

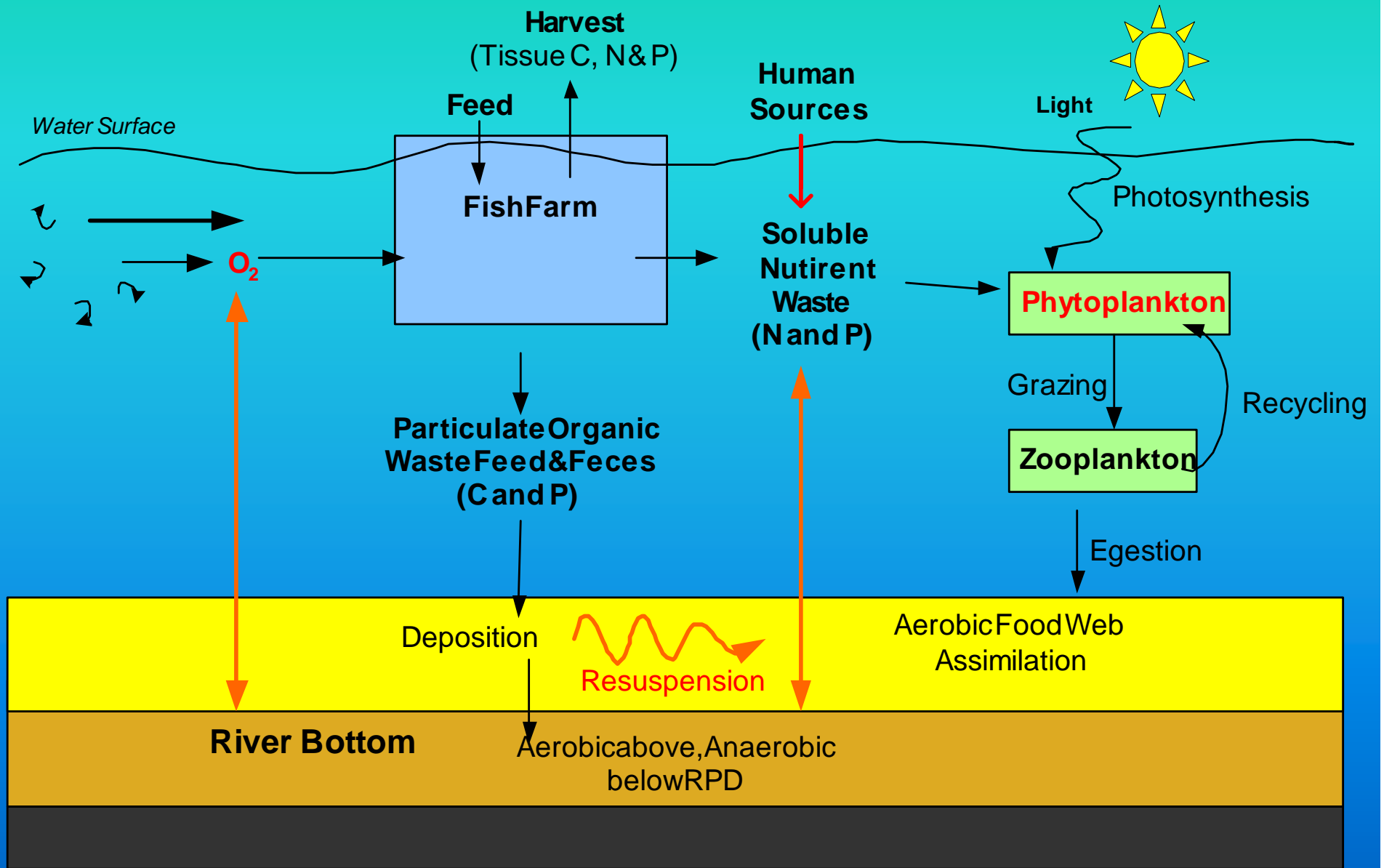
Modeling Fish Farm Operations and Impacts

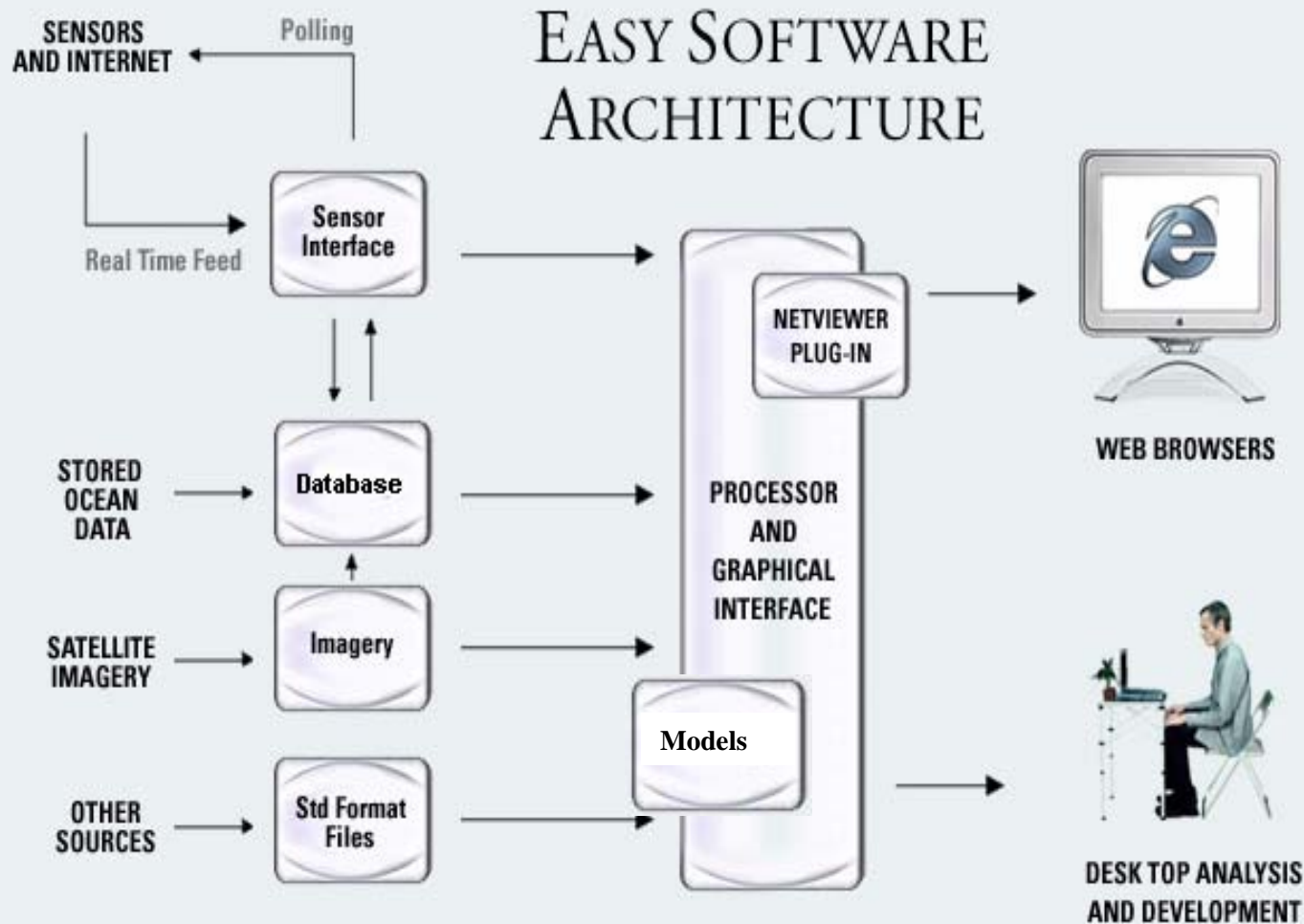
By
Dale A. Kiefer
Frank O'Brien and Jack Rensel
System Science Applications

American Fisheries Association
September 5, 2007

More Information: [Google "AquaModel"](#)

