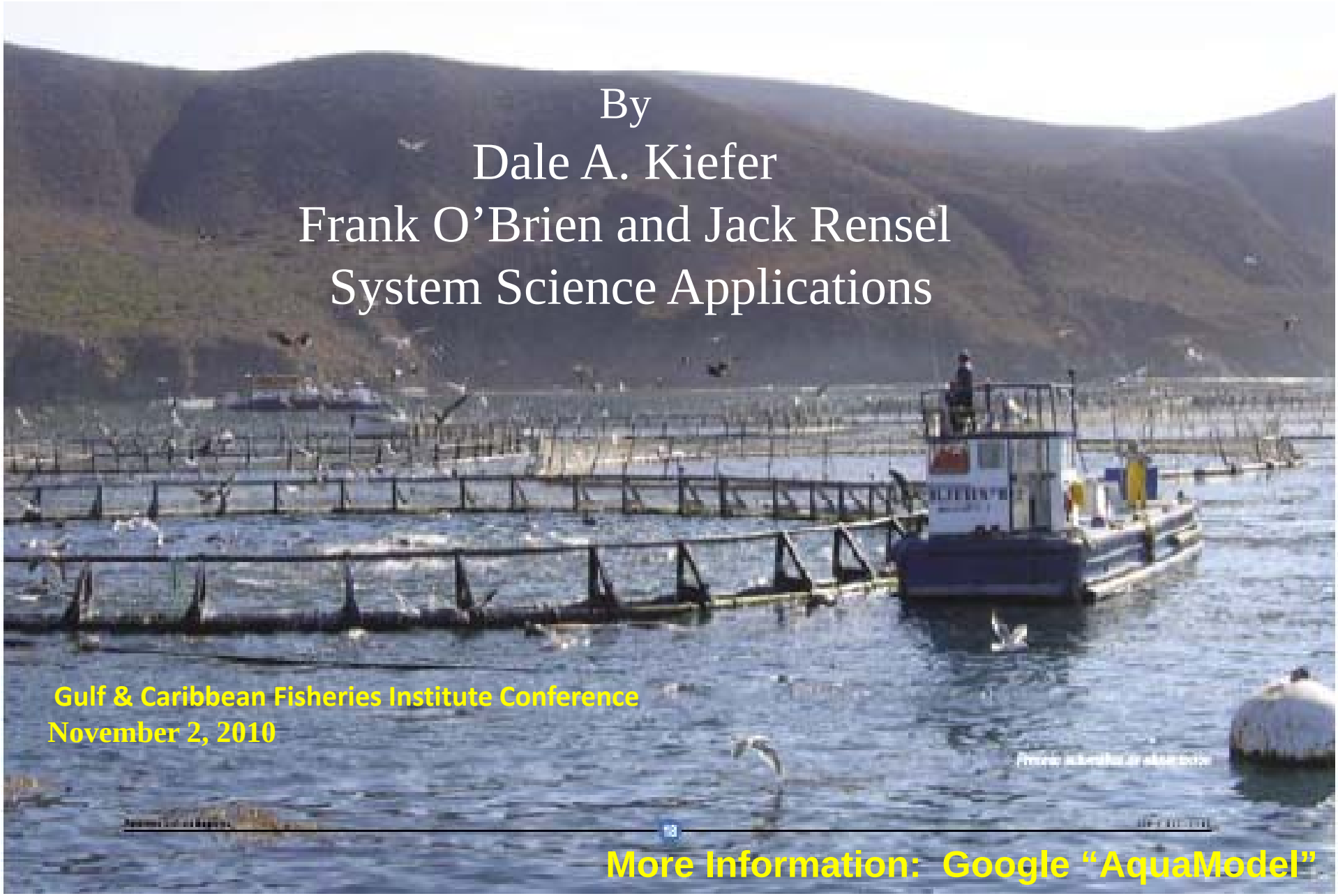
Modeling Fish Farm Operations and Impacts

