The role of the sediment in the functioning of semi-intensive shrimp pond ecosystem: focus on the benthic primary production.

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The ECOBAC program:

Study of the benthic pelagic coupling in a system submitted to a strong eutrophication: application to shrimp farming.

Objectives:

⇒To understand the interactions between the animals and their environment during the farming.

⇒To identify the environmental and microbial factors favorable to the good issue of the grow out.

⇒To propose responses for a better management of the pond in order to enhance survival and avoid diseases.

Why to study the role of the sediment?

Strong interactions between the sediment and the water column in shallow ecosystems.

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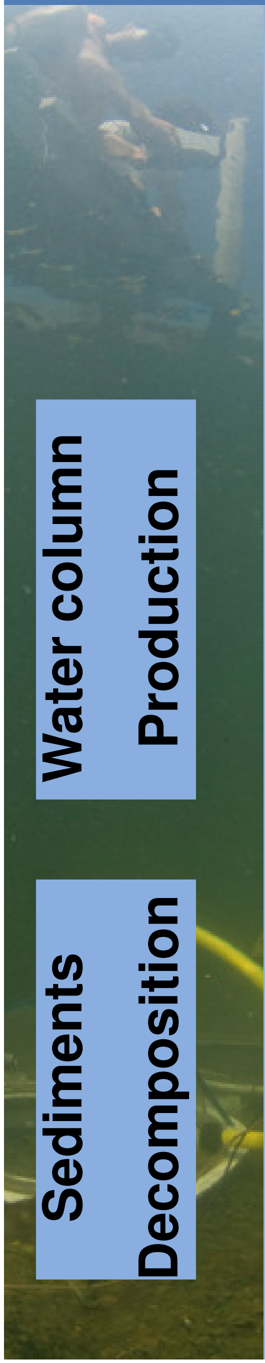

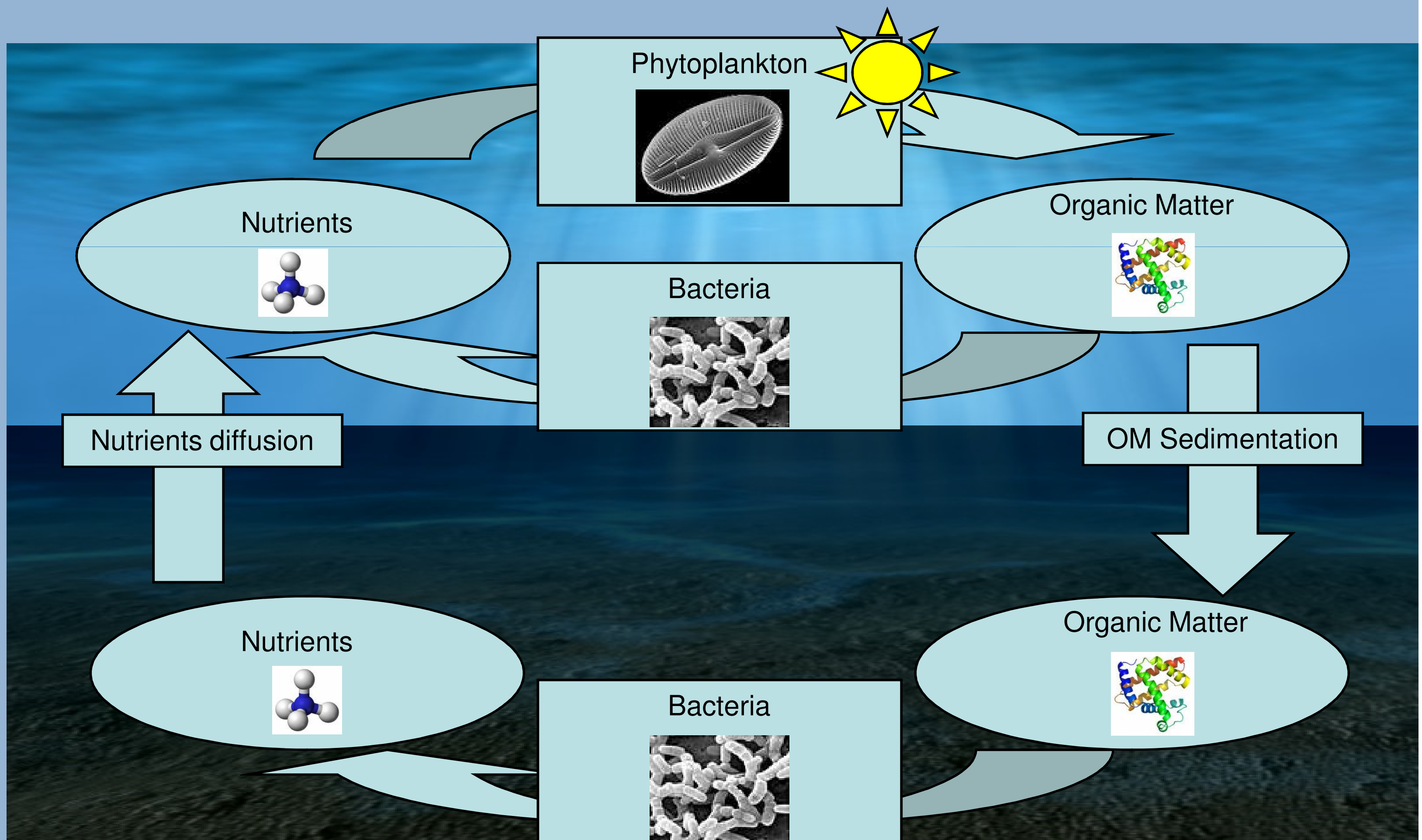

Strong interactions between the sediment and the water column in shallow ecosystems.

Sediments = Place of remineralization of the organic matter produced in the water column.

Sediments = Source of nutrients for the water column.
=> sustain water column primary production

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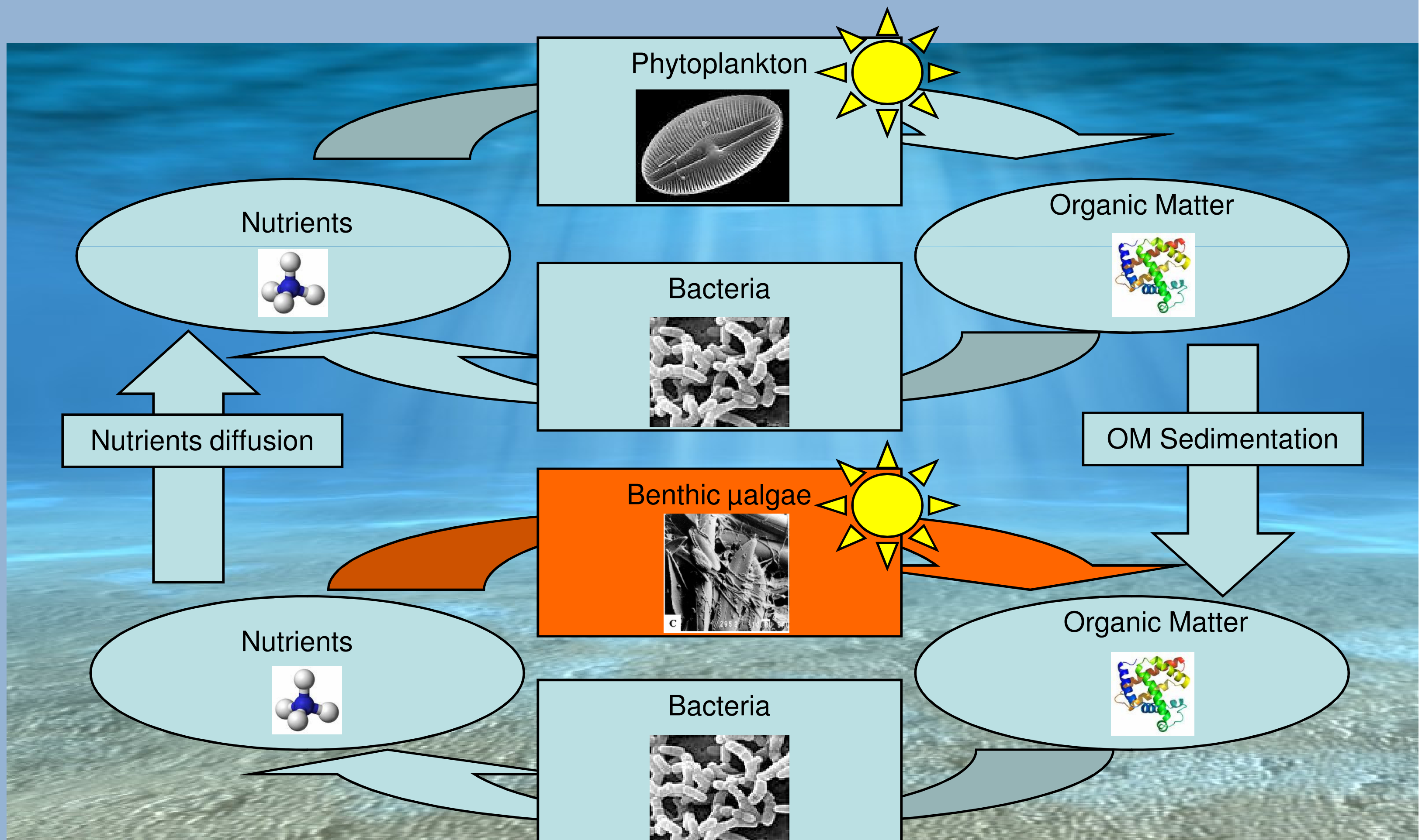
Strong interactions between the sediment and the water column in shallow ecosystems.

