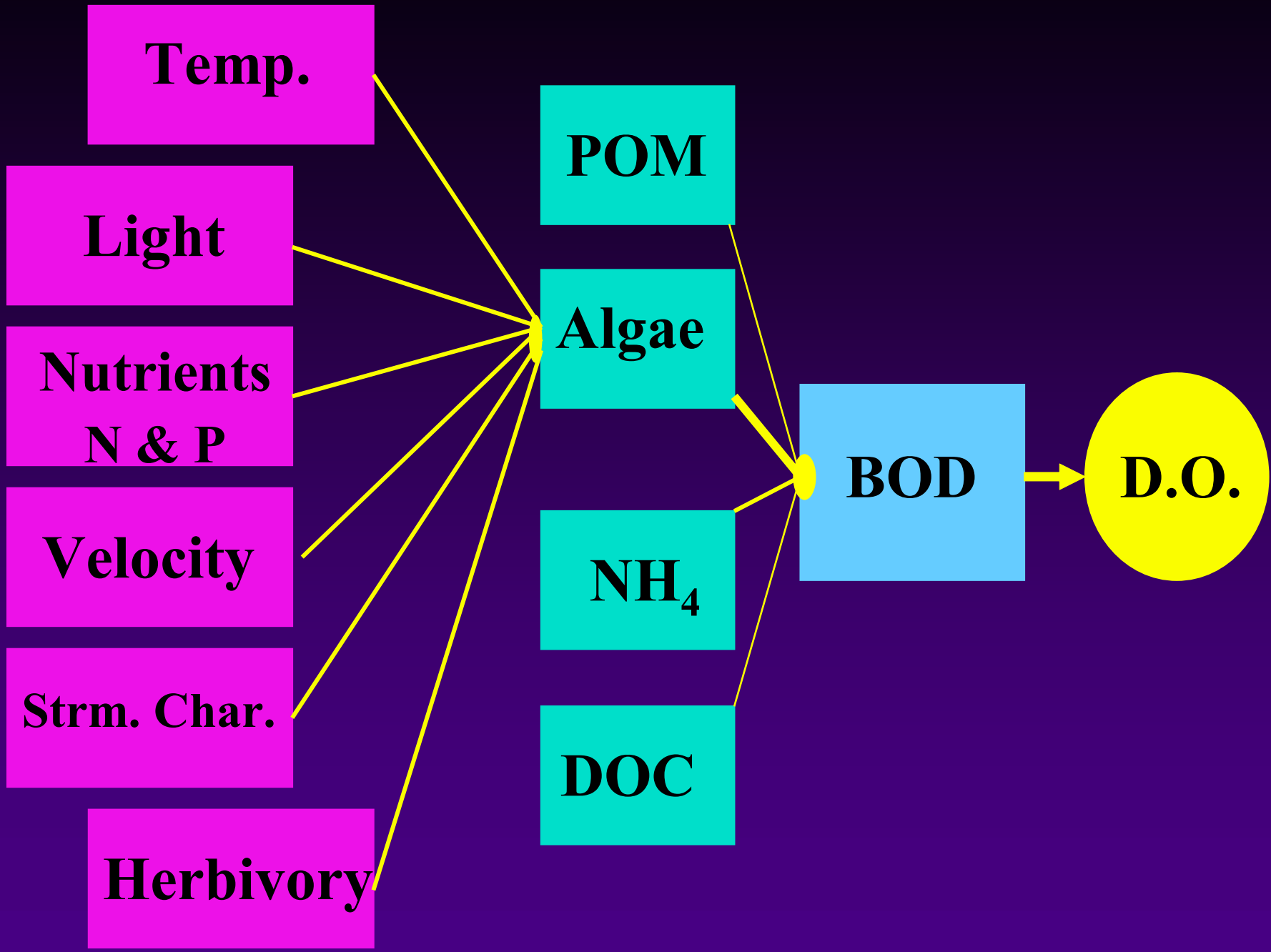
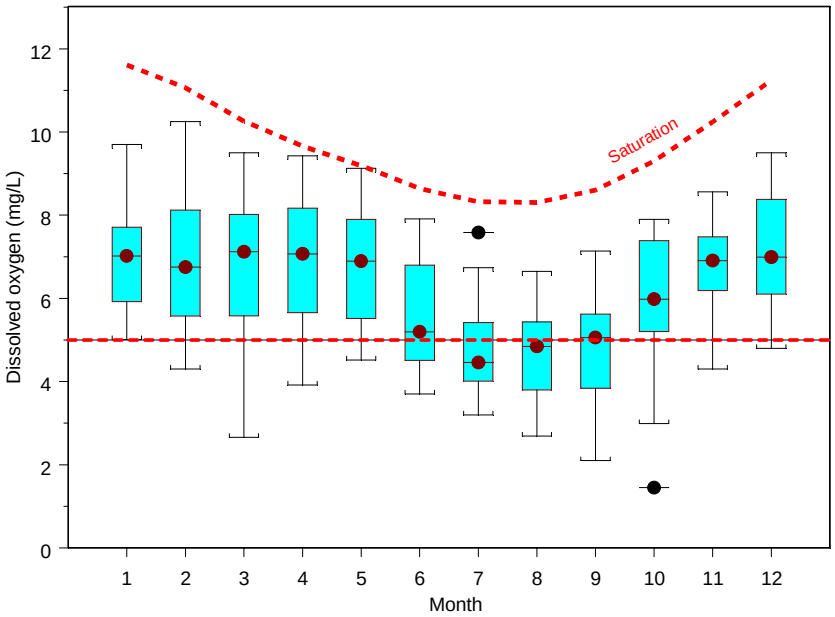
Overview of Upstream Water Quality in the San Joaquin River Watershed

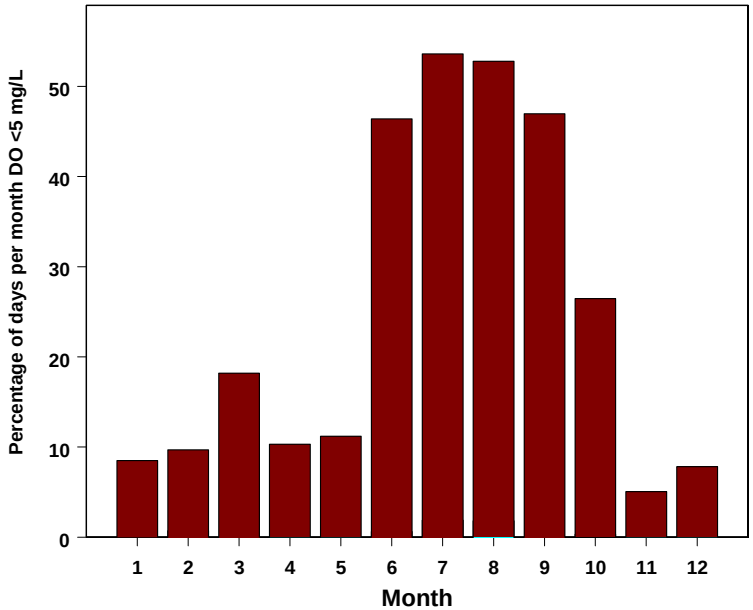
Randy A. Dahlgren, Sol Henson, Emily Volkmar,
Toby O'Geen and Erwin Van Nieuwenhuyse

University of California – Davis and USBR

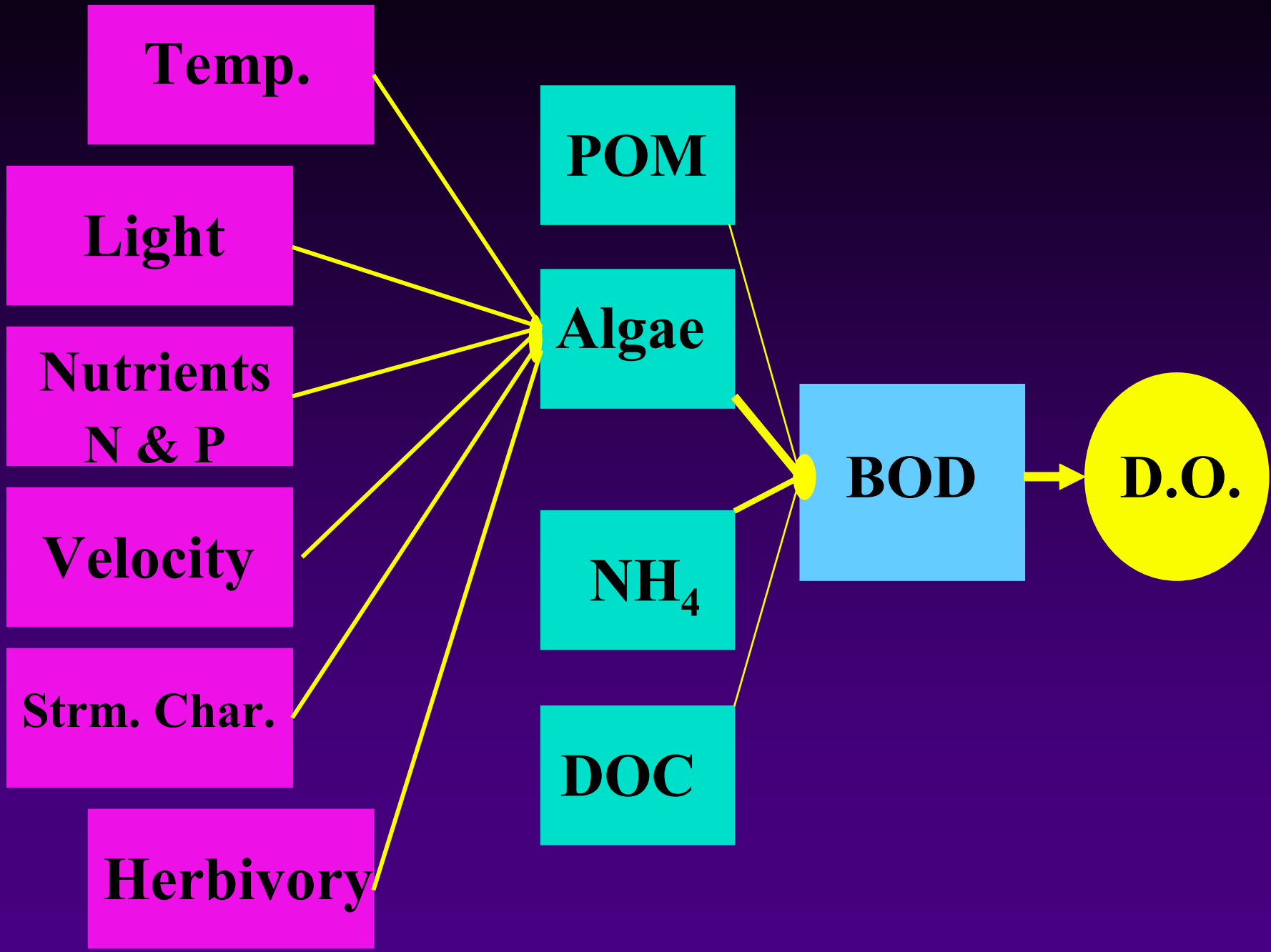

Temp.
Light
Nutrients
N & P
Velocity
Strm. Char.
Herbivory
POM
Algae
NH4
DOC
BOD
D.O.