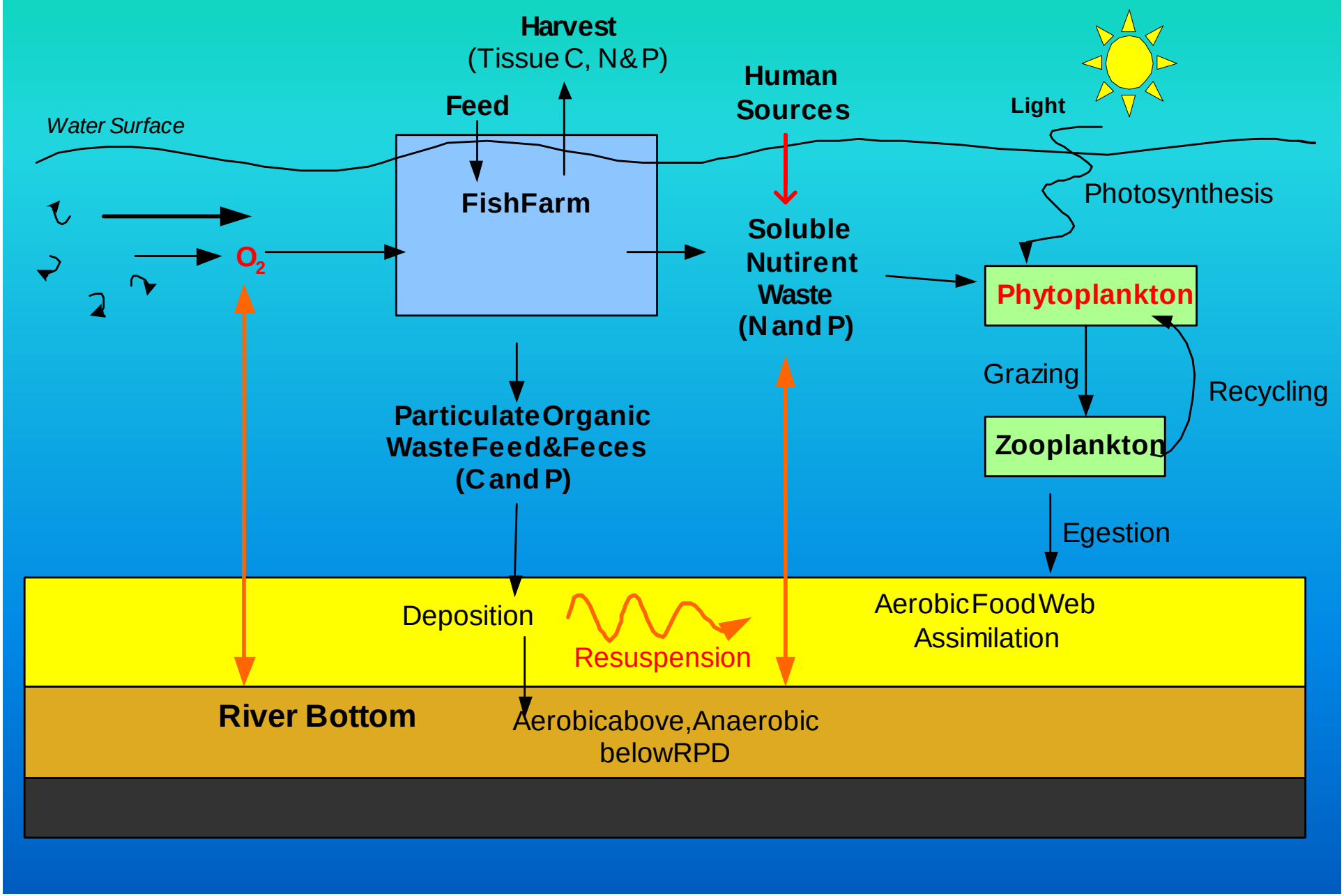


By
Dale A. Kiefer
Frank O'Brien and Jack Rensel
System Science Applications

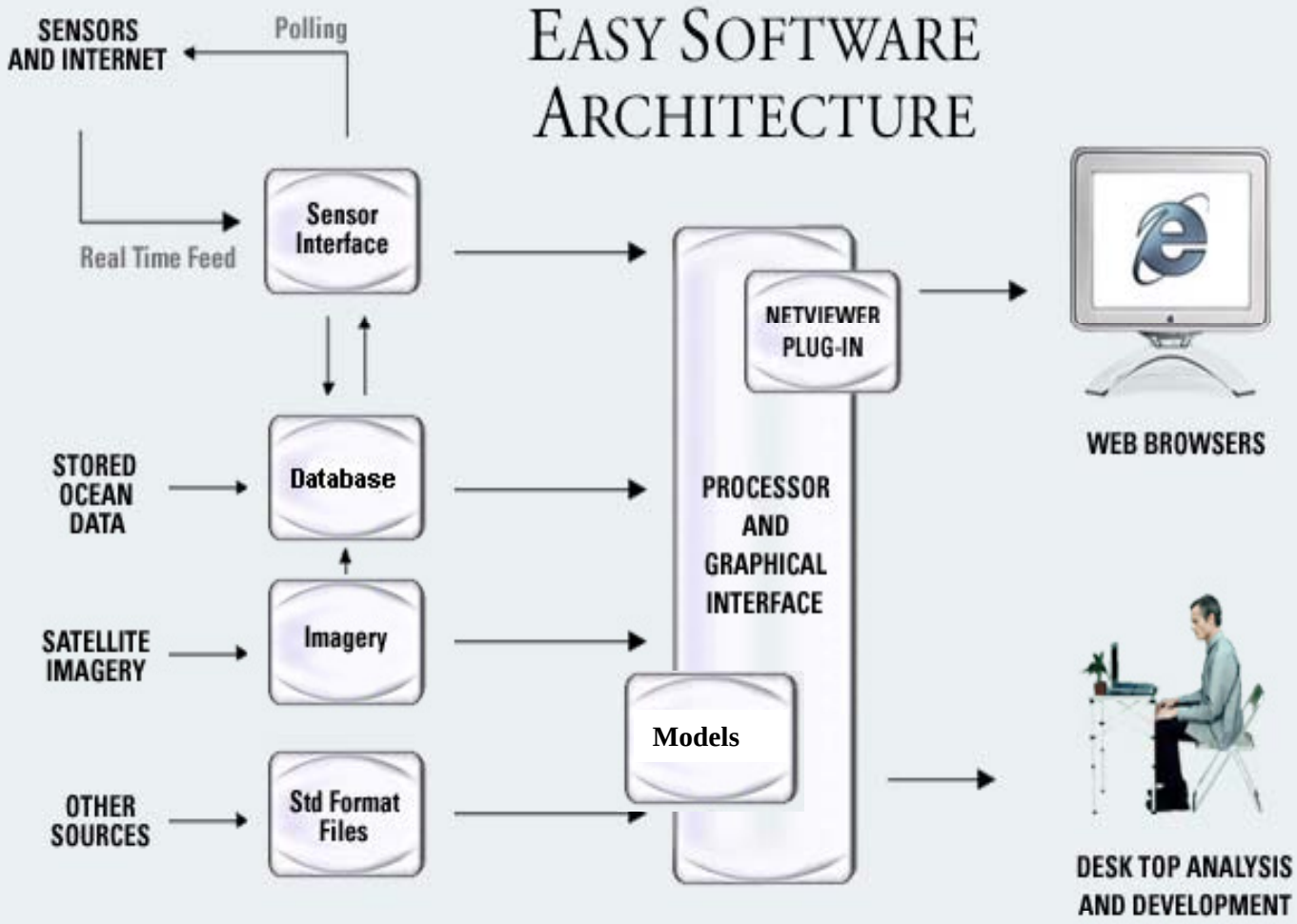
Gulf & Caribbean Fisheries Institute Conference
November 2, 2010

More Information: Google "AquaModel"