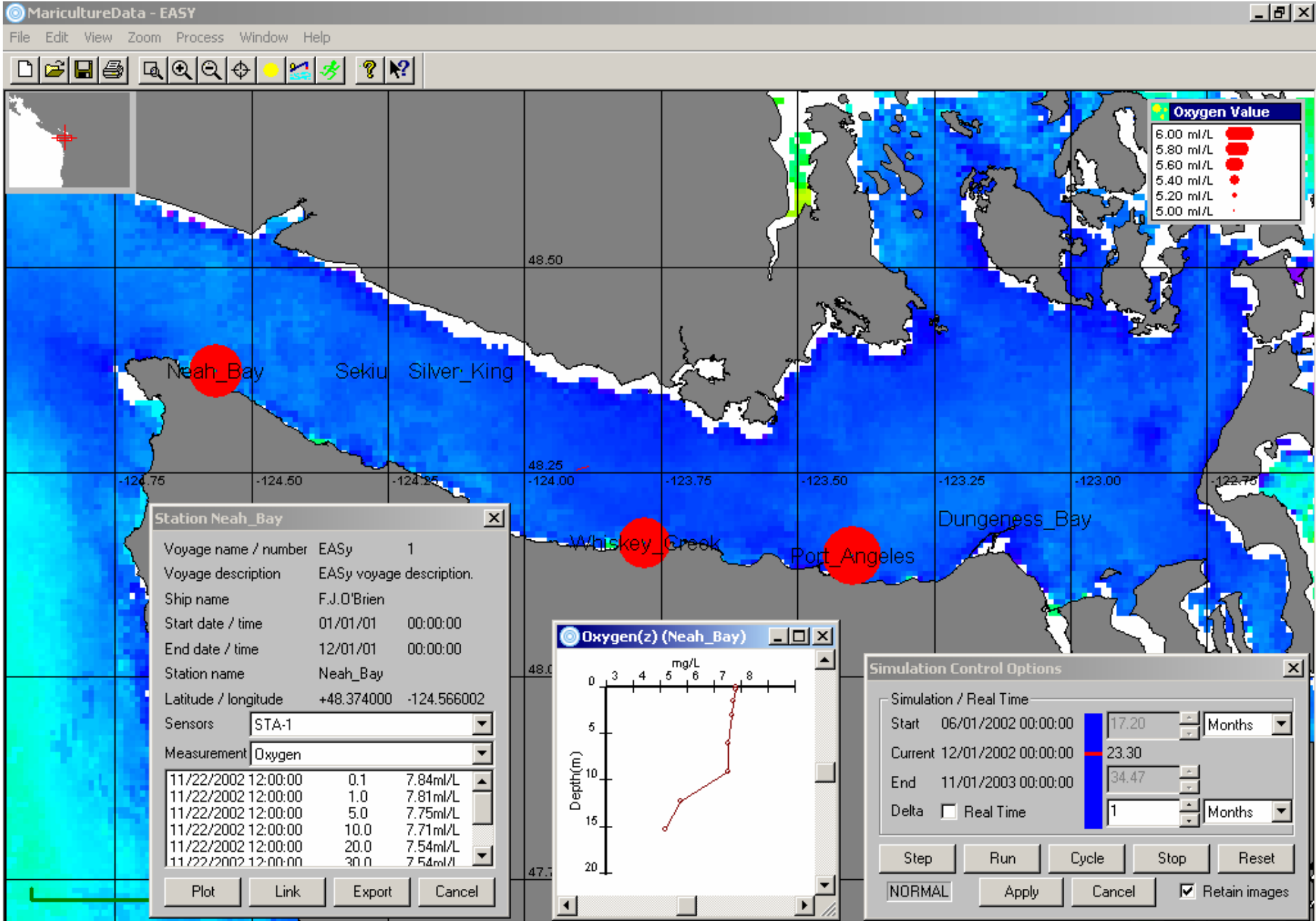
Model Overview





- Three dimensional system for marine applications
- Interfaces for models, spreadsheets, databases, and Internet
- PC Desktop & Web-enabled GIS applications
- Compatible with ESRI (arc-info) GIS

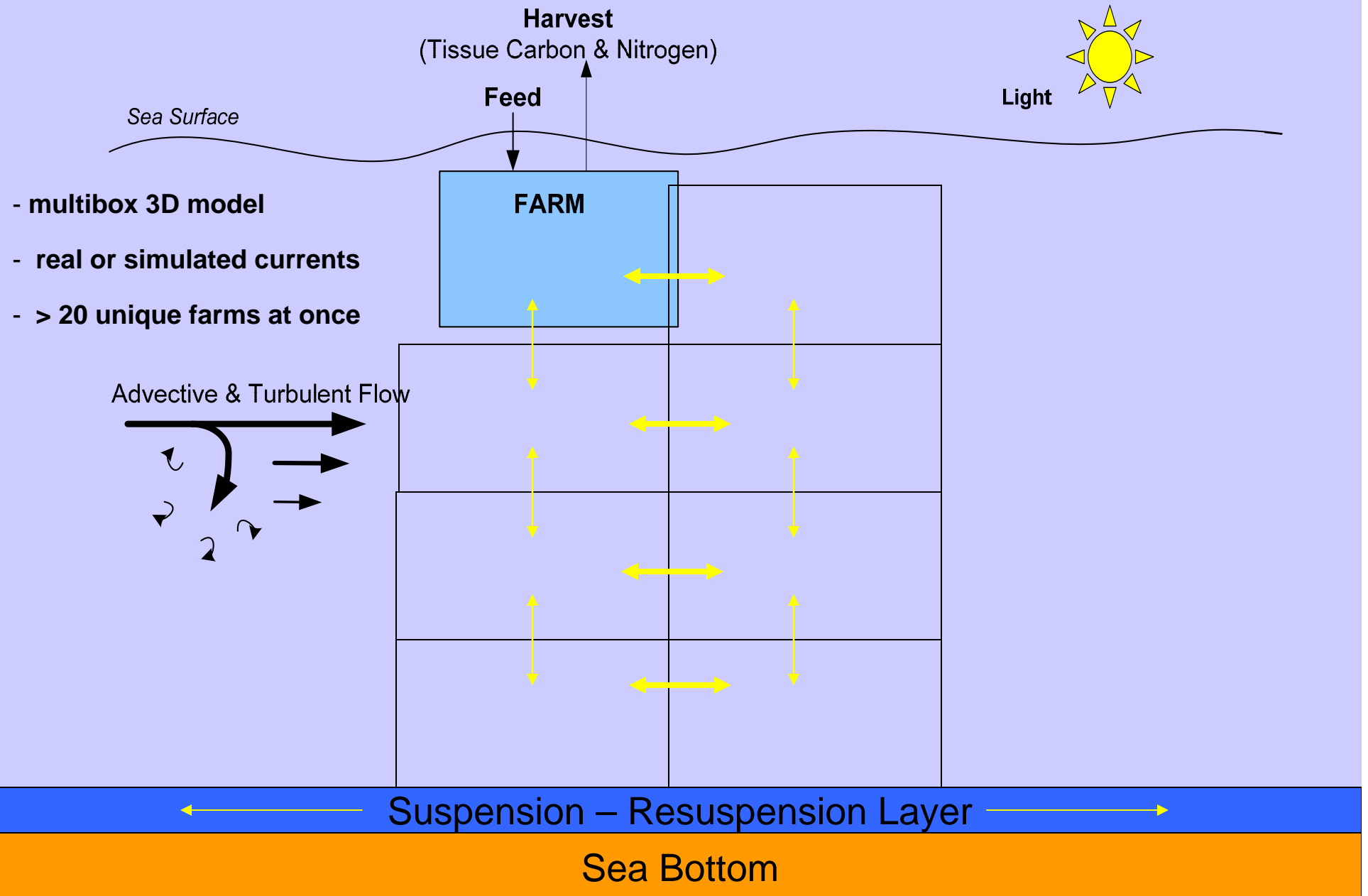




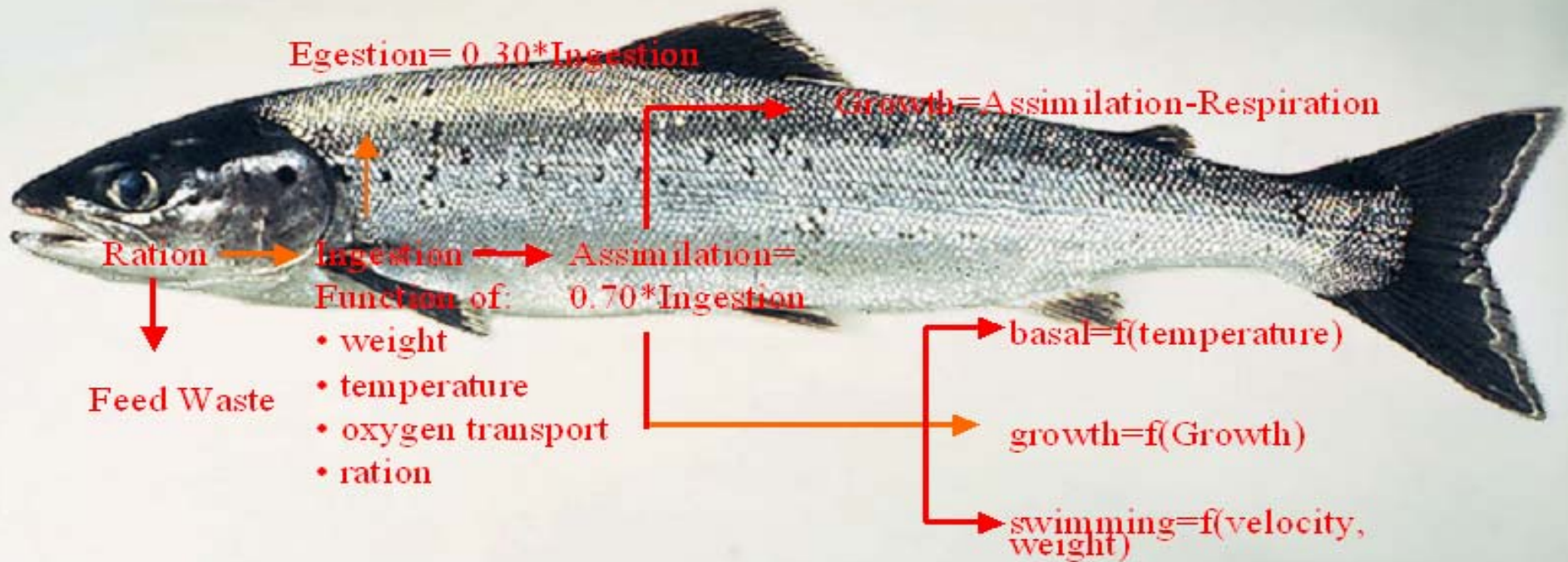
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Hydrodynamic Module