Hypoxia in lower San Joaquin River





Source: IEP, Environmental Monitoring Program


Temp.
Light
Nutrients
N & P
Velocity
Strm. Char.
Herbivory
POM
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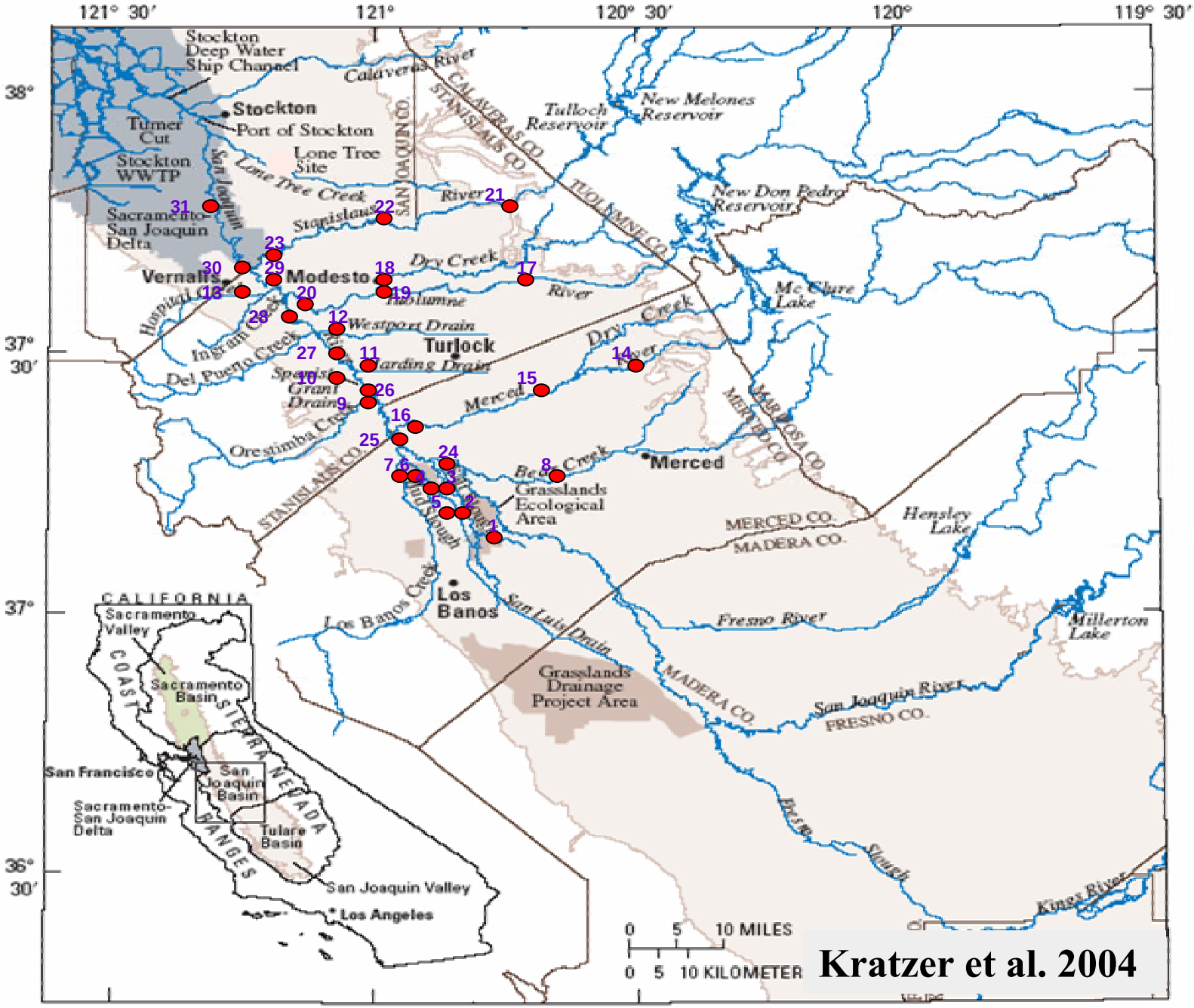
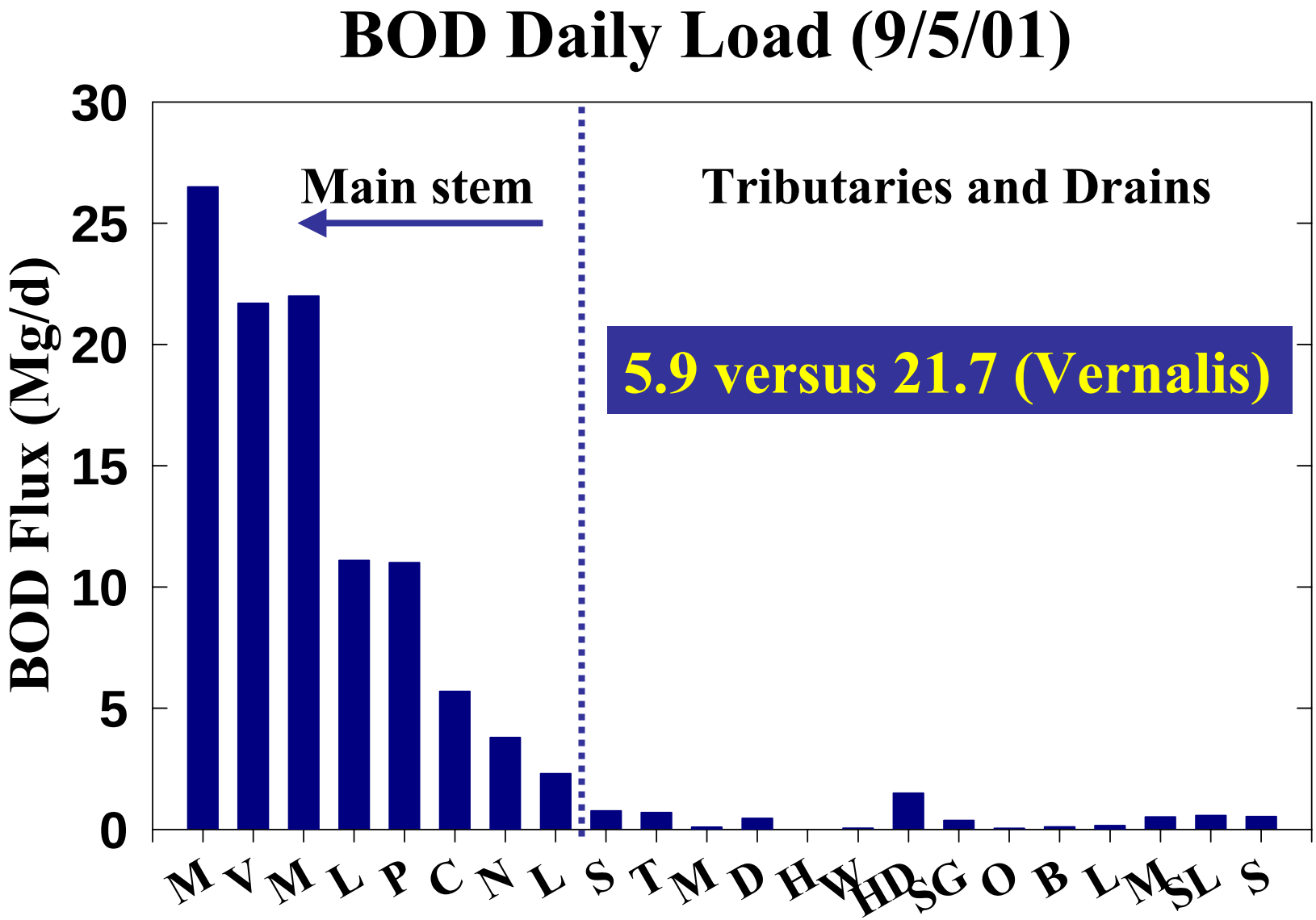
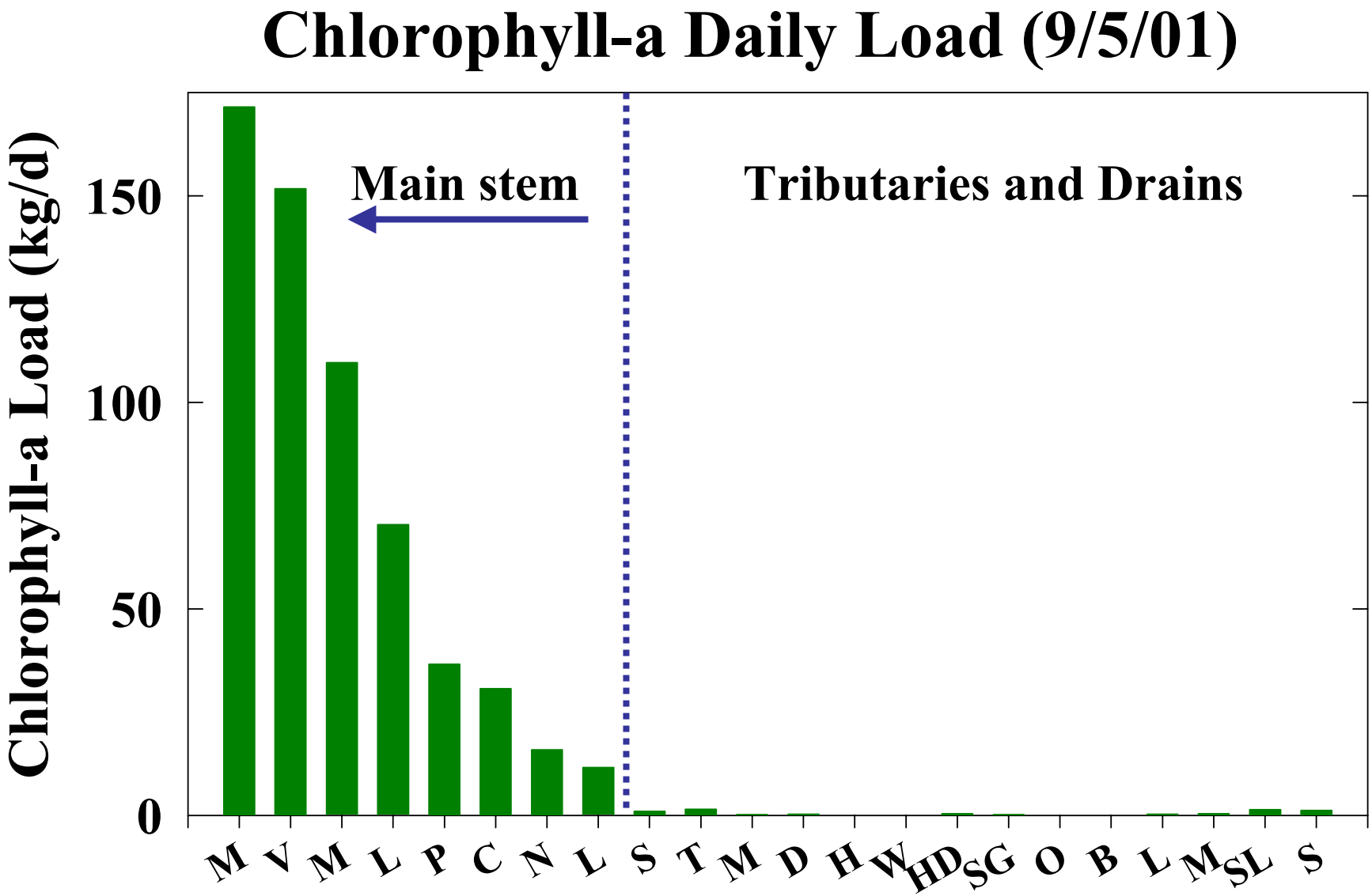
NH4
DOC
BOD
D.O.



Kratzer et al. 2004

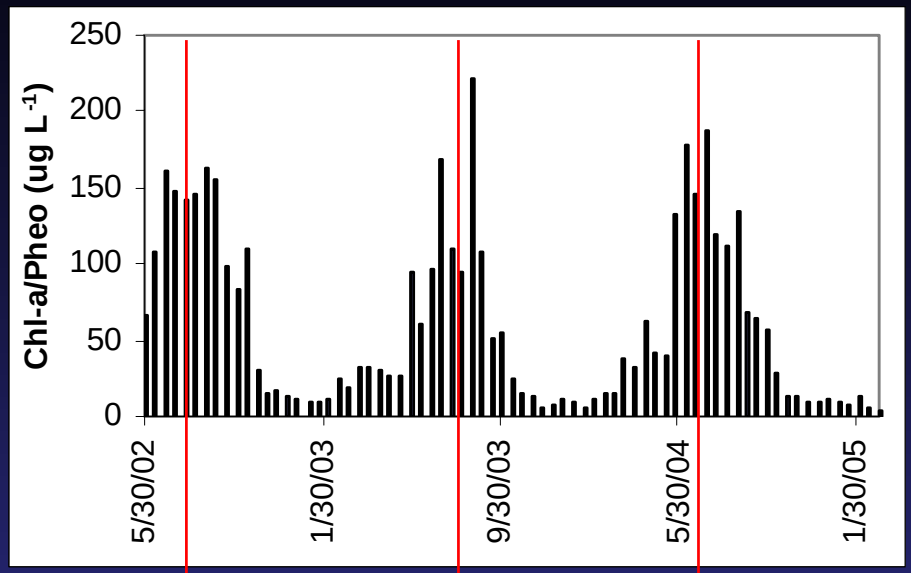

BOD Daily Load (9/5/01)
BOD Flux (Mg/d)
30
25
20
15
10
5
0
Main stem
Tributaries and Drains
5.9 versus 21.7 (Vernalis)
M V M L P C N L S T M D H W HD SG O B L M SL S


Chlorophyll-a Daily Load (9/5/01)
Chlorophyll-a Load (kg/d)
150
100
50
0
Main stem
Tributaries and Drains
M V M L P C N L S T M D H W HD SG O B L MSL S

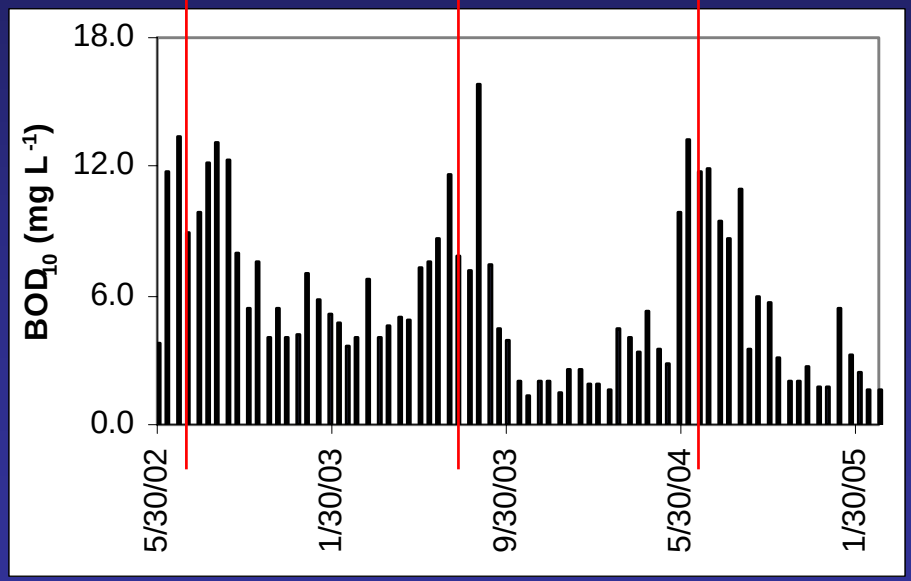
BOD Rate Constants

	k (d^{-1})	½ life (d)	Chloro (ppb)
➢ SJR sites	0.090	11.1	46
➢ Tribs/Drains	0.088	11.4	31
➢ East-side Tribs	0.067	14.9	3

