Predicting the energy budget of the scallop *Argopecten purpuratus* in an oxygen–limiting environment

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The Peruvian Scallop

Marine aquaculture in Peruvian coastal environments produces mainly scallops

The Peruvian scallop is a Pectinid bivalve that lives naturally in bays and islands along the coast of Peru and northern Chile.

The Peruvian production of scallops is about **100 million dollars per year.**

Scallop growing-up is done directly on the seabed (> 70% of total production)

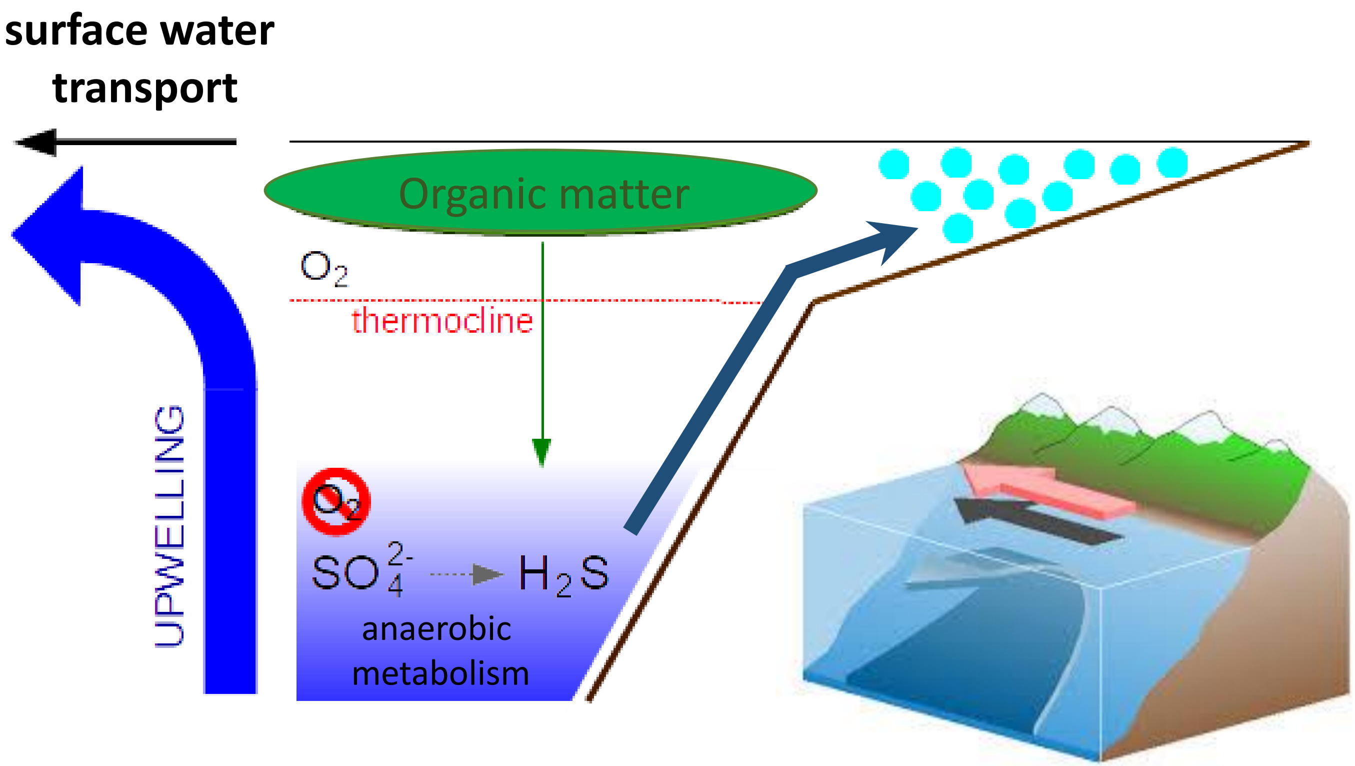
Cultivation system in suspended lantern nets

More than 25,000 jobs!