Water column
Production

Sediments
Decomposition
production



Strong interactions between the sediment and the water column in shallow ecosystems.

Sediments = Place of remineralization of the organic matter produced in the water column.

⇒ Benthic µalgae=« In situ » production of labile organic matter

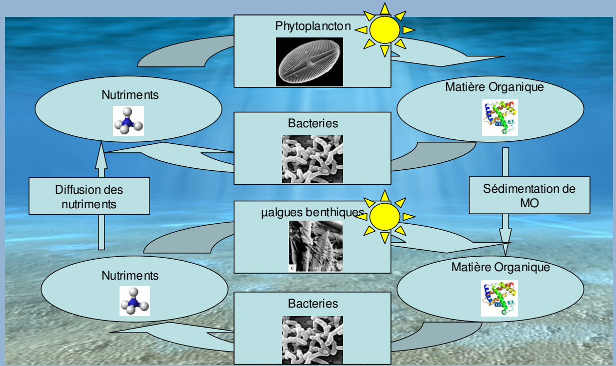
Sediments = Source of nutrients for the water column.
=> sustain water column primary production

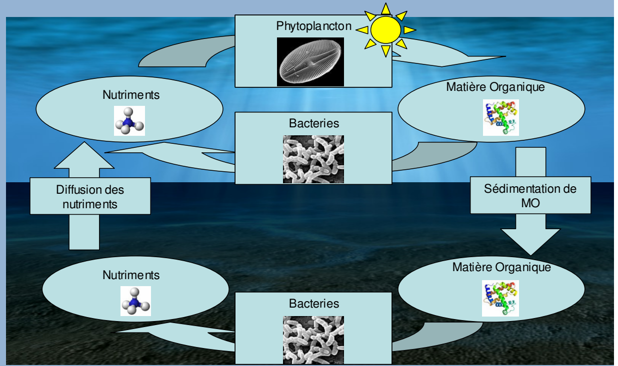
⇒ Benthic µalgae= Control of the nutrients fluxes at the interface.

Application to shrimp farming

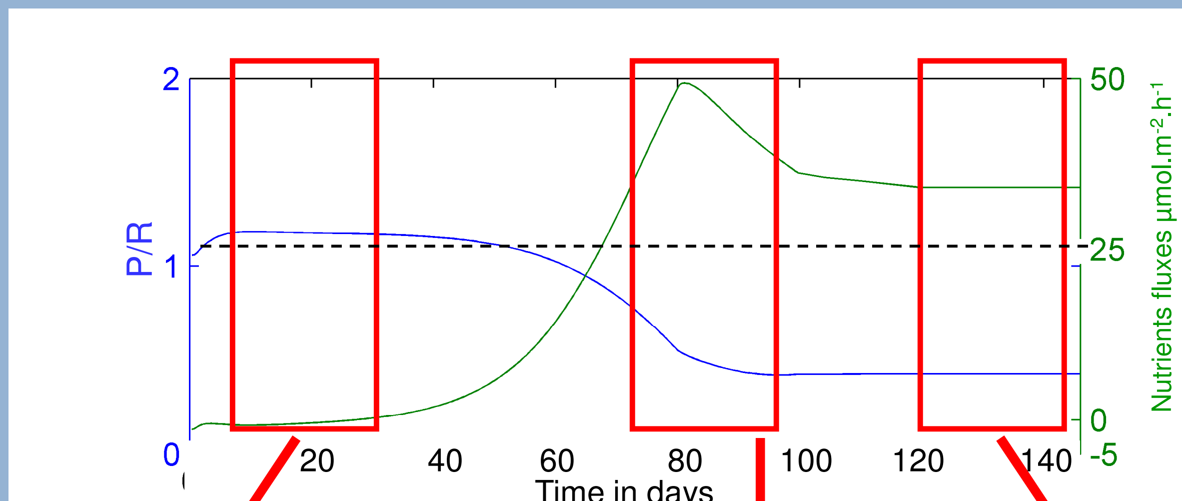
Beginning of the farming

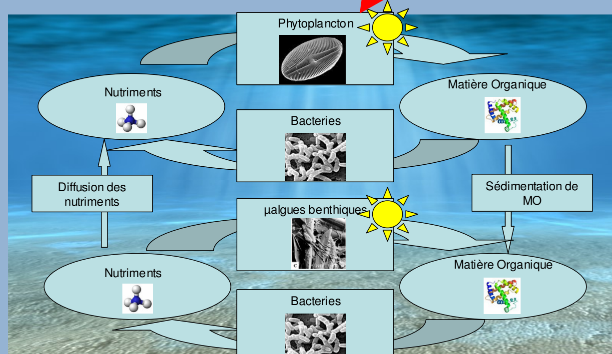
End of the farming





How does the system shift from one state to another?





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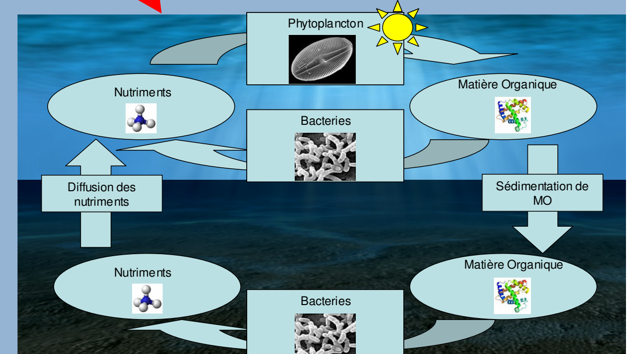
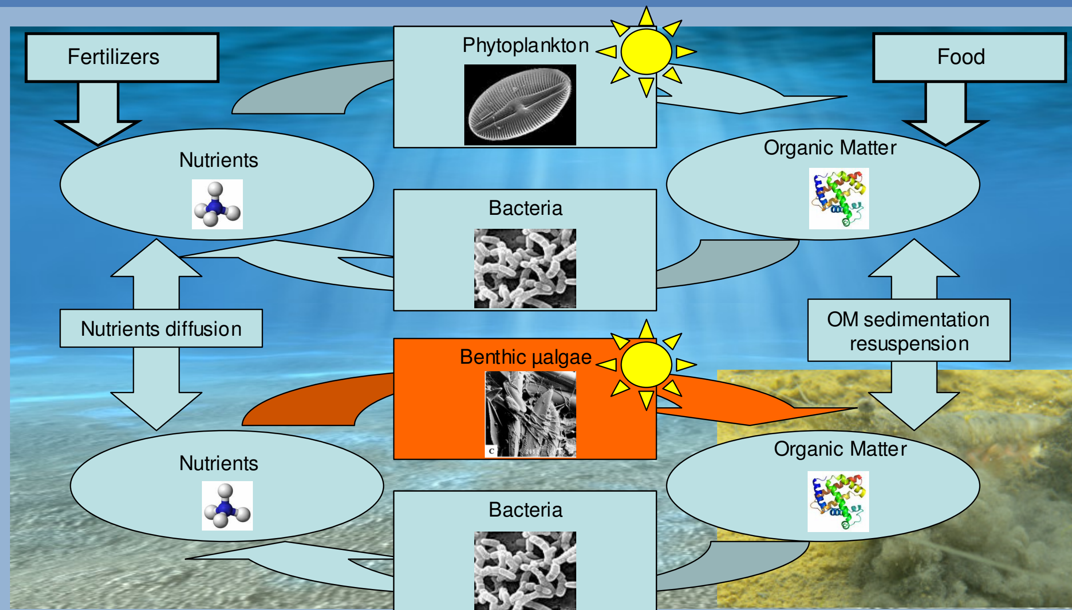
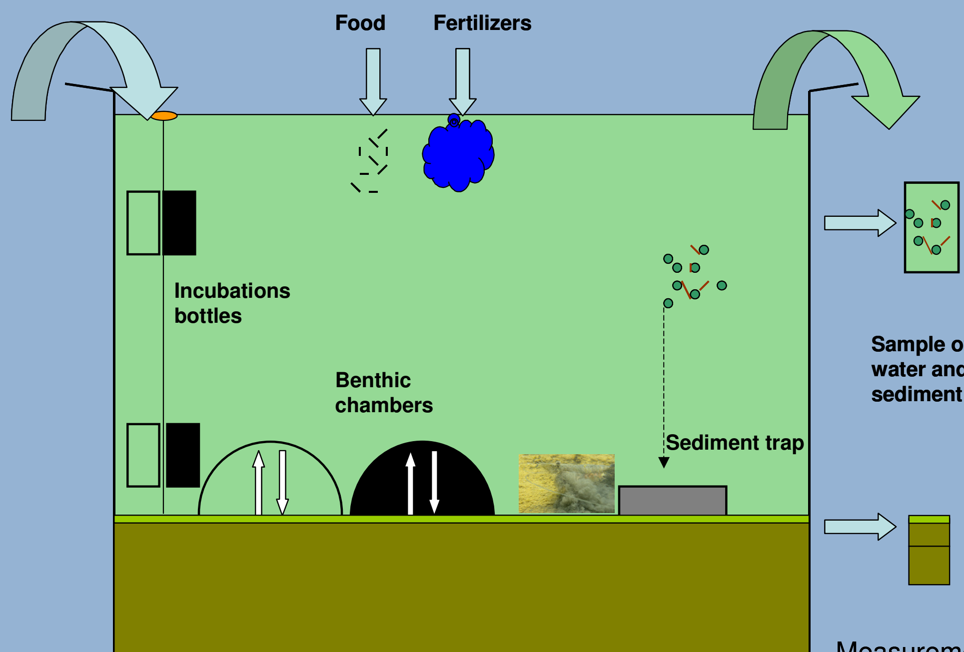