Mossdale

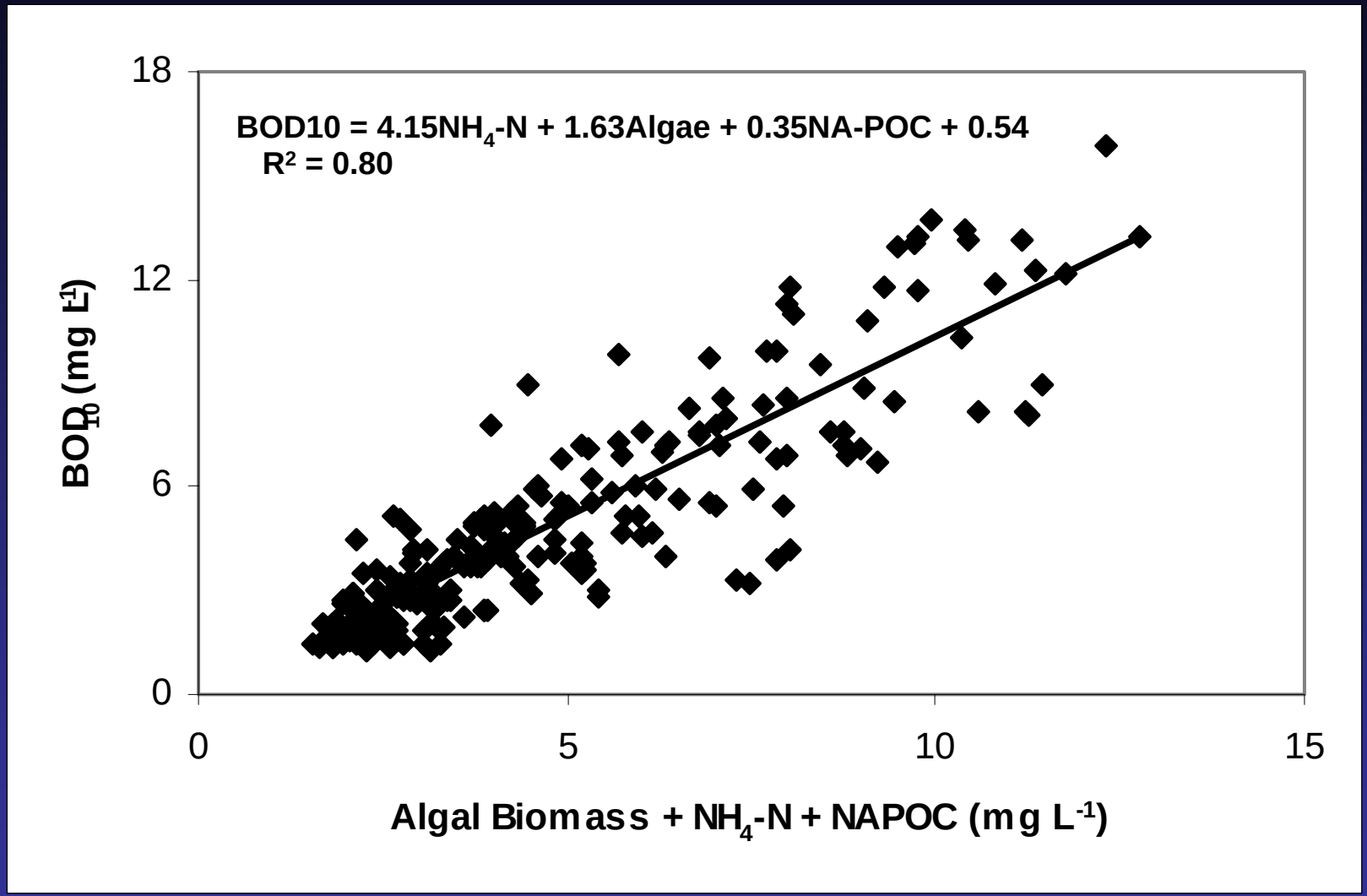


Chlorophyll + Pheophytin



BOD_{10}

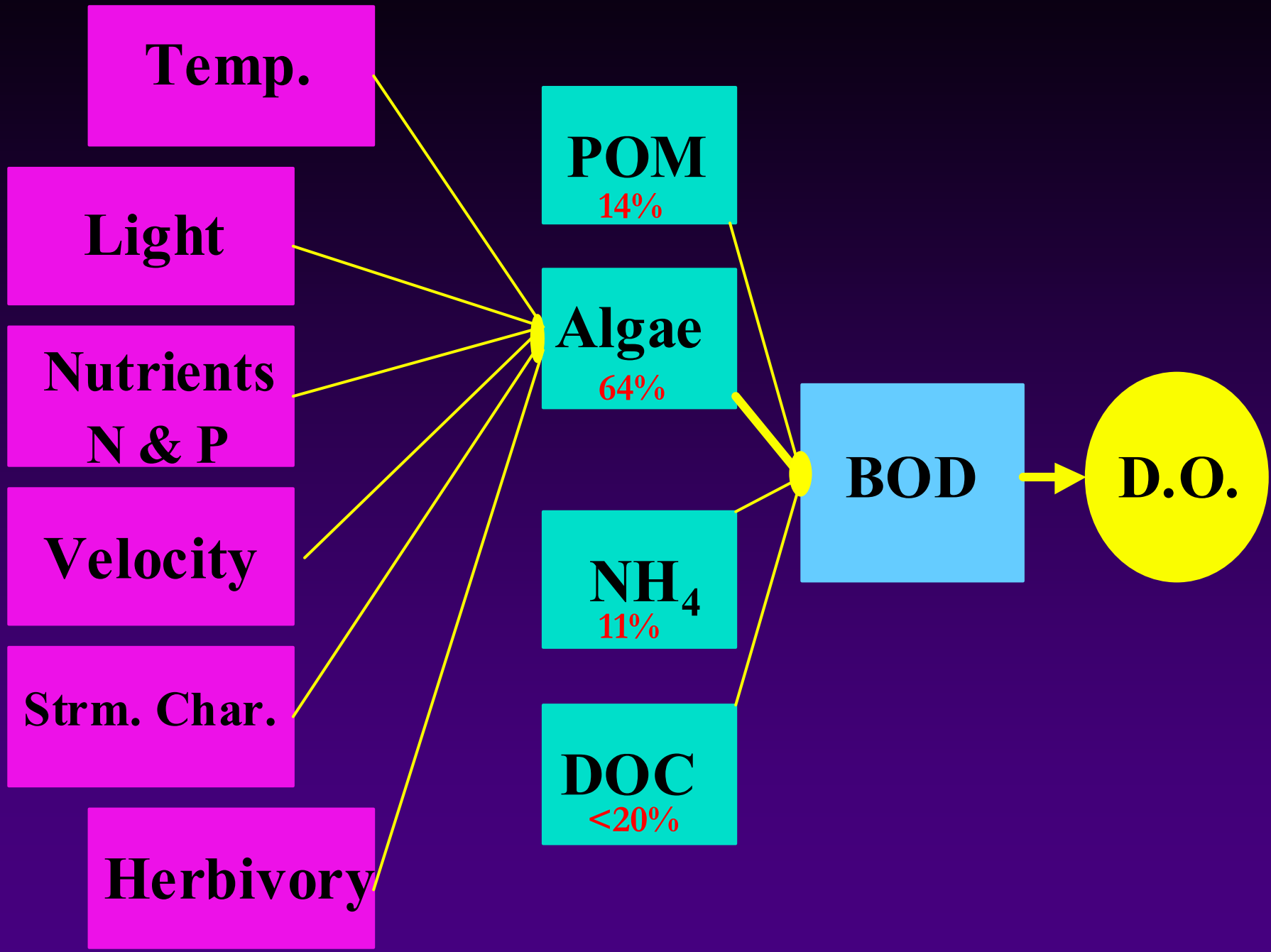
BOD Component Modeling



Contributions Based on Mean Values

- **Ammonia** **11%**
- **Algal C** **64%**
- **Non-Algal C** **14%**
- **Not identified** **11%**

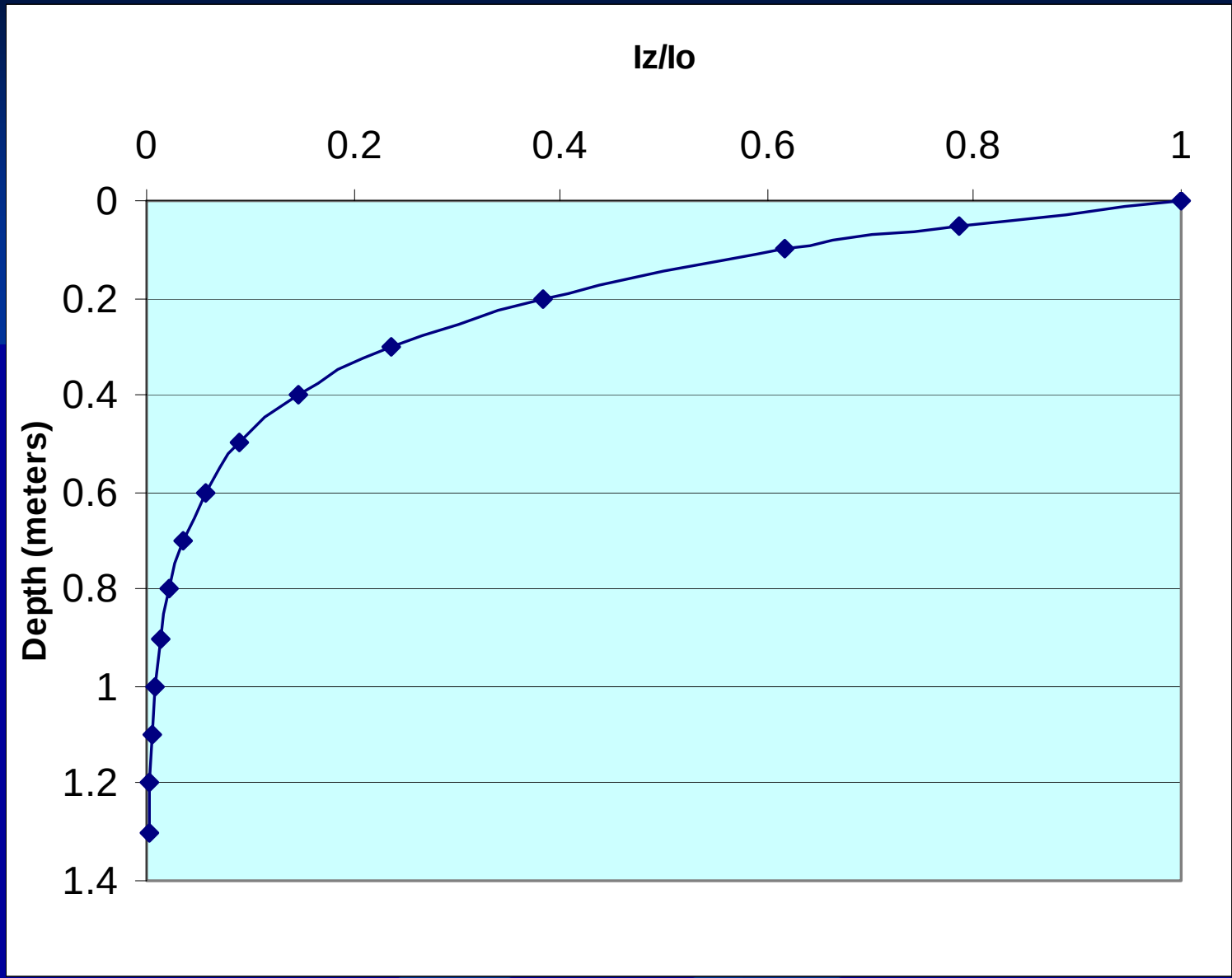
Dissolved fraction **<20% of BOD**

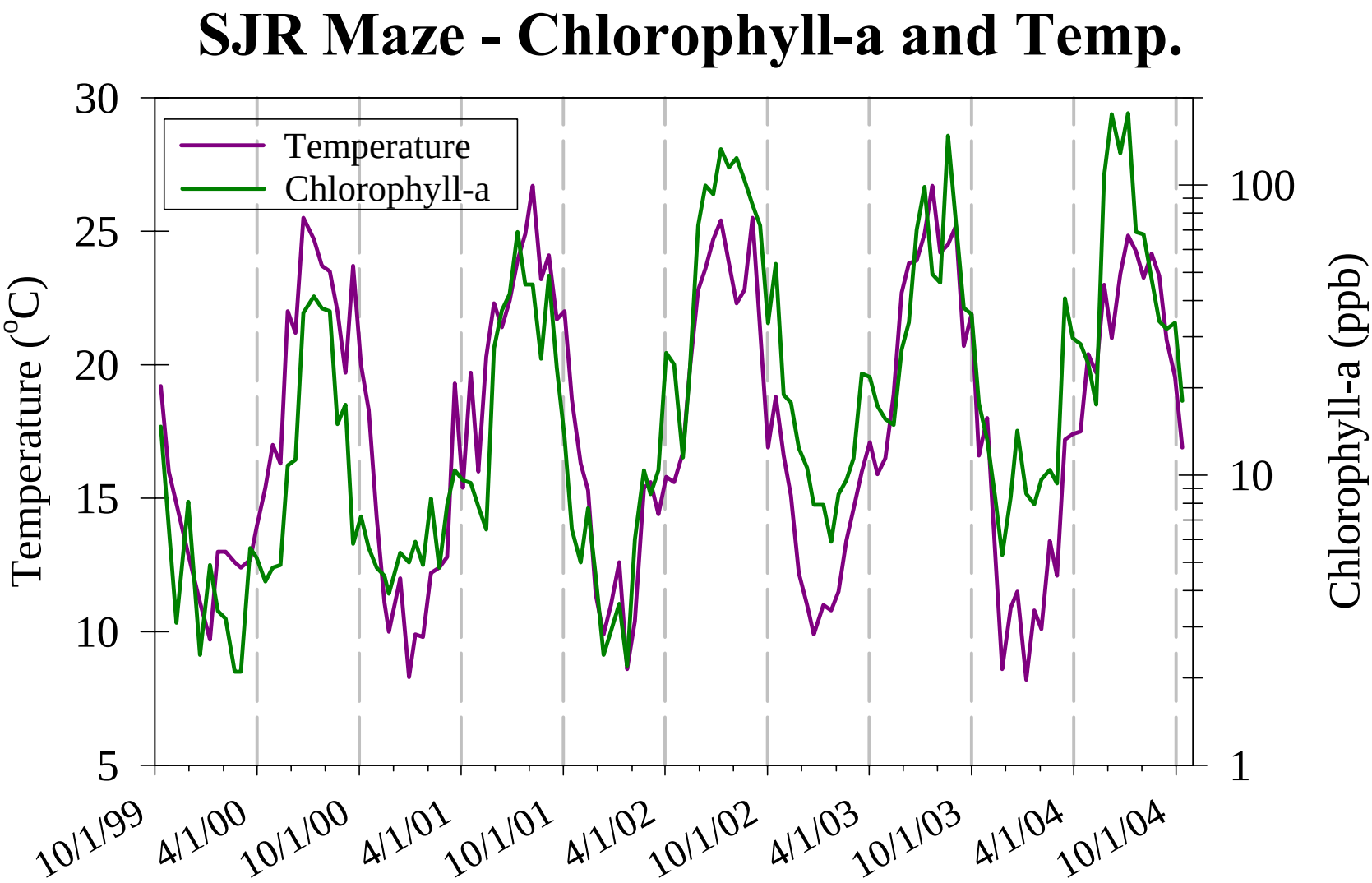

Temp.
Light
Nutrients
N & P
Velocity
Strm. Char.
Herbivory
POM
14%
Algae
64%
NH4
11%
DOC
<20%
BOD
D.O.