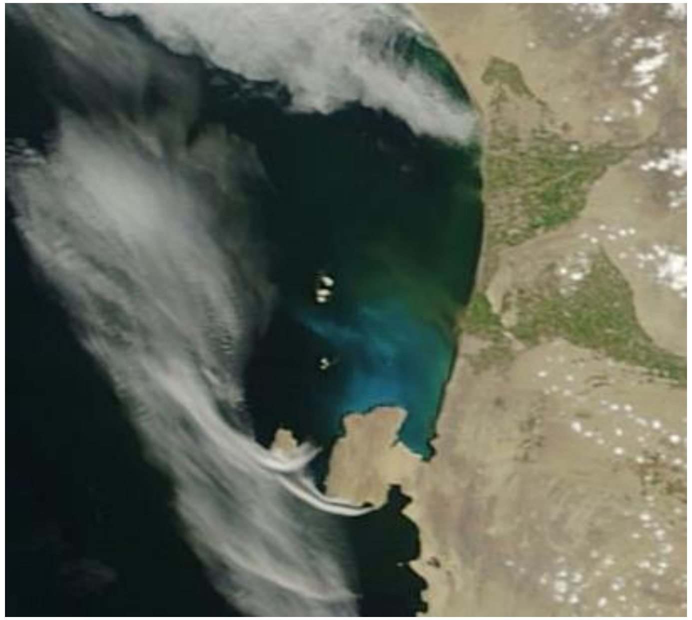
For fishermen and their families

Processing of scallops for export

The Peruvian upwelling: productive but poor in oxygen

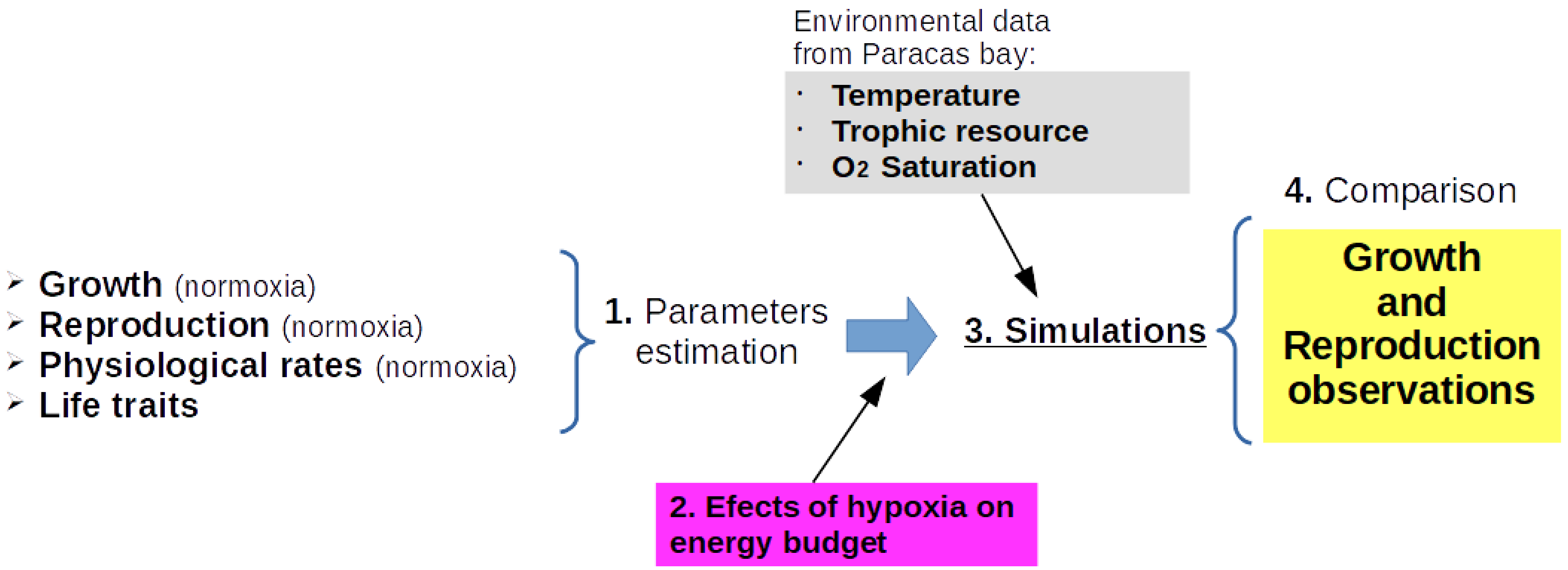


Milky turquoise waters

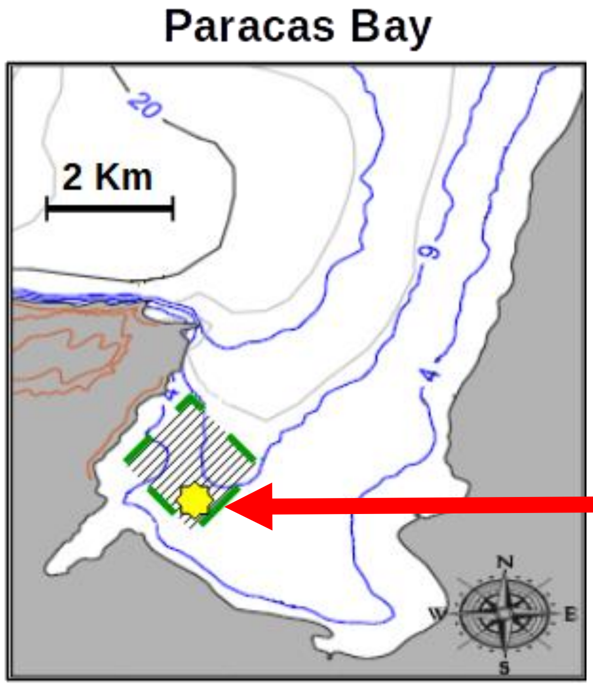


Oxygen limitation and exposure to toxic sulphide

Approach: make it simple



