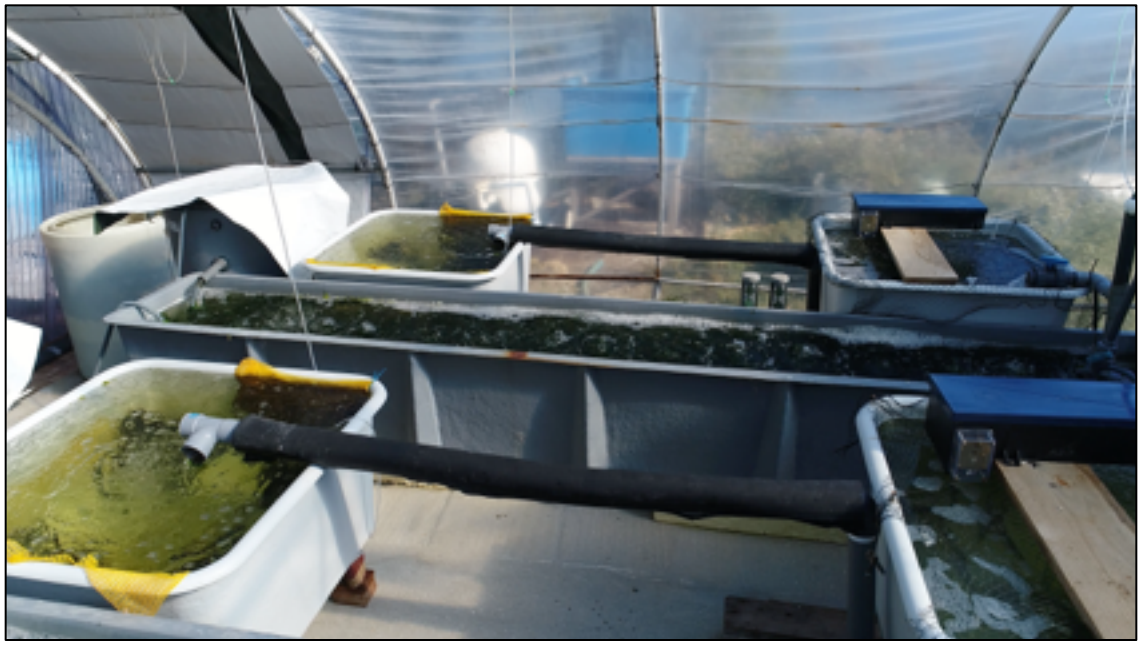
A low running costs recirculating aquaculture using an integrated multi-trophic system



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19/10/2017

European aquaculture challenges

Reduce environment impact

Increase production

Reduce production energy cost

IMTA

One way to resolve these issues

Reduce waste

Increase productivity

Aims of the experiment

Push the IMTA concept to its maximum

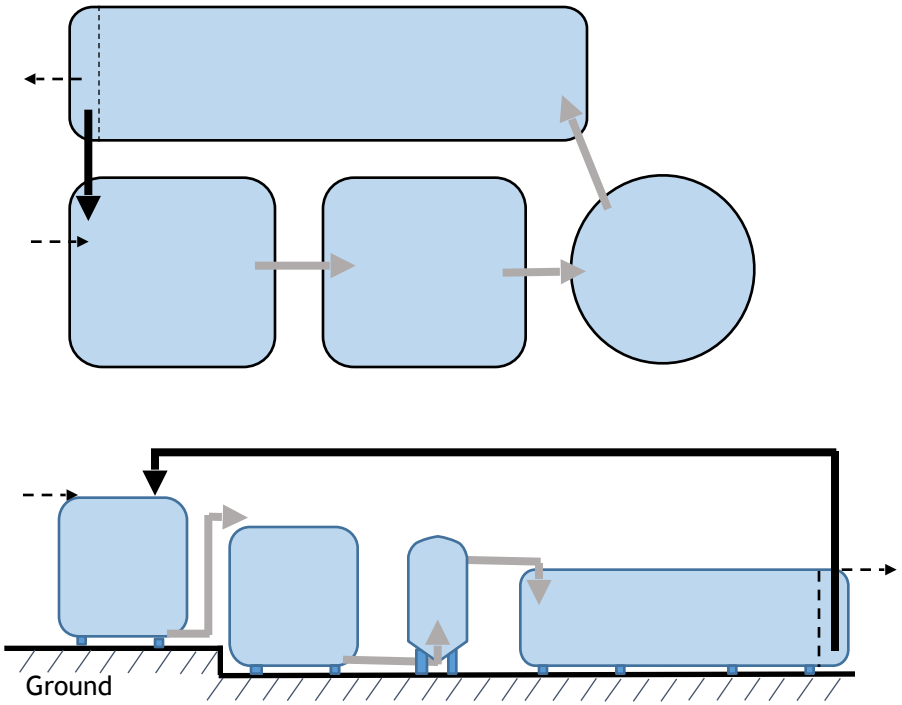
Decrease waste by using RAS

Increase productivity and decrease care by exploiting all the trophic chain level