Nutrient Limitations to Algae

- Mineral N limitation: <0.1 ppm N
  - S.J. River: 2 – 2.5 ppm
- SR-PO_4 limitation: <10 ppb P
  - S.J. River: 100 – 150 ppb
- Silica limitation <0.06 ppm Si
  - S.J. River: 5.5-8.5 ppm

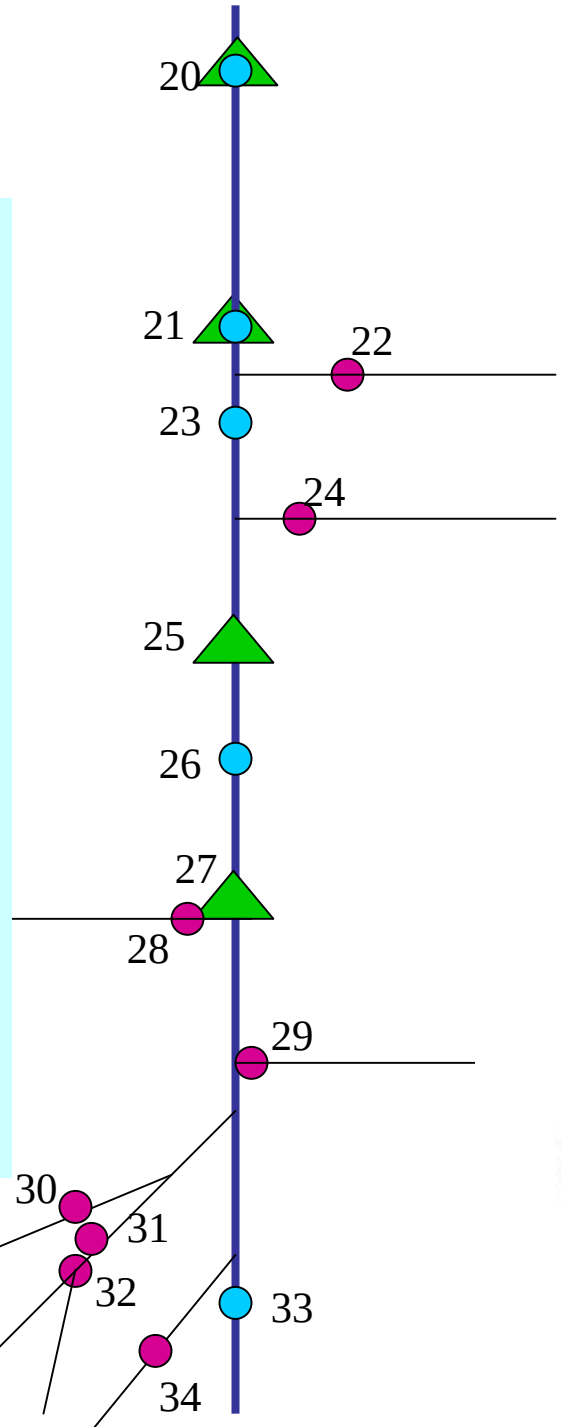
Light Extinction




SJR Maze - Chlorophyll-a and Temp.
Temperature
Chlorophyll-a
Temperature (°C)
Chlorophyll-a (ppb)
30
25
20
15
10
5
100
10
1
10/1/99
4/1/00
10/1/00
4/1/01
10/1/01
4/1/02
10/1/02
4/1/03
10/1/03
4/1/04
10/1/04

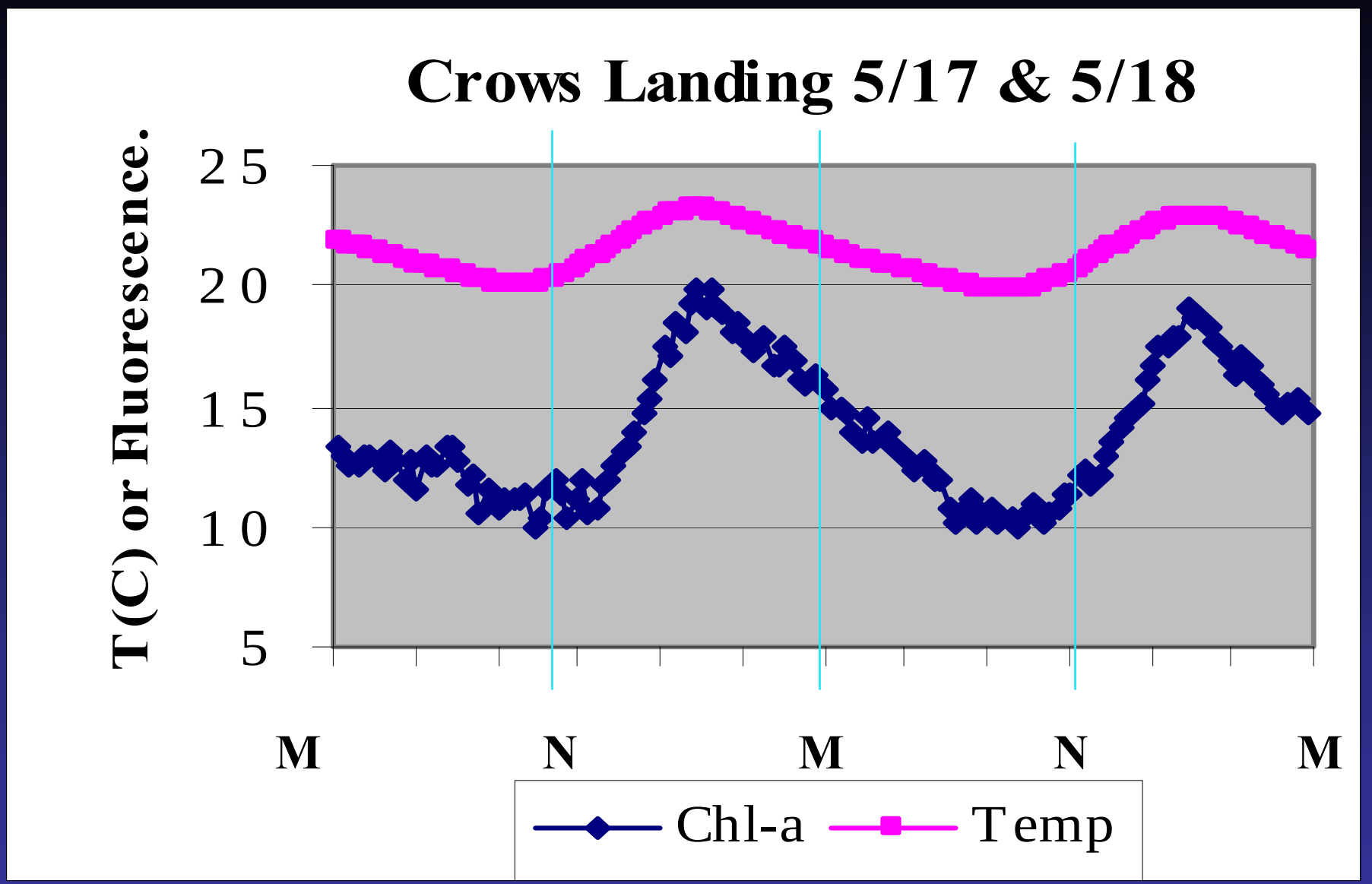
San Joaquin River Watershed

20. S.J. Mossdale
21. S.J. Vernalis
22. Stanislaus River
23. S.J. Maze
24. Tuolumne River
25. S.J. Grayson
26. S.J. Patterson
27. S.J. Crows Landing
28. Orestimba Creek
29. Merced River
30. Los Banos Creek
31. Mud Slough
32. San Luis Drain
33. S.J. Lander Ave.
34. Salt Slough

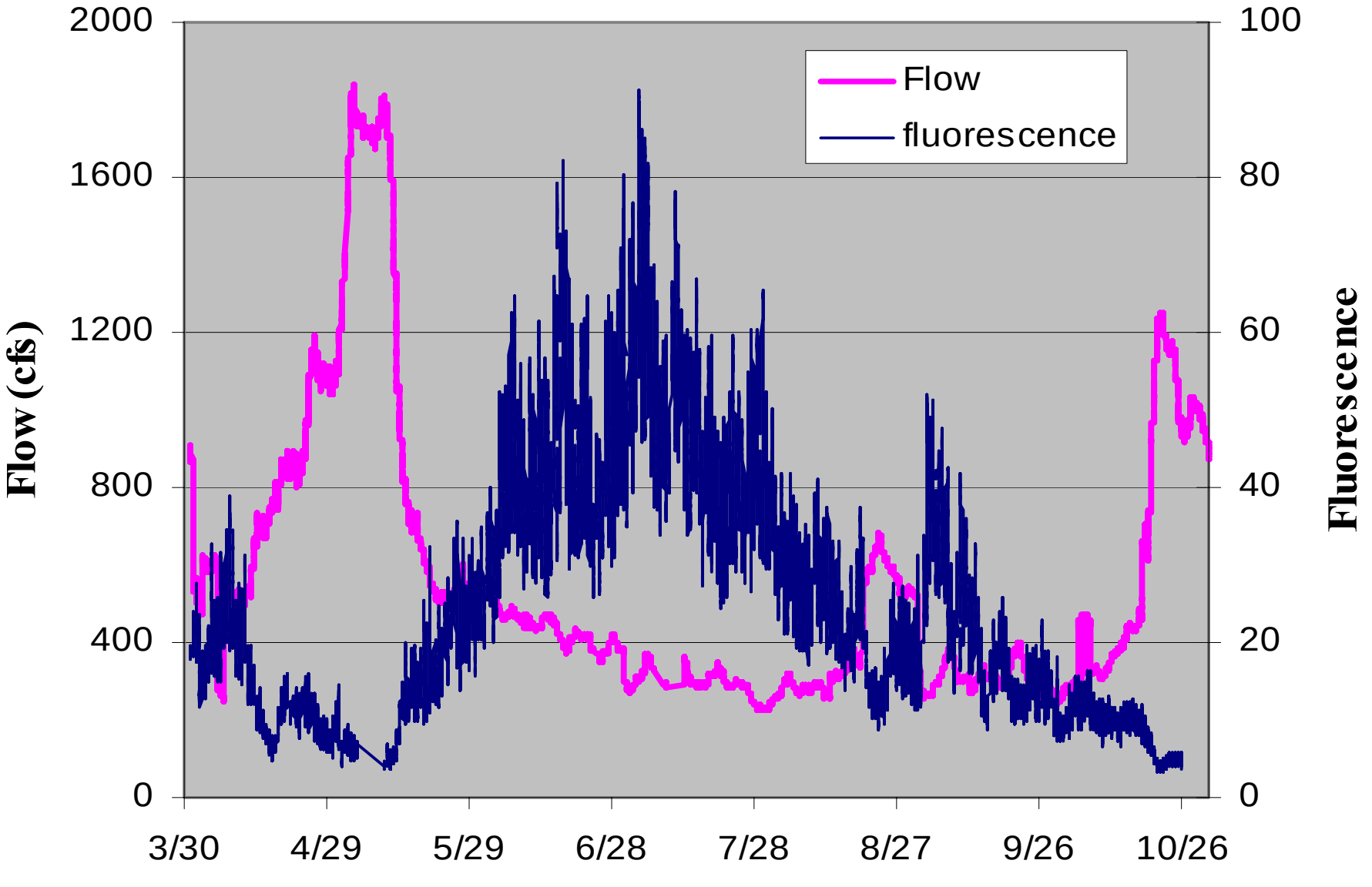


Continuous Chlorophyll

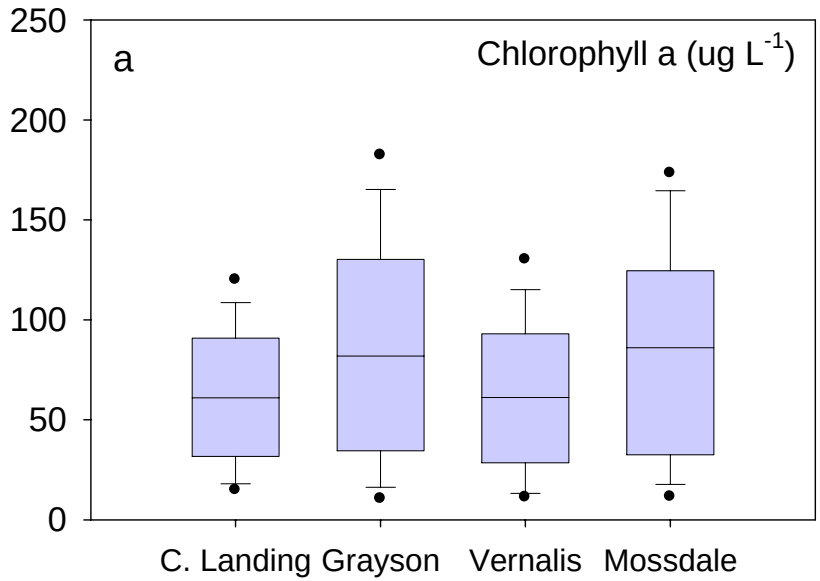
Grab sampling sites

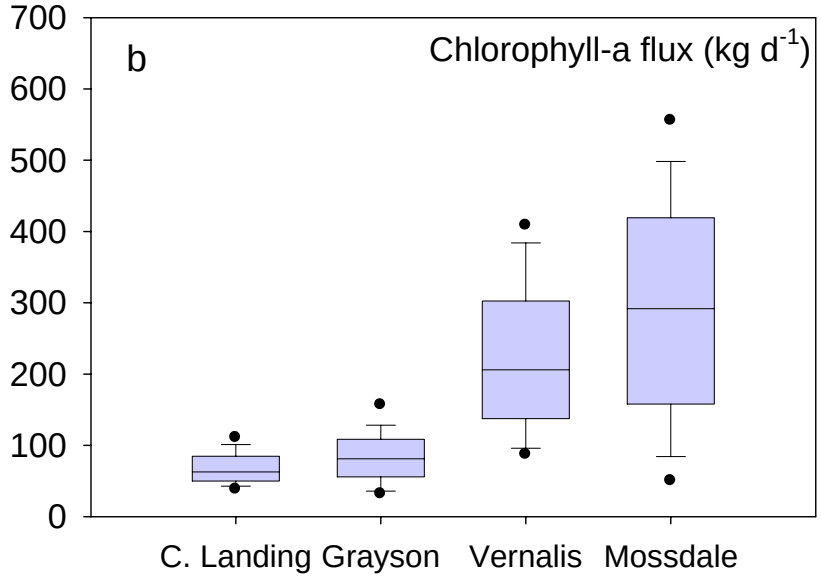

Crows Landing 5/17 & 5/18
T(C) or Fluorescence.
25
20
15
10
5
M
N
M
N
M
Chl-a
Temp