Paracas bay

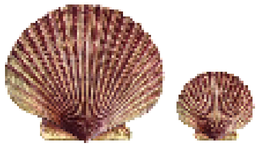


- Mean depth: 5m
- Tide range: < 1m
- **Traditional aquaculture**

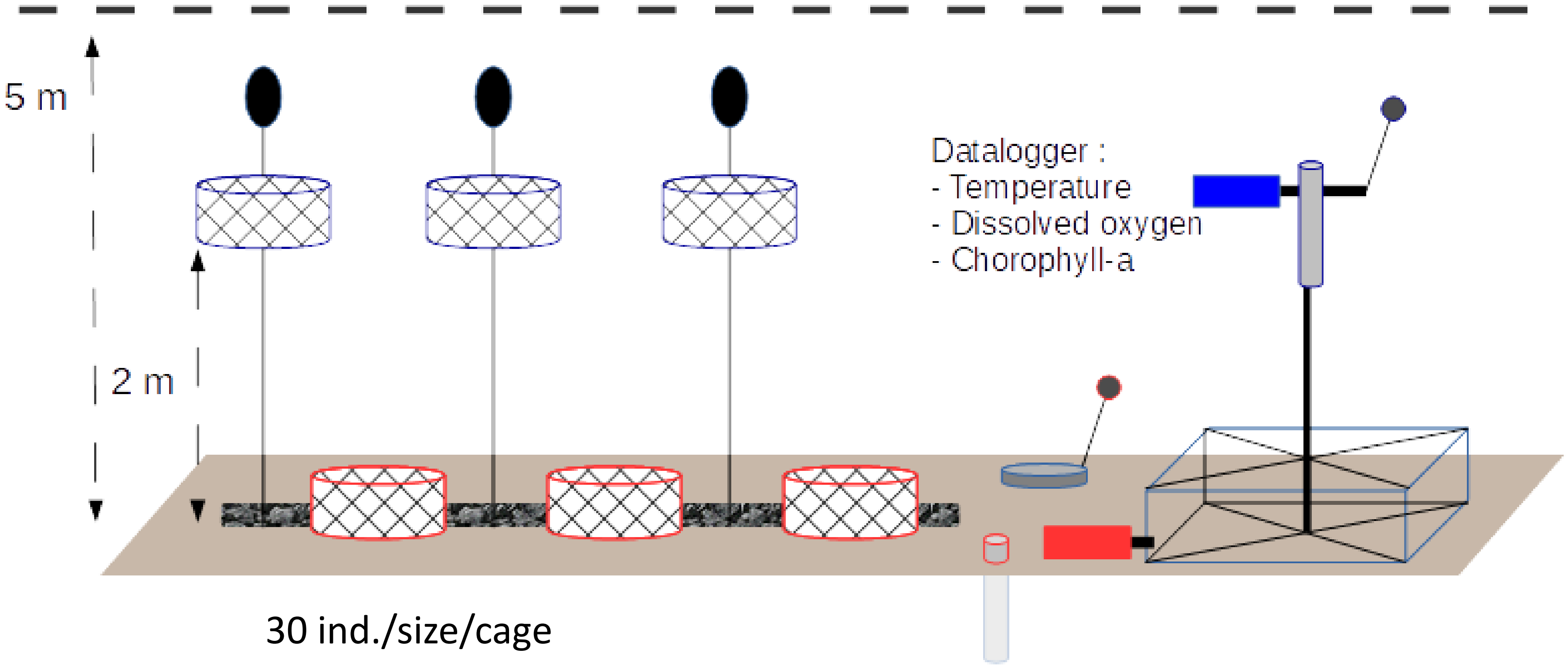
Environmental and growth/reproduction survey at Paracas bay

- 7 month from late austral winter to summer
- 2 growing-up depths
- High frequency environmental records (each hour)