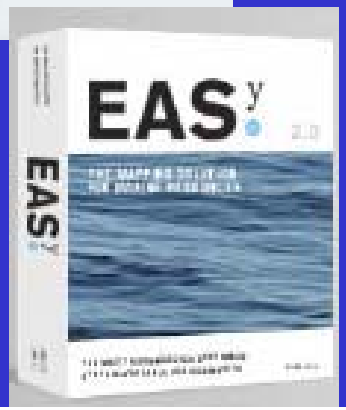
Model Overview

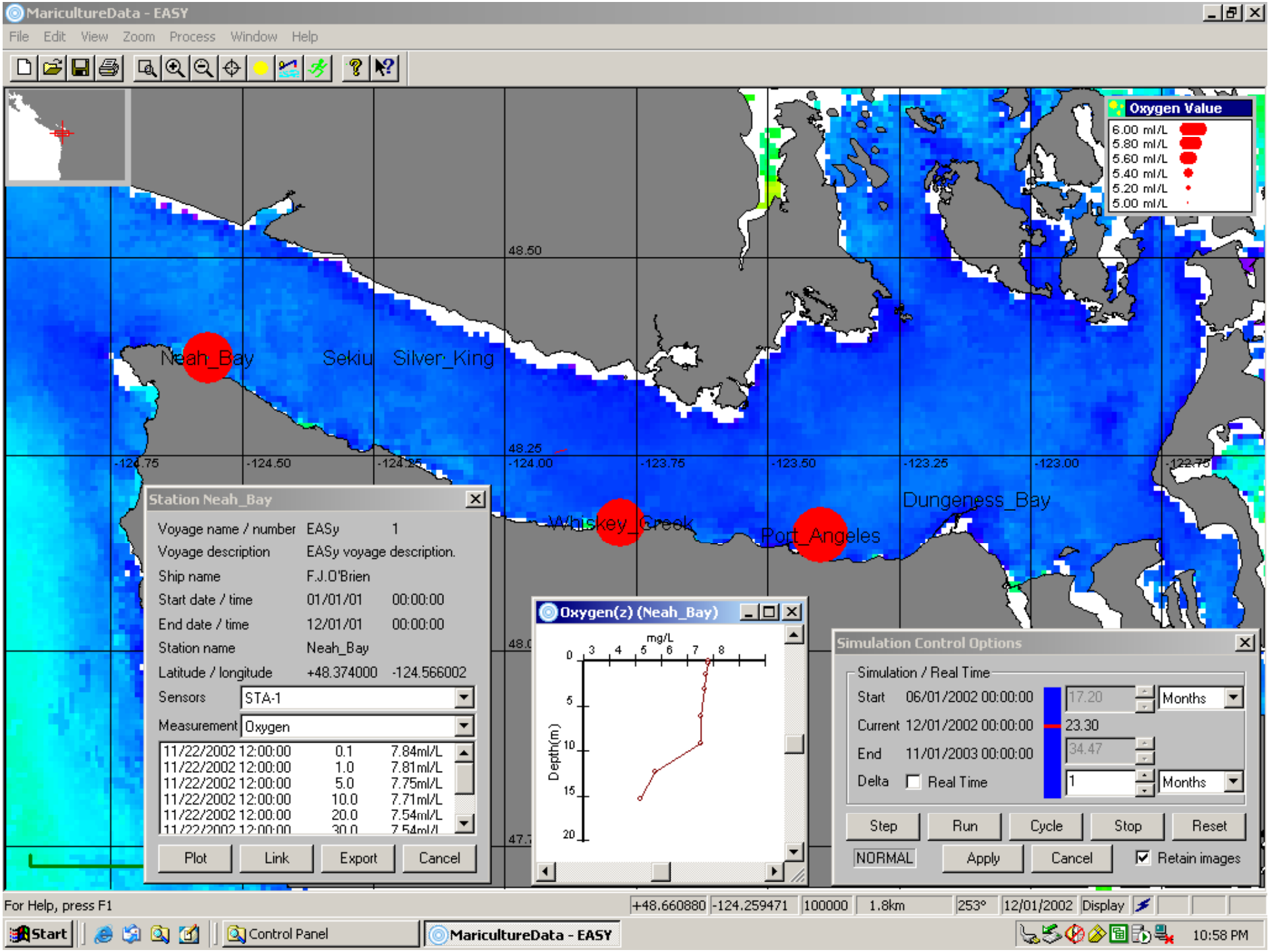


EASY SOFTWARE ARCHITECTURE

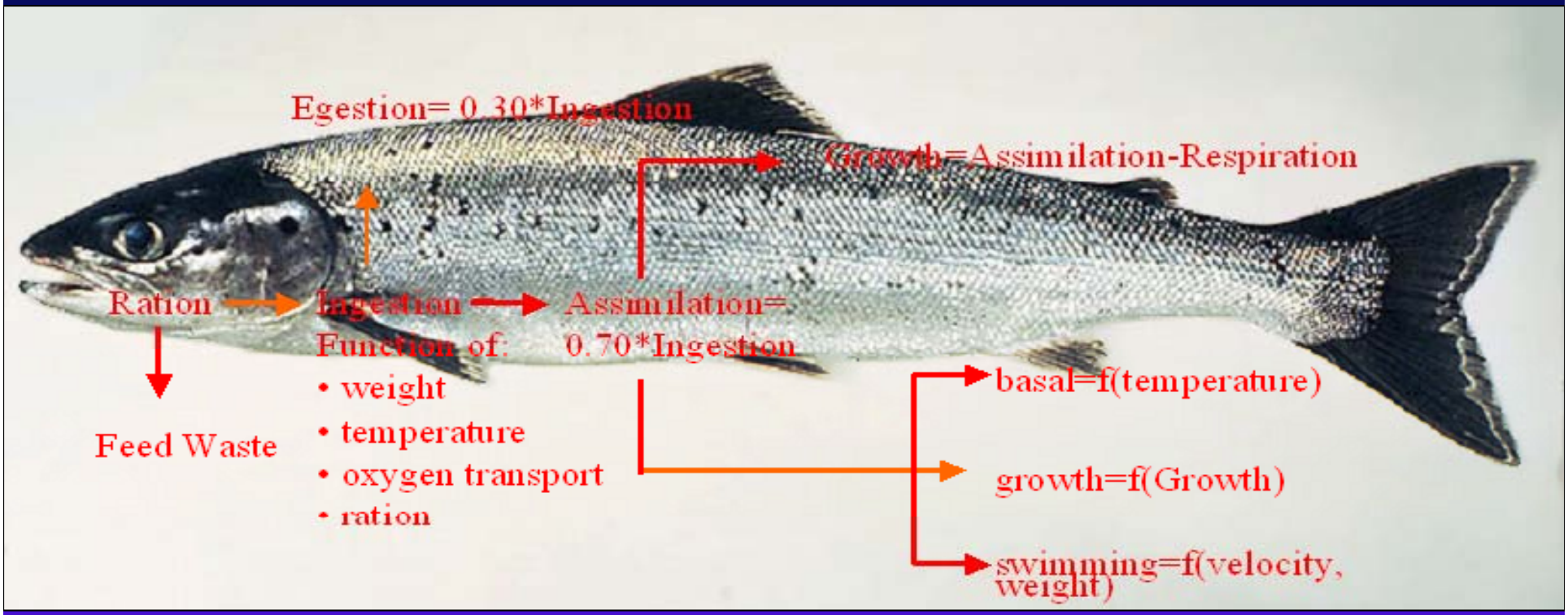


- Three dimensional system for marine applications
- Interfaces for models, spreadsheets, databases, and Internet
- PC Desktop & Web-enabled GIS applications
- Compatible with ESRI (arc-info) GIS

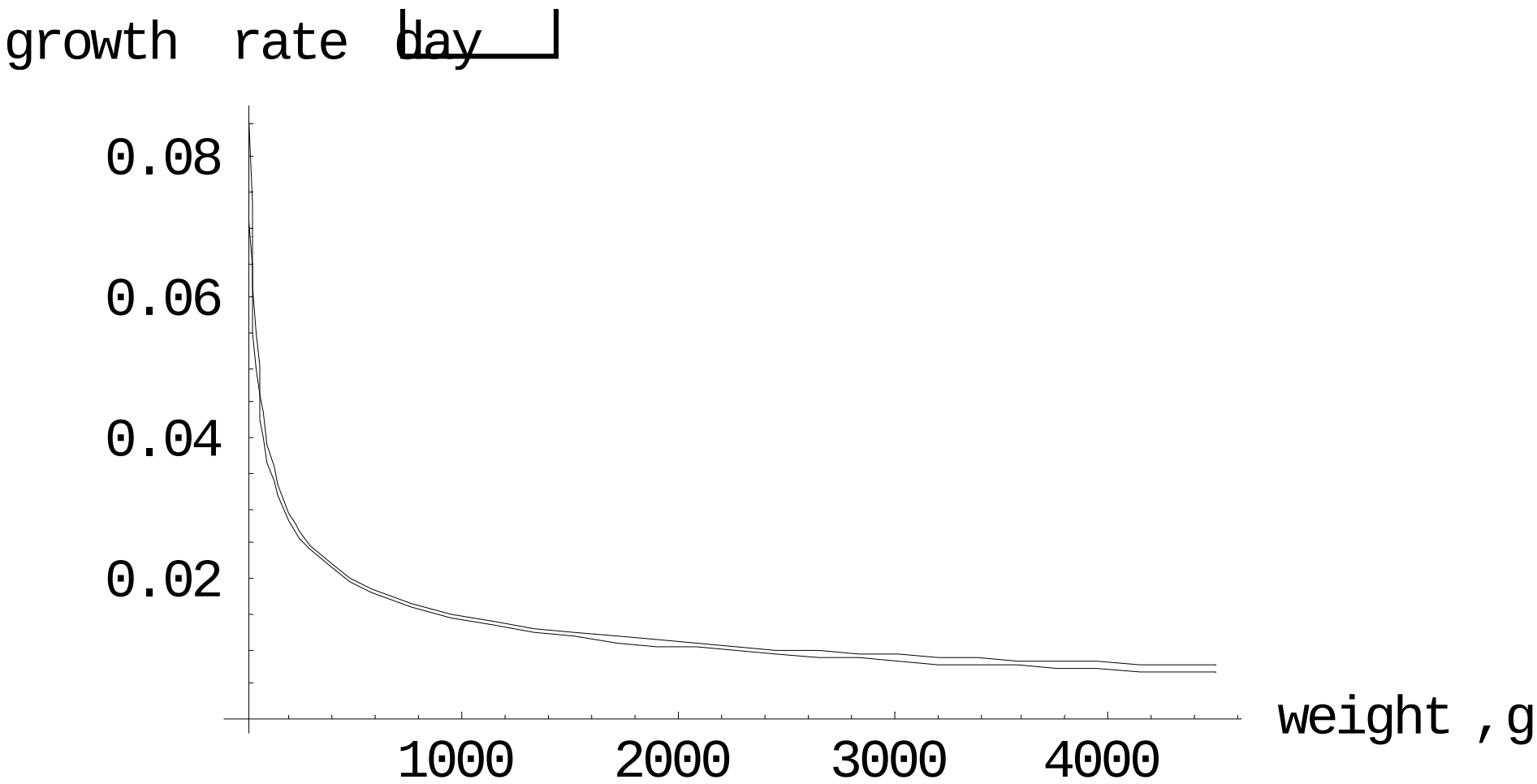



MaricultureData - EASY
File Edit View Zoom Process Window Help
Oxygen Value
6.00 ml/L
5.80 ml/L
5.60 ml/L
5.40 ml/L
5.20 ml/L
5.00 ml/L
48.50
48.25
-124.75
-124.50
-124.25
-124.00
-123.75
-123.50
-123.25
-123.00
Neah_Bay
Sekiu
Silver_King
Whiskey_Creek
Port_Angeles
Dungeness_Bay
Station Neah_Bay
Voyage name / number EASy 1
Voyage description EASy voyage description.
Ship name F.J.O'Brien
Start date / time 01/01/01 00:00:00
End date / time 12/01/01 00:00:00
Station name Neah_Bay
Latitude / longitude +48.374000 -124.566002
Sensors STA-1
Measurement Oxygen
11/22/2002 12:00:00 0.1 7.84ml/L
11/22/2002 12:00:00 1.0 7.81ml/L
11/22/2002 12:00:00 5.0 7.75ml/L
11/22/2002 12:00:00 10.0 7.71ml/L
11/22/2002 12:00:00 20.0 7.54ml/L
Plot
Link
Export
Cancel
Oxygen(z) (Neah_Bay)
mg/L
Depth(m)
Simulation Control Options
Simulation / Real Time
Start 06/01/2002 00:00:00
Current 12/01/2002 00:00:00
End 11/01/2003 00:00:00
Delta Real Time
17.20
23.30
34.47
Months
Step
Run
Cycle
Stop
Reset
NORMAL
Apply
Cancel
Retain images
For Help, press F1
+48.660880
-124.259471
100000
1.8km
253°
12/01/2002
Display
Start
Control Panel
MaricultureData - EASY
10:58 PM