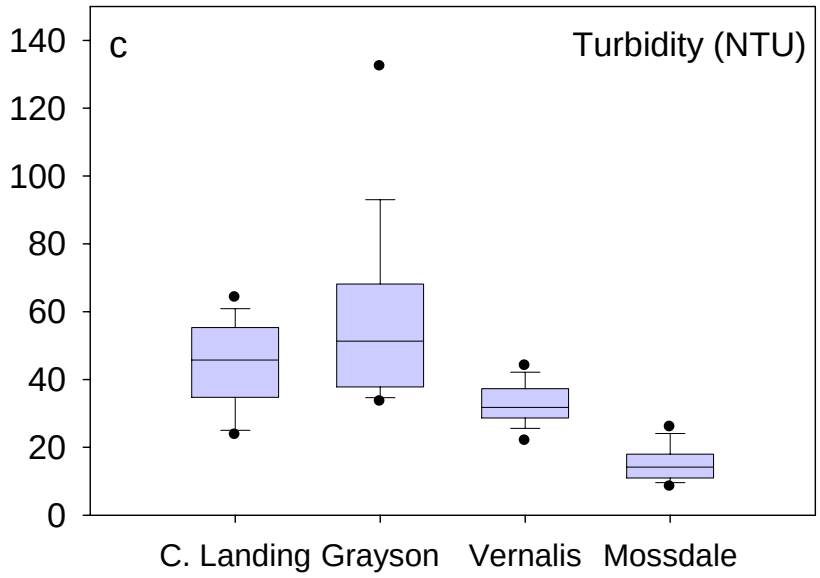
Crows Landing 2004

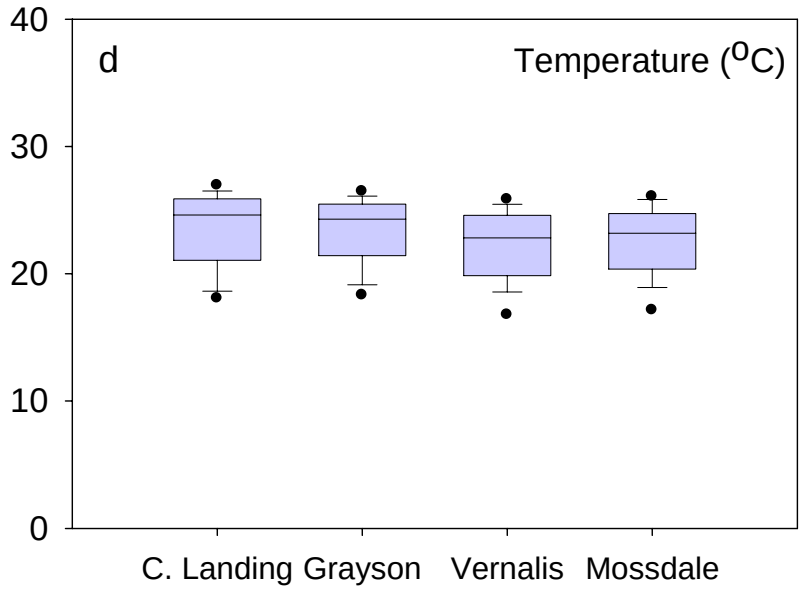


Site Water Quality Characteristics - April-Sept. 2004

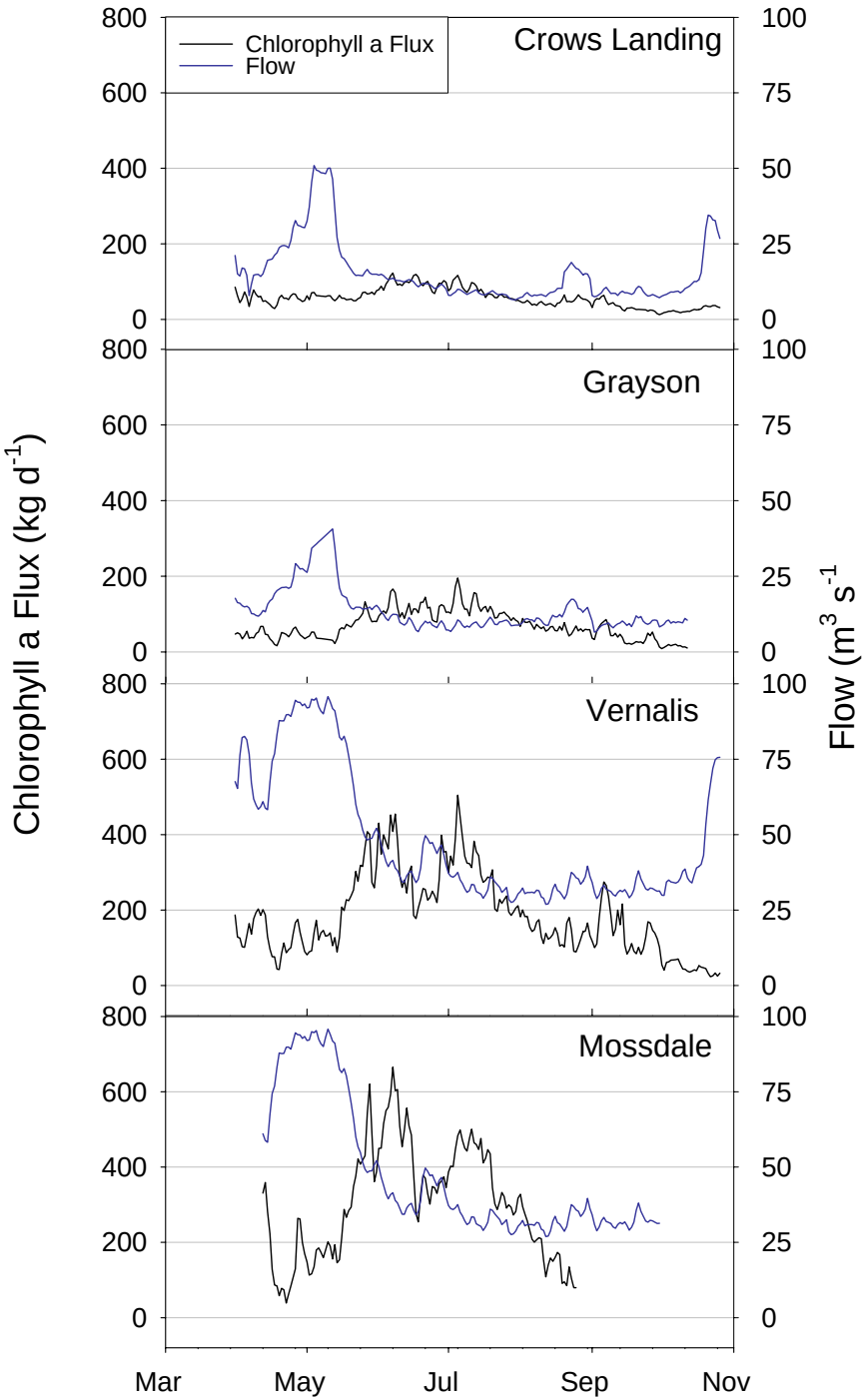


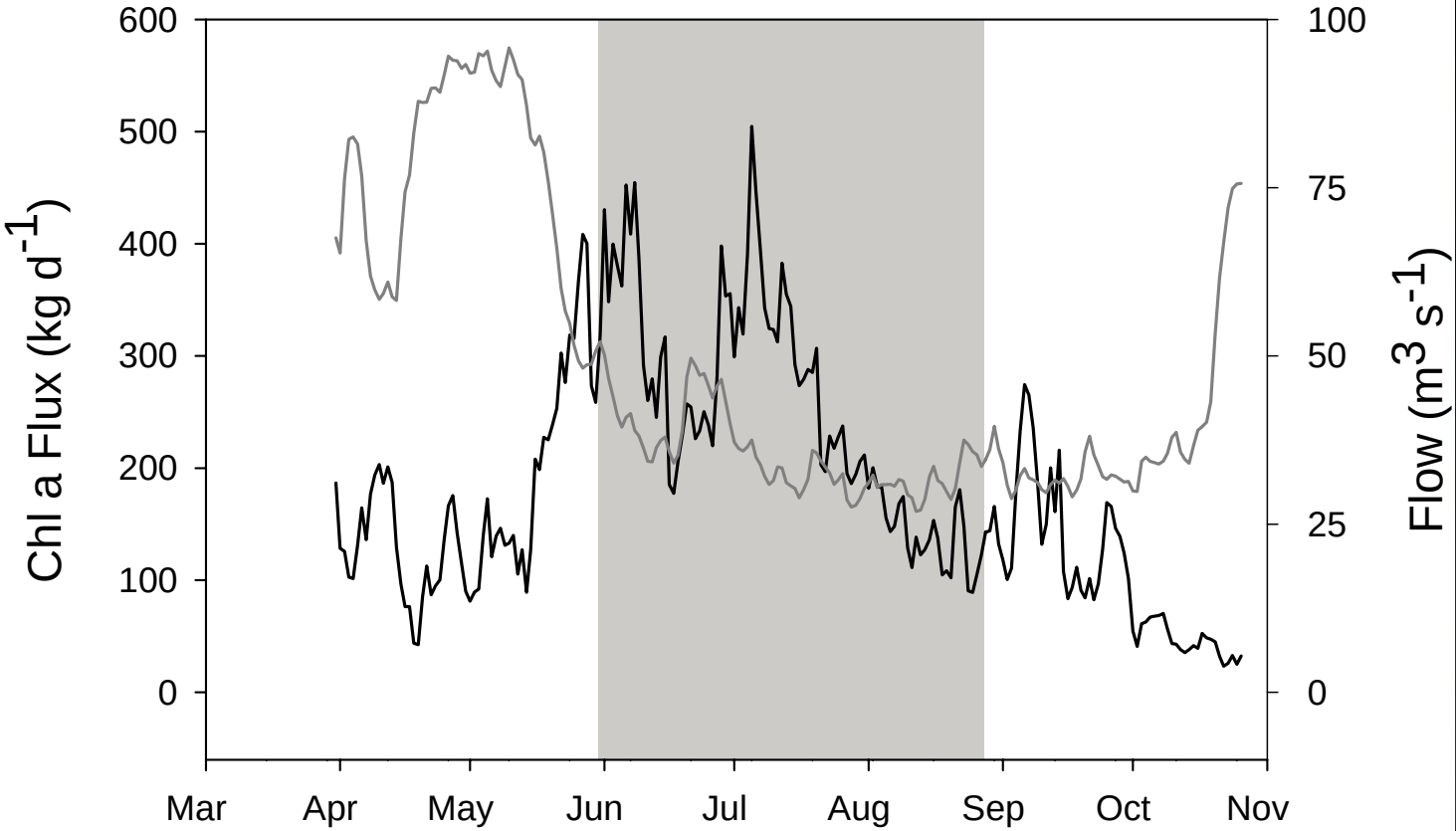






Chlorophyll Daily Loads and Flow - 2004





PAR

Temp.

Salinity

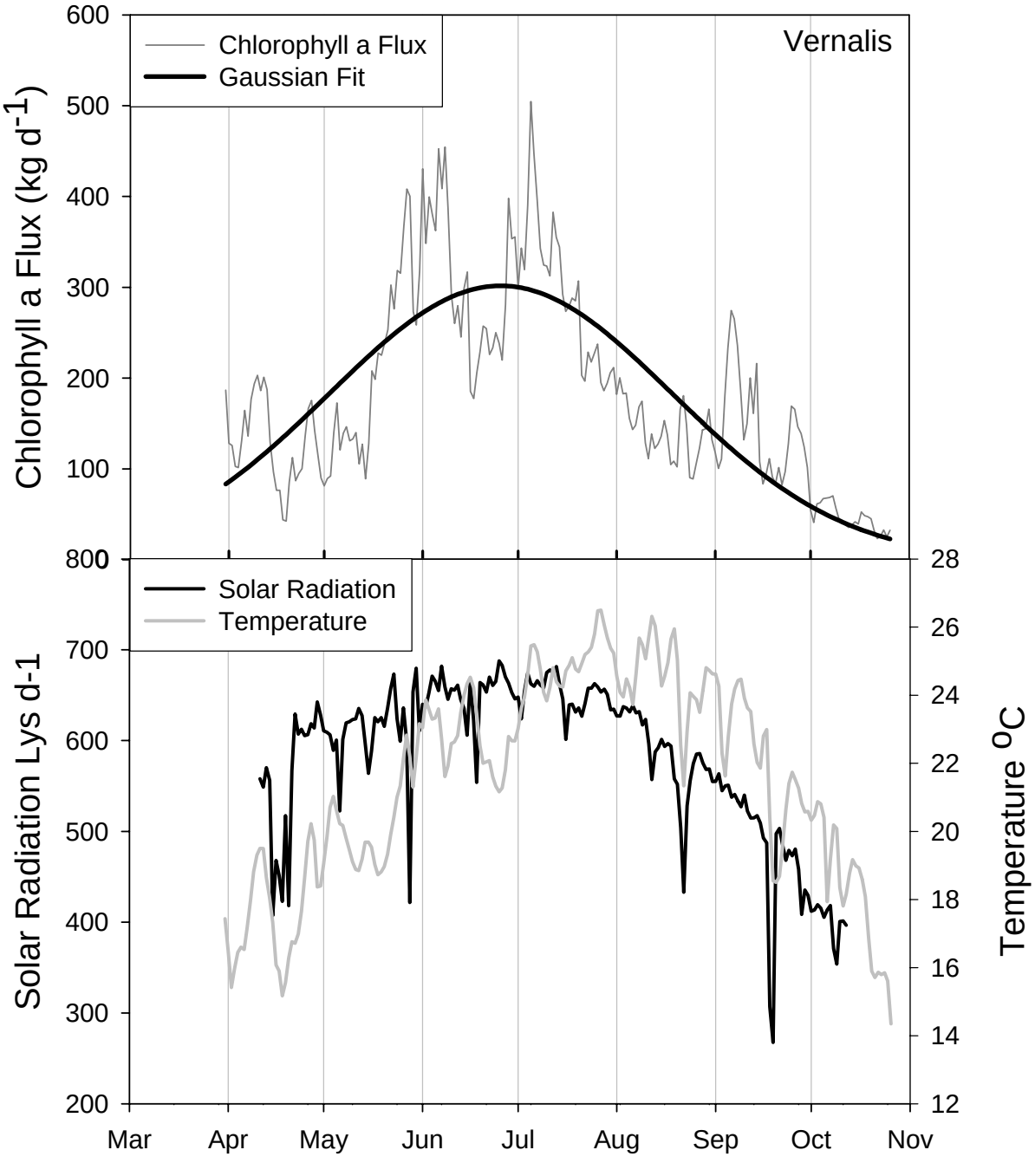
Travel time

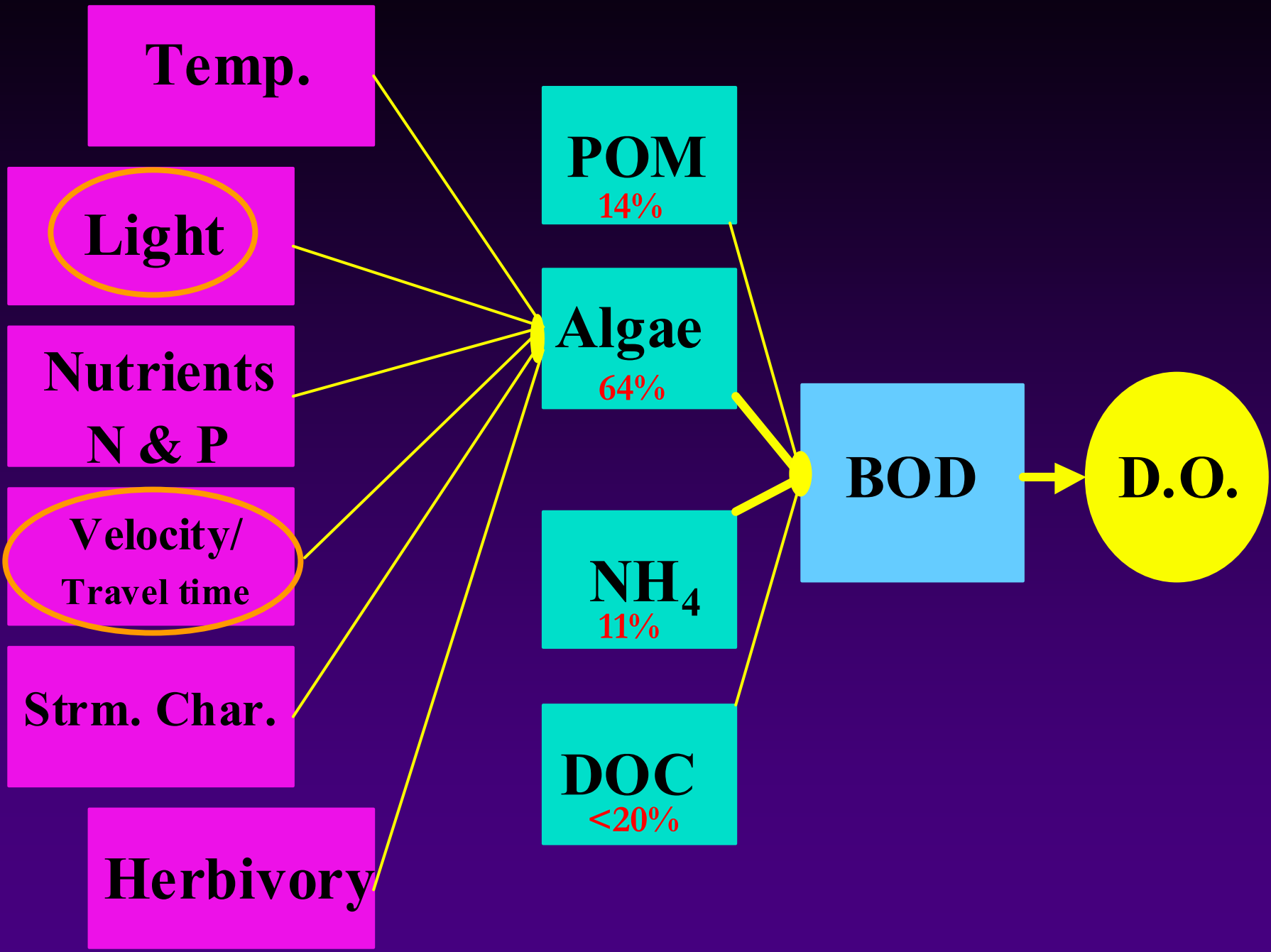
Flow

Turbidity

Chlorophyll Flux Modeling

Summer Flow (R^2 = 0.80)		
		P
Intercept		<0.0001
Flow		<0.0001
River Miles		<0.0001
Solar Radiation		<0.0001


Vernalis
Chlorophyll a Flux
Gaussian Fit
Chlorophyll a Flux (kg d-1)
600
500
400
300
200
100
800
Solar Radiation
Temperature
Solar Radiation Lys d-1
700
600
500
400
300
200
Temperature °C
28
26
24
22
20
18
16
14
12
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov


Temp.
Light
Nutrients
N & P
Velocity/
Travel time
Strm. Char.
Herbivory
POM
14%
Algae
64%
NH4
11%
DOC
<20%
BOD
D.O.