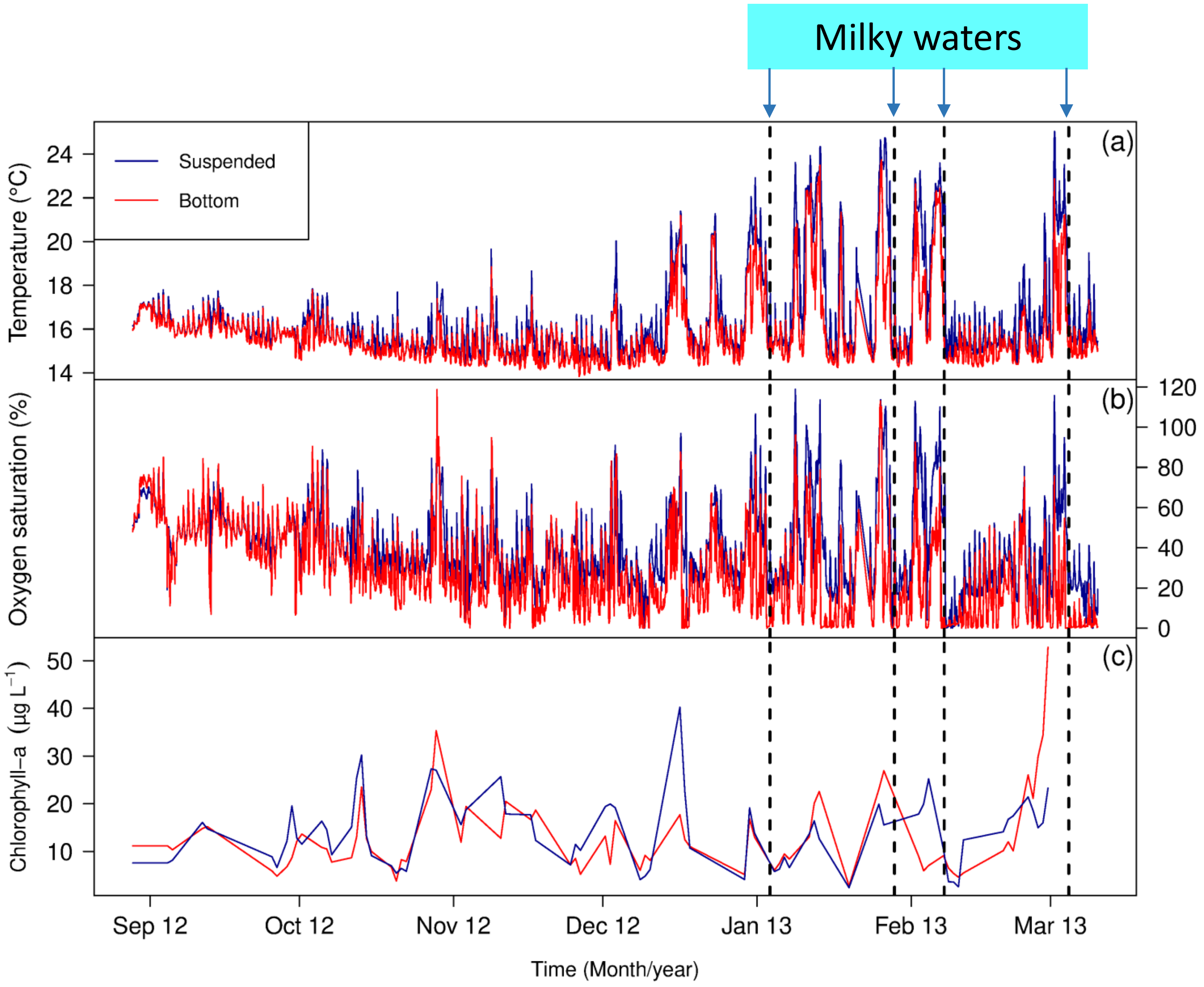
2 group sizes



- 3-4 cm
- 6-7 cm



Environmental data



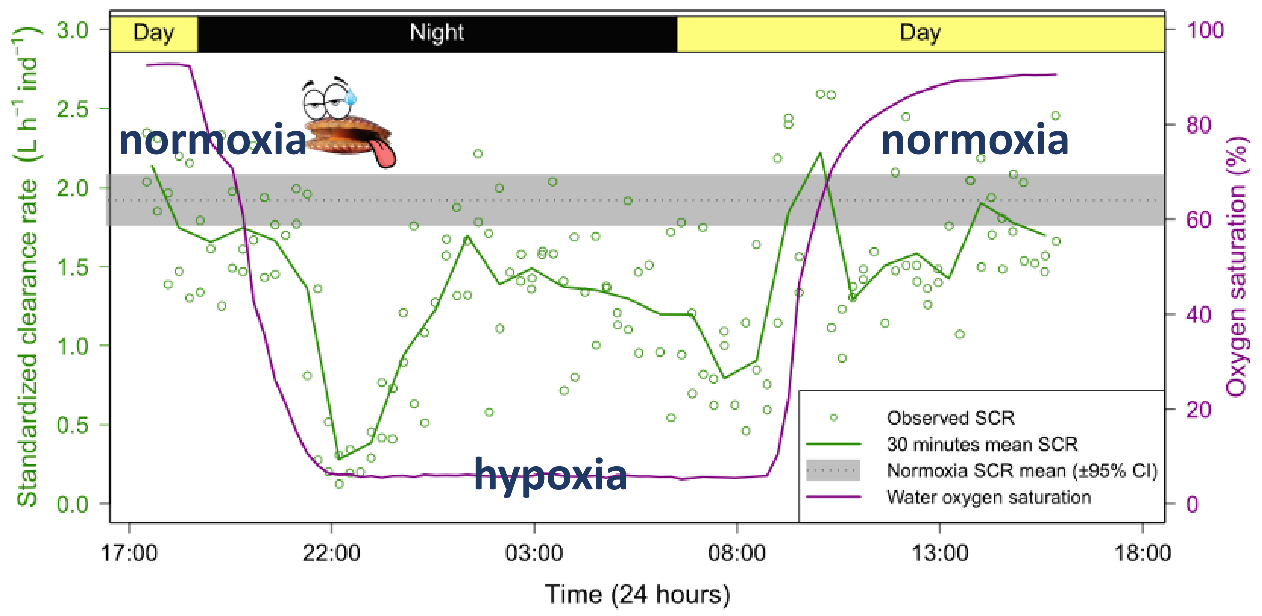
- Important temperature variations in the summer