Two ponds surveys and two experimentations in mesocosms

Presentation of the result of the pond survey of the Sodacal farm



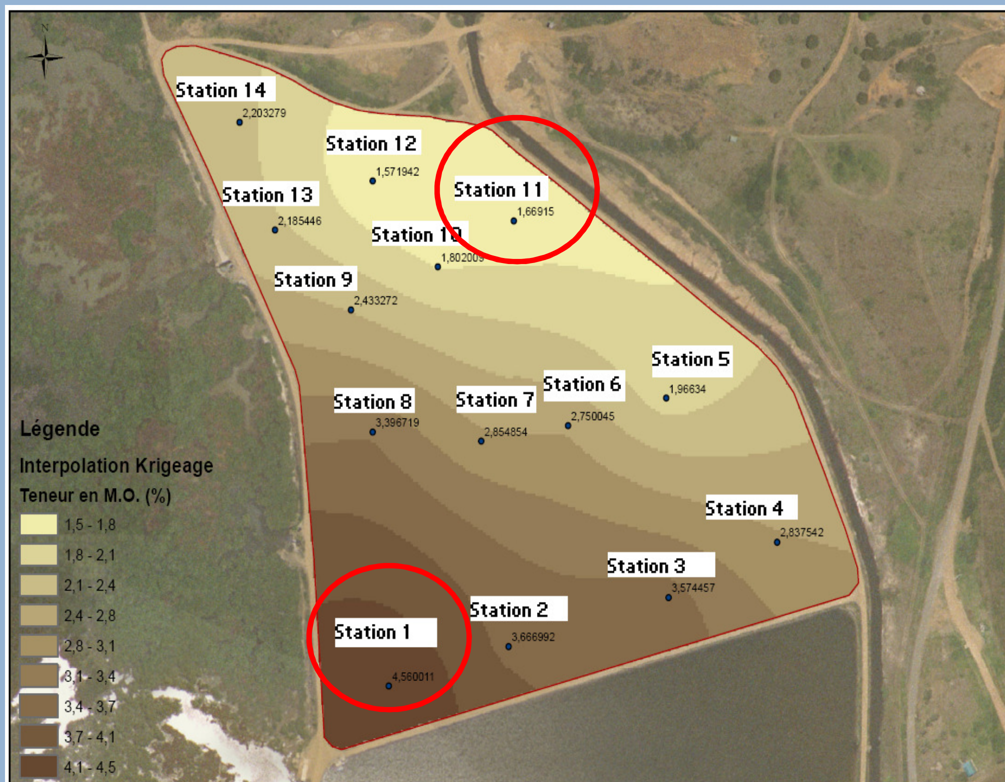


Measurement of biogeochemical processes.

Measurement of environmental variables

Sampling stations

Map of the sediment OM content



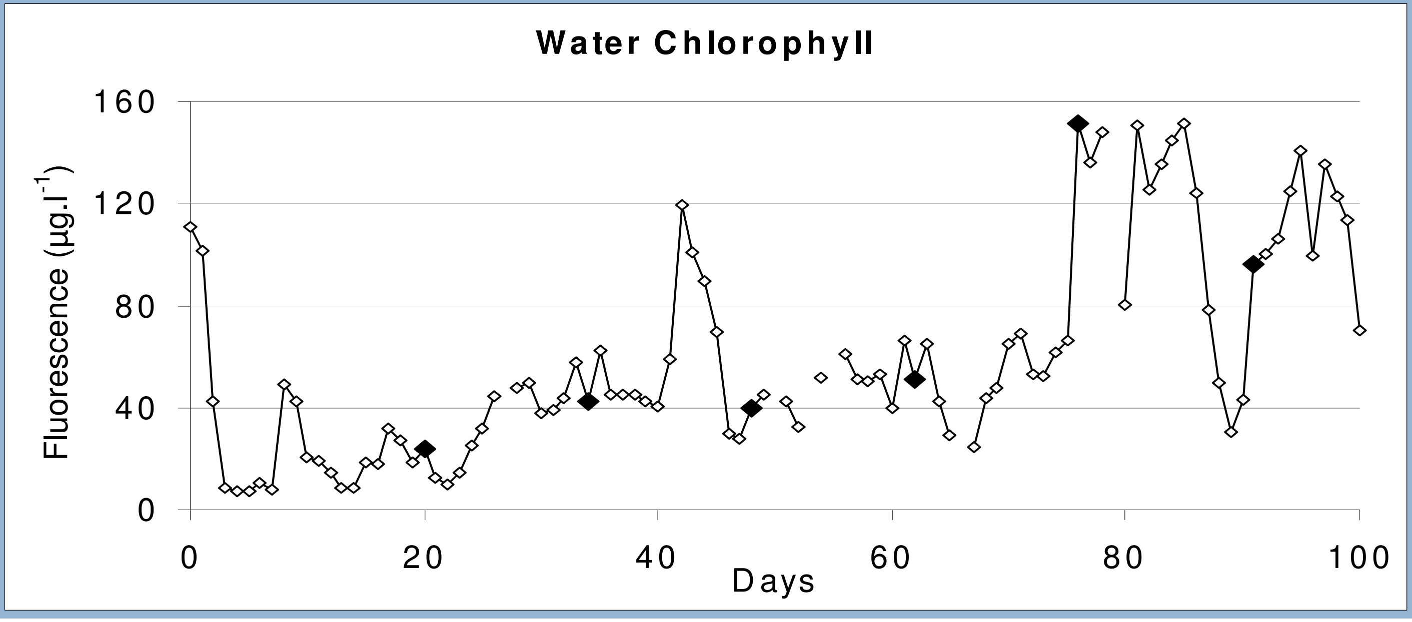
Station 1 : Maximum de OM (4.5%)
⇒Max of deposition
⇒Max of respiration

Station 2 : min of OM (1,6%)
=>Min of deposition
=>Min of respiration

No differences between the stations

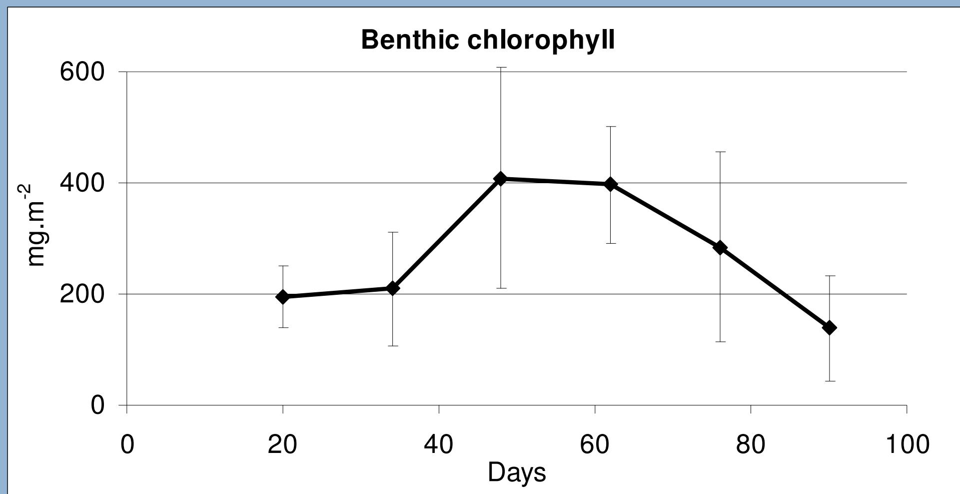
Zootechnical performances

- Typical from New Caledonian performances at this season (February-May)
- Shrimp density : 16 ind.m^{-2}
- Beginning of the survey : shrimp weighted 3.5g
- End of the survey : Shrimp weighted 20g
- Growth : 0.22 g.day^{-1}
- Survival estimated at the end of the survey : 75%
- Food Conversion Ratio : 1.6
- No oxygen problem



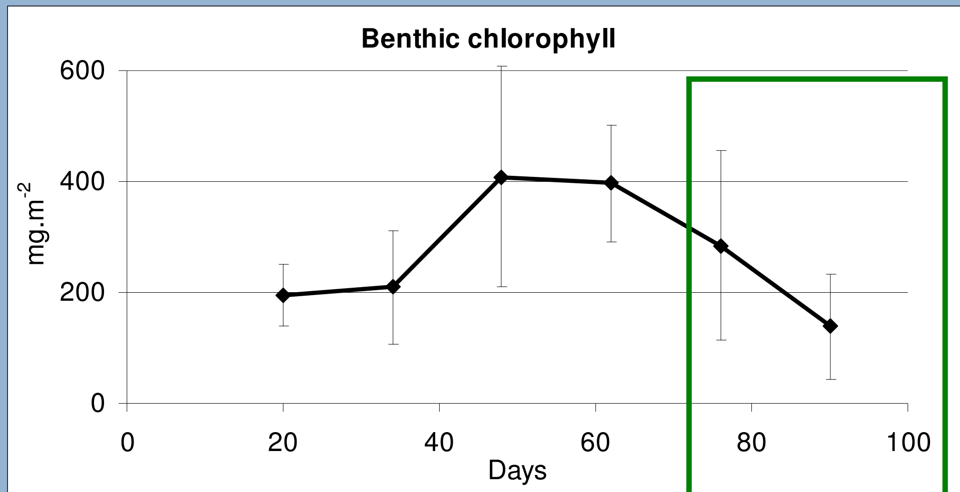
Sediments functioning and controls factors