Bioenergetics Model



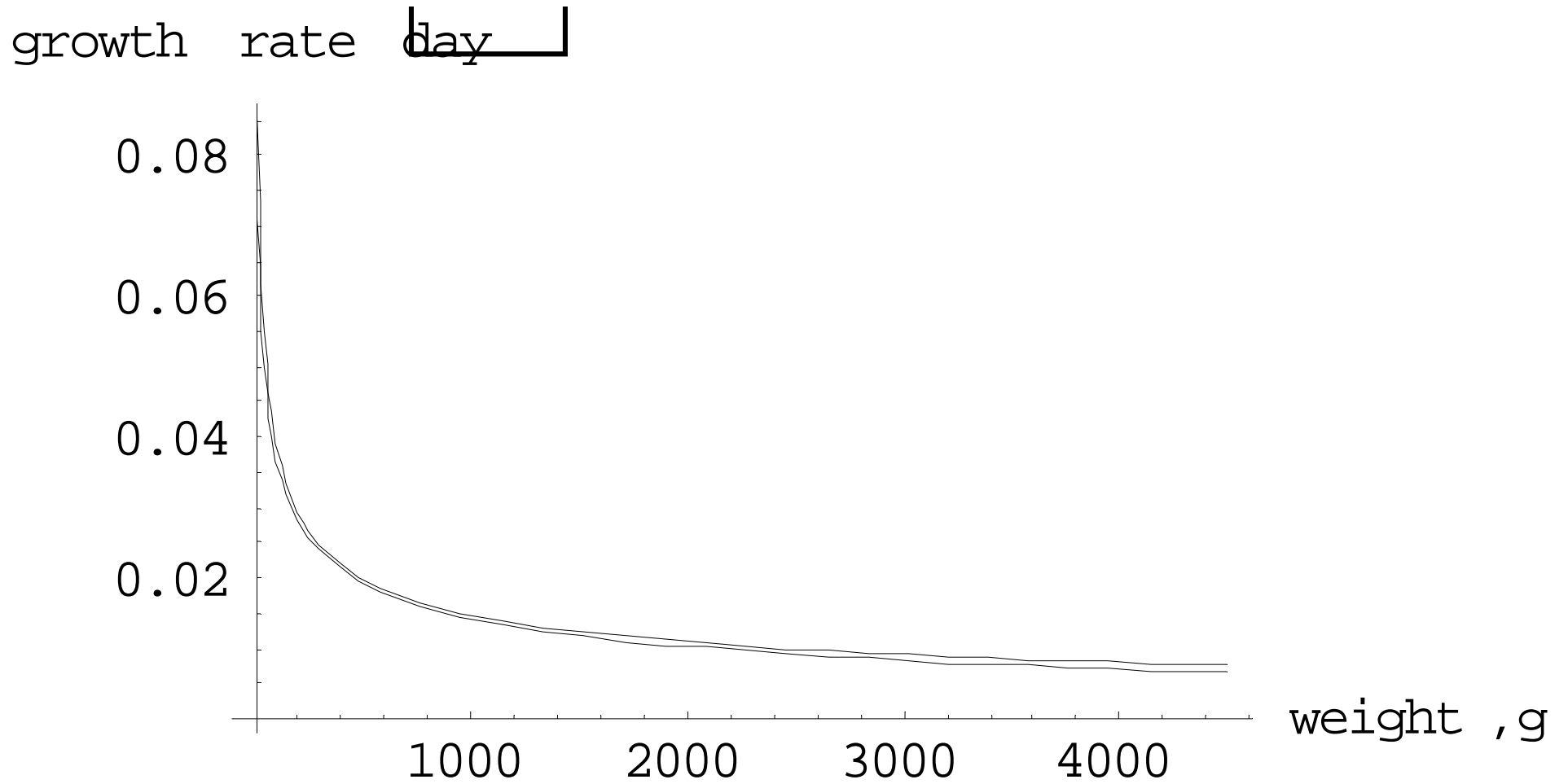
Carbon/Nitrogen/Oxygen Metabolism

- rate of loss of uneaten feed = feed rate – ingestion rate
- ingestion rate = egestion rate + assimilation rate
- rate of feces production = egestion rate
- assimilation rate = rate of respiration + rate of growth
- respiration rate = resting rate of respiration (i.e. basal) + respiration rate of activity (swimming) + respiration rate of anabolic activity (growth)

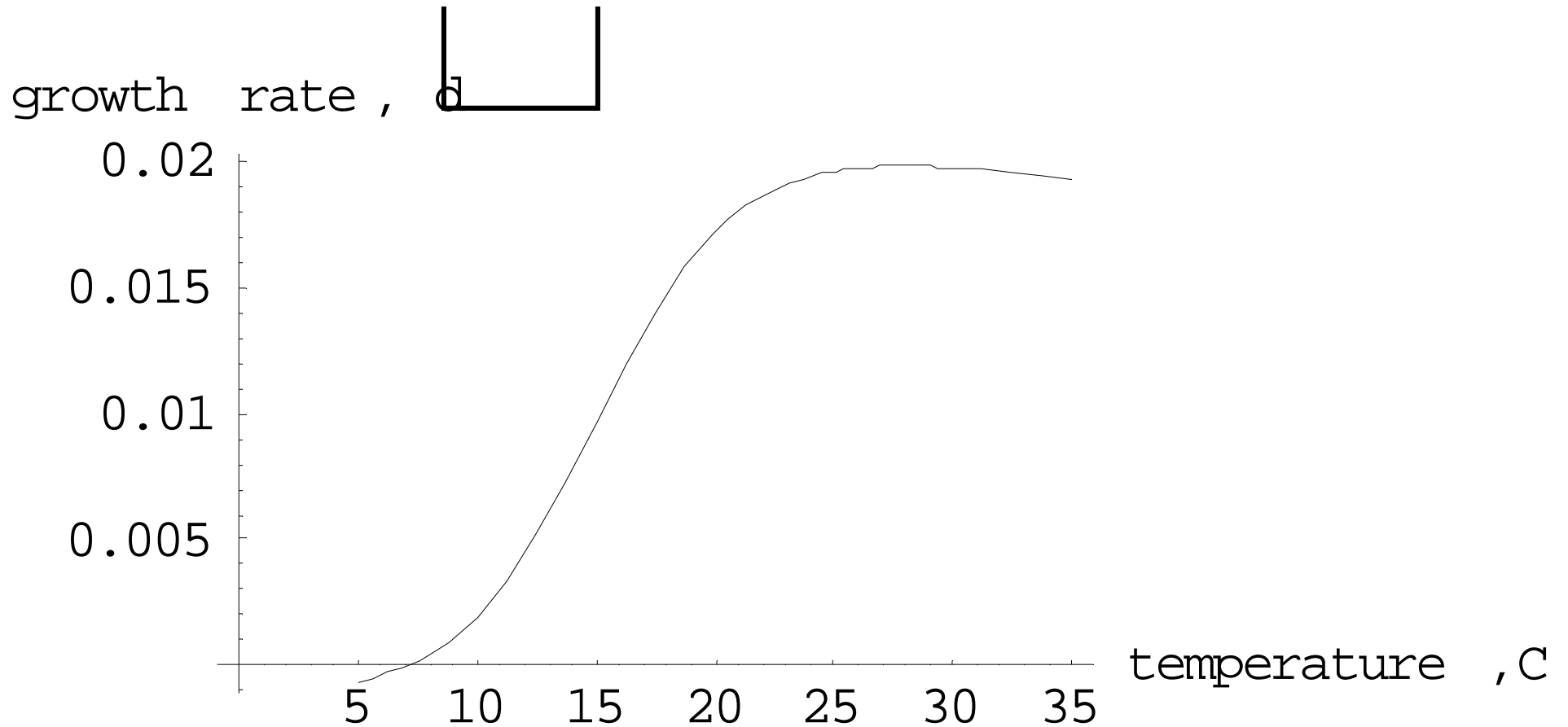
Equations invoke principle of most limit metabolic process:

Assimilation may be limited by fish size, water temperature, oxygen, feed rate

AquaModel vs Von Bertalanffy Growth Rates

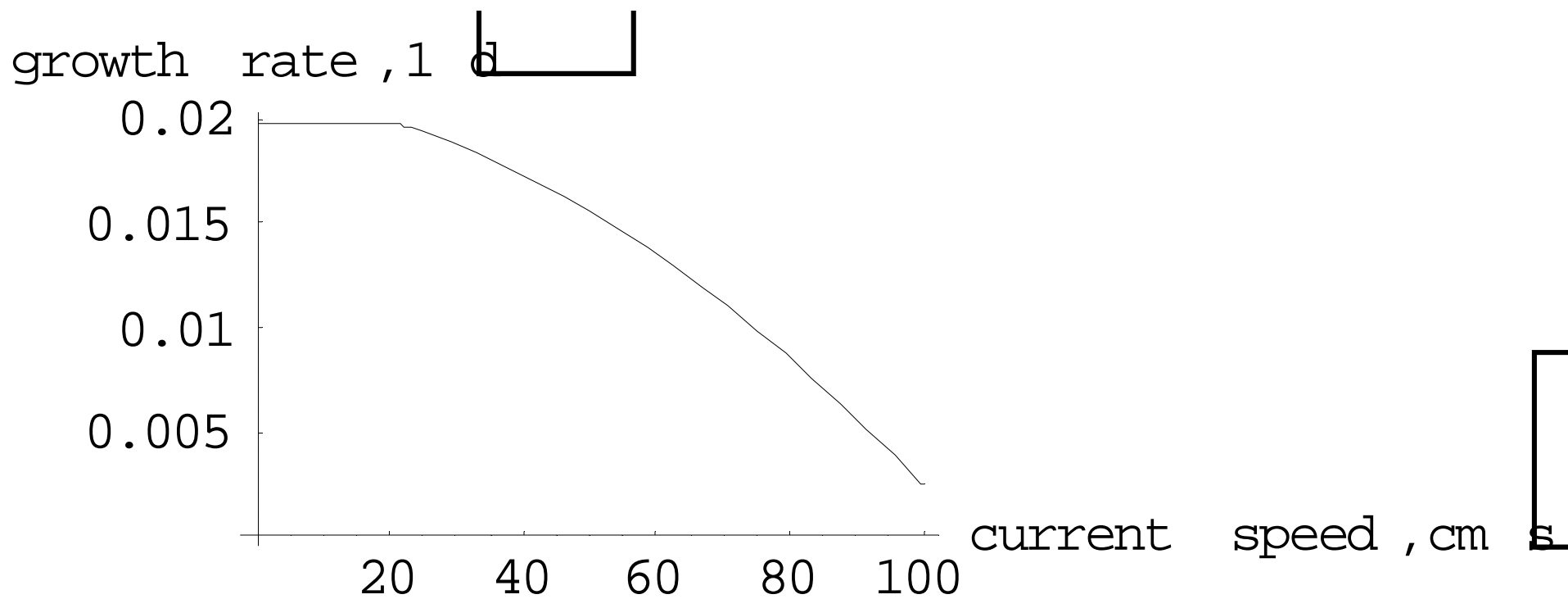


Rachycentron 500 gm wet weight:
AquaModel growth rate vs temperature

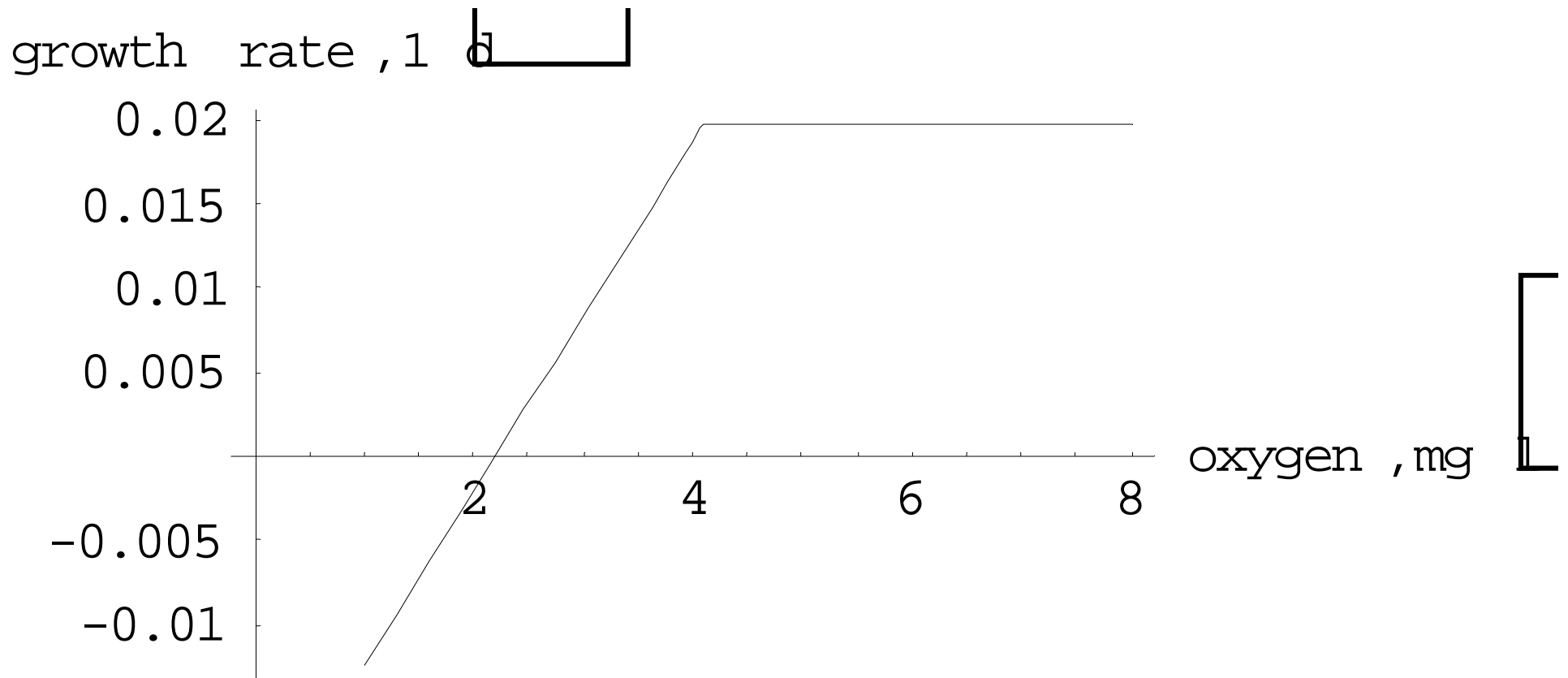


AquaModel growth rate as function of current speed

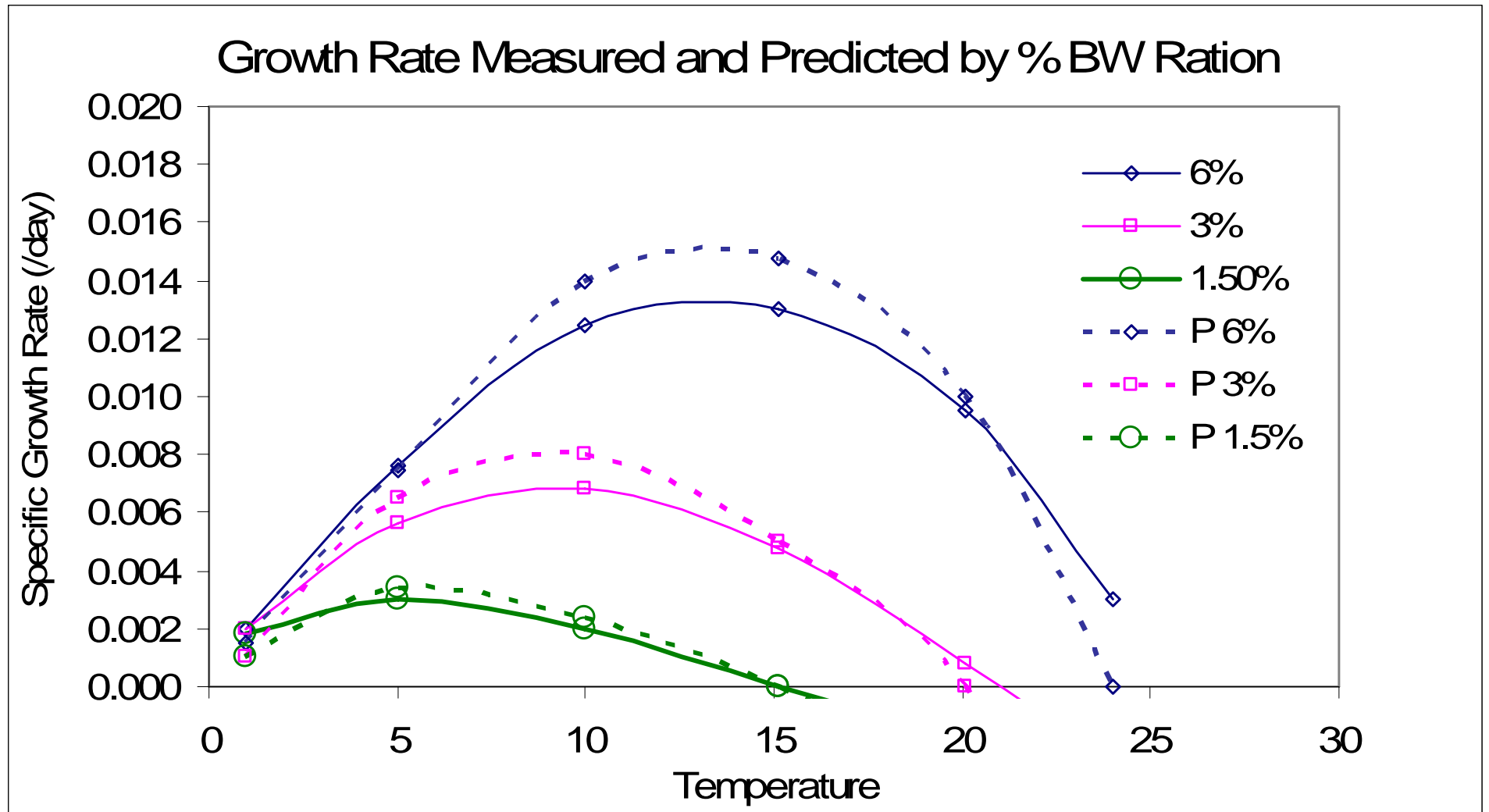
(500 g fish, 28 deg. C, 5.7 mgO₂/l)



