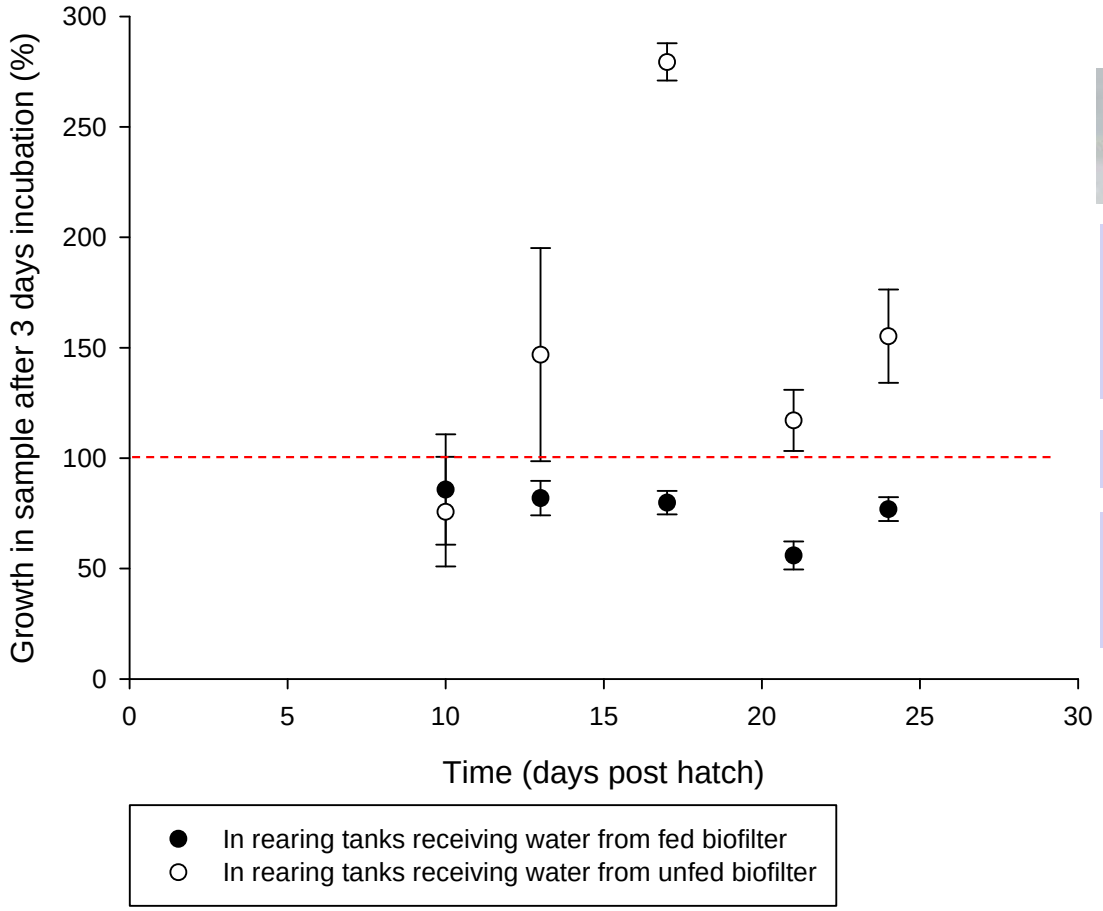

Photo: T. Bardal

Increased # bacteria after 3 days of incubation – growth potential in the sample

No net growth

No growth potential: crowded environment resistant to invasion

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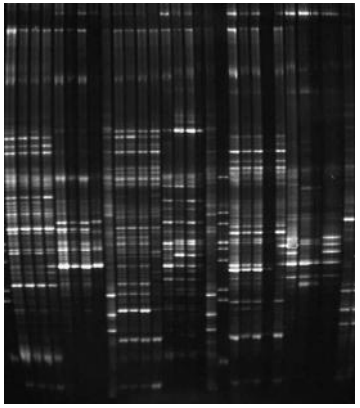
Closing the gap 2
Feed the maturation filter (flow through)