Evolution of benthic µalgae



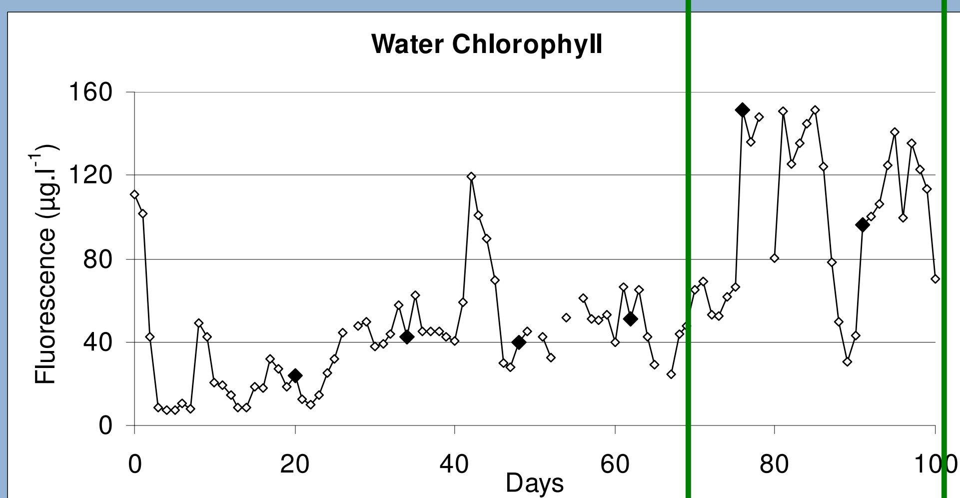
- Beginning of the farming: development of µalgae
- End of the farming: decay of µalgae

Evolution of benthic µalgae



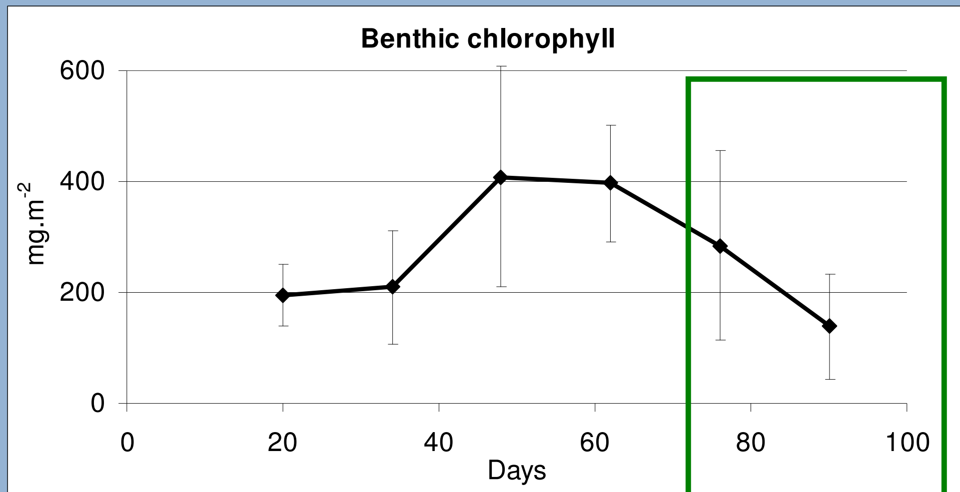
- Beginning of the rearing: development of µalgae
- End of the rearing: decay of µalgae

Control factors



Diminution of light availability at the sediment surface.

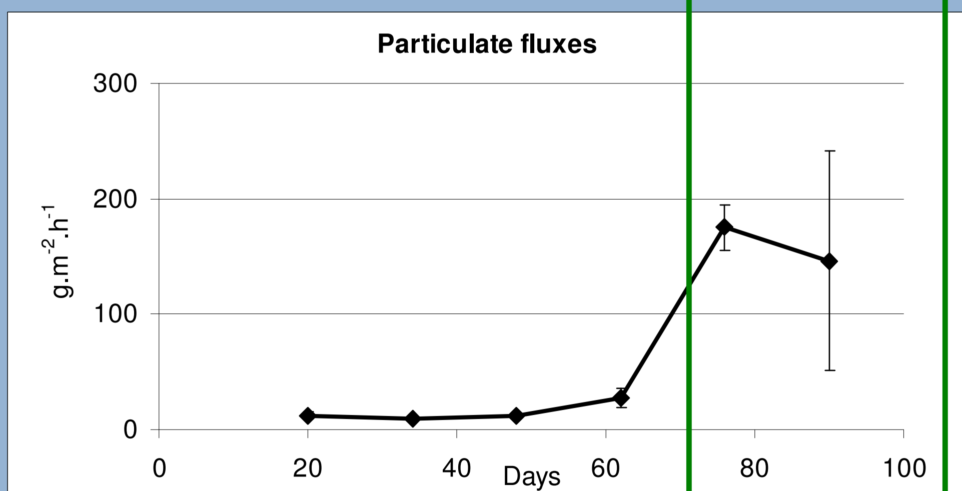
Evolution of benthic µalgae



•Beginning of the farming: development of µalgae

•End of the farming: decay of µalgae

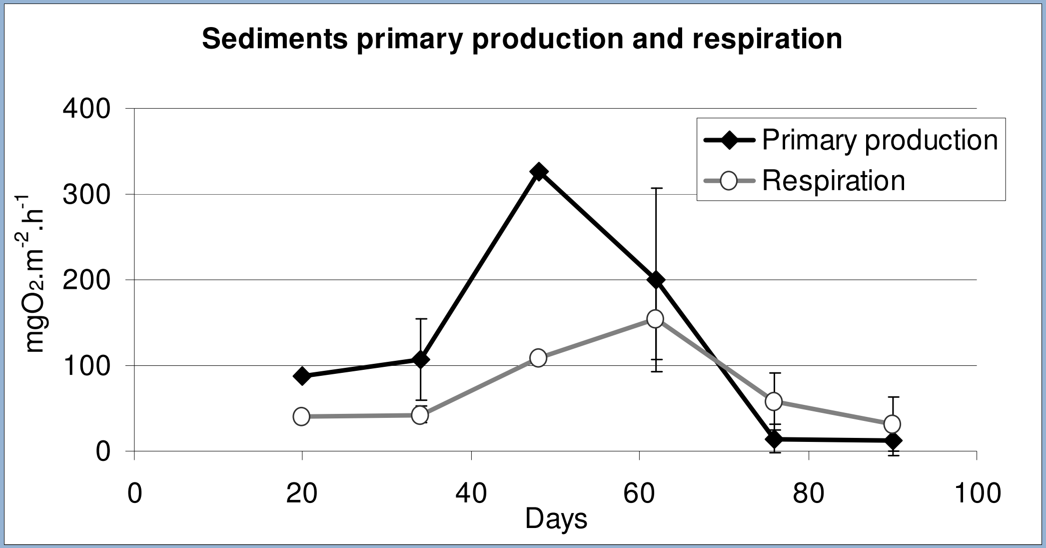
Control factors

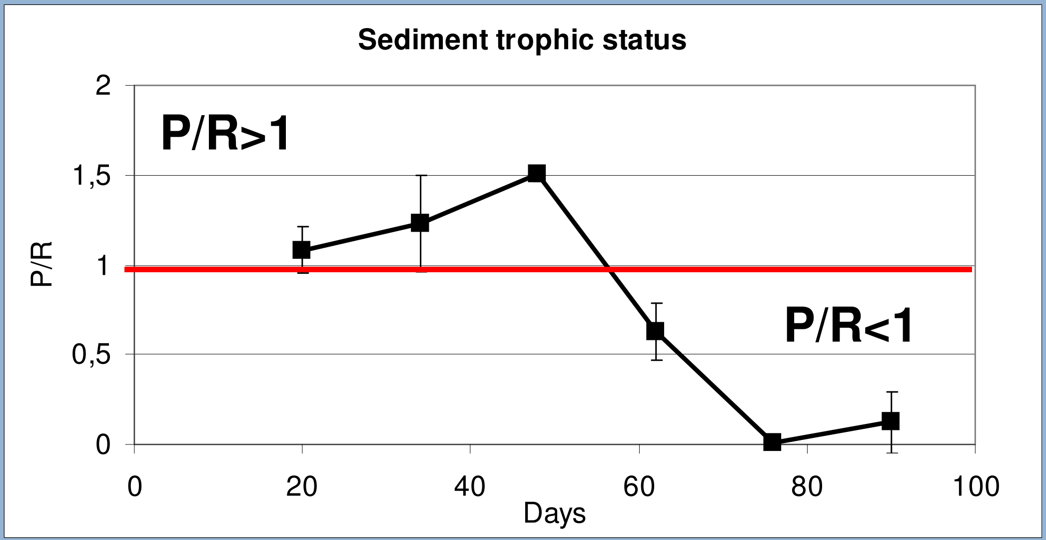


Diminution of light availability at the sediment surface.