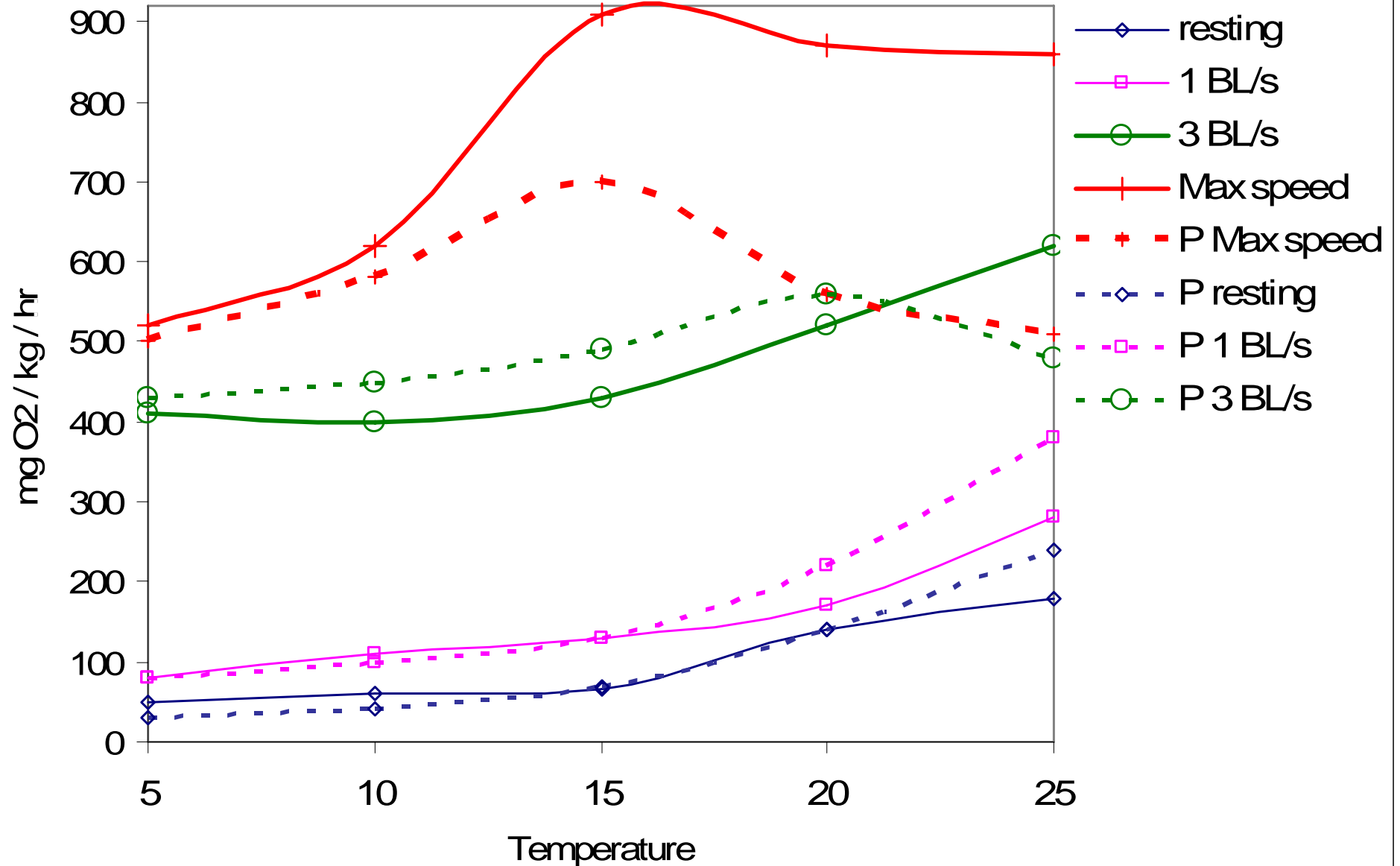
Cobia Aquamodel: growth rate vs oxygen concentration (500 g fish, 28 degC, resting)



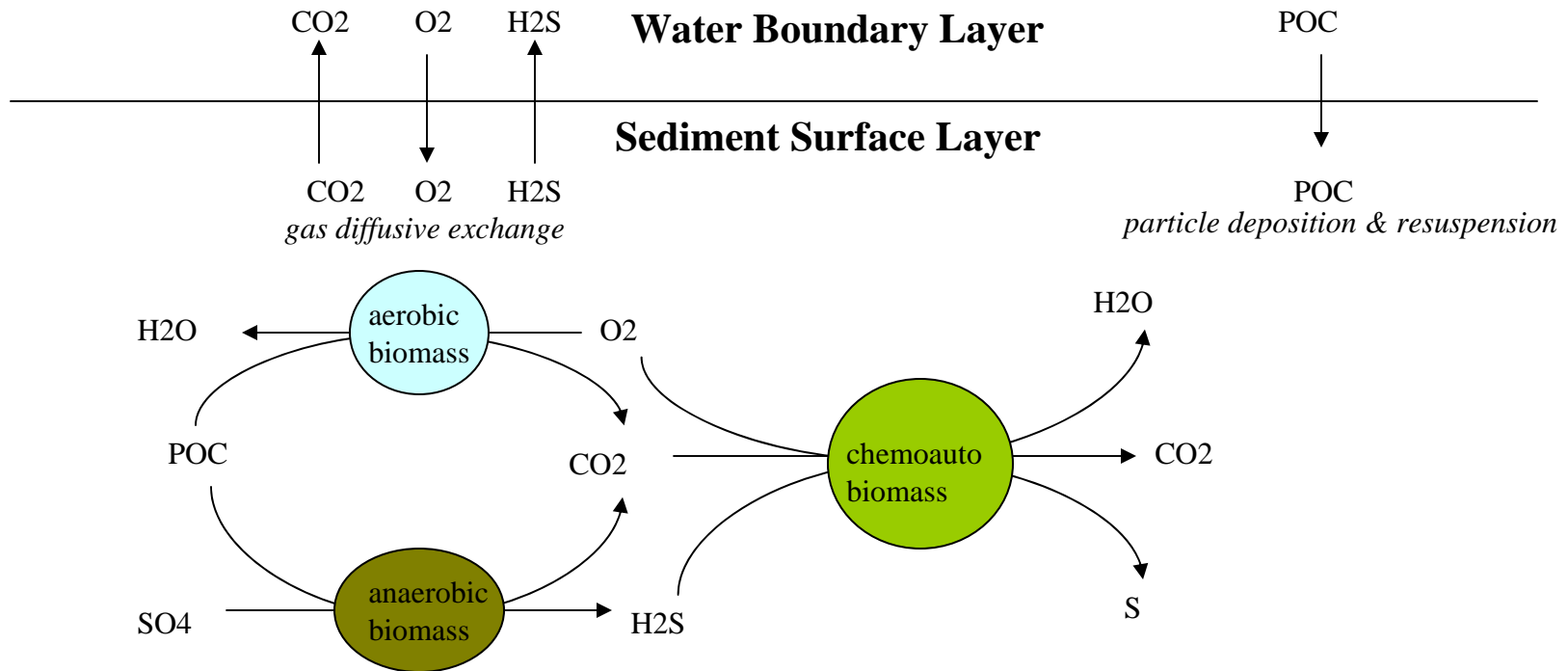
Atlantic Salmon measurements and AquaModel calculations



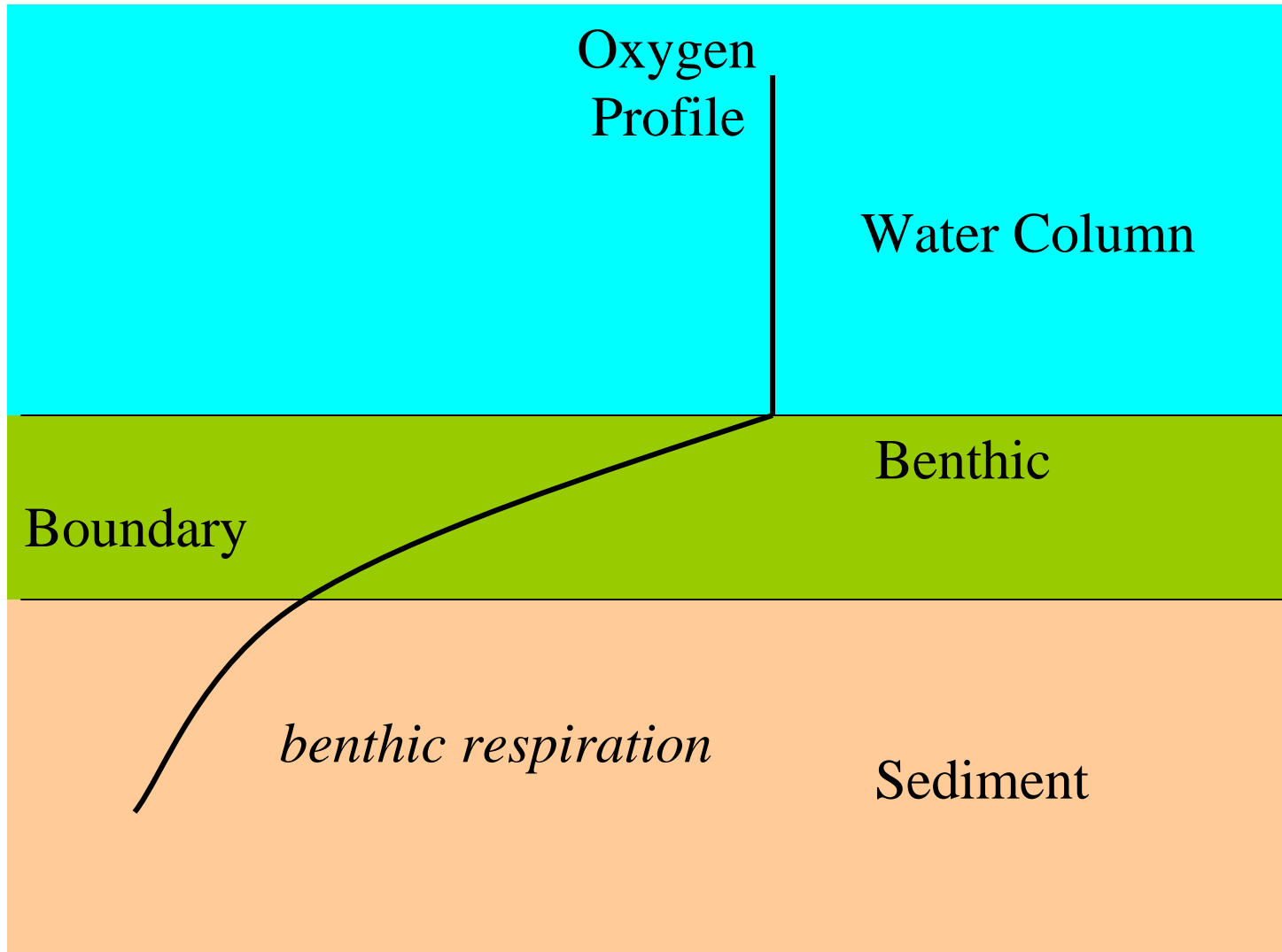
Respiration Rate Measured and Predicted (P)