Microbial community composition

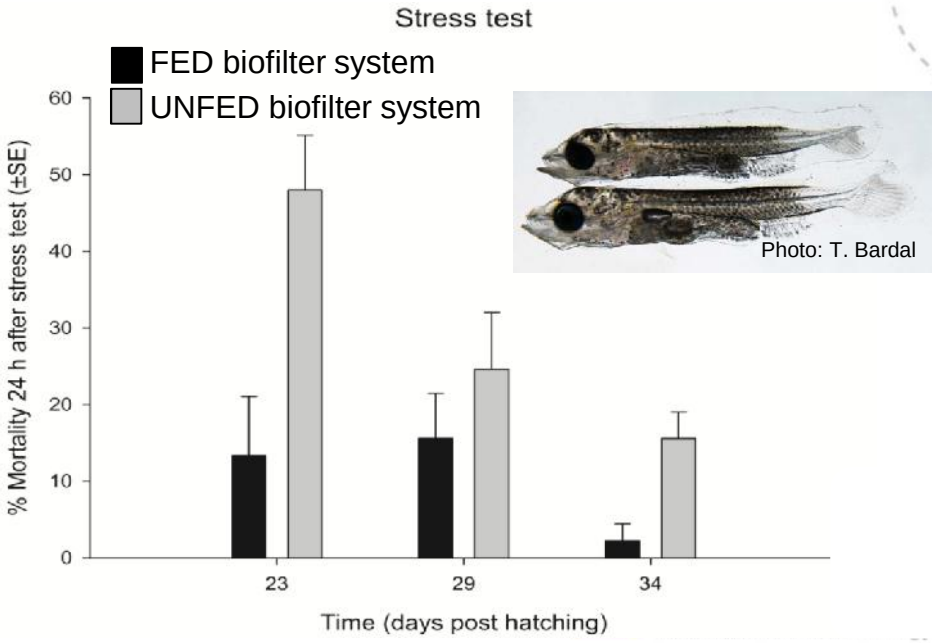
- Tank water sign. more similar to intake water in FED
- Replicate tanks sign. more similar in FED
- Stability in tanks over time, species richness, diversity (Shannon's index H') and evenness (J') significantly higher in tanks in FED

DGGE



Larval performance

- Survival (27 dph): 5% in FED, 20% in UNFED
- Stress tolerance: significantly higher in FED
- Growth: significantly higher in FED*



Reduce the use of disinfection inside the RAS 1

In the recirculation loop

Strong disinfection within the RAS loop may reduce the maturing effect of the microbial community:

FTS: high disinfection efficiency on the incoming water lead to to proliferation of bacteria in tank

RAS UV: high disinfection efficiency reduce abundance and activity of bacteria in incoming water and may open for proliferation in tank

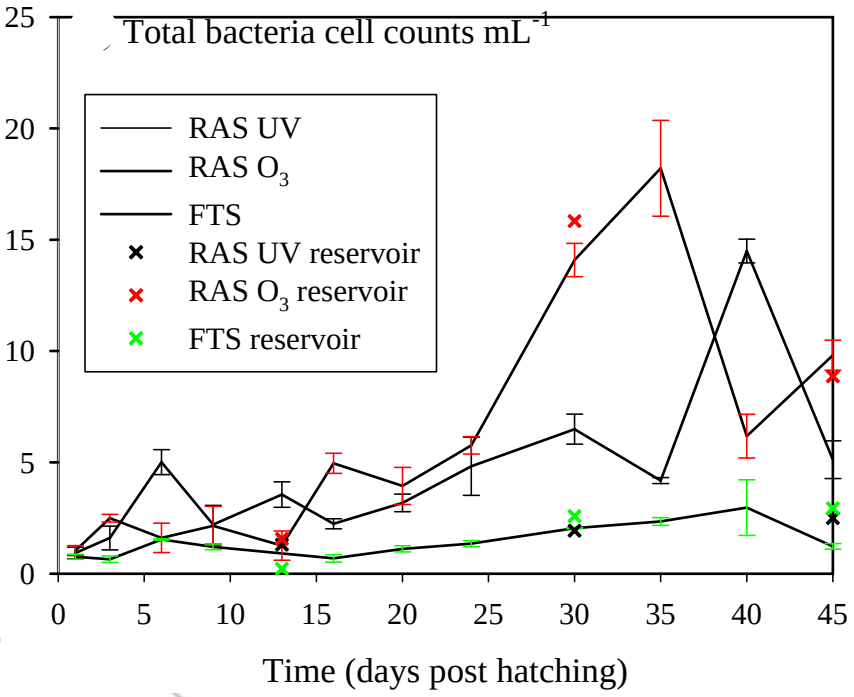
RAS O_3: ozonation to 350 mV in protein skimmer results in low or no disinfection and an incoming water similar to the water in tanks

Reduce the use of disinfection inside the RAS 1

In the recirculation loop

RAS_{O3} more mature and stable microbial community than RAS_{UV}

Incoming water microbial community composition more similar to tank water in RAS_{O3} compared to RAS_{UV} and FTS:

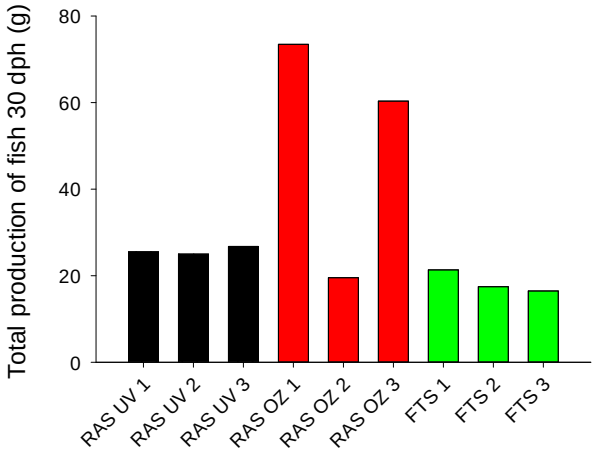


Microbial activity (production of bacterial biomass) in tanks compared to inflowing water:

O_3 RAS 1.2 × higher

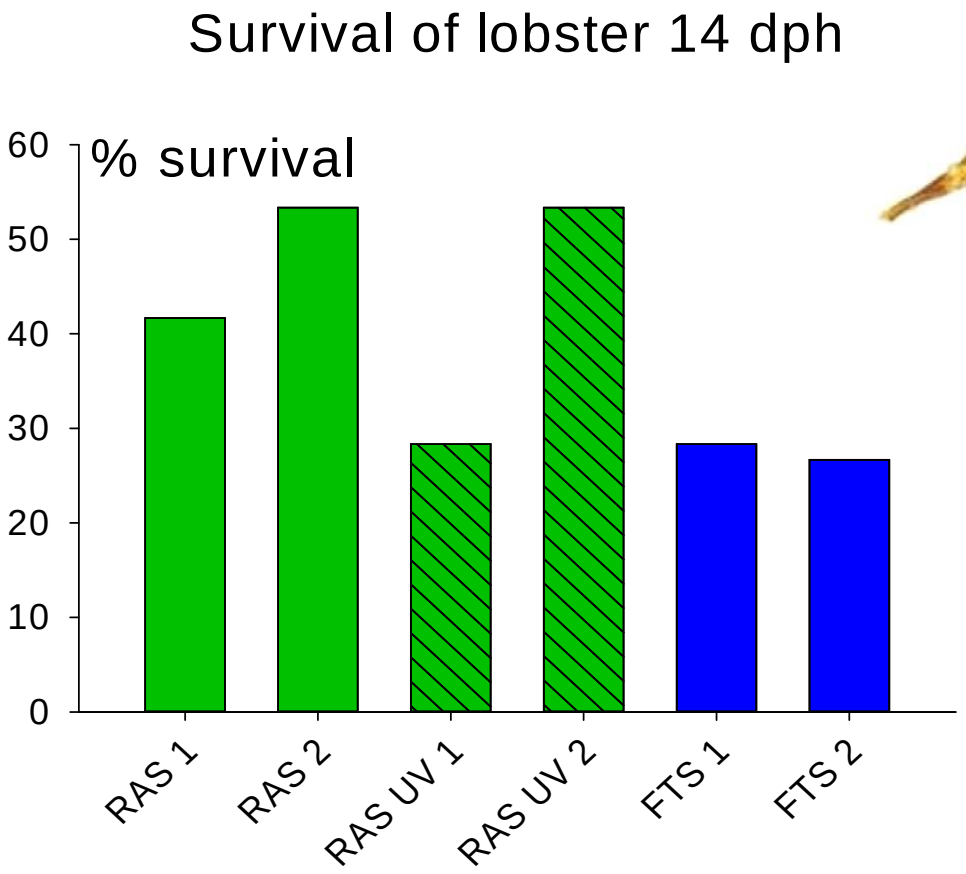
UV RAS 3.0 × higher

FTS 17.5 × higher



Reduce the use of disinfection inside the RAS 2

Before rearing tanks (From John Vegard Øien)



Best survival in RAS with no disinfection

Microbiota yet to be analysed

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Conclusions

Similarity of the selective conditions for the microbes in the incoming water and in the rearing water is a key to microbial control in the fish tanks, and opens for optimization of water treatment of the incoming water to benefit larviculture

Controlling the microbial carrying capacity in the different components of the system is a very good idea!

Using strong disinfection on the incoming water can be smart (biosecurity), but avoid it in the recirculation loop!

Recycle!

Thank you for listening!

Kari Attramadal

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