Reduce energy cost & easy care system

LTR-IMTA

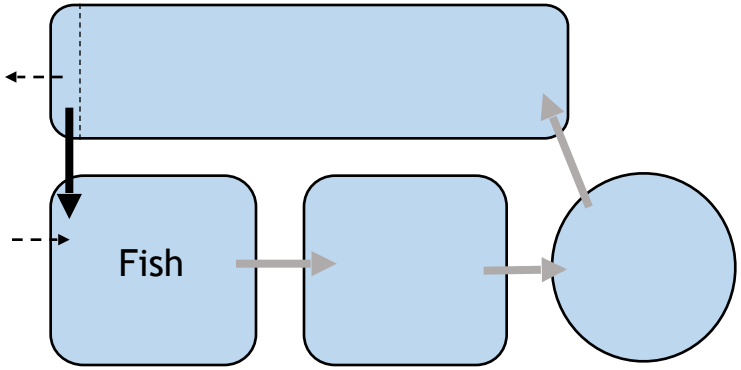
How technicaly the system works?



Air-lift
Gravity flow
5 % renewal water per day

Only bioremediation
No pump: Energy saving

How biologicaly the system works ?



Fish Food (nutrient intake)

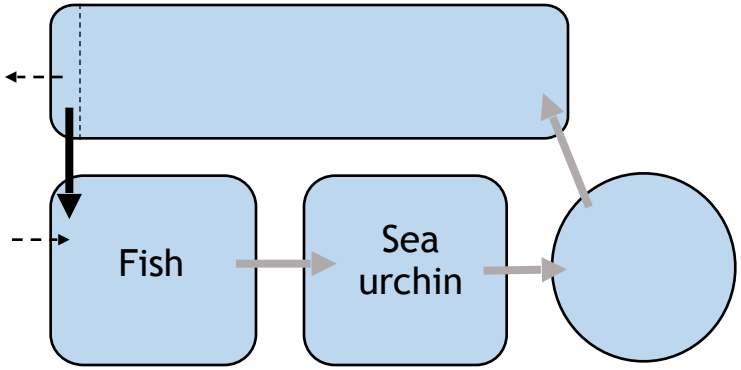
Dicentrarchus labrax
Fed aquaculture

Fish tank:
400 l

Fish density:
1.5 $kg.m^{-3}$

Fish diet:
2% of their body weight

How biologicaly the system works ?



Paracentrotus lividus
Extractive aquaculture

Sea urchin tank:
400 l

Sea urchin density:
10 kg.m^{-3}

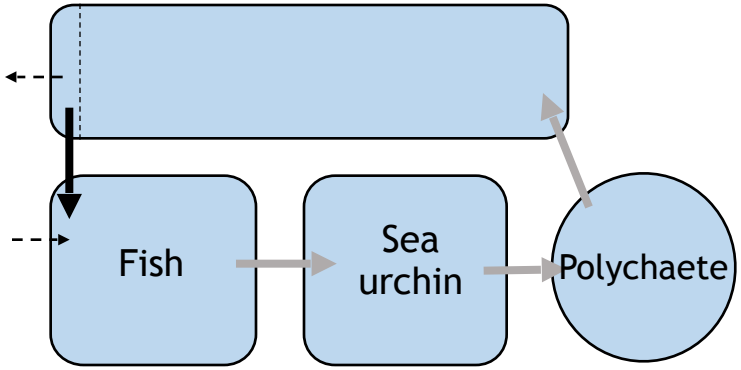
Fish Food (nutrient intake)

Wastes

Part of fish faeces intake

Uneaten fish food

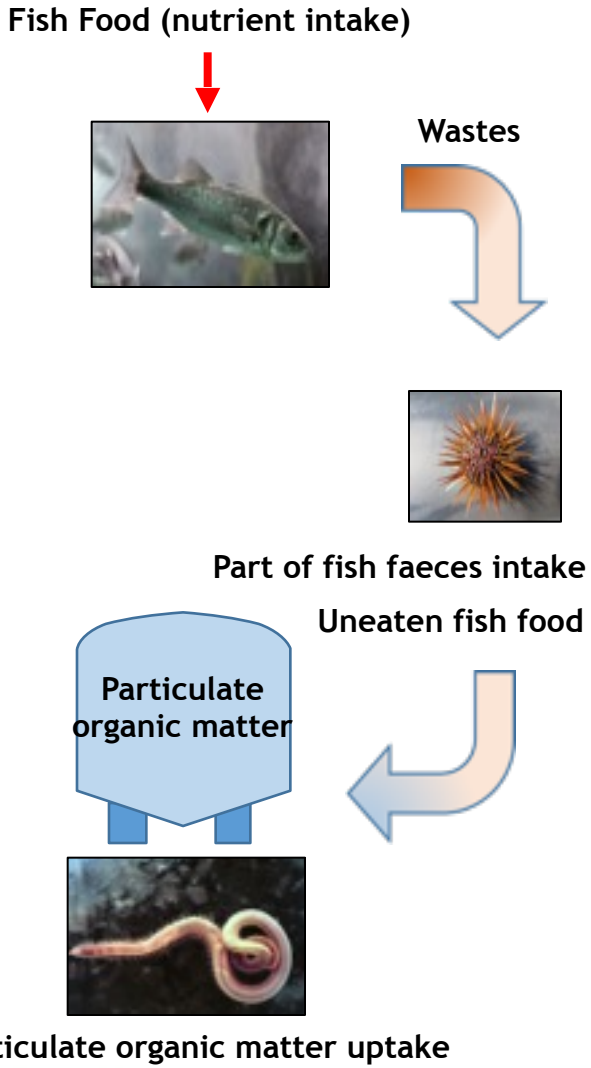
How biologicaly the system works ?