Enhance shrimp bioturbation

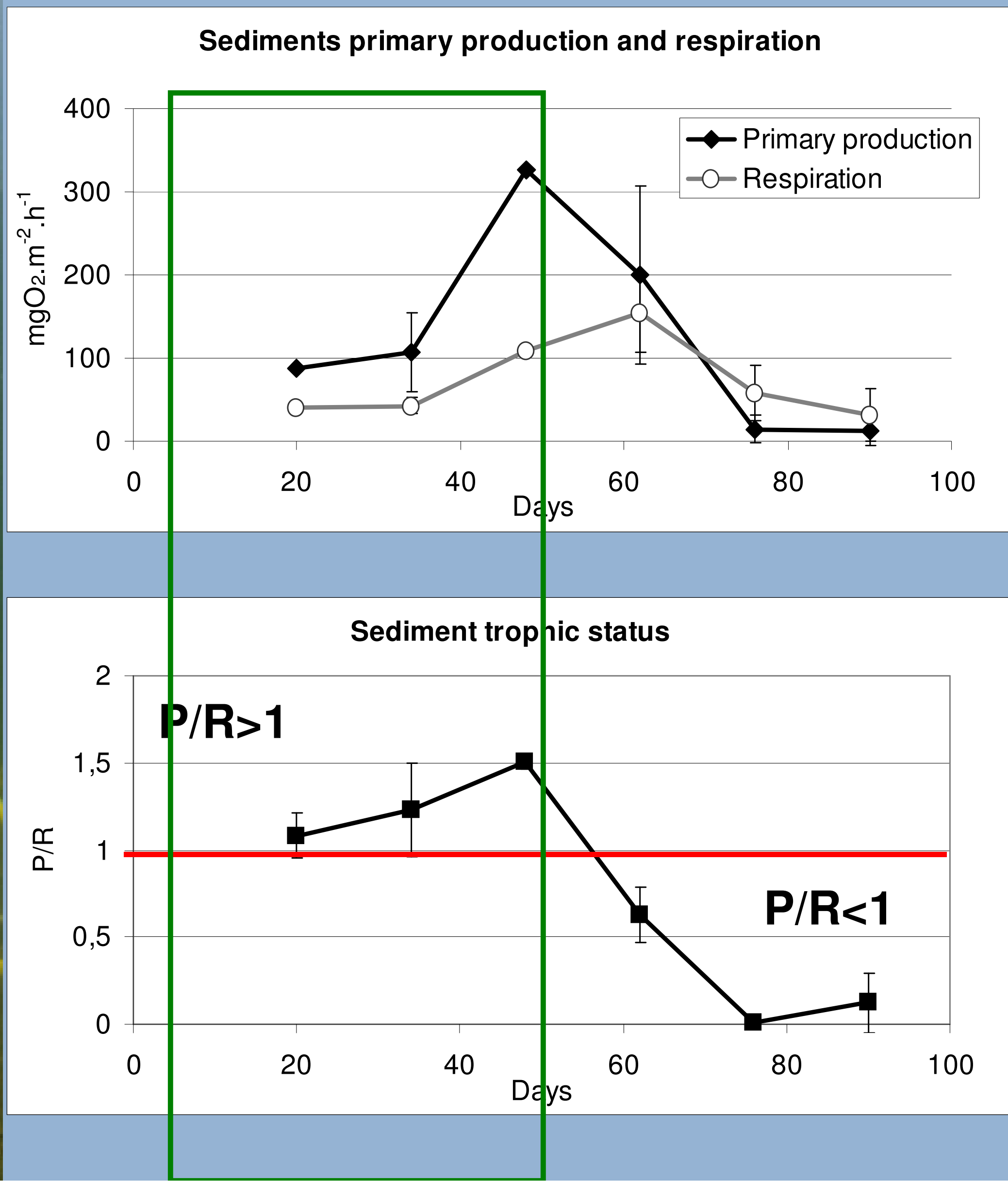
Sediment primary production and respiration





Three steps can be identified

Sediment primary production and respiration

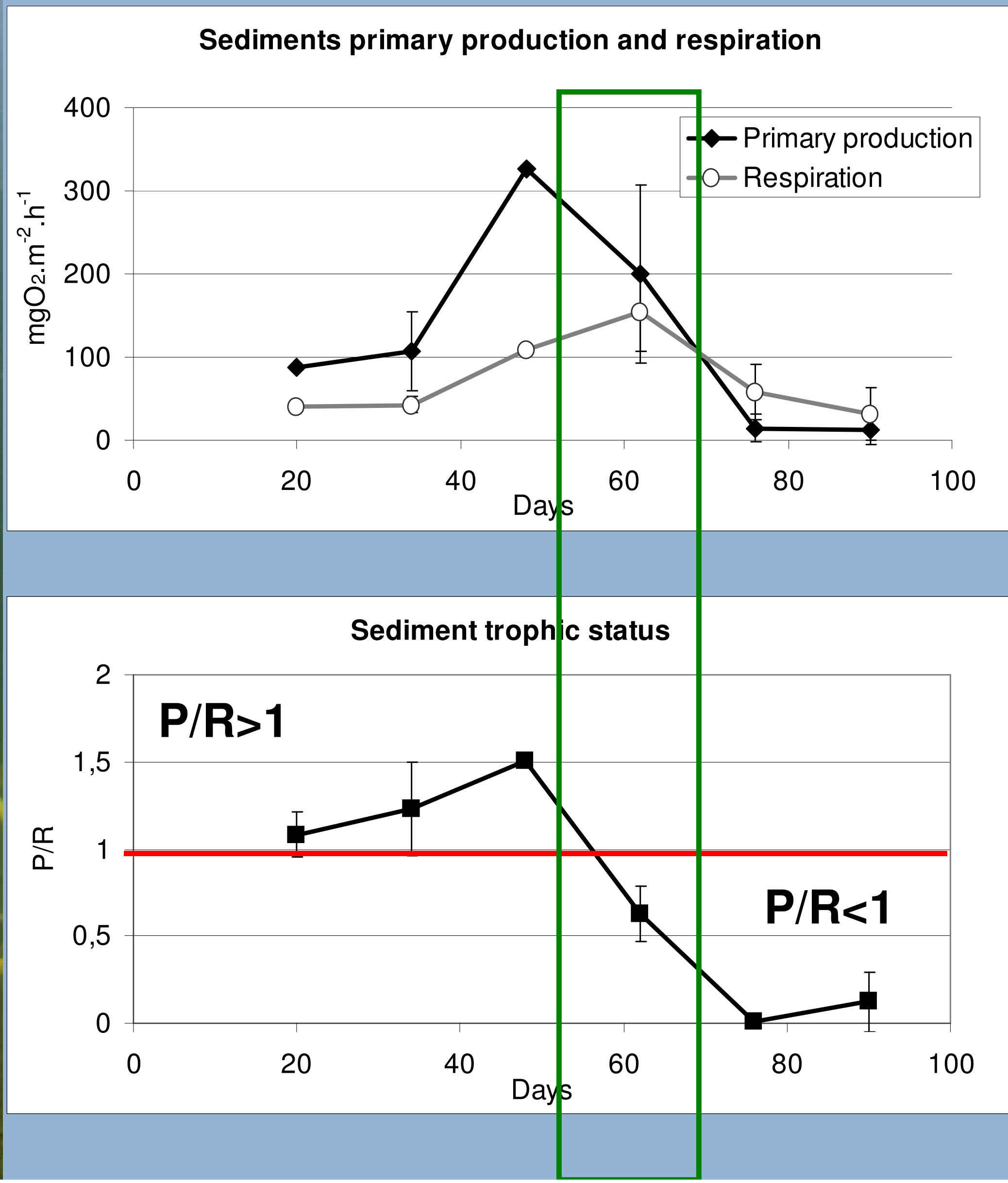


Step 1:

Production > respiration

Sediment metabolism is sustained by benthic primary production

Sediment primary production and respiration



Step 2:

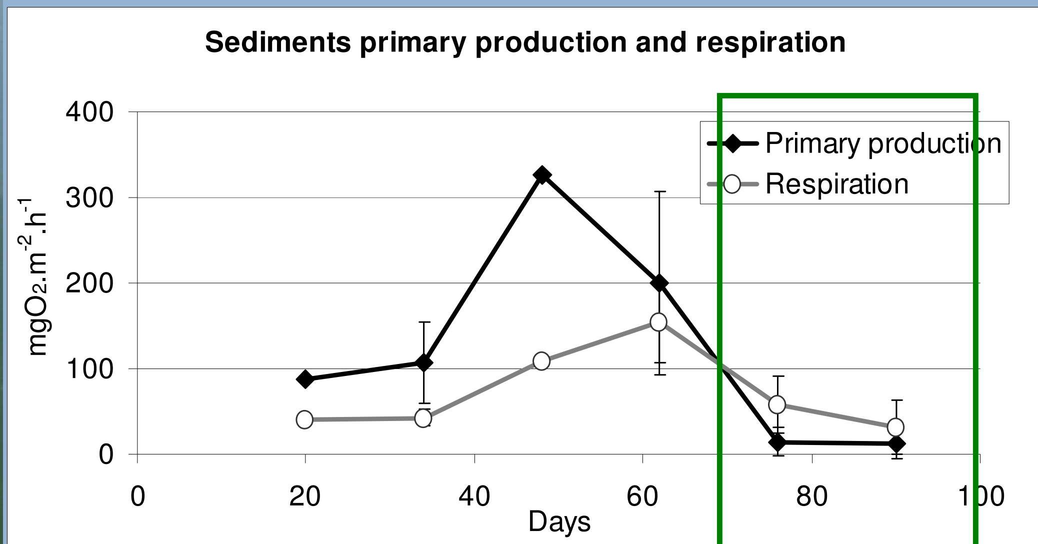
Production < respiration

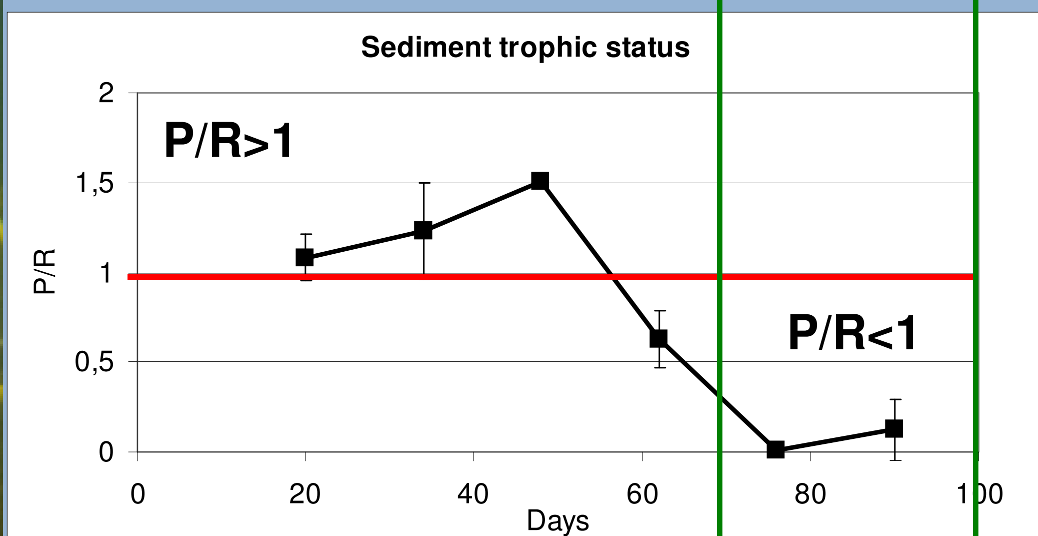
Diminution of primary production

Enhancement of the input of OM (food and phytoplankton)