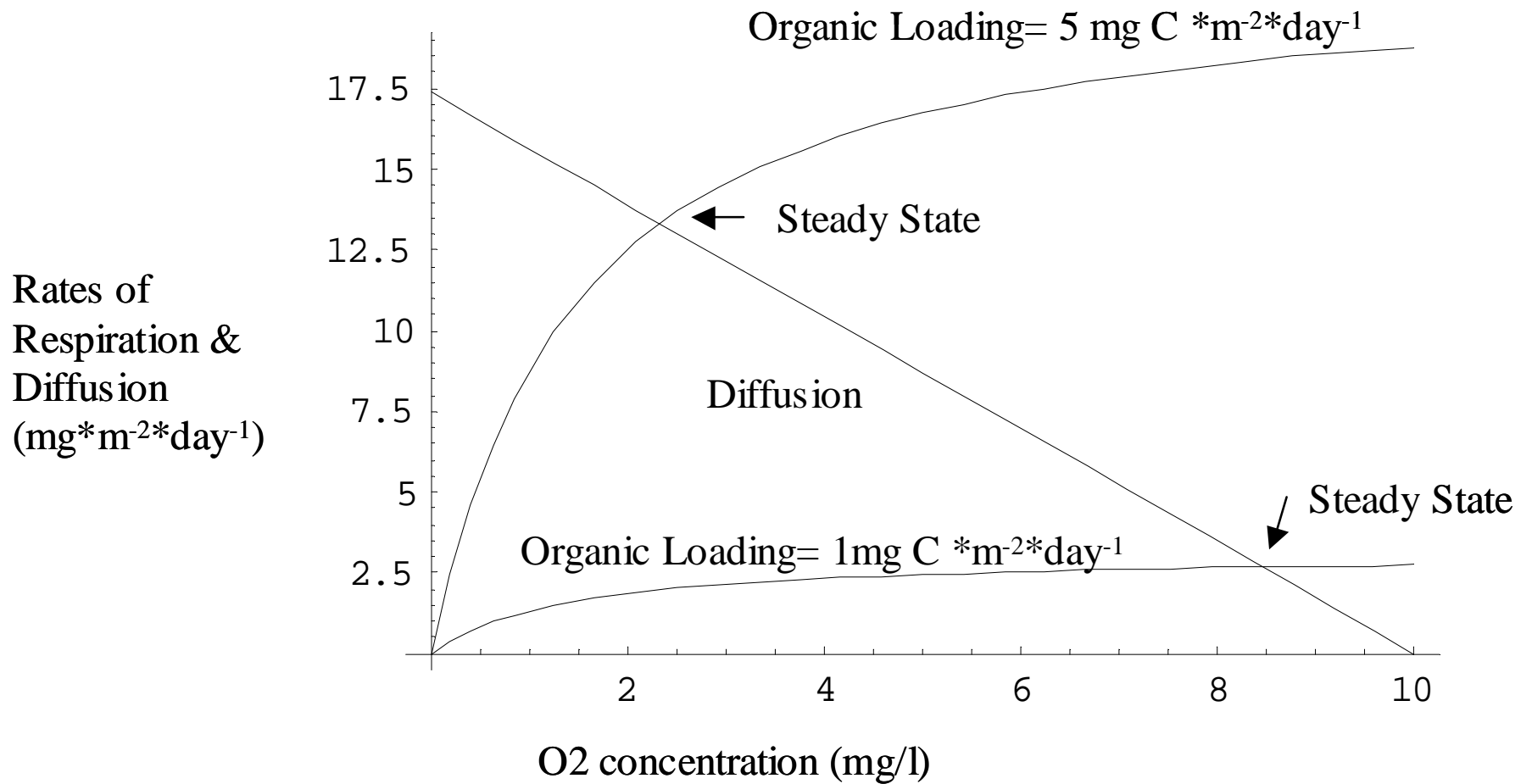
Benthic Dynamics



Oxygen Profile at Benthic Boundary Layer



Behavior of benthic subroutine: steady state conditions defined for low and high rates of loading.



Findlay & Watling (94, 95, 97)