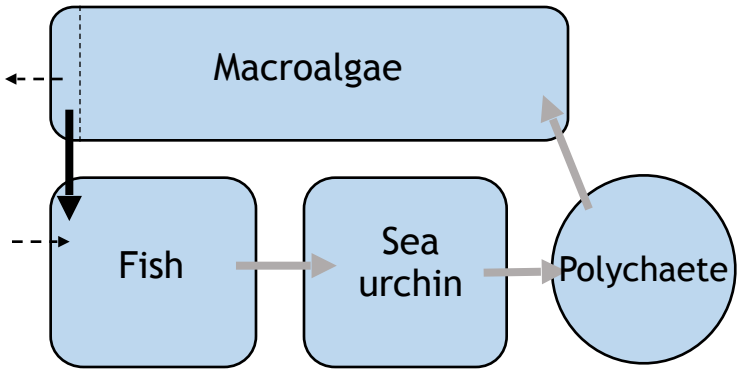
Hediste diversicolor
Extractive aquaculture

Polychaete tank:
220 l cylindroconical tank

Polychaete density:
10 kg.m^{-3}



How biologicaly the system works ?

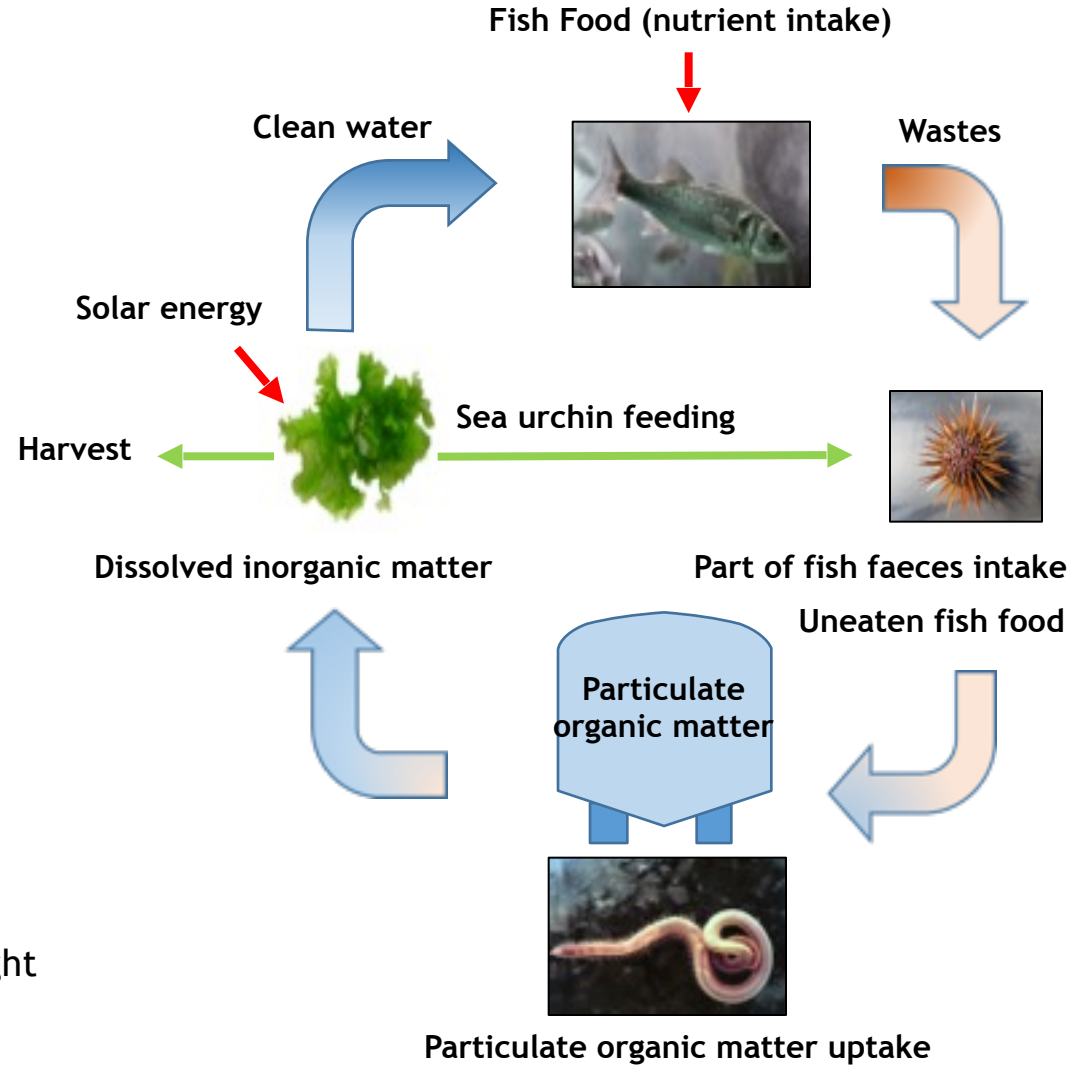


Ulva sp.
Extractive aquaculture

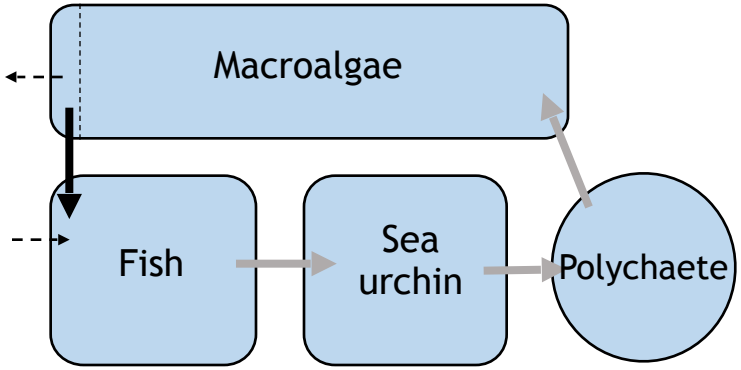
Macroalgae tank:
900 l

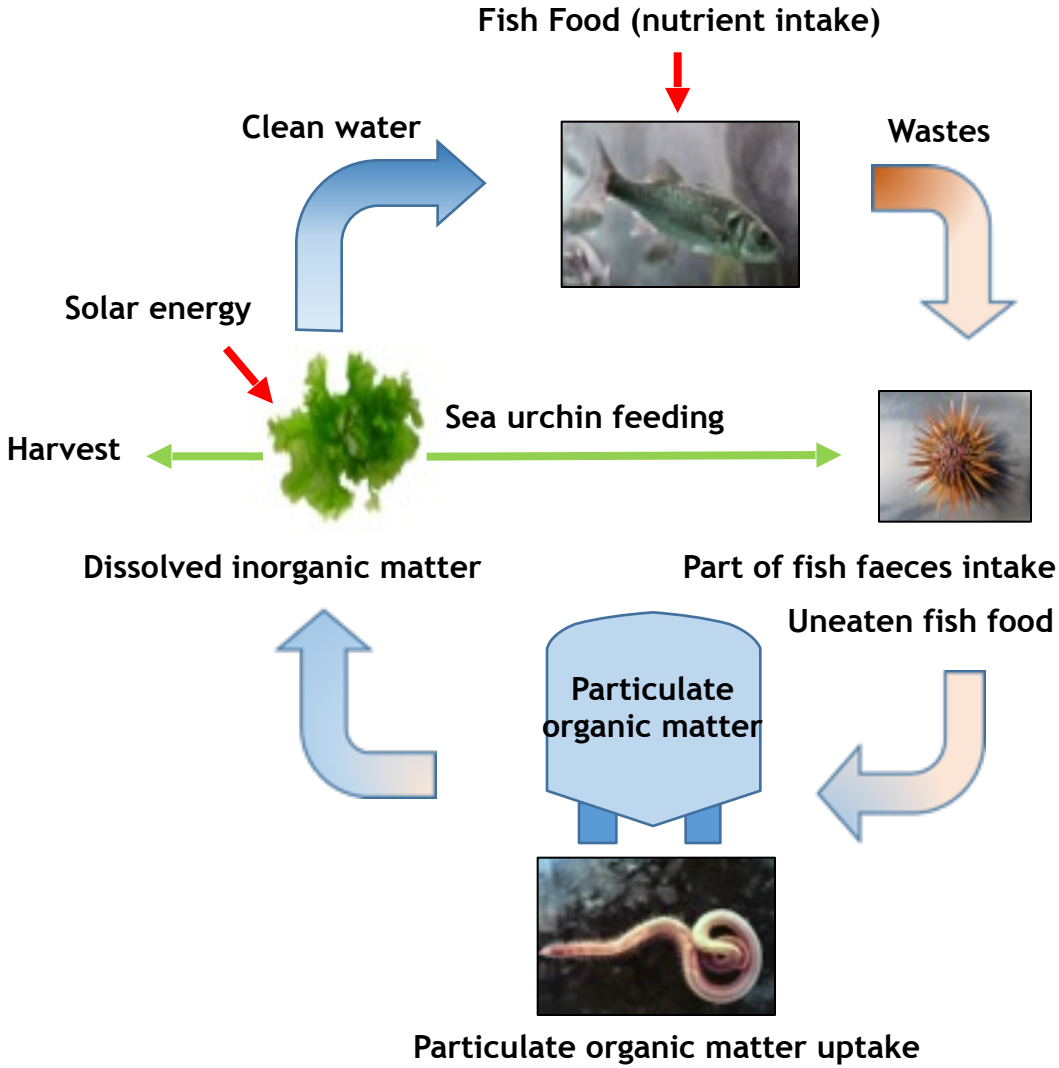
Macroalgae density:
3.3 kg.m^{-3}

Harvested twice a week:
-Feeding sea urchin at 2% of their body weight
-Extract from the system