- Low oxygen saturation: chronic and severe hypoxia (+ anoxic events). **Oxygen limitation more evident near the bottom**

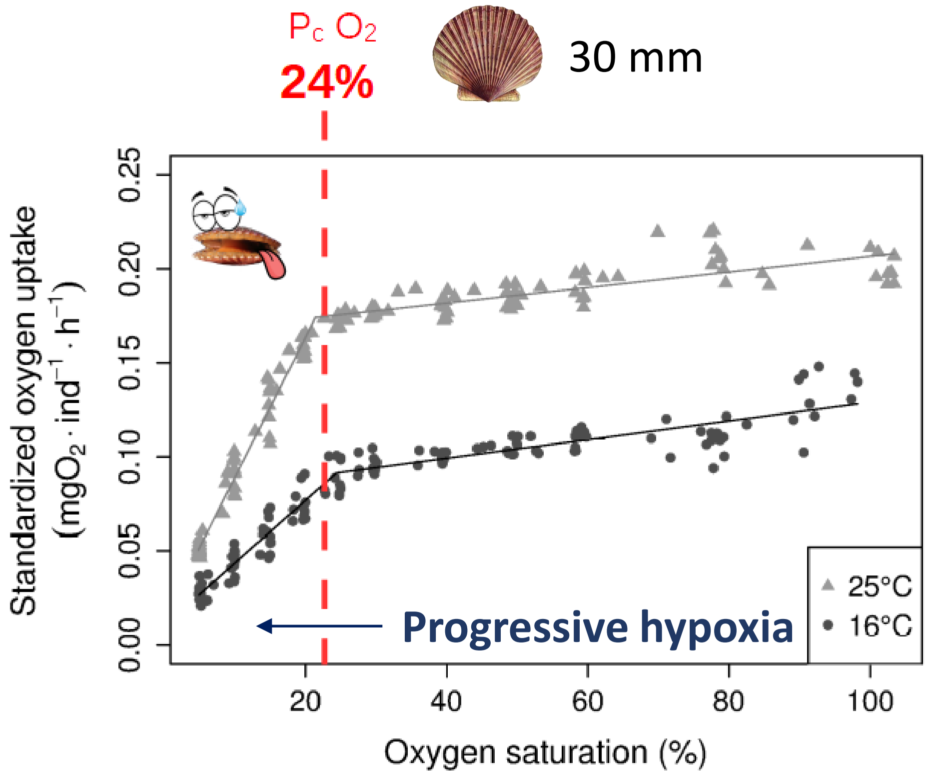
- No significant differences for trofic resource