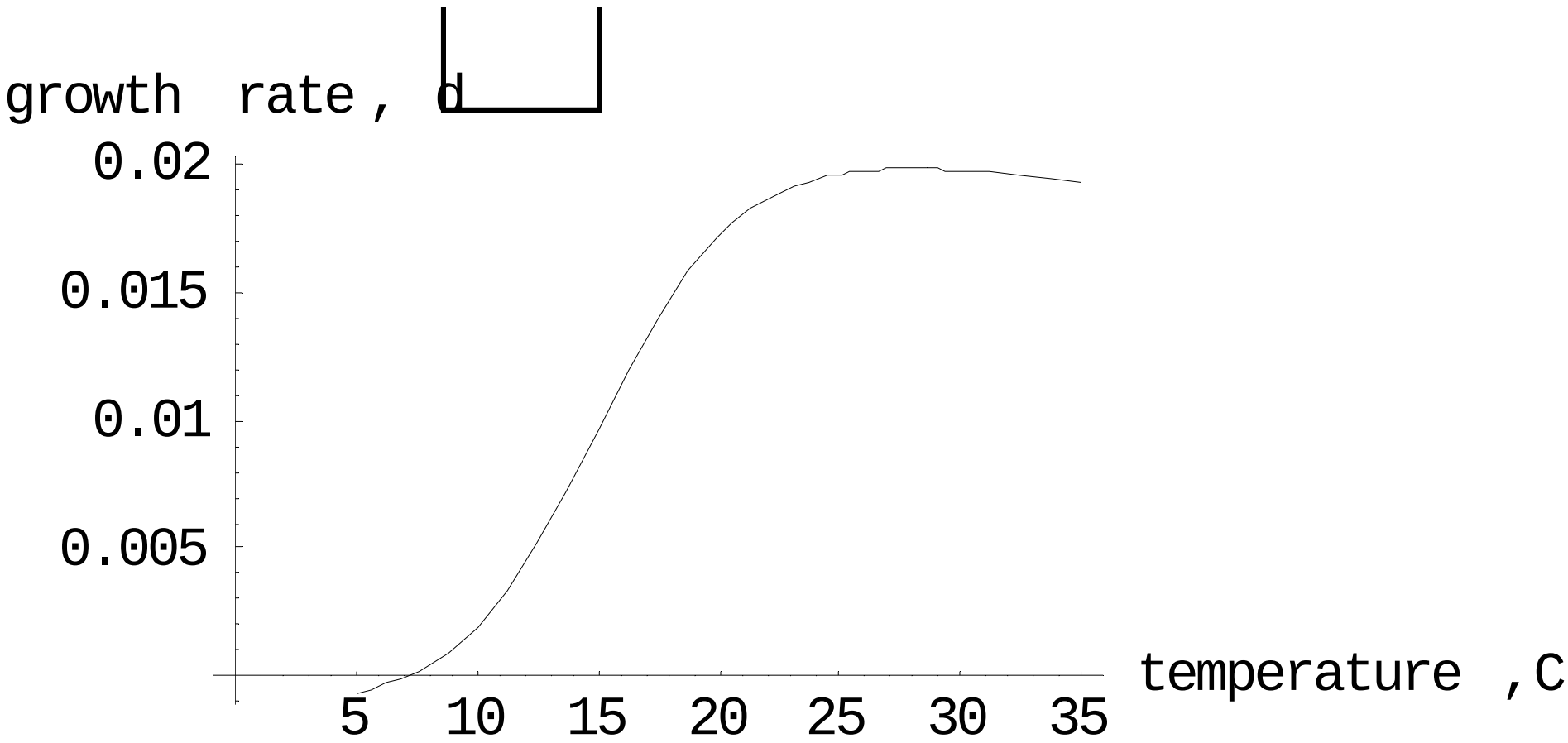
Bioenergetics Model



AquaModel vs Von Bertanlanffy Growth Rates

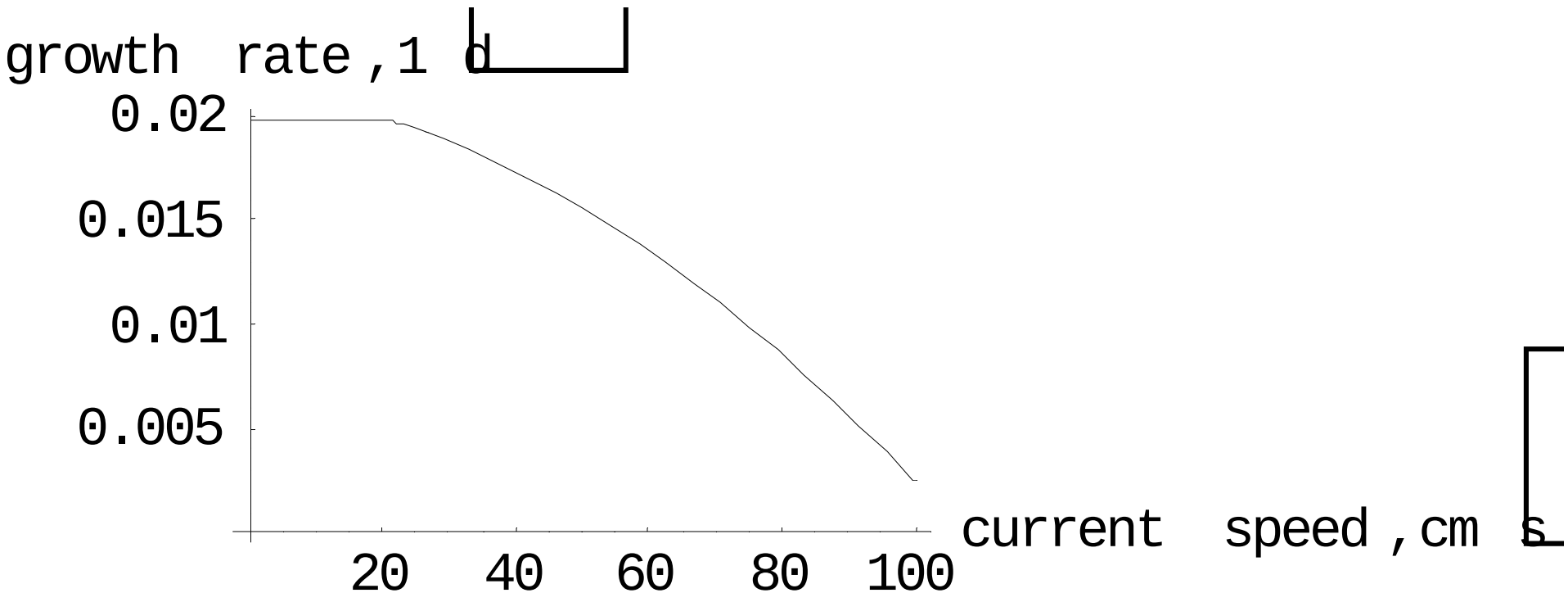


Rachycentron 500 gm wet weight:
AquaModel growth rate vs temperature

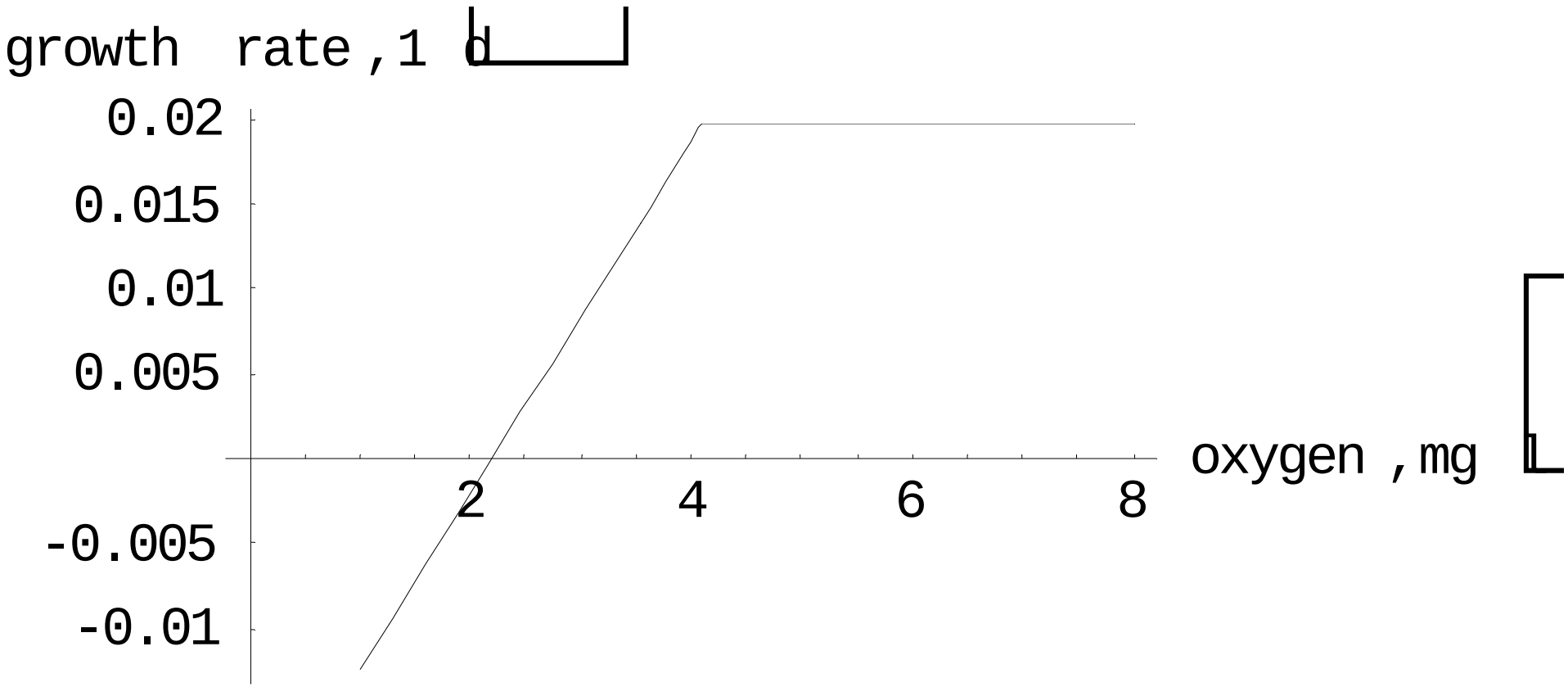