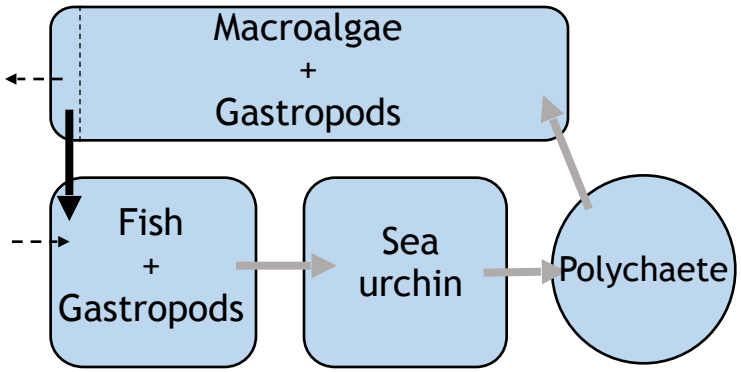
How biologicaly the system works ?





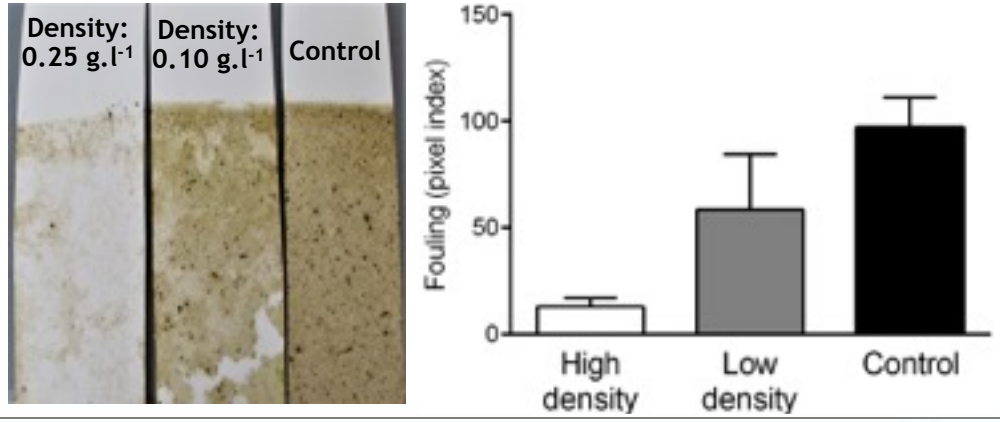
Bioremediation:
Particulate matters
Dissolve matters

How biologicaly the system works ?



Phorcus turbinatus
Biofouling cleaner

1 week on fish farm effluent



Cleaning care reduced (and productivity increased)

Water quality analysis

Measured once a week in each tank

- Ammonia
- Nitrite
- Nitrate
- Phosphate
- Biochemichal oxygen demand
- Phytoplankton
- Total suspended solids