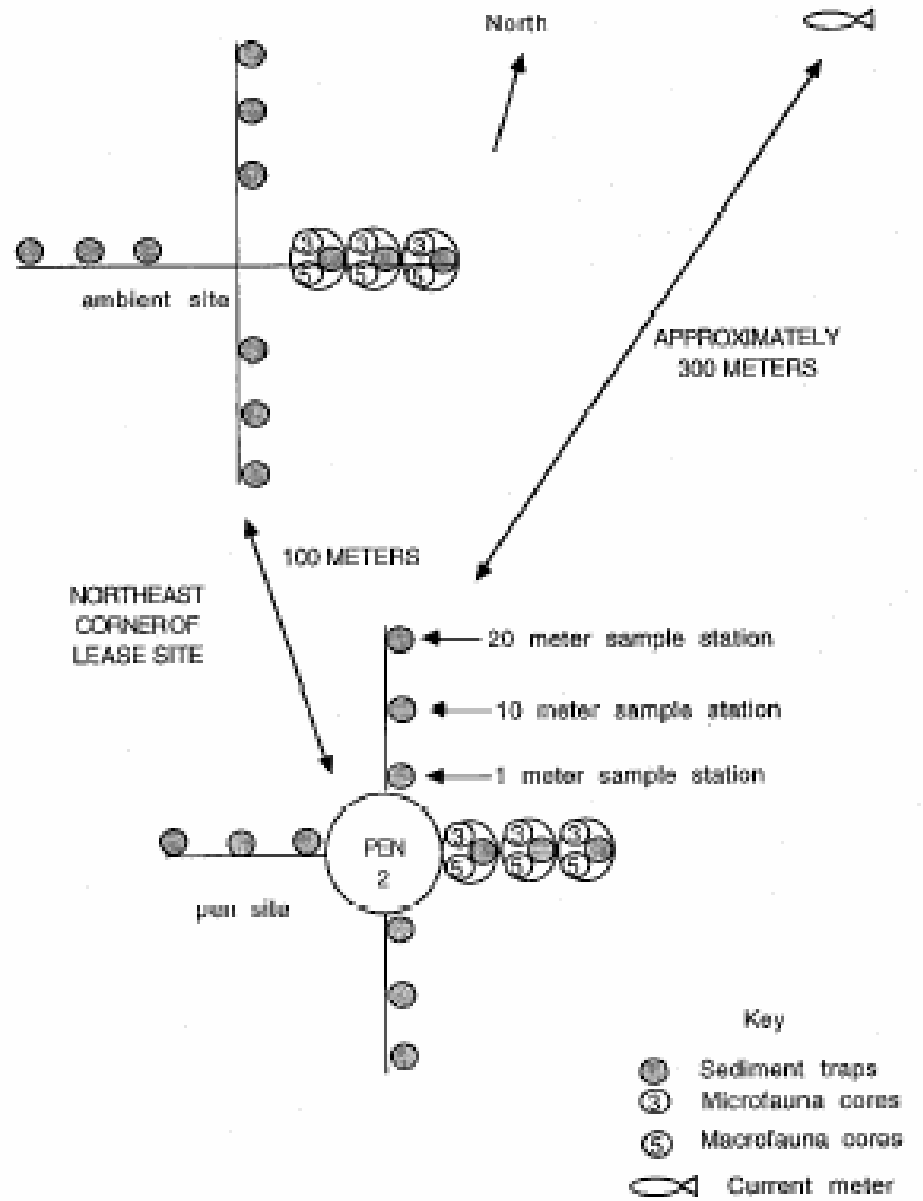
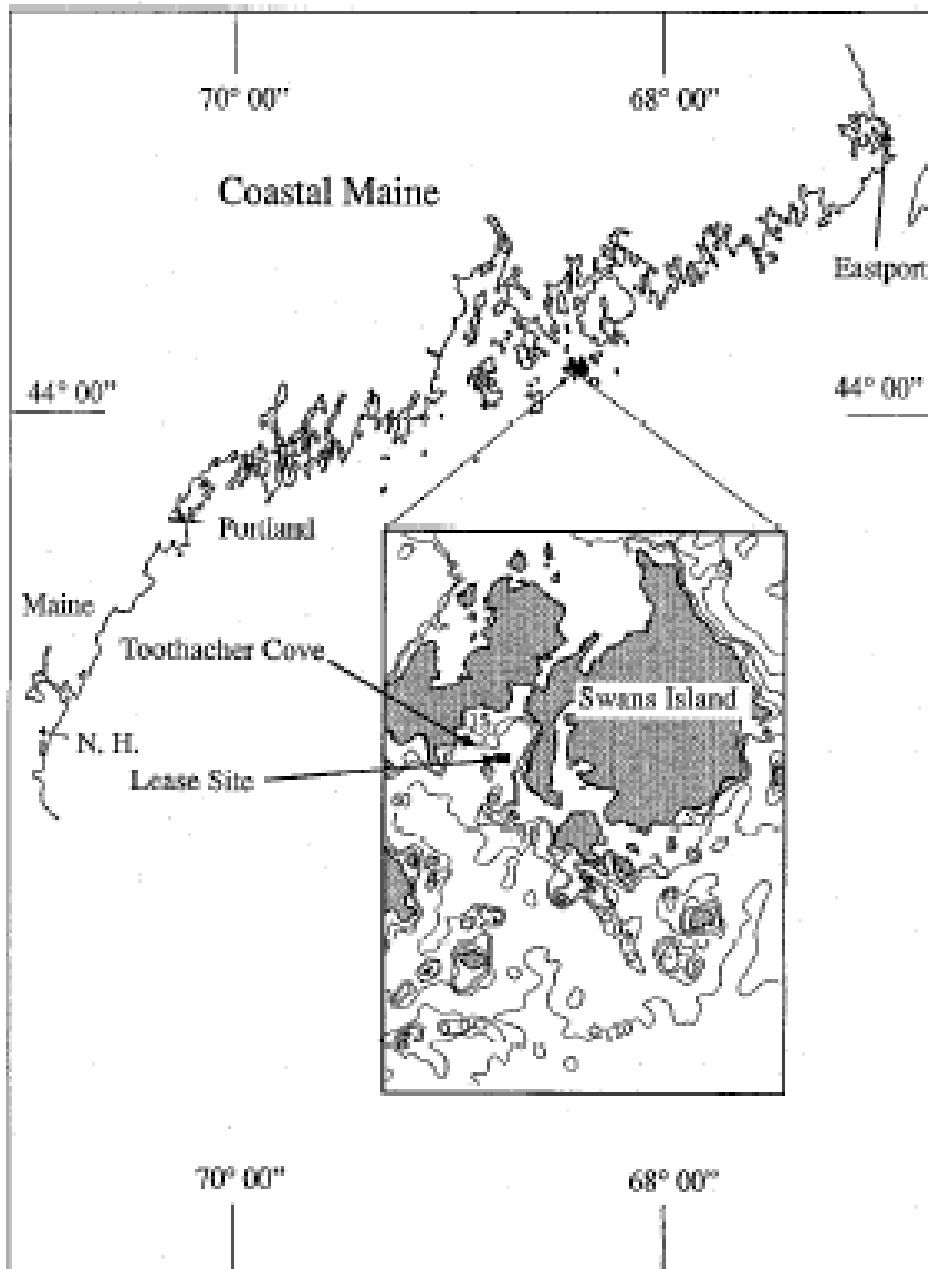
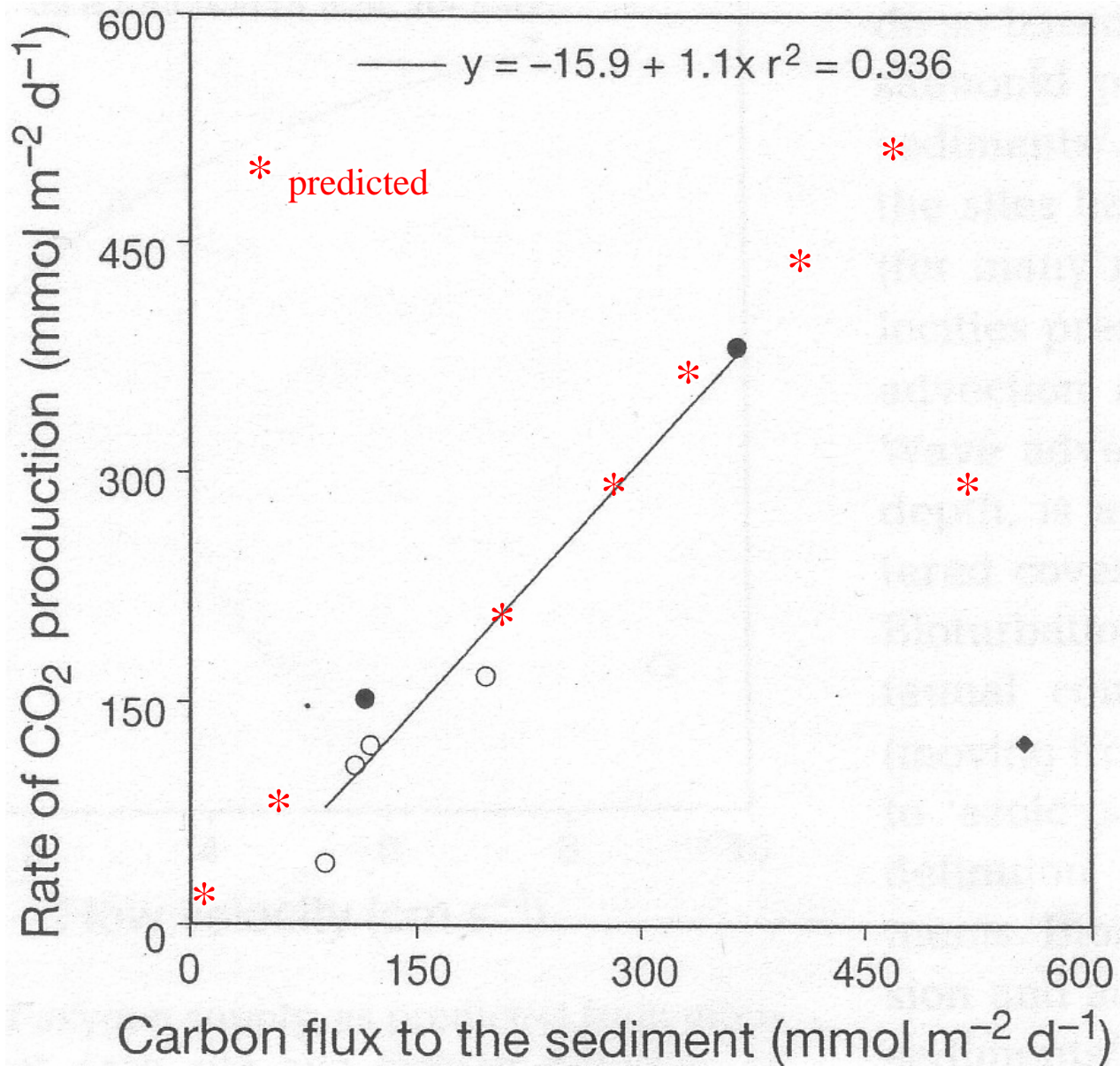
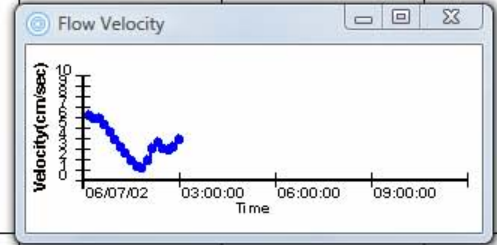
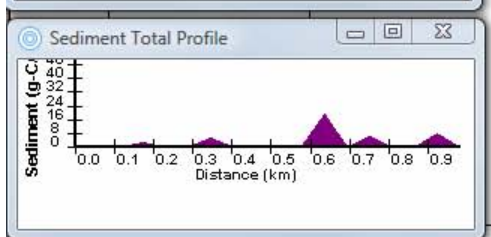
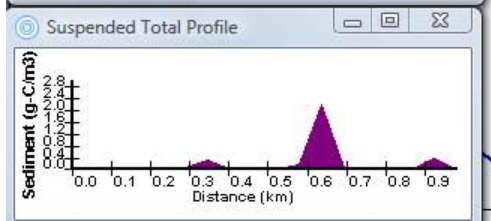
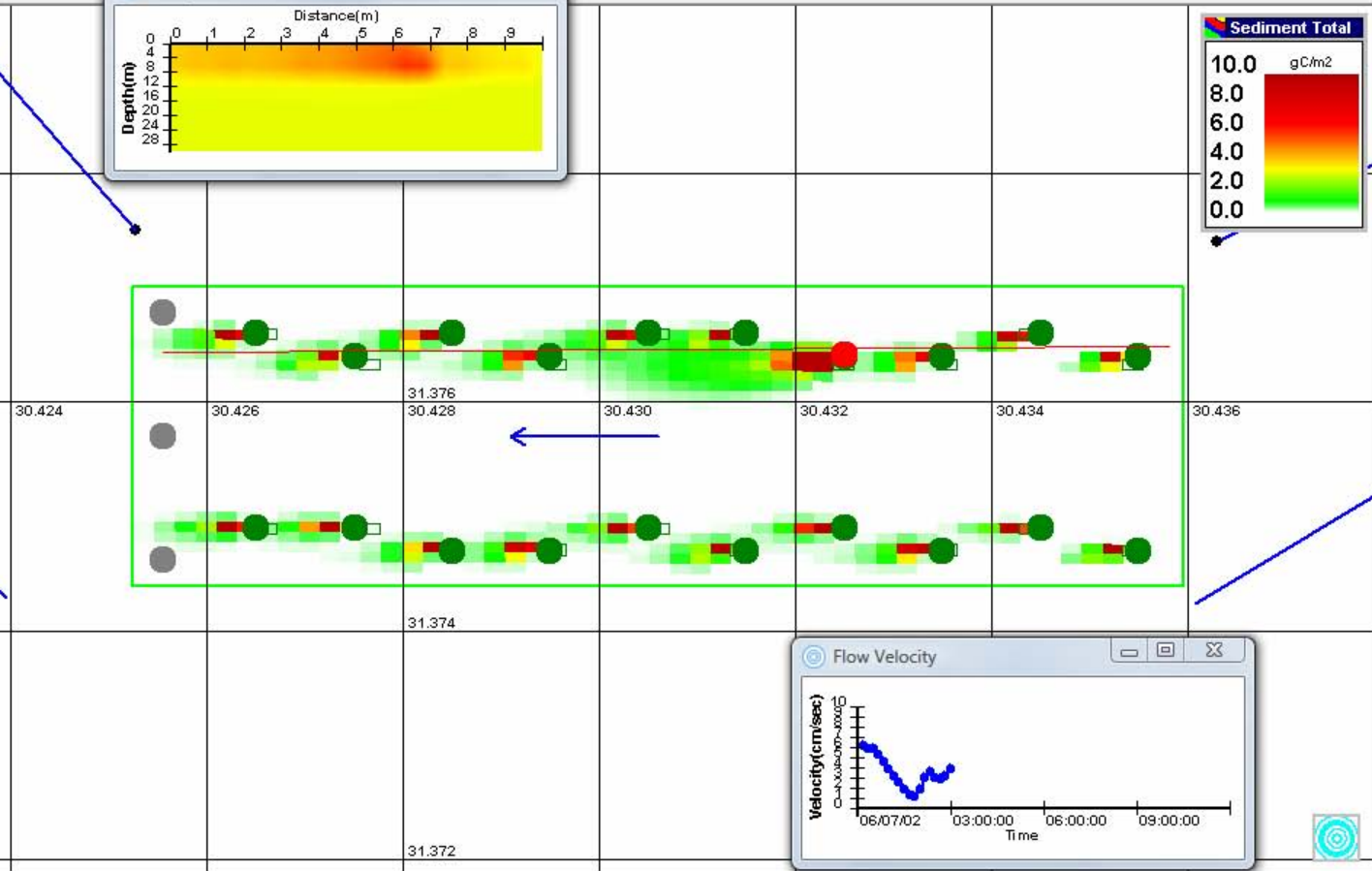
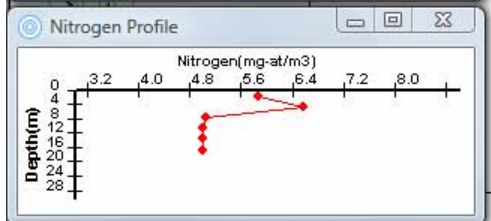
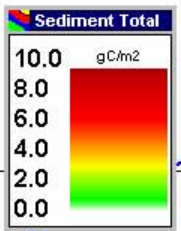
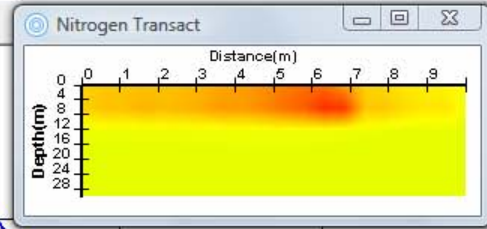
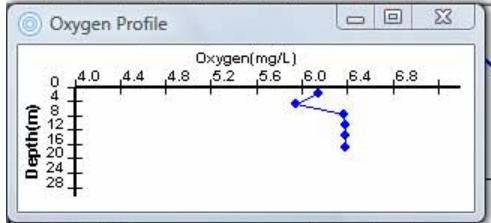
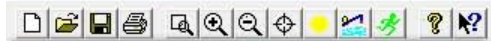
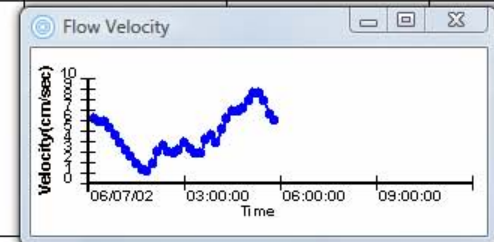
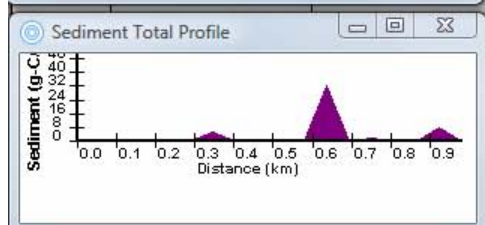
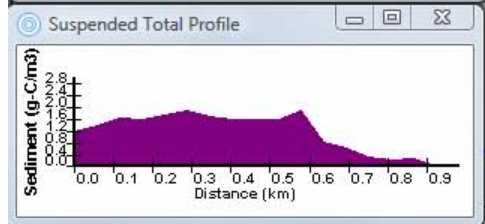
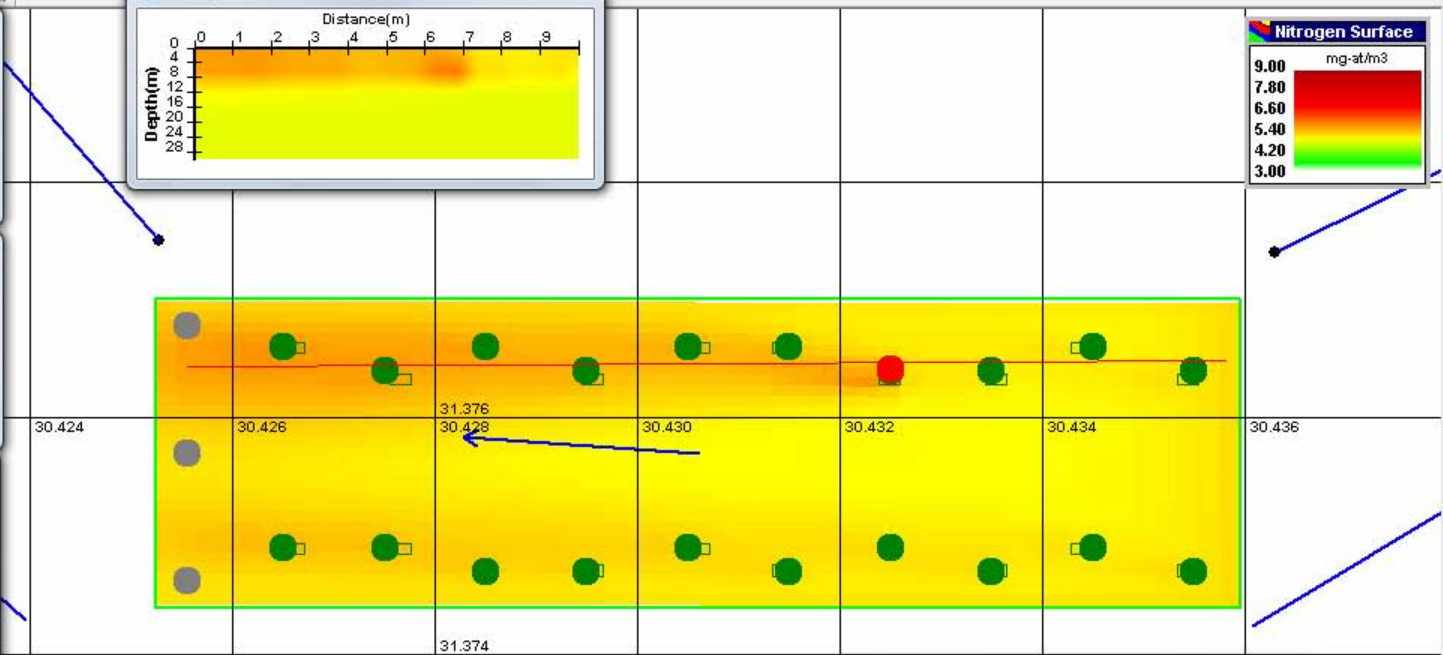
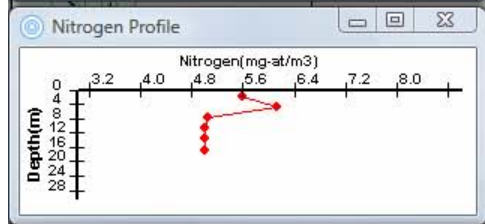
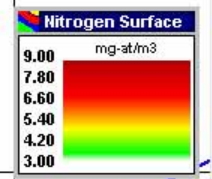
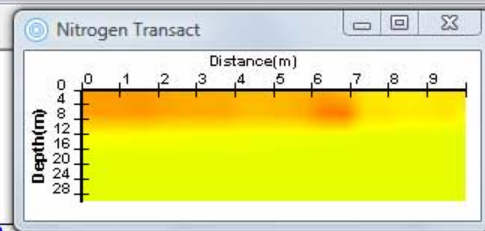
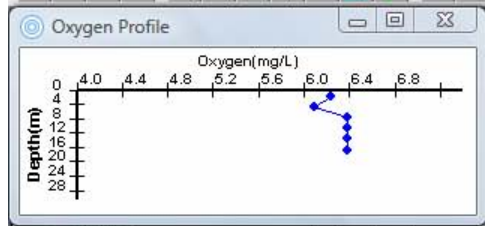
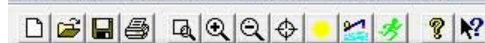


Fig. 3. Graphic representation of experimental design utilized for Toothacher Cove net-pen study.

CO₂ Production vs Carbon Deposition







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Conclusions

- Advances in our understanding of fish metabolism and the trophic dynamics of planktonic and benthic communities have provided us with the opportunity to develop a model of fish farm operations and environmental impacts.
- When tuned the model we believe the model will provide accurate predictions.
- Thus, questions concerning the environmental impact of waste production by fish farms can now be addressed objectively and without the bias that currently dominates much of the debate on the costs and benefits of fish farms.