=> Maximum respiration

Sediment primary production and respiration





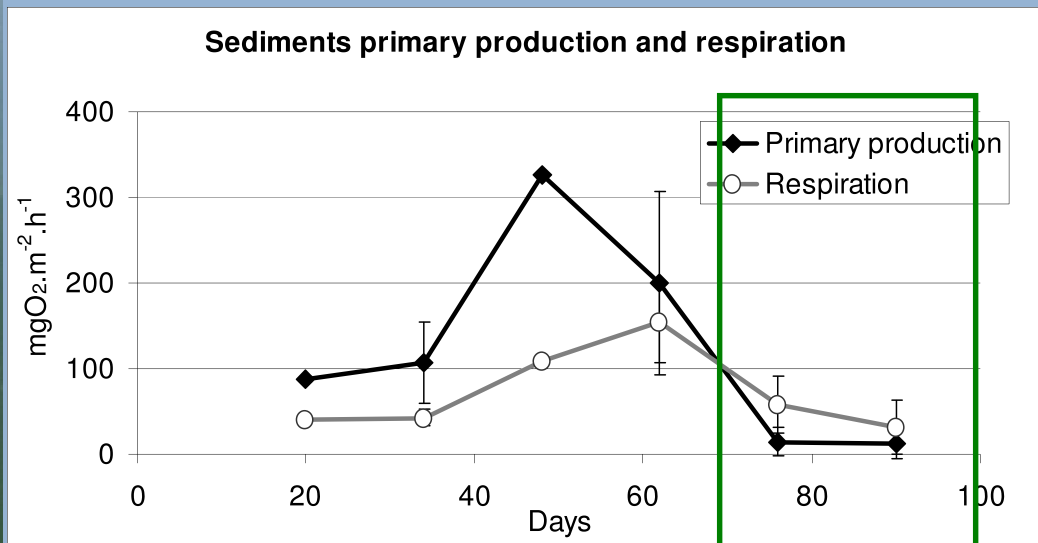
Step3:

Production < respiration

No more primary production

Diminution of respiration

Sediment primary production and respiration

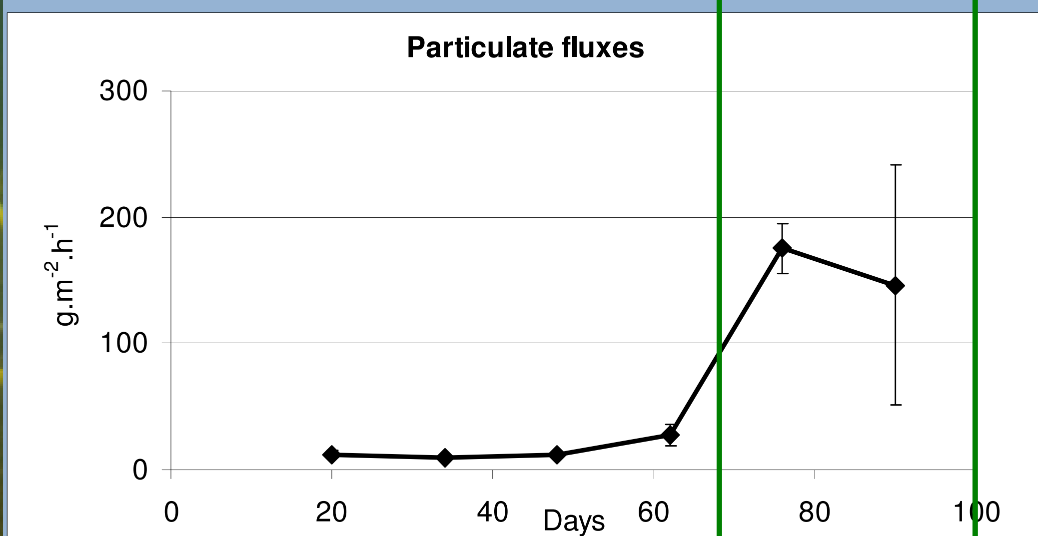


Step3:

Production < respiration

No more primary production

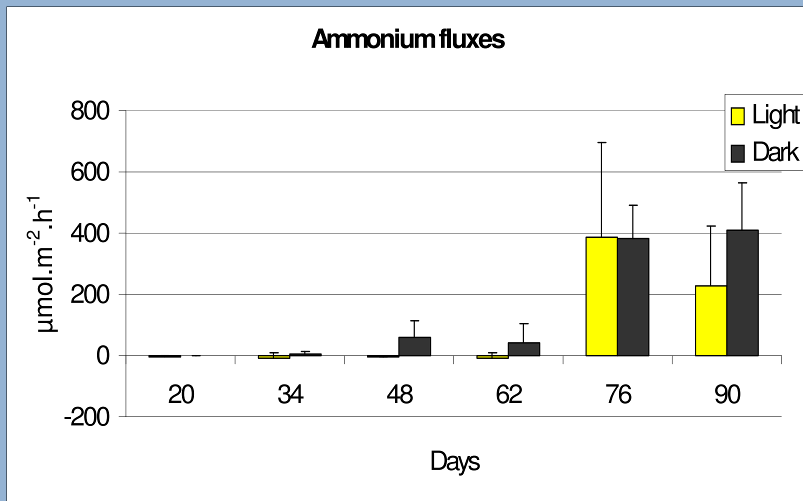
Diminution of respiration

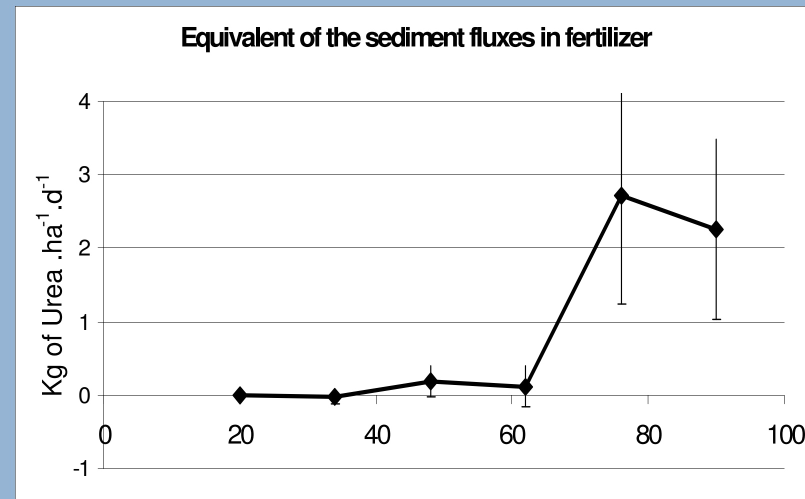


Diminution of light availability at the sediment surface.

Enhance shrimp bioturbation

Nitrogen exchanges between the sediment and the water column





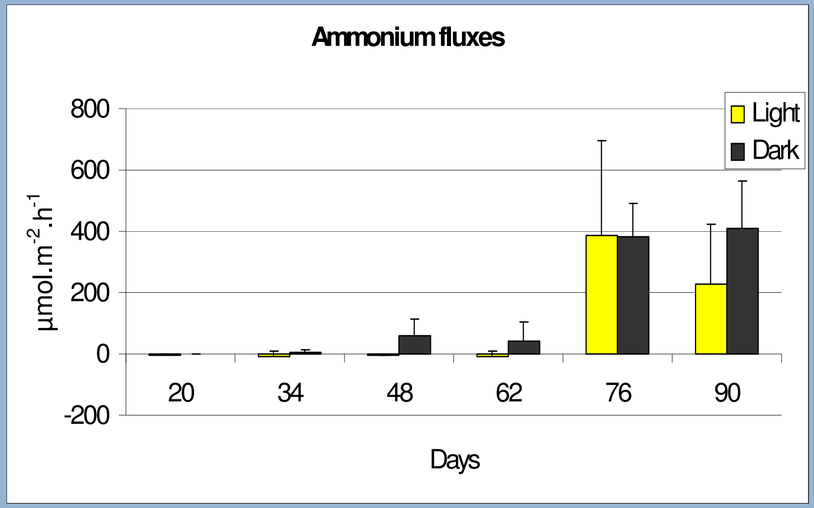
Beginning of the farming : No nitrogen exchanges