Controlled everyday

- Dissolved oxygen
- pH
- Salinity
- Temperature

Water quality analysis

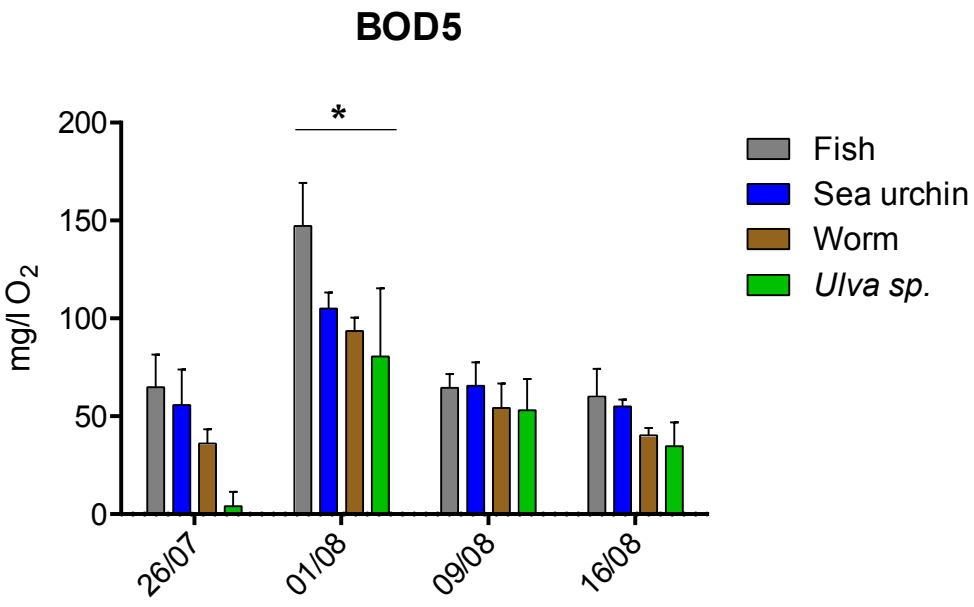
- **Ammonia**
- **Nitrite**
- **Nitrate**
- **Phosphate**
- Biochemichal oxygen demand
- Phytoplankton
- Total suspended solids

	NH4	NO2	NO3	P
Mean	< 0.03	< 0.01	0.6	0.5
Min	-	-	<0.01	< 0.03
Max	-	-	2.4	5.3

Nutrient widely under toxicity threshold

Water quality analysis

- Ammonia
- Nitrite
- Nitrate
- Phosphate
- **Biochemichal oxygen demand**
- Phytoplankton
- Total suspended solids

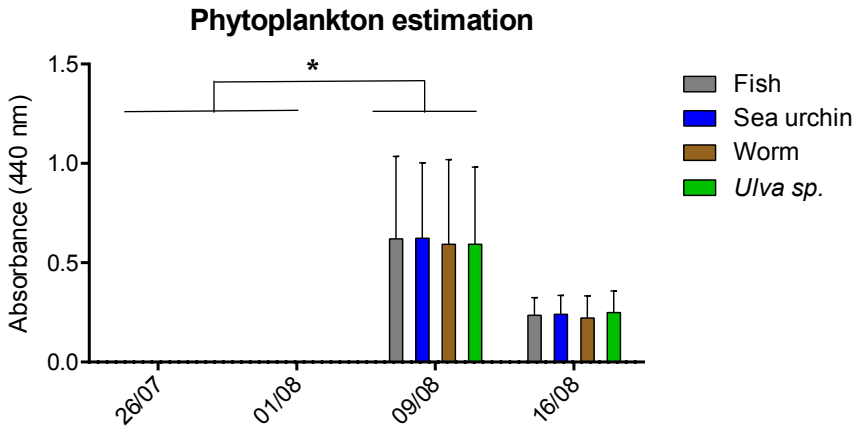


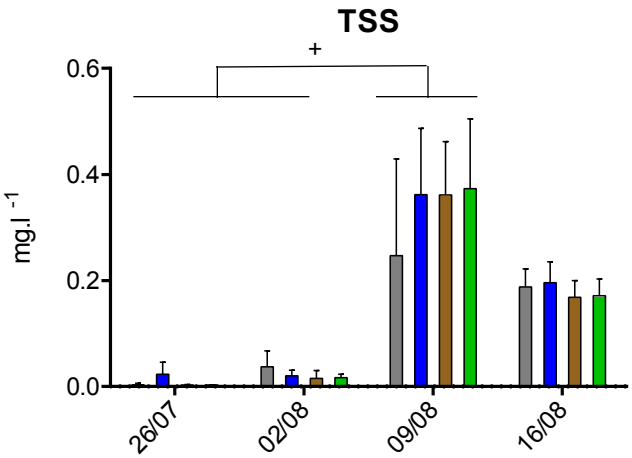
Tukey's multiple comparisons test
Adjusted p value:
* : 0.0001
Fish vs. *Ulva sp:* 0.005

Fast increase followed by a suposed stabilization
Achieve a longer experiment

Water quality analysis

- Ammonia
- Nitrite
- Nitrate
- Phosphate
- Biochemichal oxygen demand
- **Phytoplankton**
- **Total suspended solids**