AquaModel growth rate as function of current speed

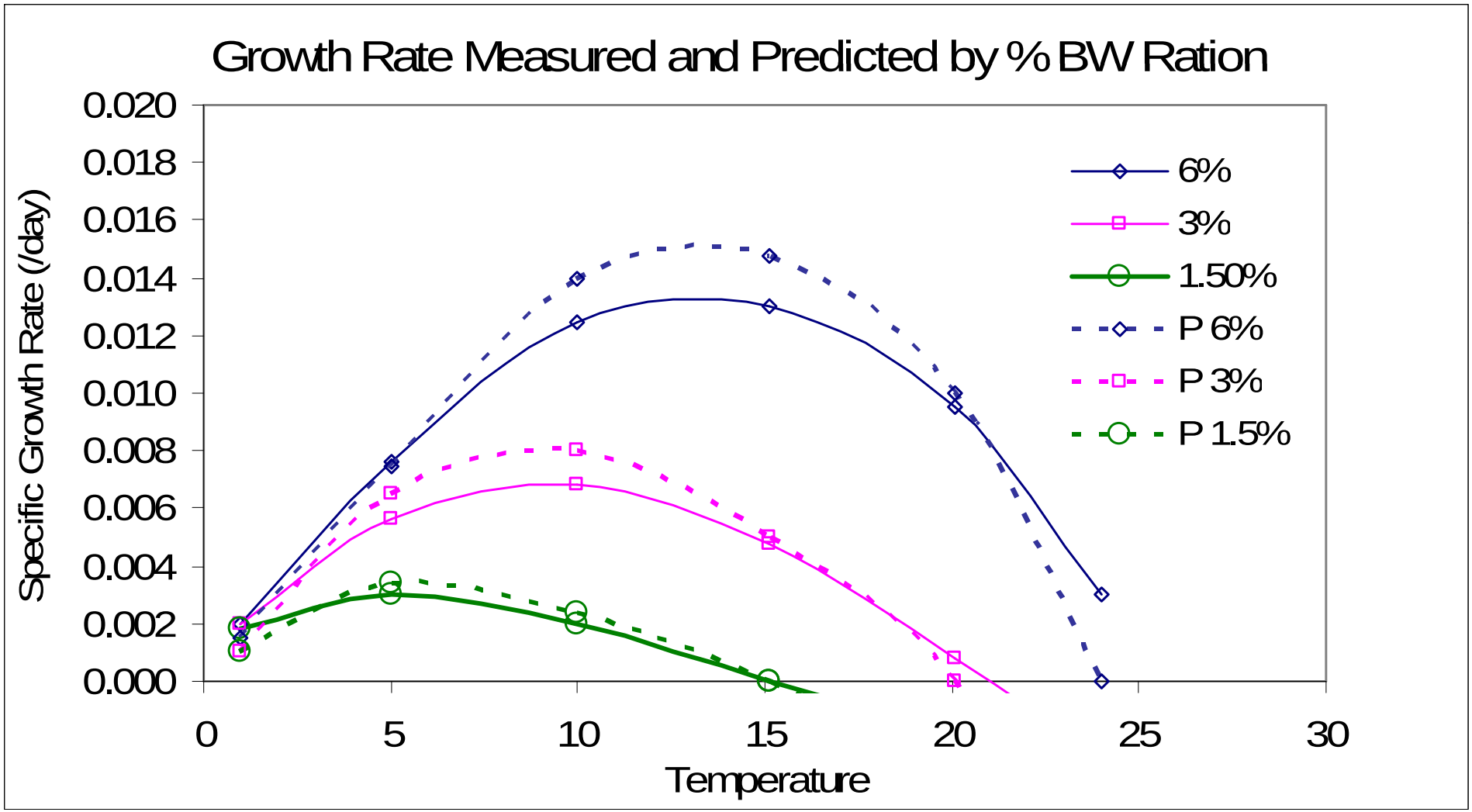
(500 g fish, 28 deg. C, 5.7 mgO2/l)

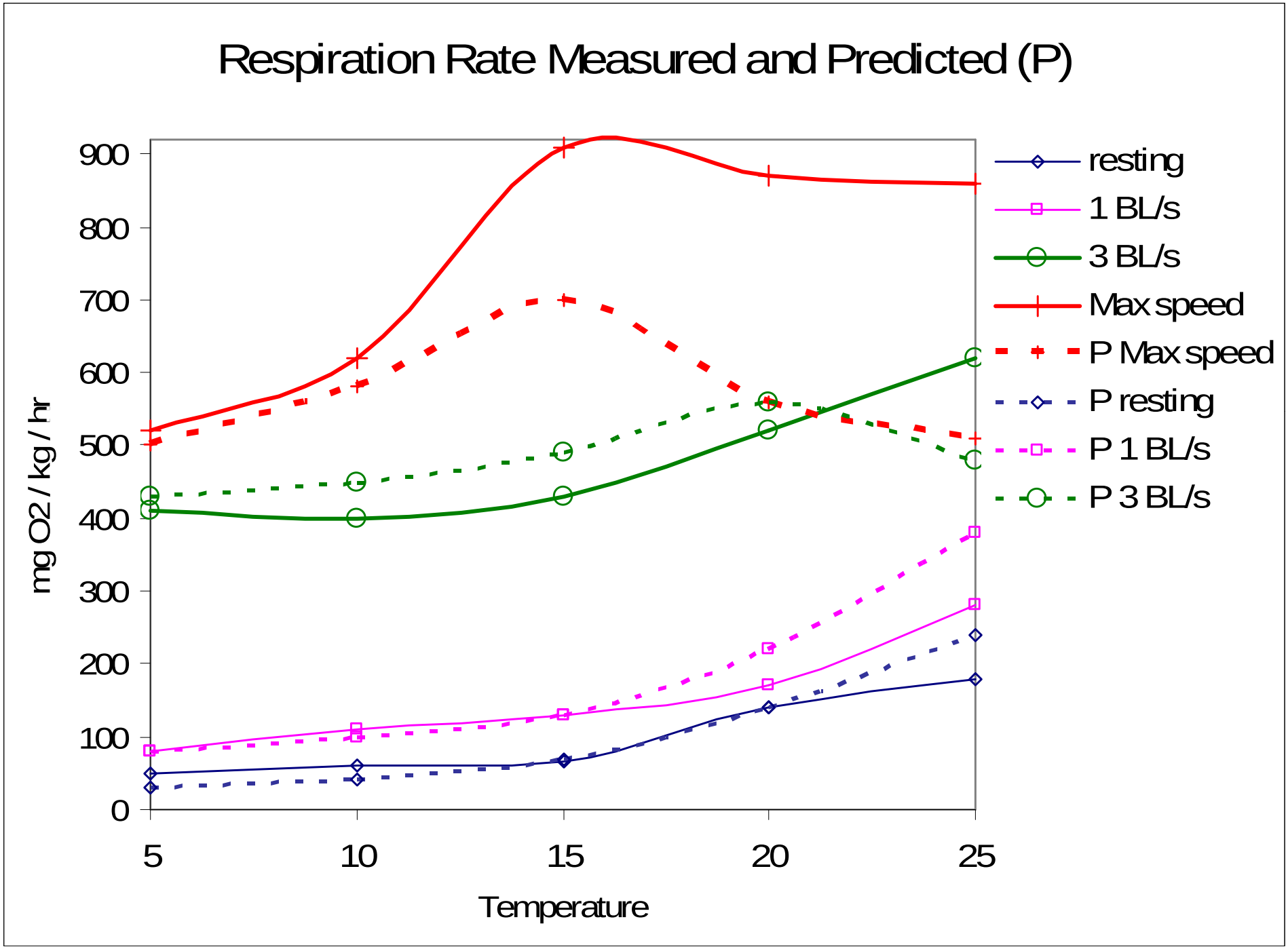


Cobia Aquamodel: growth rate vs oxygen concentration (500 g fish, 28 degC, resting