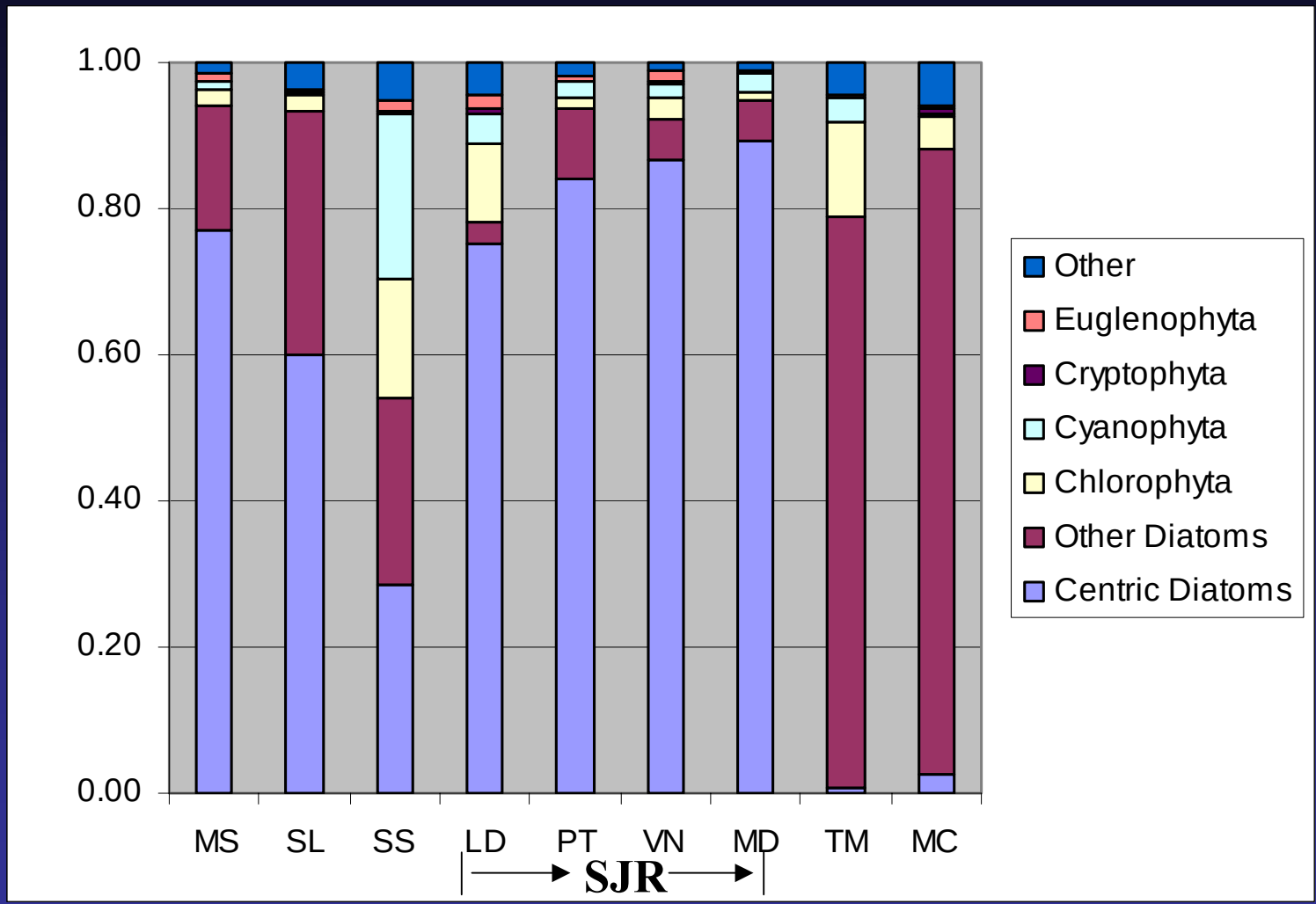
	Crows Landing	Grayson	Vernalis	Mossdale
	chlorophyll-a (kg)			
April	1949	1338	3301	4754
May	1981	1927	5956	8575
June	3012	3430	9041	13082
July	3091	3576	8974	12171
August	1742	1973	4143	5279

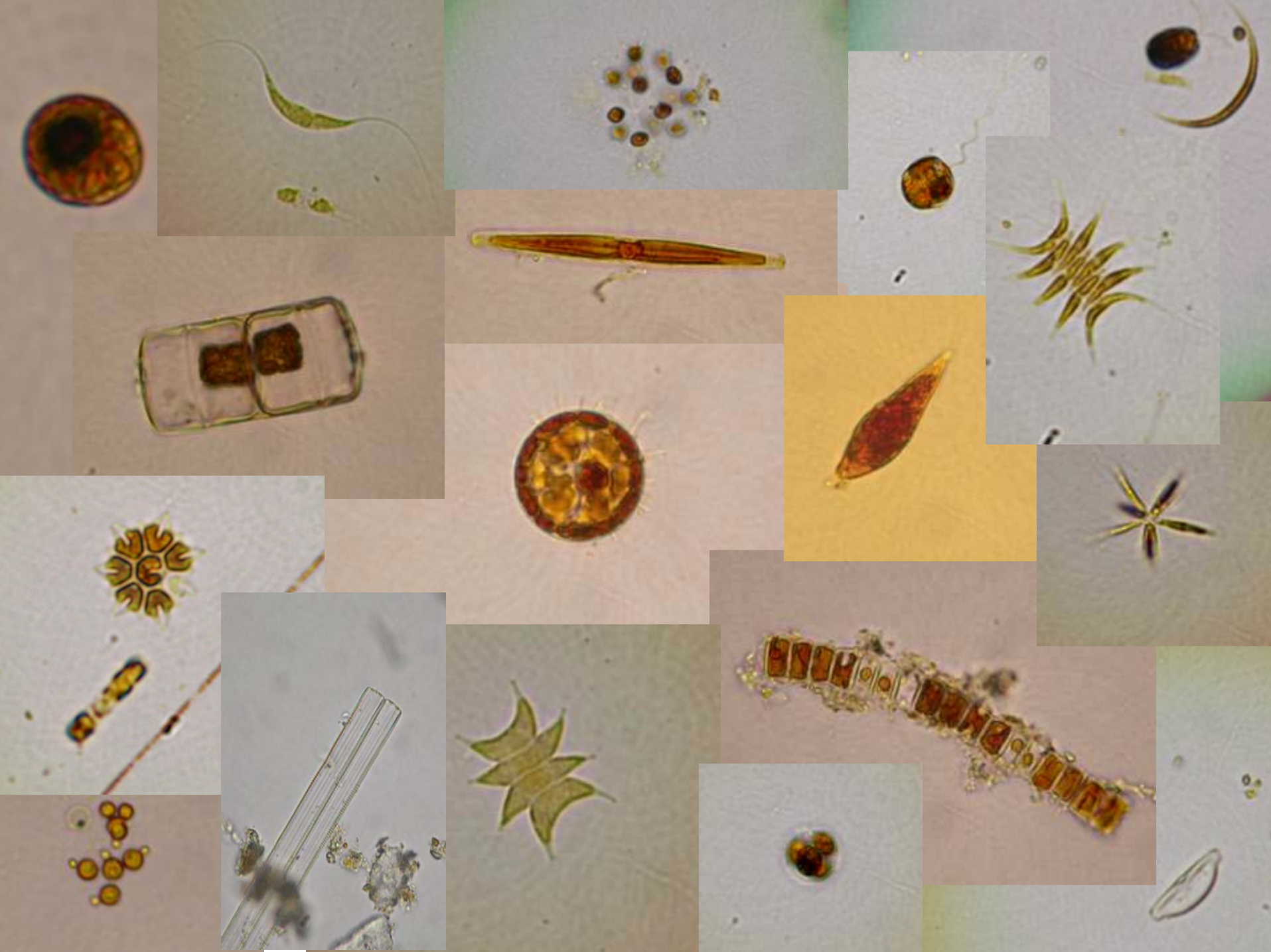
	Net Growth Rate (Divisions/day)			
	C->G	G->V	V->M	C->M
April	-0.52	1.57	0.66	0.48
May	-0.04	1.96	0.66	0.78
June	0.18	1.68	0.67	0.78
July	0.20	1.60	0.55	0.73
August	0.17	1.29	0.44	0.59


San Joaquin
Stanislaus

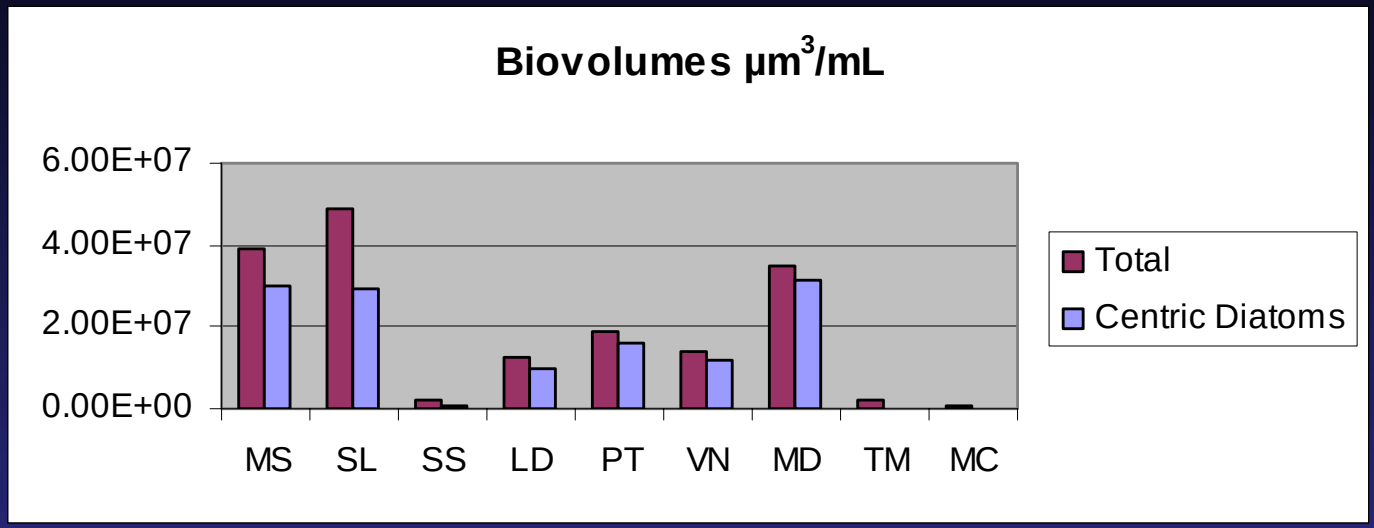
	Net Growth Rate (kg/day)			
	C->G	G->V	V->M	C->M
April	-20	88	64	62
May	-2	186	115	206
June	13	253	177	315
July	16	242	139	268
August	7	95	49	89