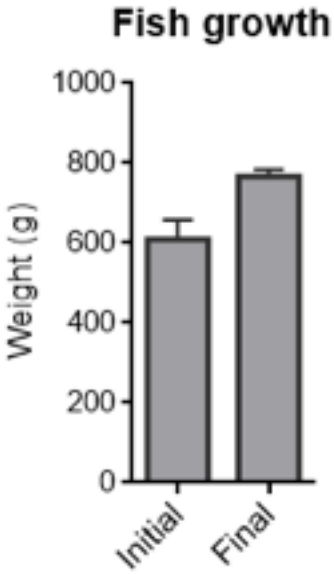




Tukey's multiple comparisons test
Adjusted p value:
* : 0.003
+ : 0.03

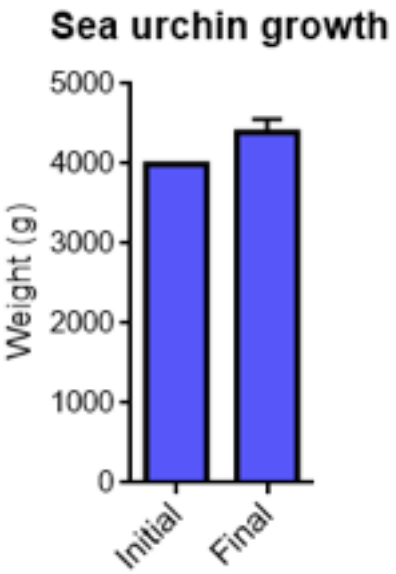
Difficulty to control particulate compartment
Achieve a longer experiment