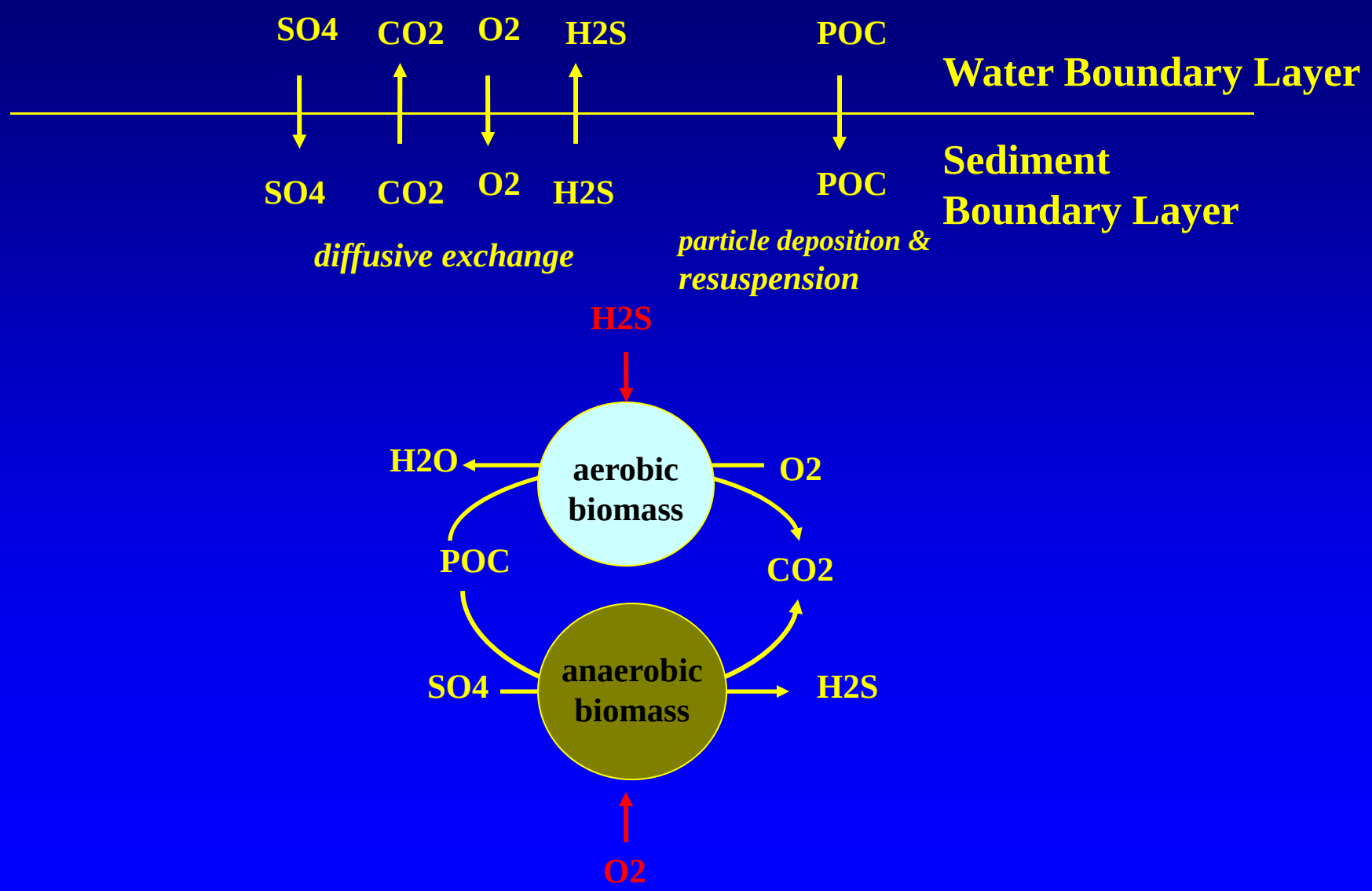


Atlantic Salmon measurements and AquaModel calculations

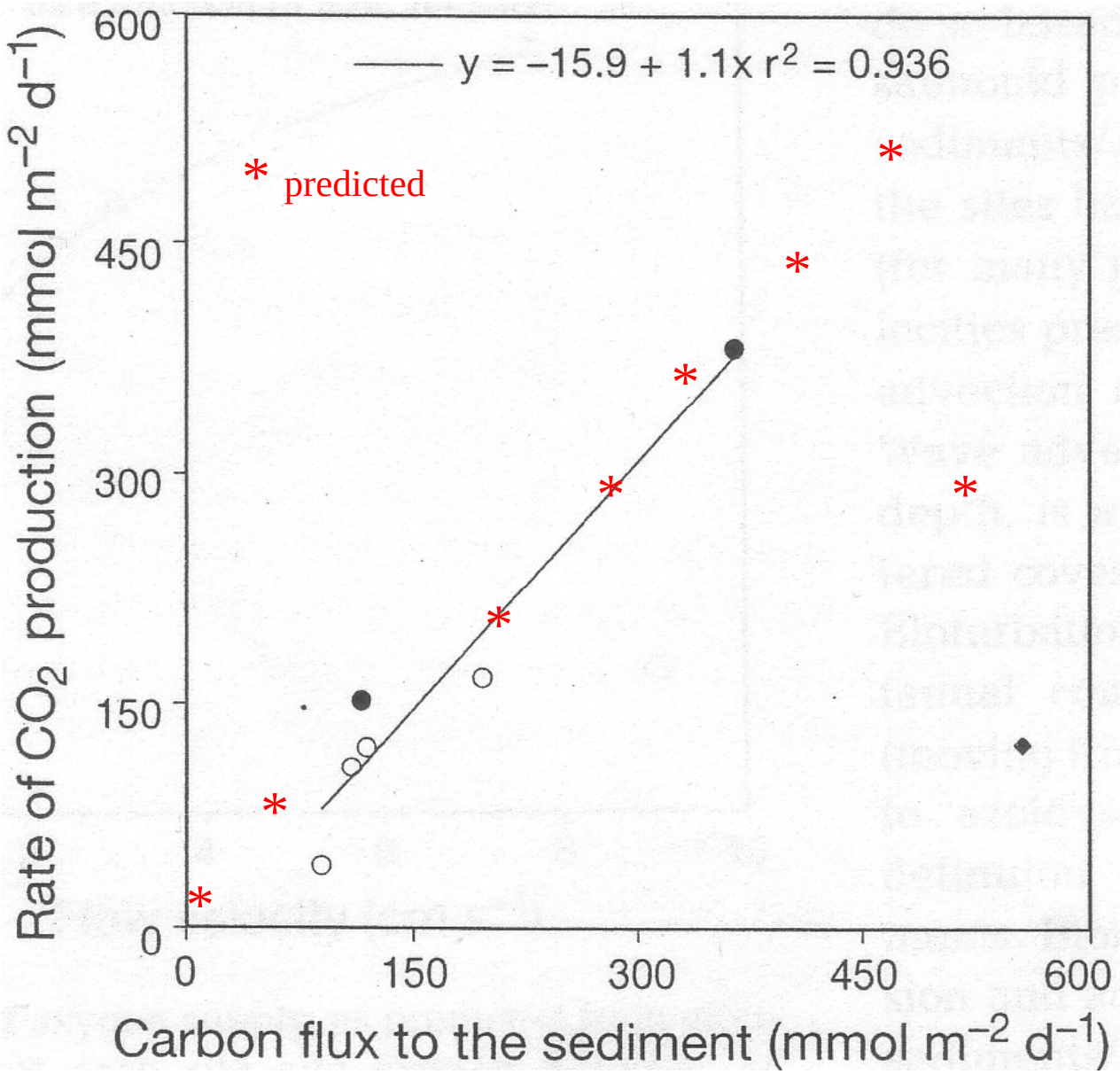



Respiration Rate Measured and Predicted (P)
900
800
700
600
500
400
300
200
100
0
mg O2 / kg / hr
5
10
15
20
25
Temperature
resting
1 BL/s
3 BL/s
Max speed
P Max speed
P resting
P 1 BL/s
P 3 BL/s