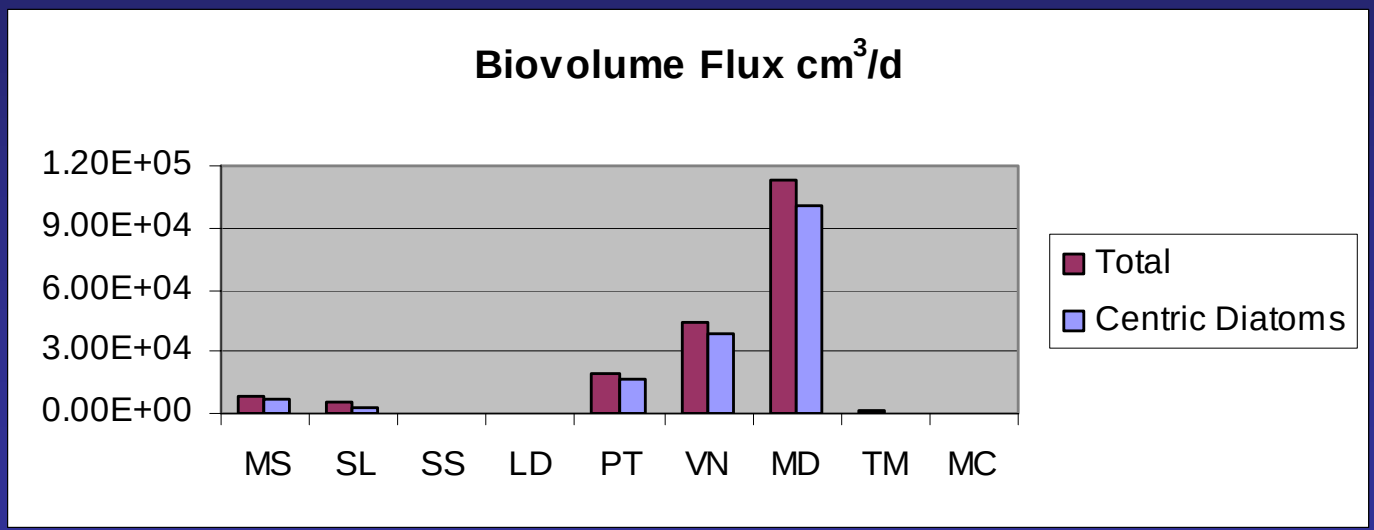
Algae Taxa Identification





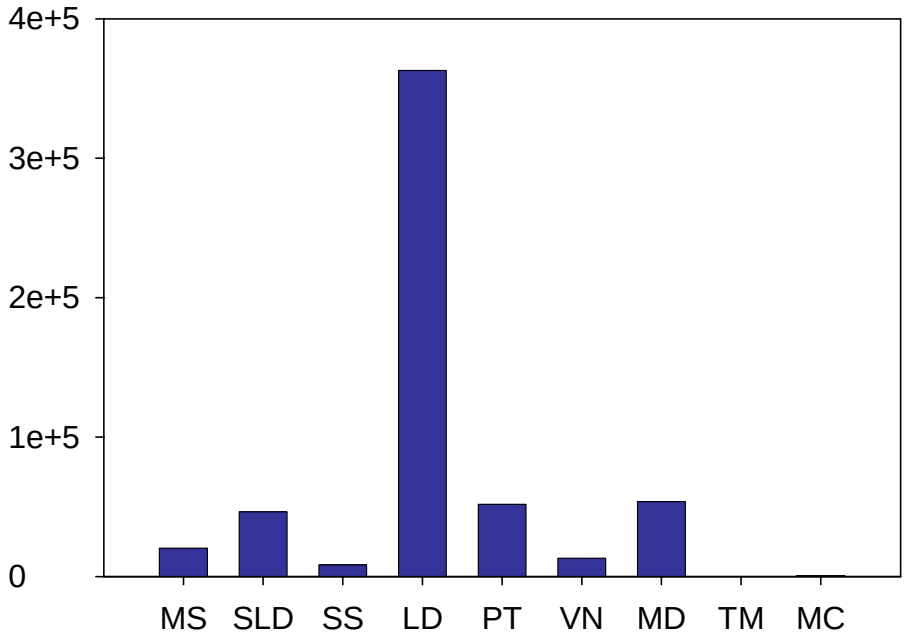
Algae Spatial Distribution



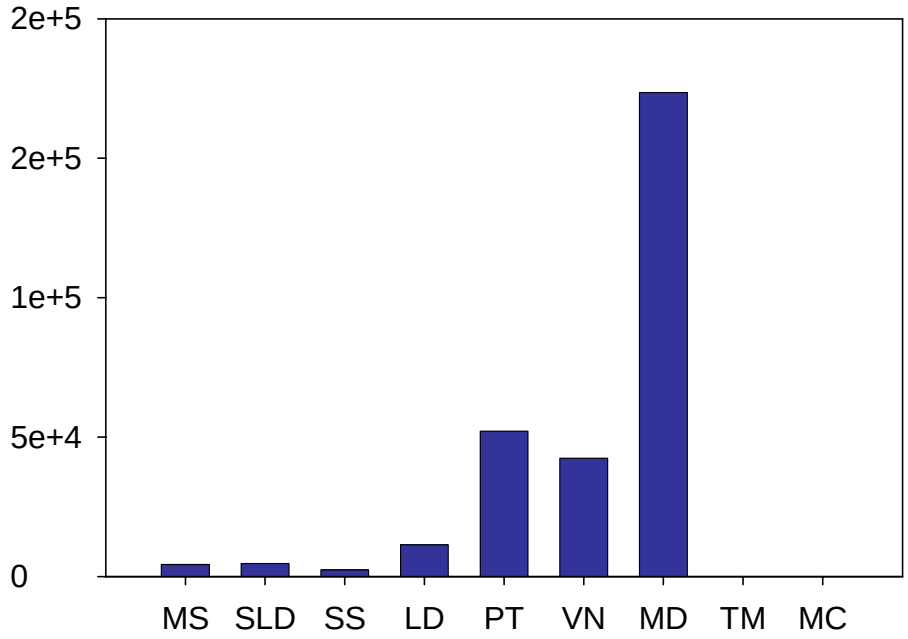


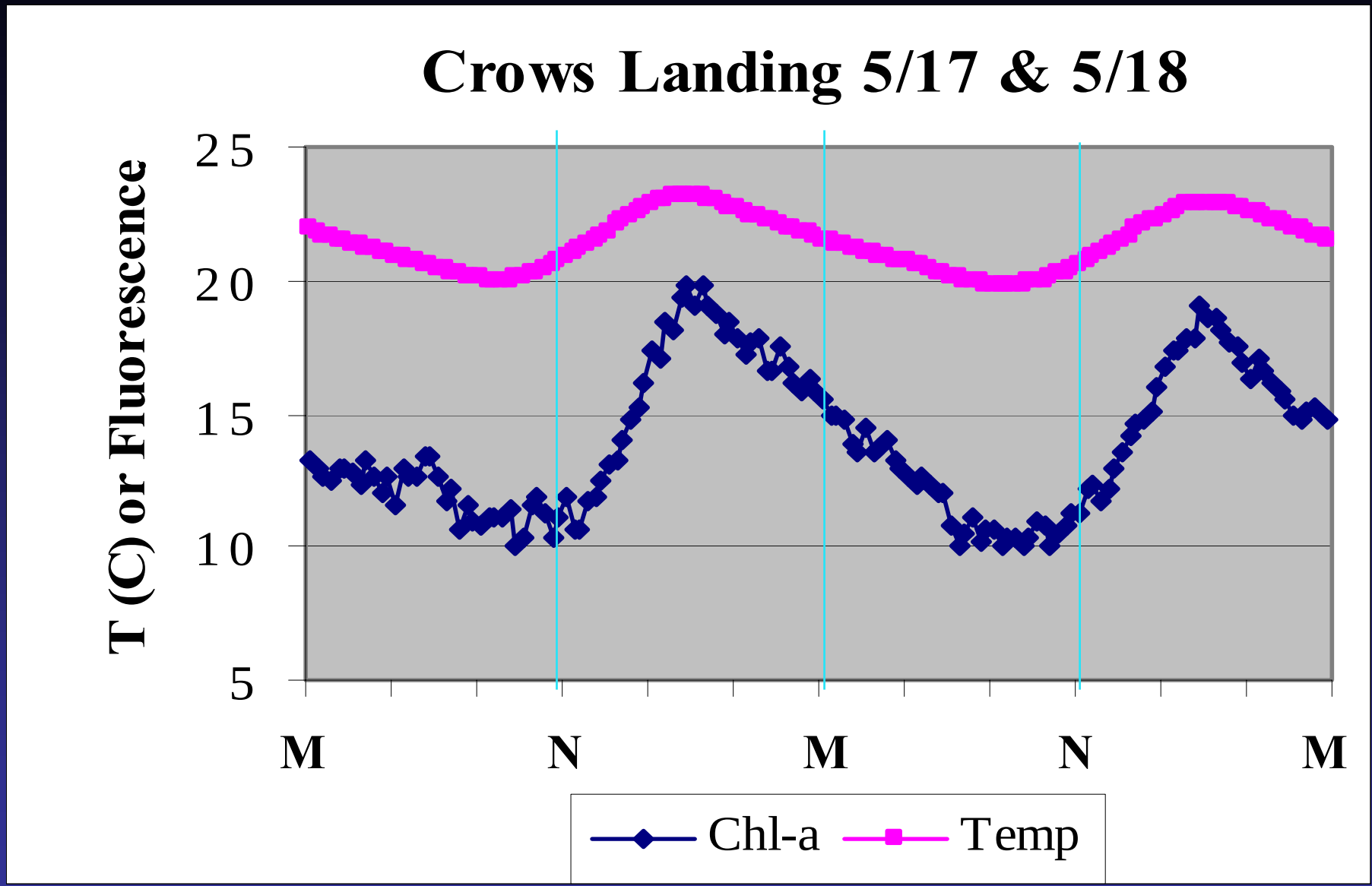
Microcystis

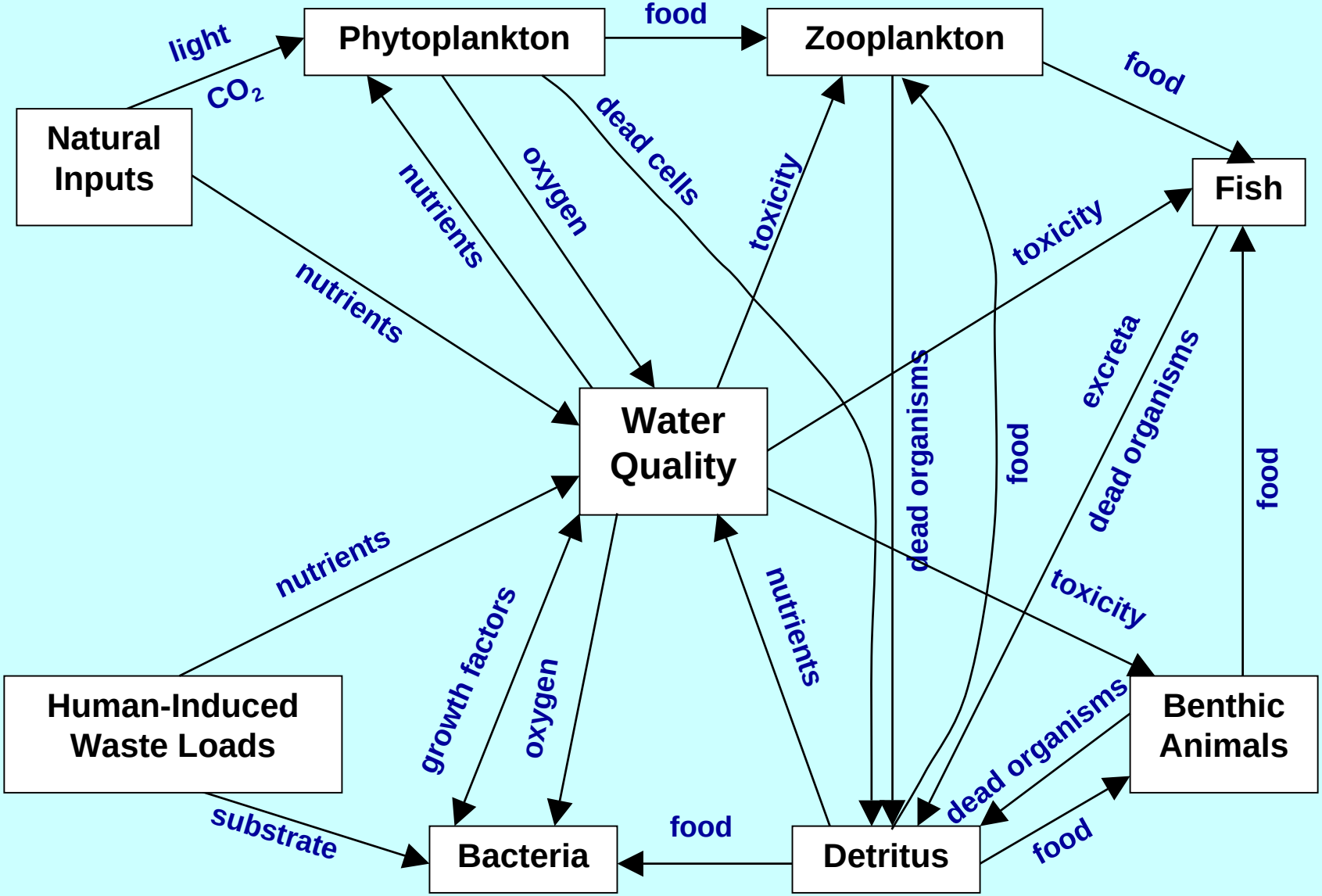
Biovolume um^3/ml



Biovolume Flux cm^3/d



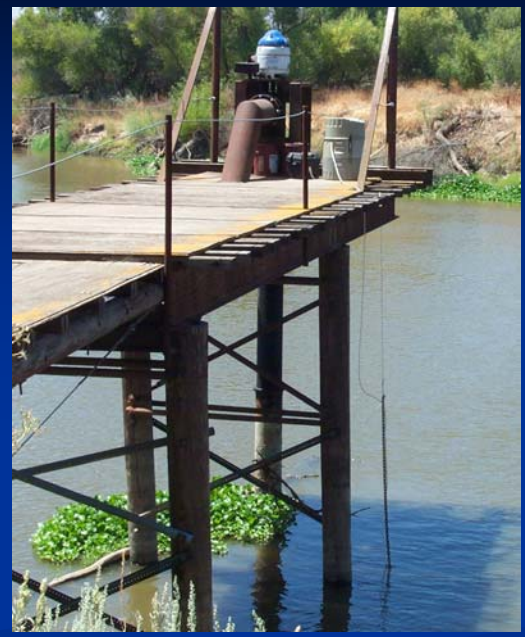

Crows Landing 5/17 & 5/18
T (C) or Fluorescence
25
20
15
10
5
M
N
M
N
M
Chl-a
Temp