Biological production



SGR
0.77% ± 0.31 d^{-1}
27% in a month

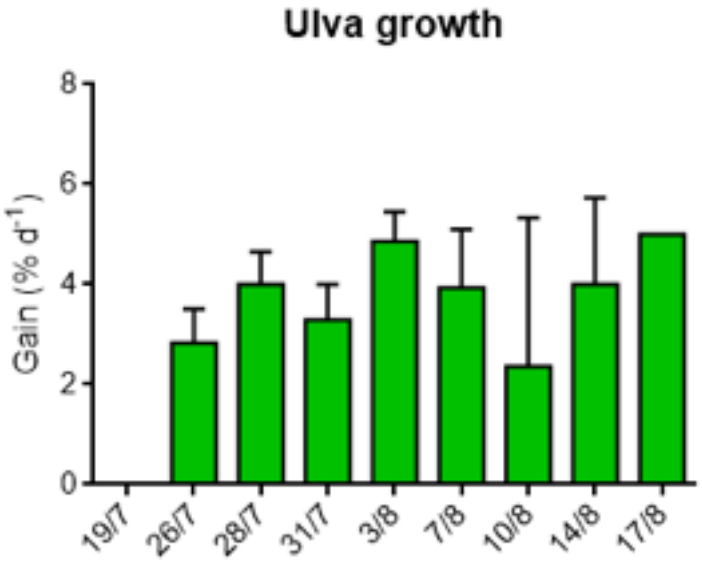
FCR
2.3 ± 0.59

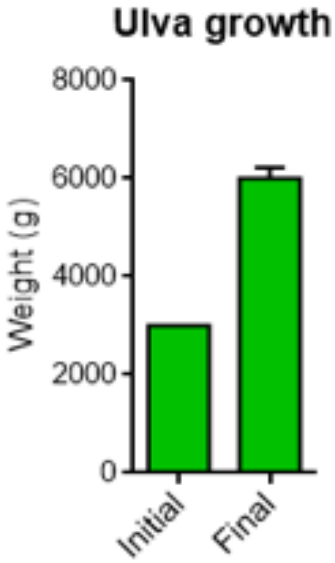


SGR
0.31% ± 0.12 d^{-1}
10% in a month

FCR
3.49 ± 1.63

Biological production

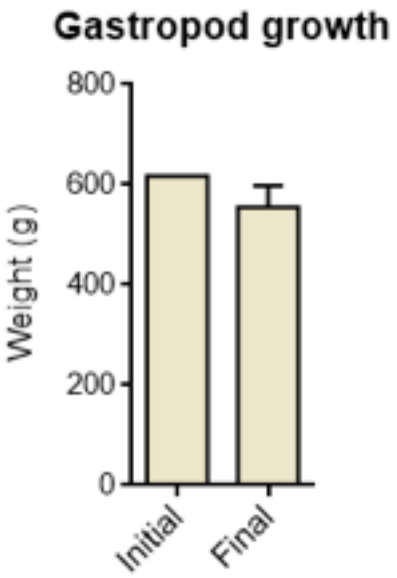


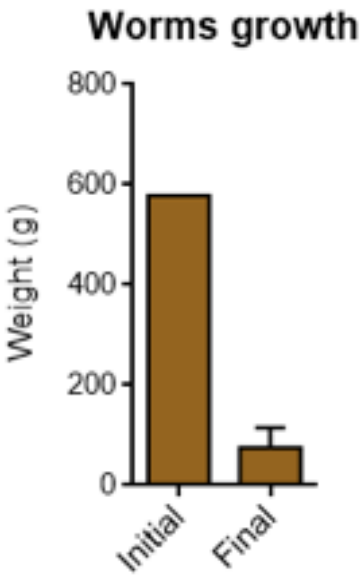


SGR
3.74% ± 1.44 d^{-1}

200 % growth in a month
53 % used to feed sea urchin

Biological production



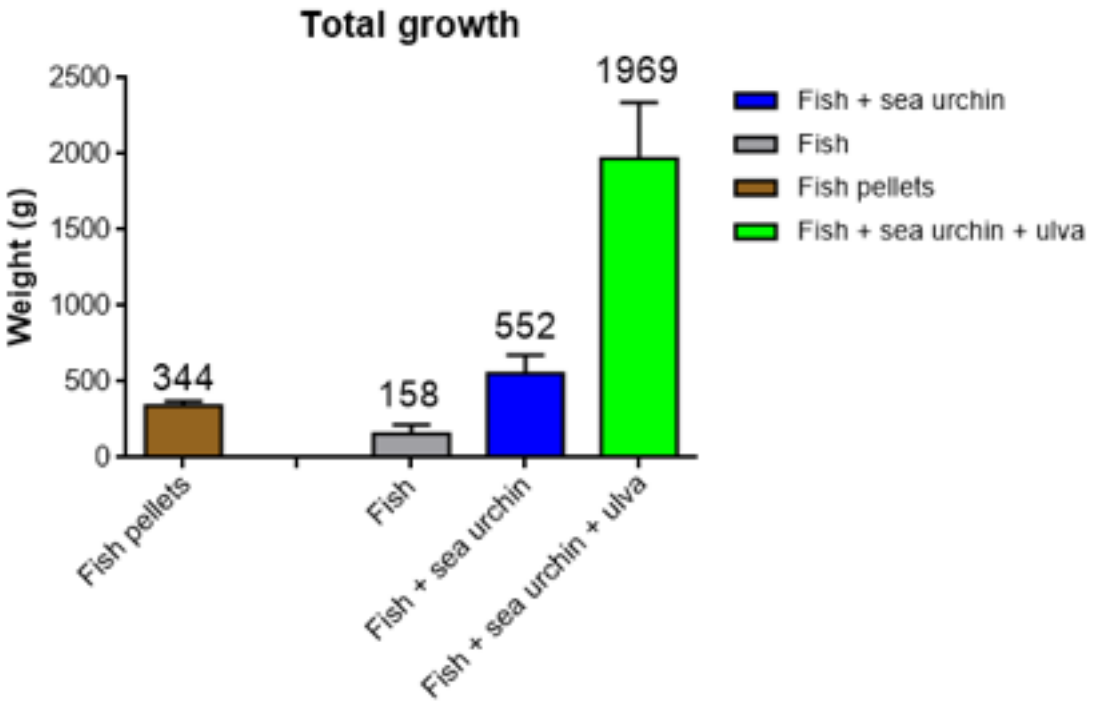


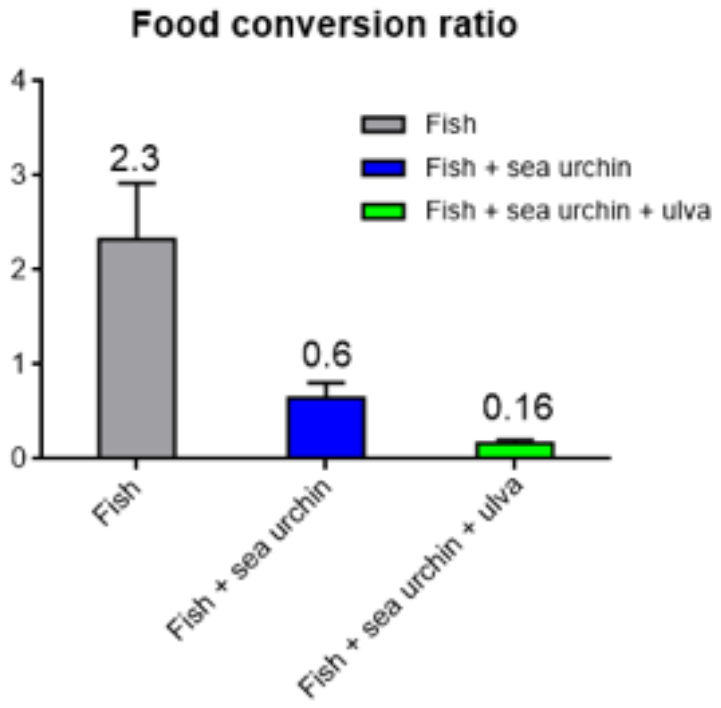
Escape from the tanks
Lot of juveniles

High mortality of *H. diversicolor*
Species switch

Need to design tanks to limit gastropods escape
Change worms species

Global production





344g intake
almost 2 kg produced

Conclusion

Difficulty to manage particulate compartment → Add a filter feeder species

Waste are reduced to the maximum → R-IMTA only with bioremediation works

Compare to classical fish aquaculture production is increased by 12

LTR-IMTA

Easy care => limited human action

Low electricity consumption

Conclusion

IMTA

Issues on 2 species can be resolved

Difficulty to manage particulate compartment → Add a filter feeder species

Possibility to breed at least 5 species in the same system

R-IMTA

A system designed only with bioremediation is functional

Compare to classical fish aquaculture production is increased by 12

LTR-IMTA

Easy care → limited human action

Low electricity consumption → Energy saving

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