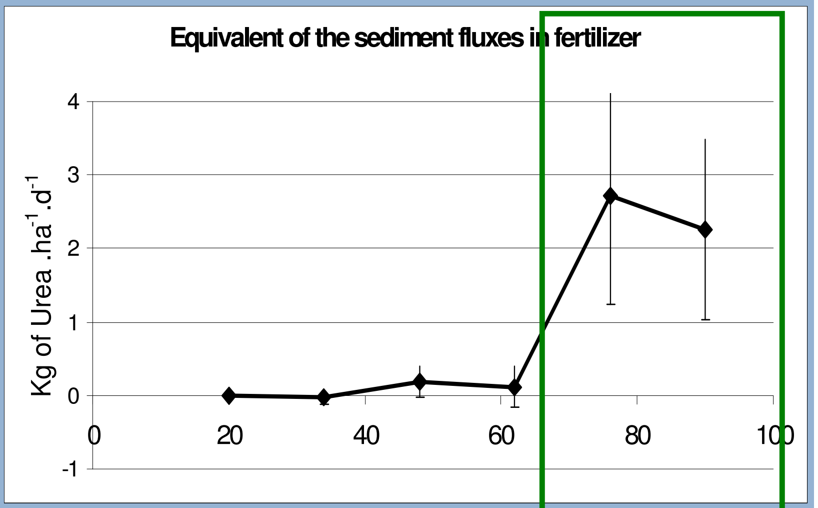
End of the farming: important nitrogen fluxes

Input of nitrogen from the sediment to the water column:

2,5 Kg urea.$ha^{-1}.d^{-1}$

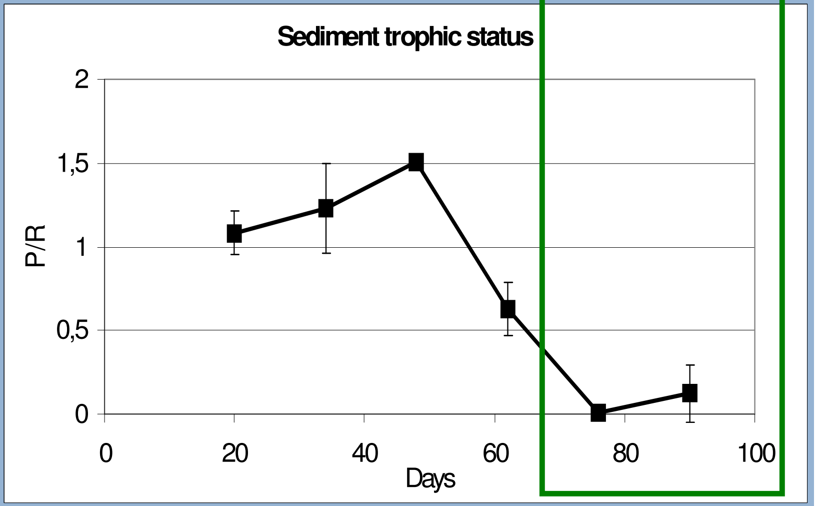
Nitrogen exchanges between the sediment and the water column



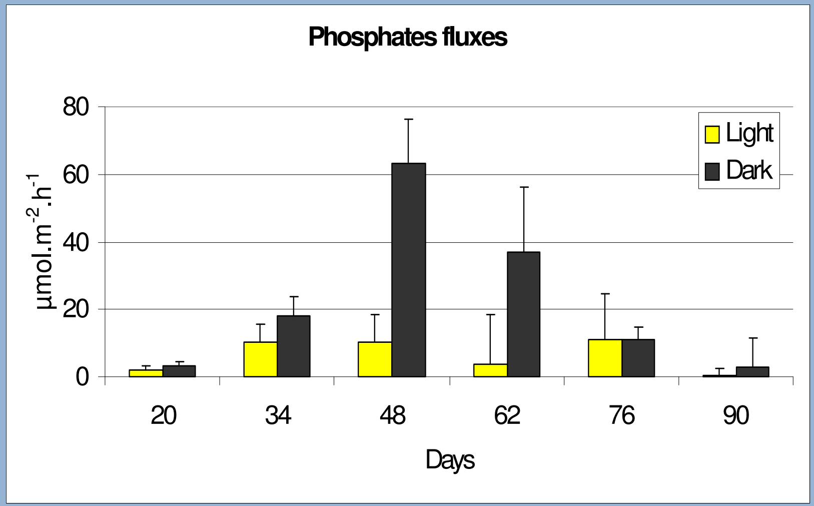


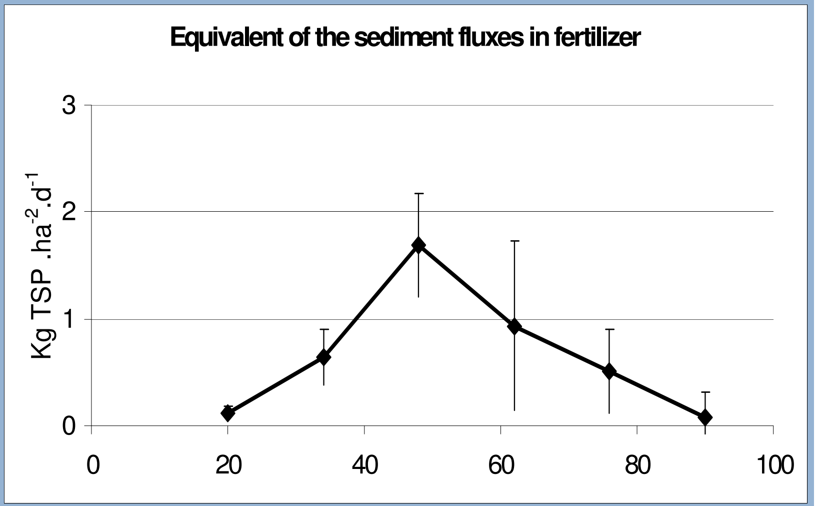
Control factors

Nitrogen exchanges are regulated by the benthic µalgae primary production.



Phosphates exchanges between the sediment and the water



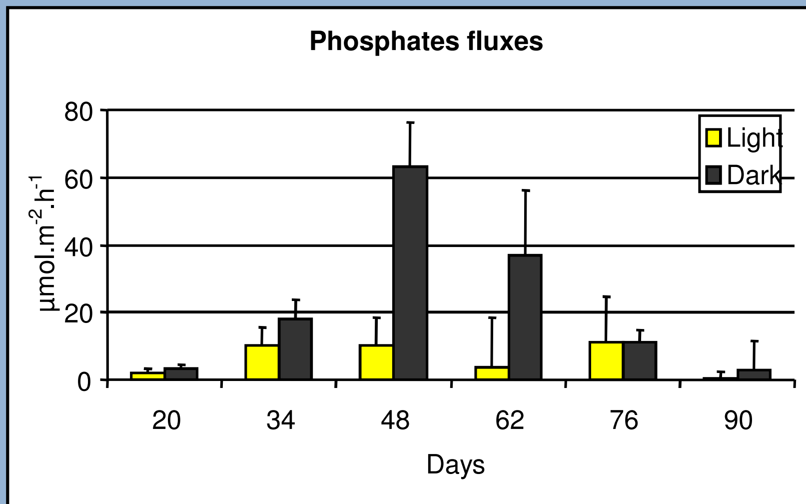


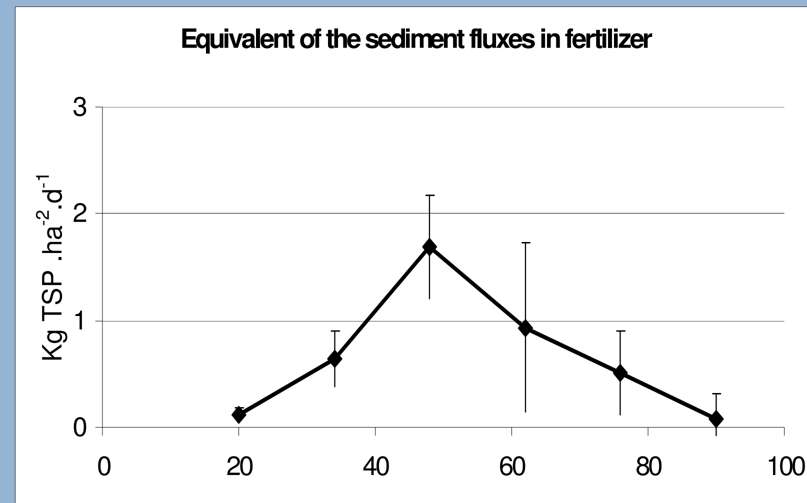
Maximum phosphates fluxes in the middle of the farming.

High light/dark variation.