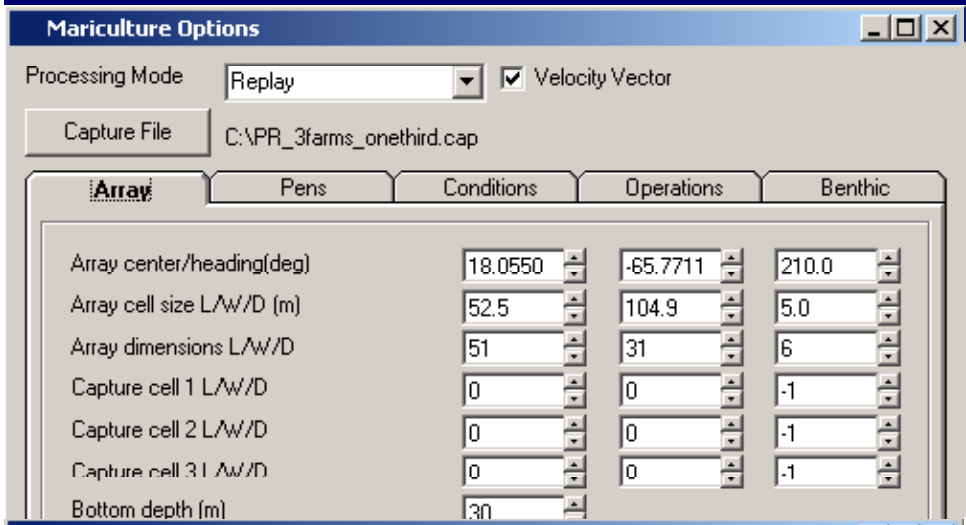
Benthic Dynamics

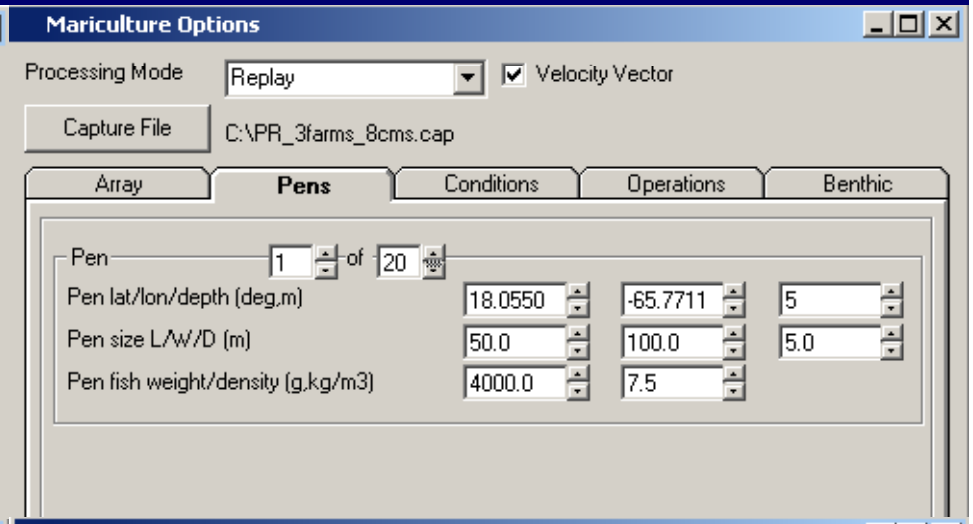


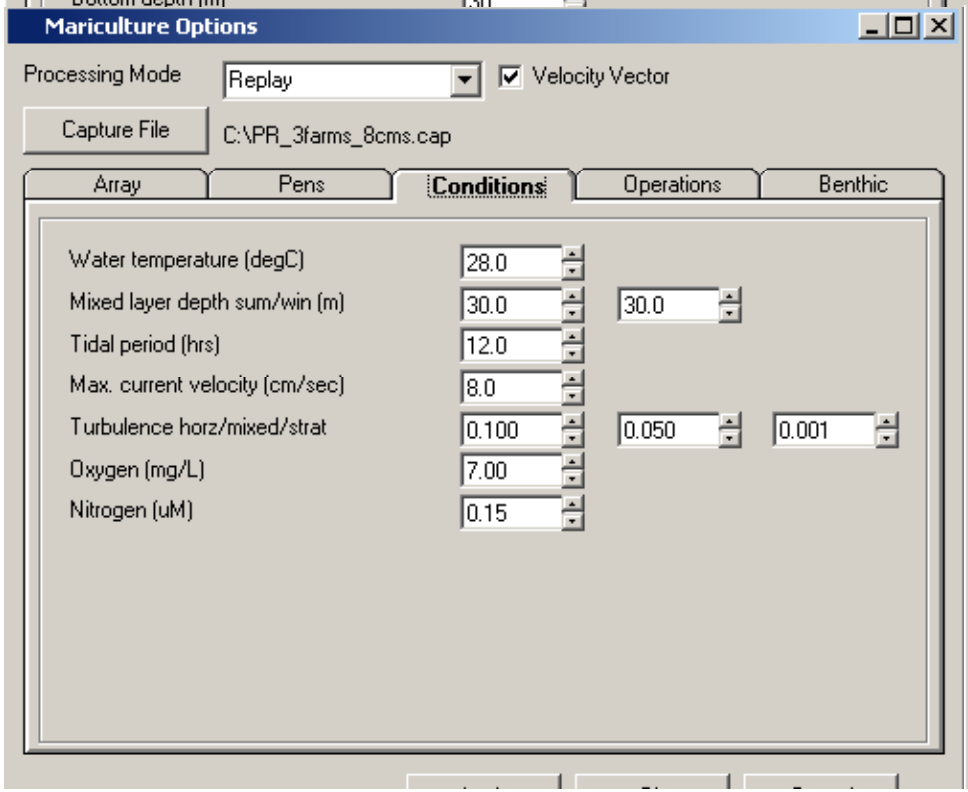
CO2 Production vs Carbon Deposition

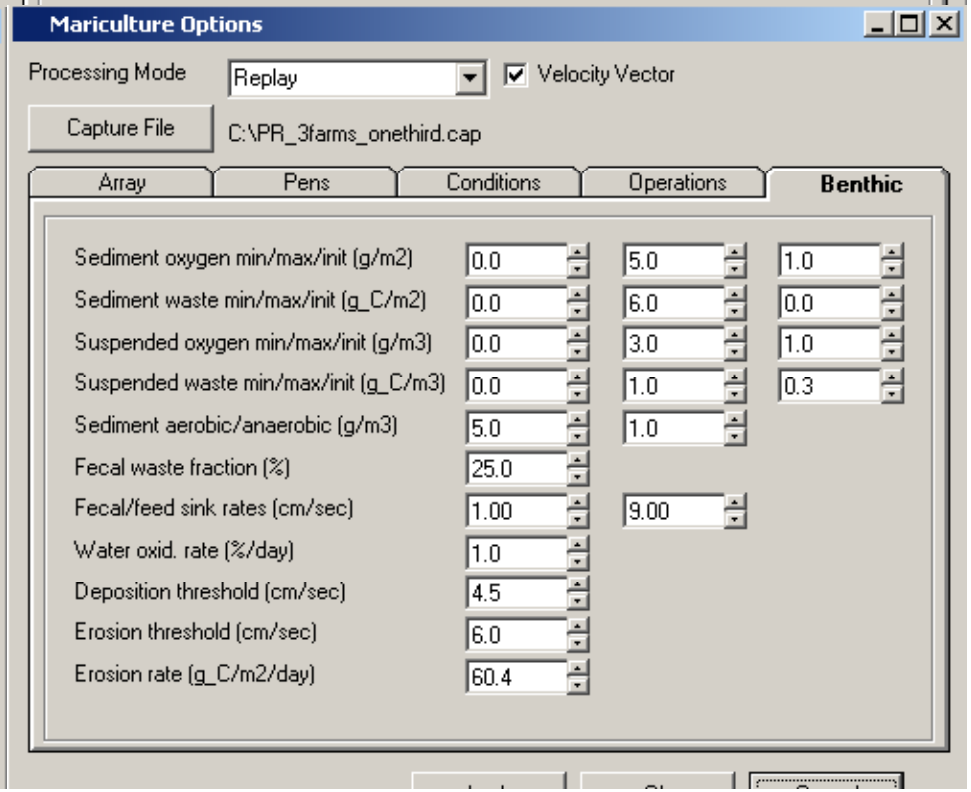


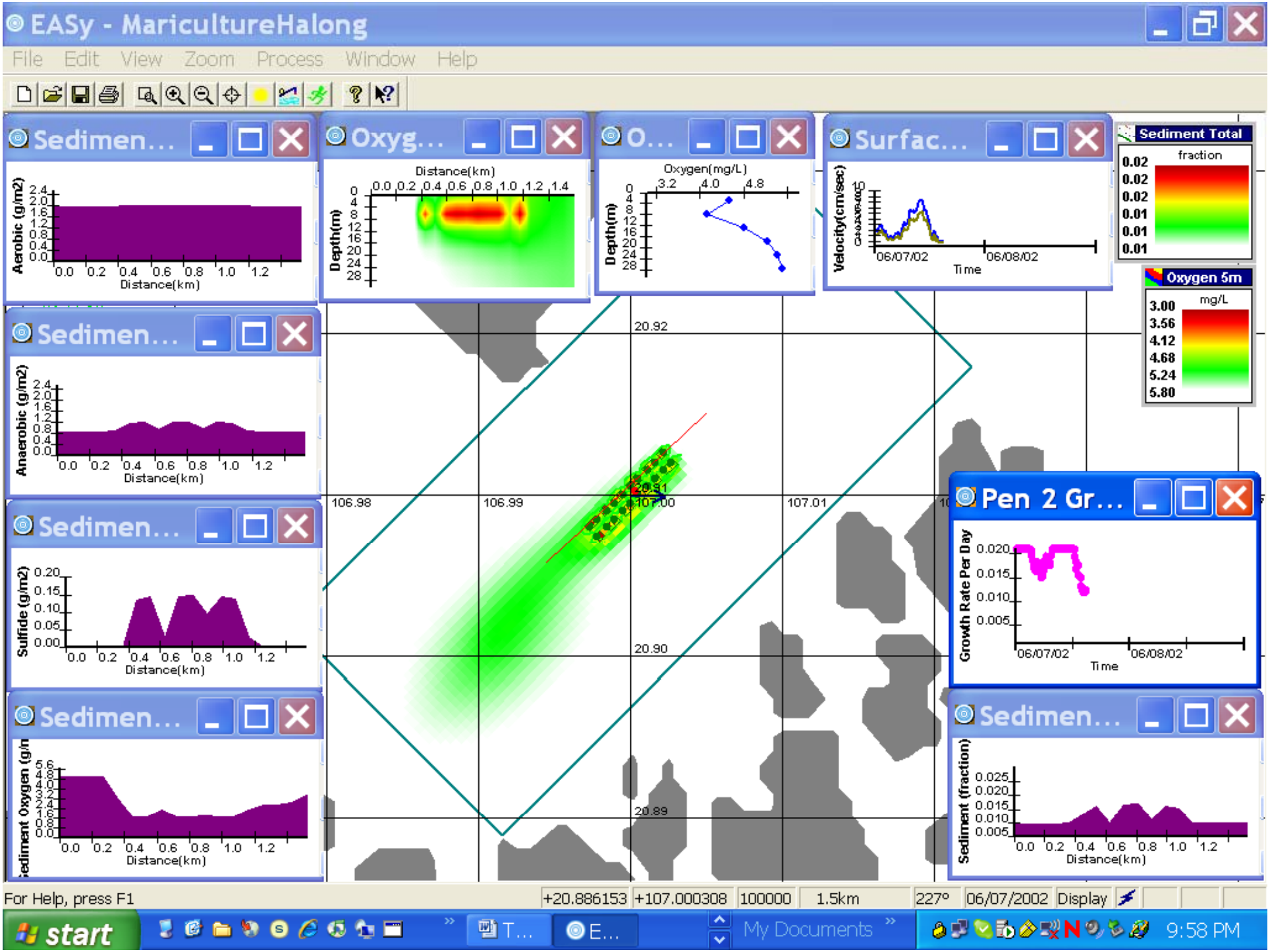
Examples of Some User Controls

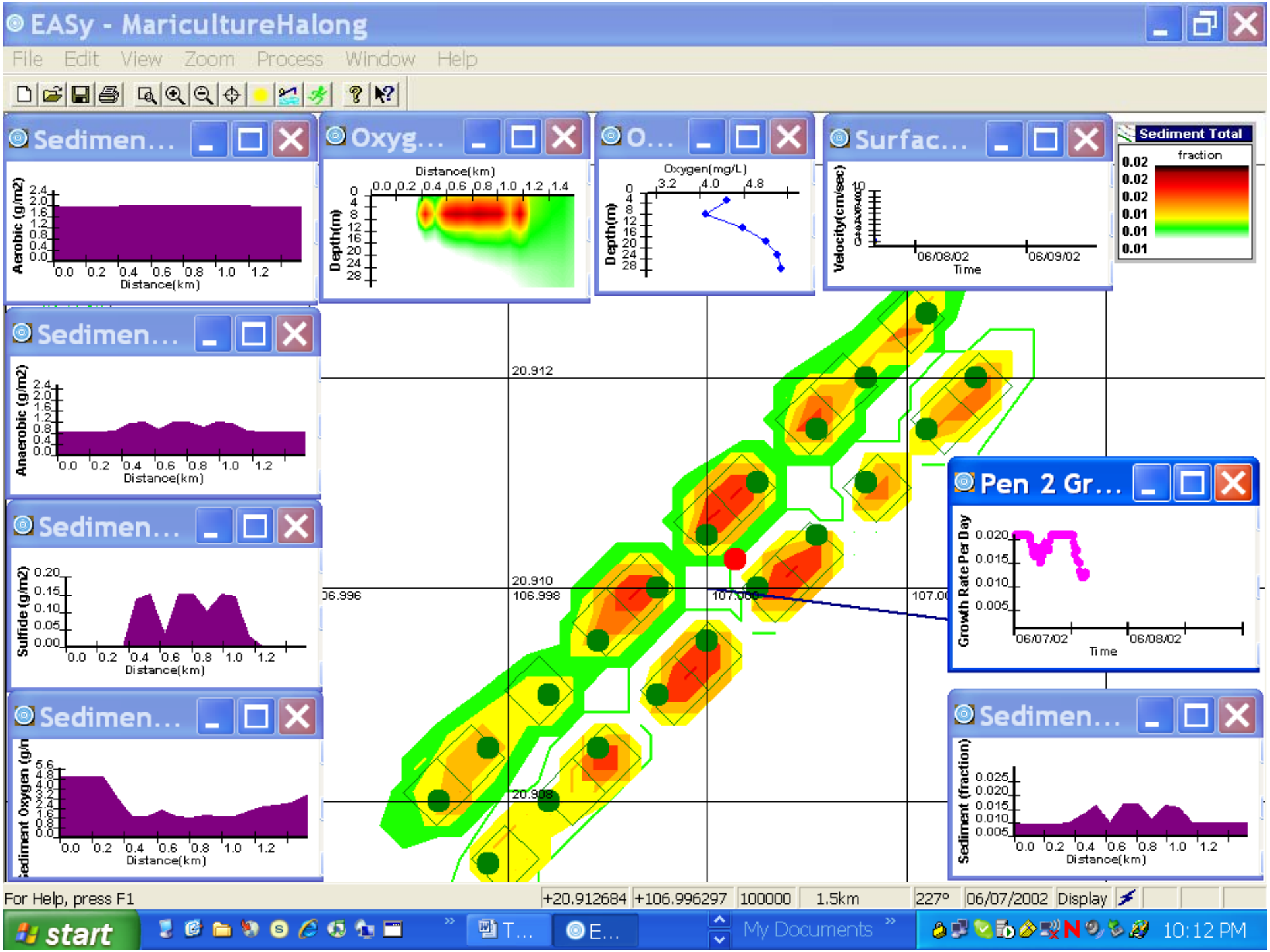









EASy - MaricultureHalong
File Edit View Zoom Process Window Help
Sedimen...
Aerobic (g/m2)
Distance(km)
Oxyg...
Distance(km)
Depth(m)
O...
Oxygen(mg/L)
Depth(m)
Surfac...
Velocity(cm/sec)
06/07/02
06/08/02
Time
Sediment Total
fraction
0.02
0.02
0.02
0.01
0.01
0.01
Oxygen 5m
mg/L
3.00
3.56
4.12
4.68
5.24
5.80
Sedimen...
Anaerobic (g/m2)
Distance(km)
Sedimen...
Sulfide (g/m2)
Distance(km)
Sedimen...
Sediment Oxygen (g/m
Distance(km)
20.92
20.91
20.90
20.89
106.98
106.99
107.00
107.01
Pen 2 Gr...
Growth Rate Per Day
06/07/02
06/08/02
Time
Sedimen...
Sediment (fraction)
Distance(km)
For Help, press F1
+20.886153
+107.000308
100000
1.5km
227°
06/07/2002
Display
start
My Documents
9:58 PM


EASy - MaricultureHalong
File Edit View Zoom Process Window Help
Sedimen...
Aerobic (g/m2)
Distance(km)
Oxyg...
Distance(km)
Depth(m)
O...
Oxygen(mg/L)
Depth(m)
Surfac...
Velocity(cm/sec)
06/08/02
06/09/02
Time
Sediment Total
fraction
Sedimen...
Anaerobic (g/m2)
Distance(km)
Sedimen...
Sulfide (g/m2)
Distance(km)
Sedimen...
Distance(km)
20.912
20.910
106.998
20.908
Pen 2 Gr...
Growth Rate Per Day
06/07/02
06/08/02
Time
Sedimen...
Sediment (fraction)
Distance(km)
For Help, press F1
+20.912684
+106.996297
100000
1.5km
227°
06/07/2002
Display
start
My Documents
10:12 PM

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