Effects of hypoxia on physiological rates

Clearance Rate

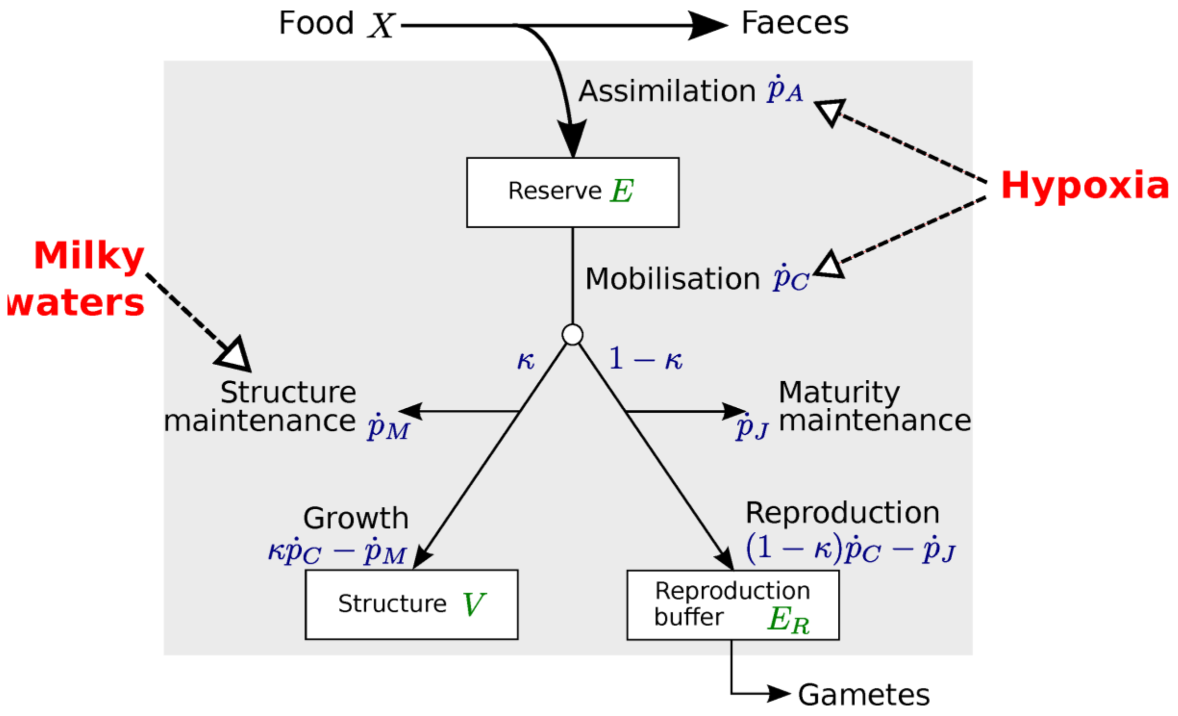


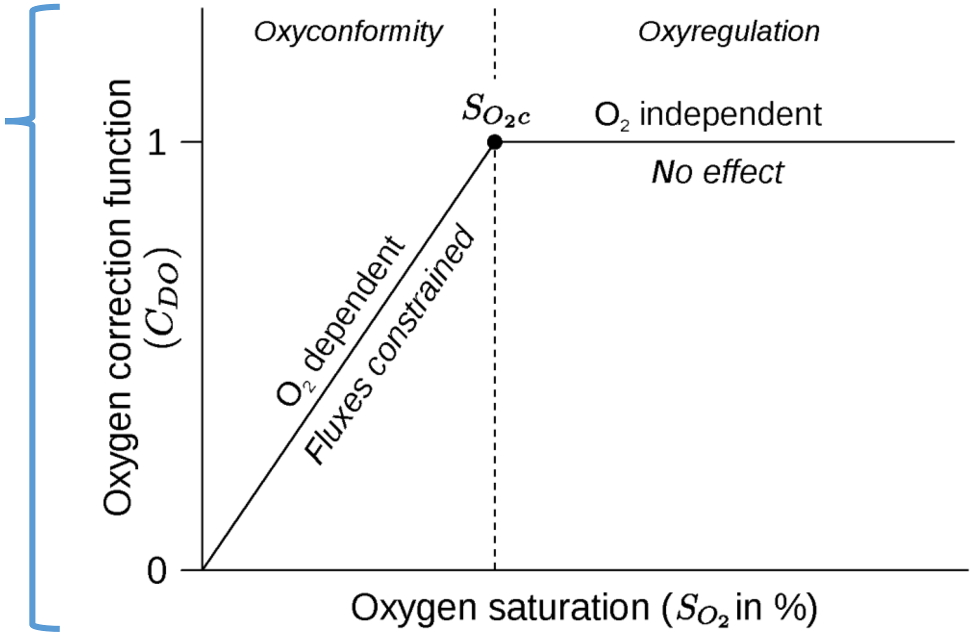
Oxygen uptake



Including effects of hipoxia on DEB model

increase in maintenance costs during milky waters events





$$\dot{p}_A = c(T)\, C_{DO} \{\dot{p}_{Am}\} f\, V^{2/3}$$

$$\dot{p}_C = c(T)\, C_{DO} \frac{[E]}{[E_G] + \kappa [E]} \left(\dot{v}\, [E_G]\, V^{2/3} + \dot{p}_M\right)$$

with $C_{DO} = \frac{S_{O_2}}{S_{O_2c}}$ if $S_{O_2} < S_{O_2c}$

$= 1$ otherwise

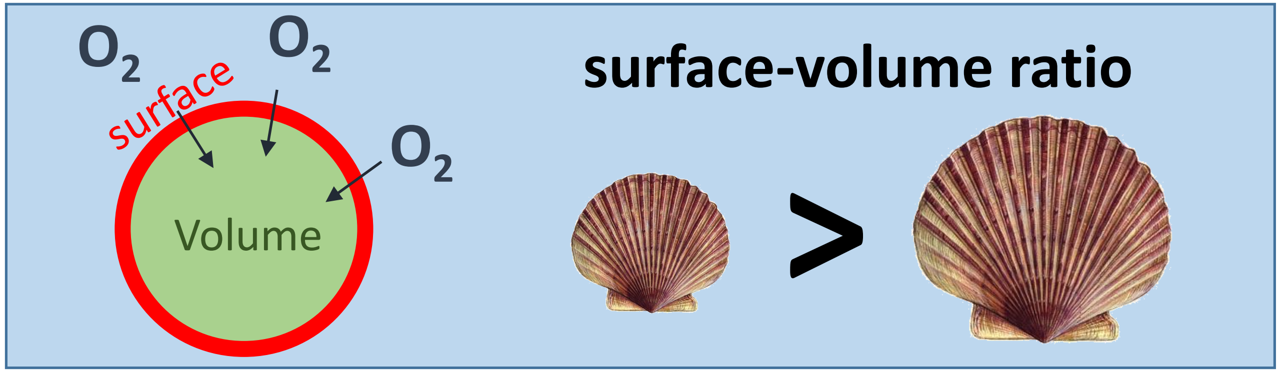
Assumptions below the *So$_2$c*:

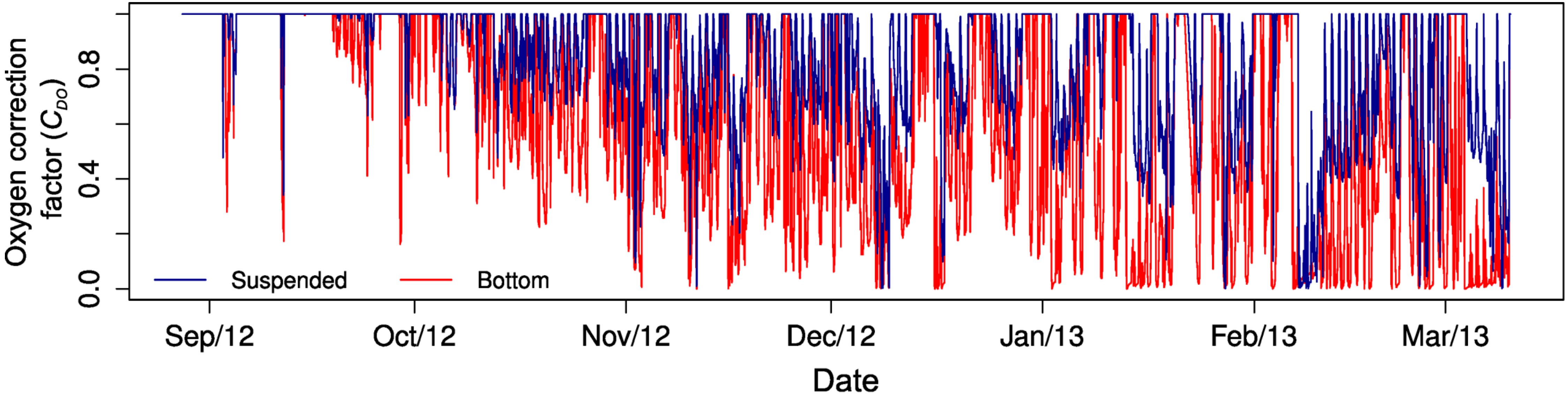
- Aerobic metabolic rate reduce proportional to environmental oxygen limitation
- The mobilization of reserves using anaerobic metabolic pathways is negligible

Oxygen correction function

Effect of hypoxia was strong than expected:

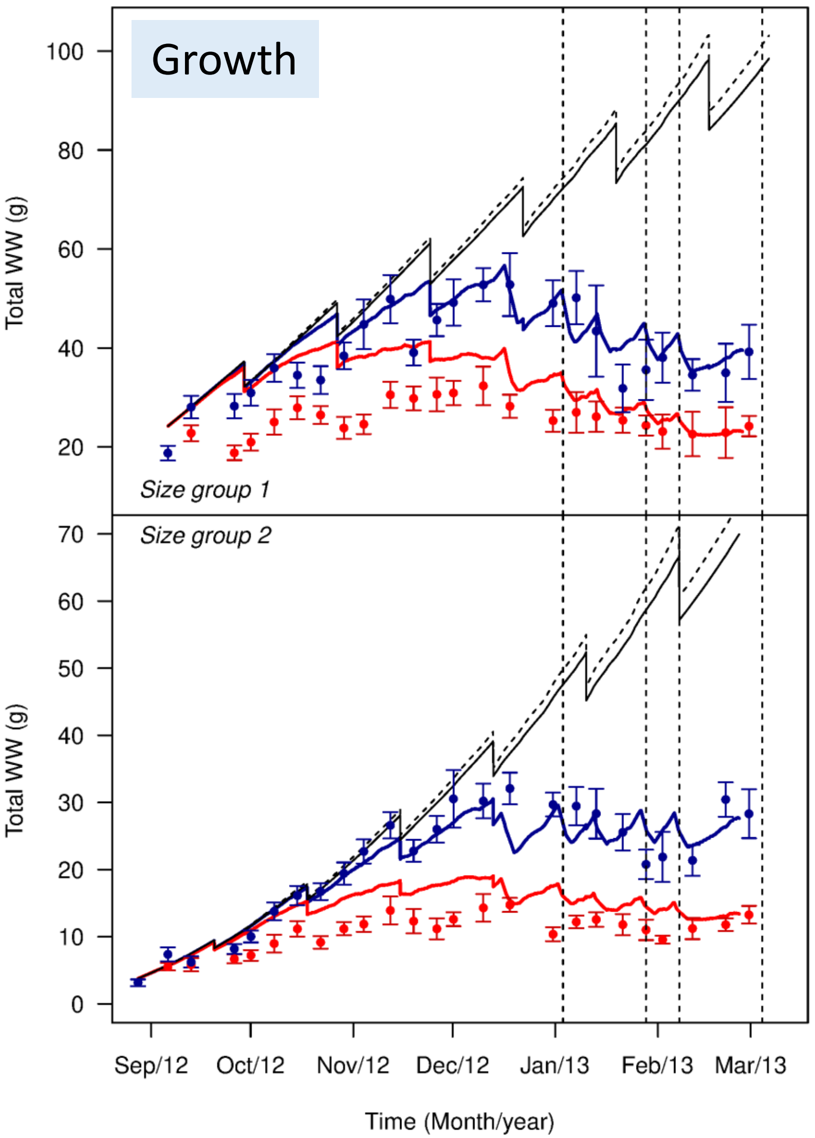
***So_2c* was increased to 40%**

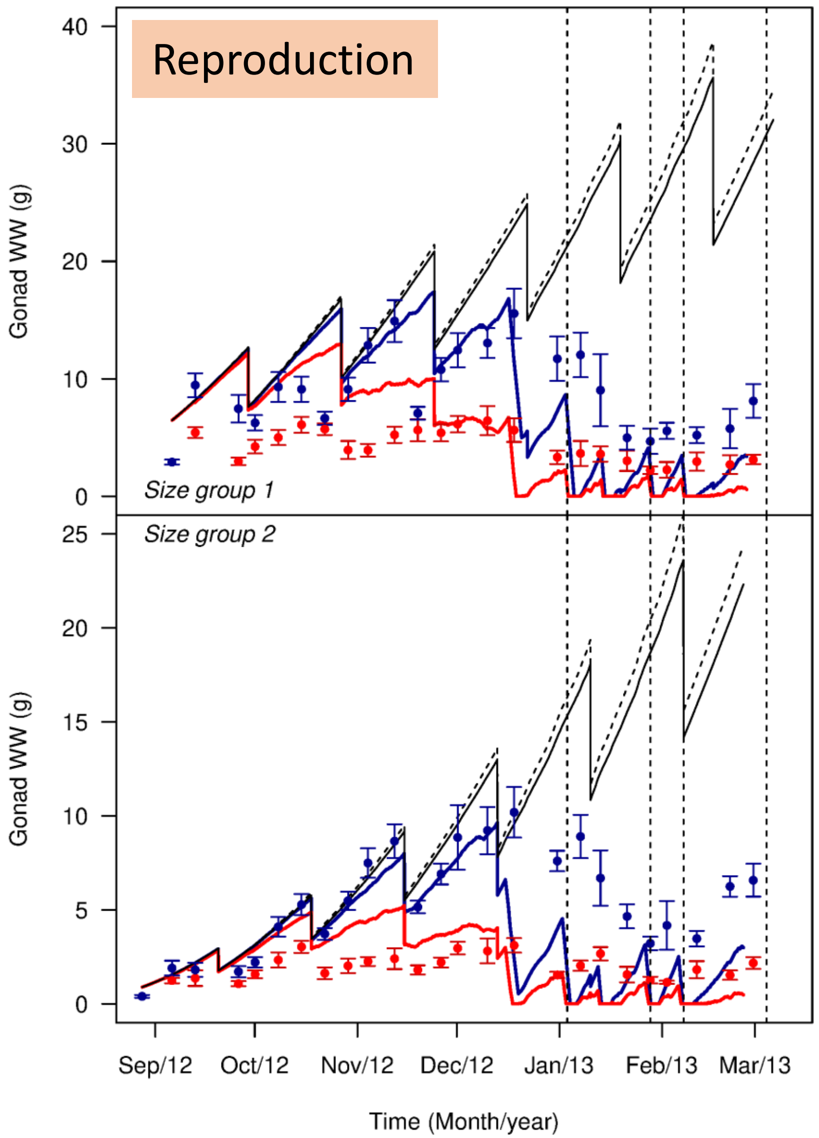




***pM* and *pA* fluxes were more restricted in scallops growing on bottom especially in summer**

Simulation outputs





Perspectives

- **Test the effect of size on the critical point**
  - Experiments in progress:
  Little scallops survive longer to severe hypoxia exposition (field reports and experimental evidence)

- **Take into account the anaerobic metabolism**
  -Several metabolic pathways
  -Metabolic toxic endproducts

- **Oxygen budget**
  Challenge: different adaptations (metabolic, physiological and behavioural strategies) must to into account

- **Approach multi-stress (hypoxia is not a isolate phenomena)**