Input of phosphates from the sediment : 1,7 Kg de TSP.ha^{-1}.d^{-1}

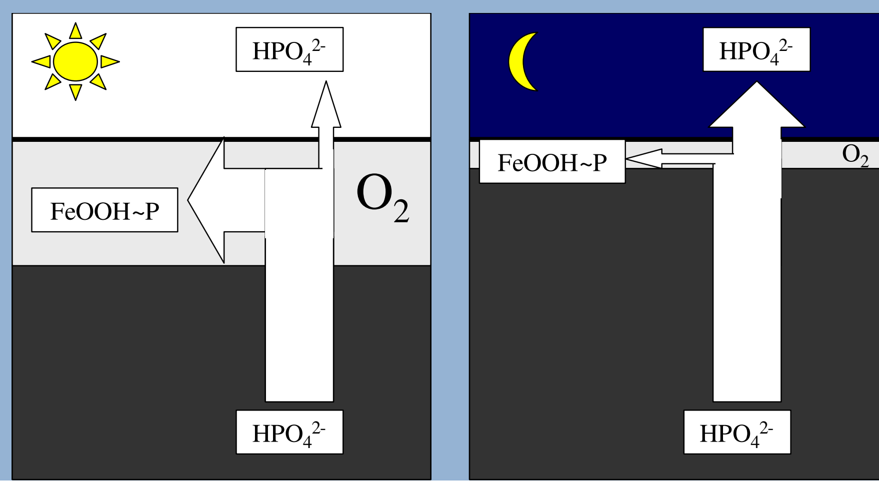
Phosphates exchanges between the sediment and the water





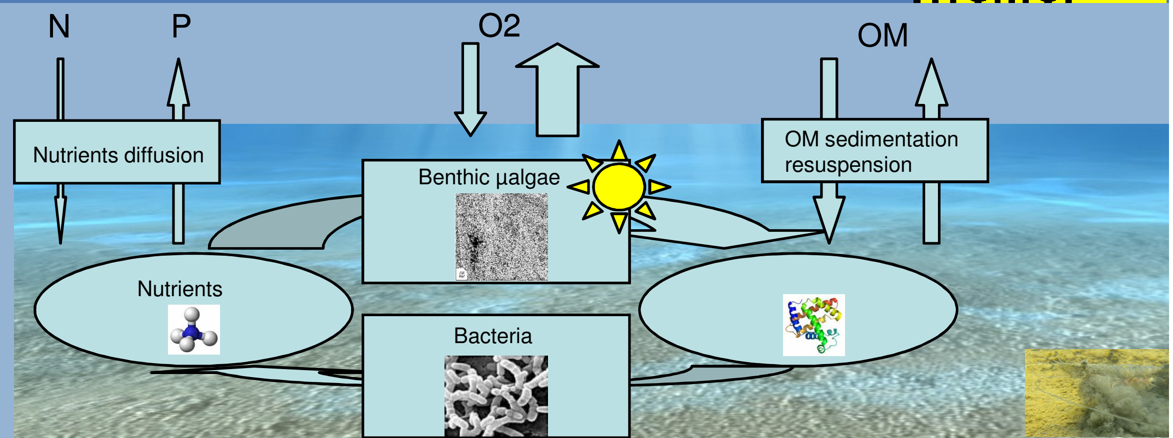
Control factors

Phosphates fluxes are regulated by µalgae activity and the oxic/anoxic conditions at the sediment surface.



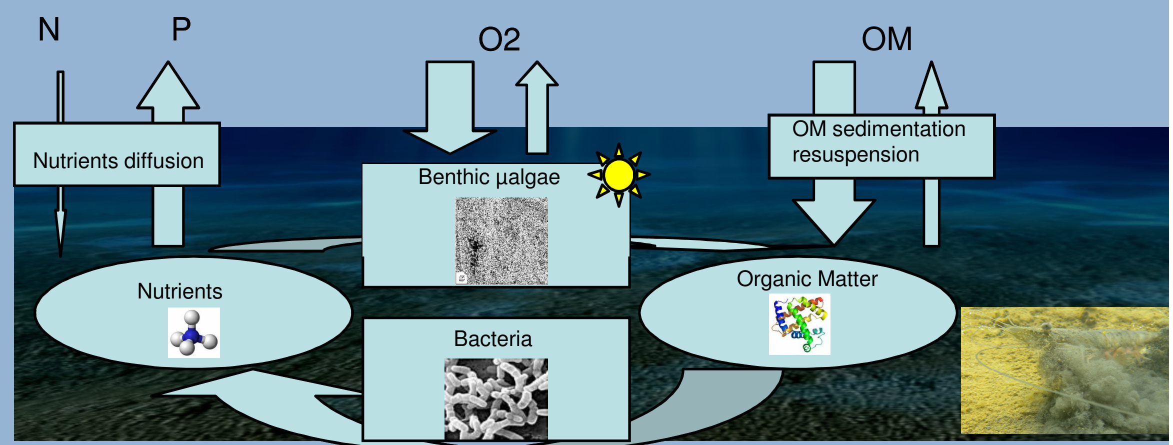
Step 1

Production > Respiration
Low OM exchanges
Low N and P fluxes



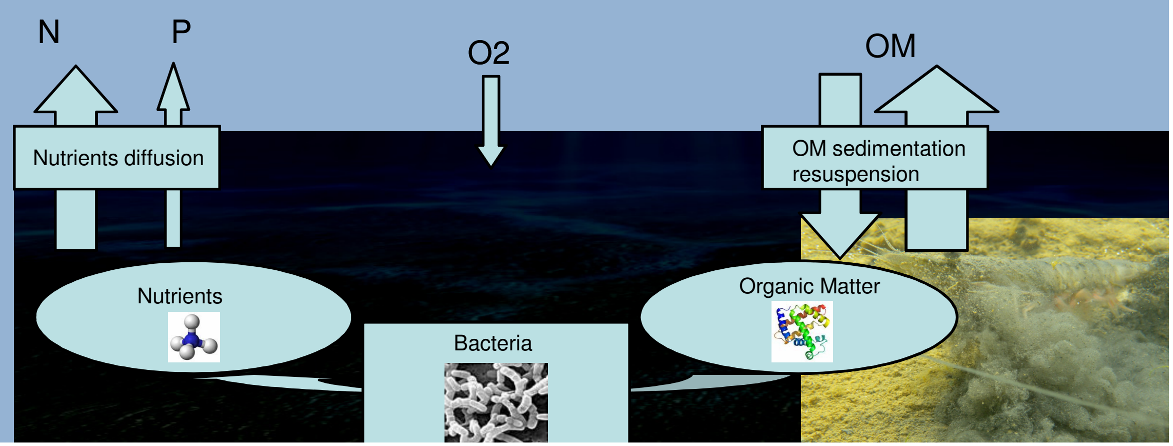
Step 2

Production < Respiration
Strong OM input
Low N fluxes
Strong P fluxes



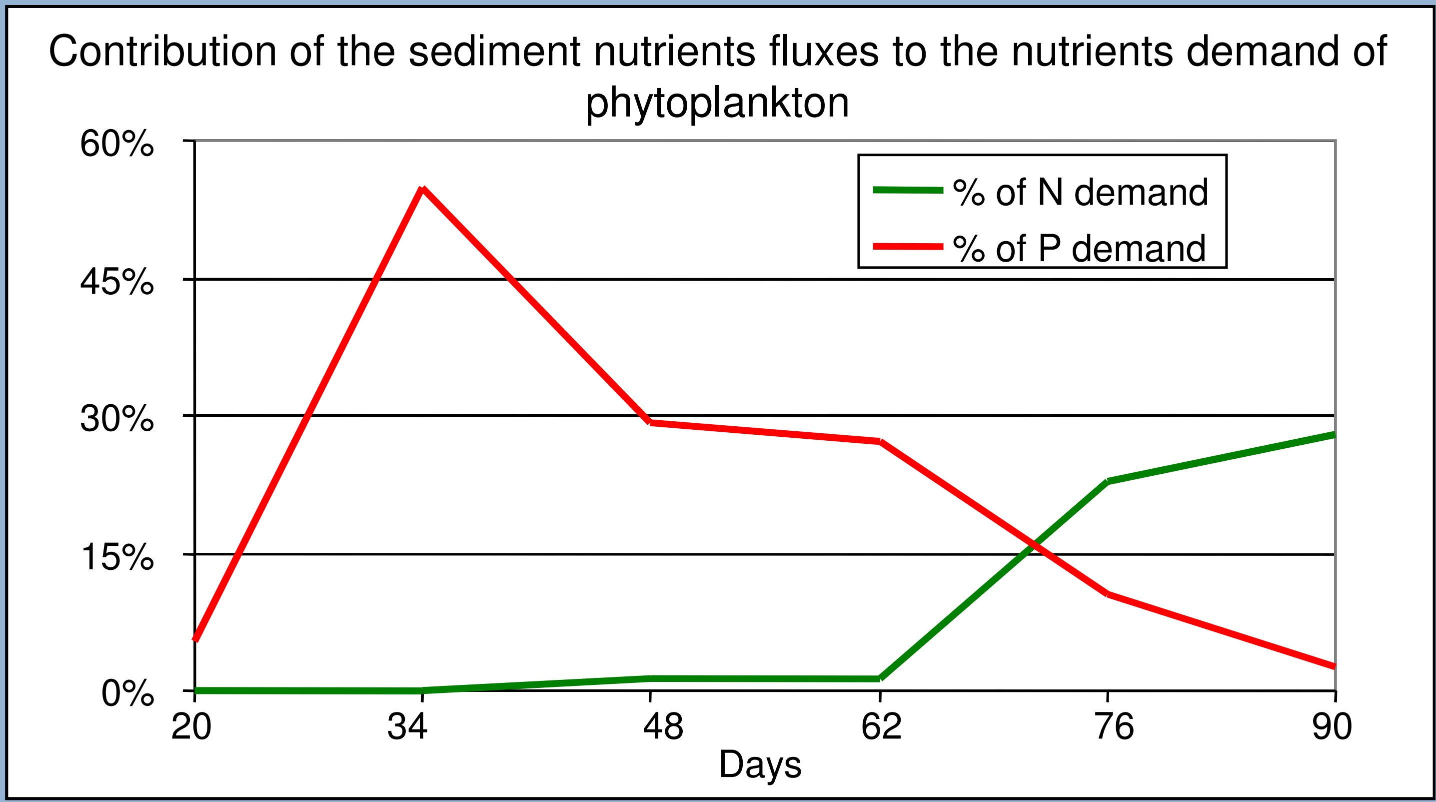
Step 3

No production
Low respiration
Strong OM exchanges
Strong N fluxes
Low P fluxes



How does it impact the pond management?

Benthic µalgae are an important driver of the pond temporal variability.



Sediment has its own fertilization program for your pond.

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Thank you for your attention

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