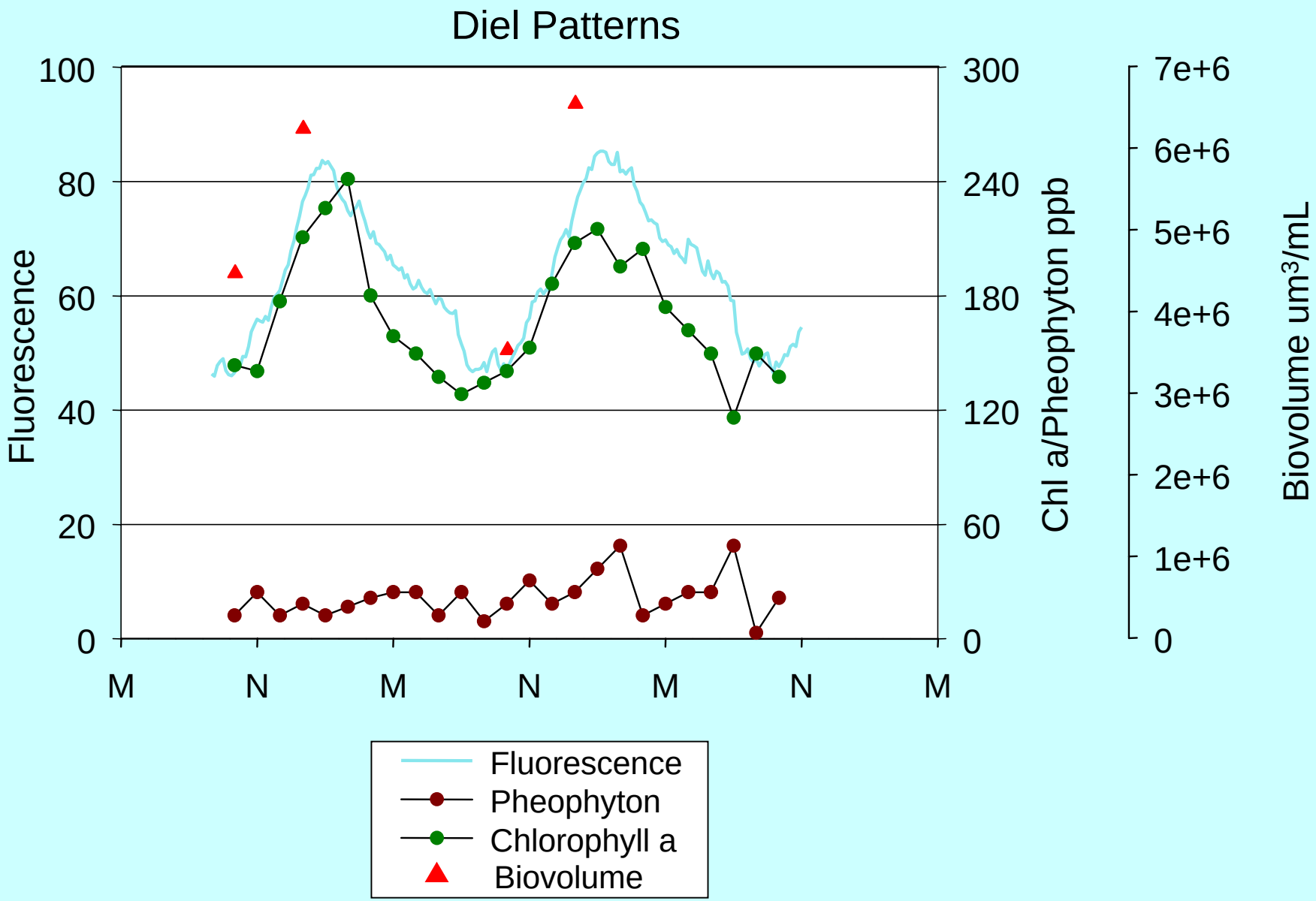

Phytoplankton
Zooplankton
Natural Inputs
Fish
Water Quality
Human-Induced Waste Loads
Benthic Animals
Bacteria
Detritus
light
CO_2
food
food
nutrients
oxygen
dead cells
toxicity
toxicity
nutrients
dead organisms
food
excreta
dead organisms
food
nutrients
growth factors
oxygen
nutrients
toxicity
dead organisms
substrate
food
food

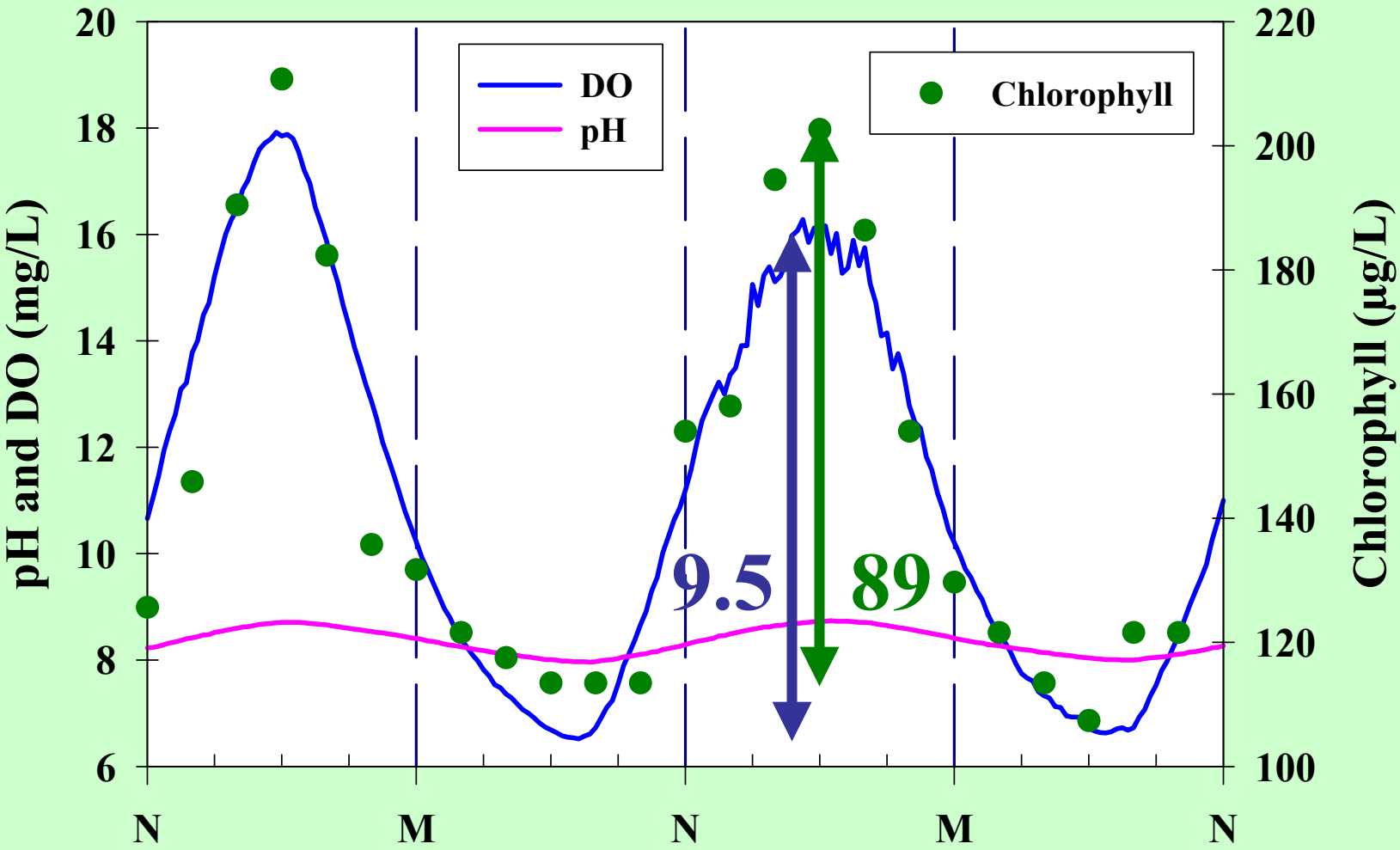
Comprehensive 48 hour studies

Measured parameters:

Fluorescence
Extractable chlorophyll
DO
Nutrients
Cell counts/Biomass determination
Dark and light bottle
Zooplankton biomass determination




Diel Patterns
Fluorescence
100
80
60
40
20
0
300
240
180
120
60
0
ChI a/Pheophyton ppb
7e+6
6e+6
5e+6
4e+6
3e+6
2e+6
1e+6
0
Biovolume um3/mL
M
N
M
N
M
N
M
Fluorescence
Pheophyton
Chlorophyll a
Biovolume


Diel DO, pH and Extractable Chlorophyll
pH and DO (mg/L)
Chlorophyll (µg/L)
DO
pH
Chlorophyll
9.5
89
20
18
16
14
12
10
8
6
220
200
180
160
140
120
100
N
M
N
M
N

Algae production versus DO production calculation

ΔChl = 89 µg/L **ΔDO = 9.5 mg/L**

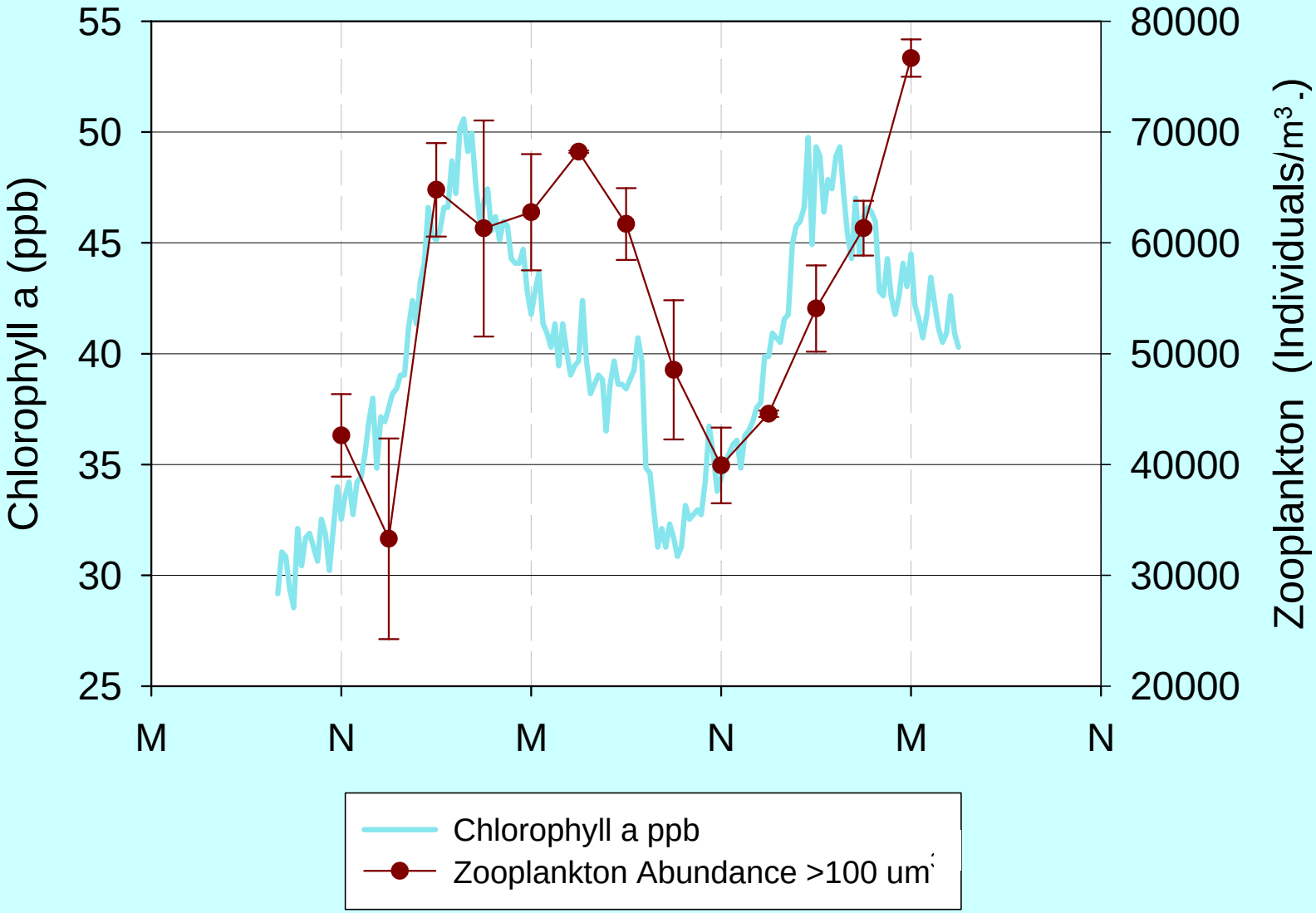
Chlorophyll = 1- 2% of algal biomass

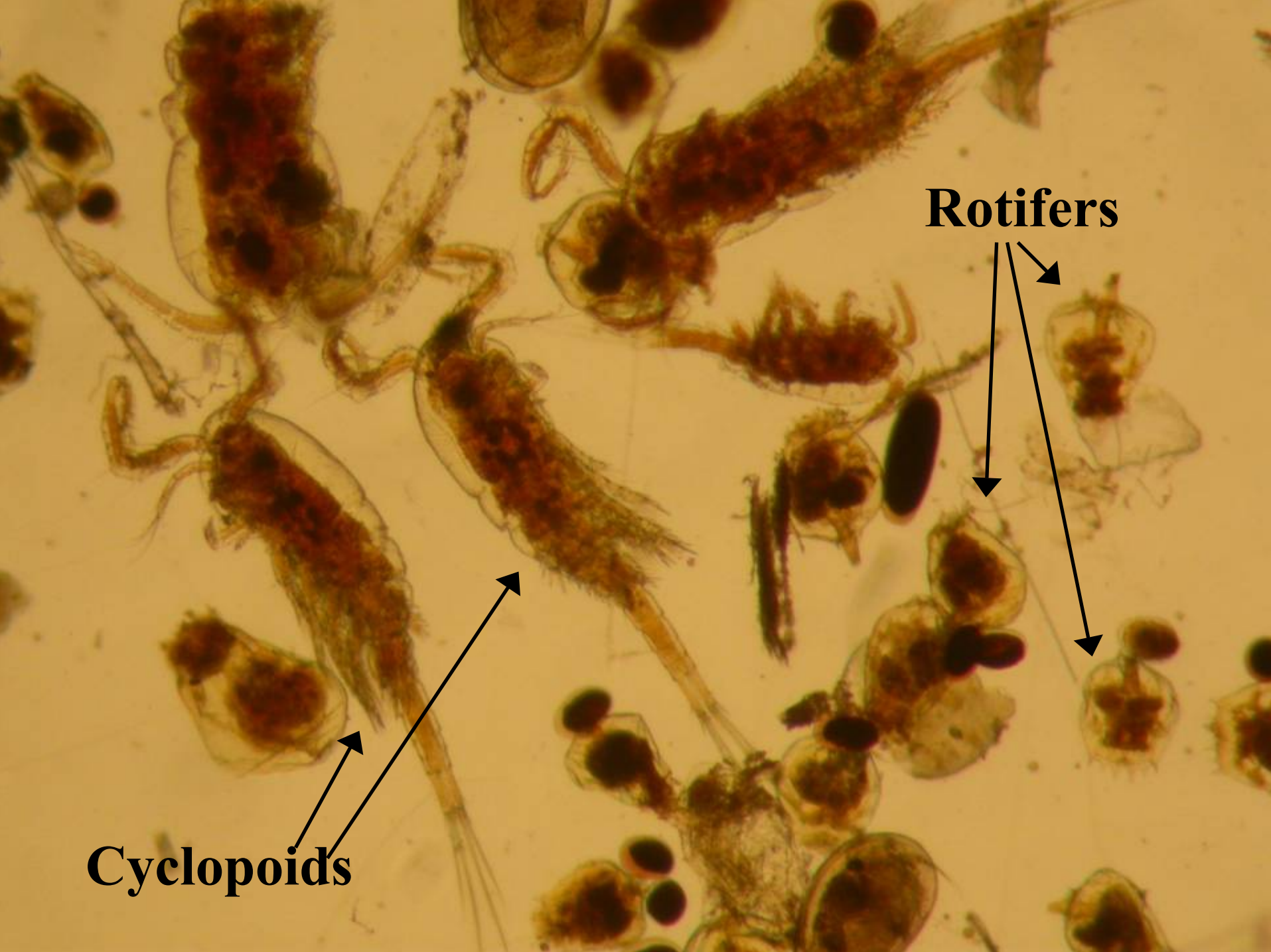
1 mg algal biomass produces 1.25 mg O_2

89 µg/L chloro = 4.45 to 8.90 mg algae biomass/L

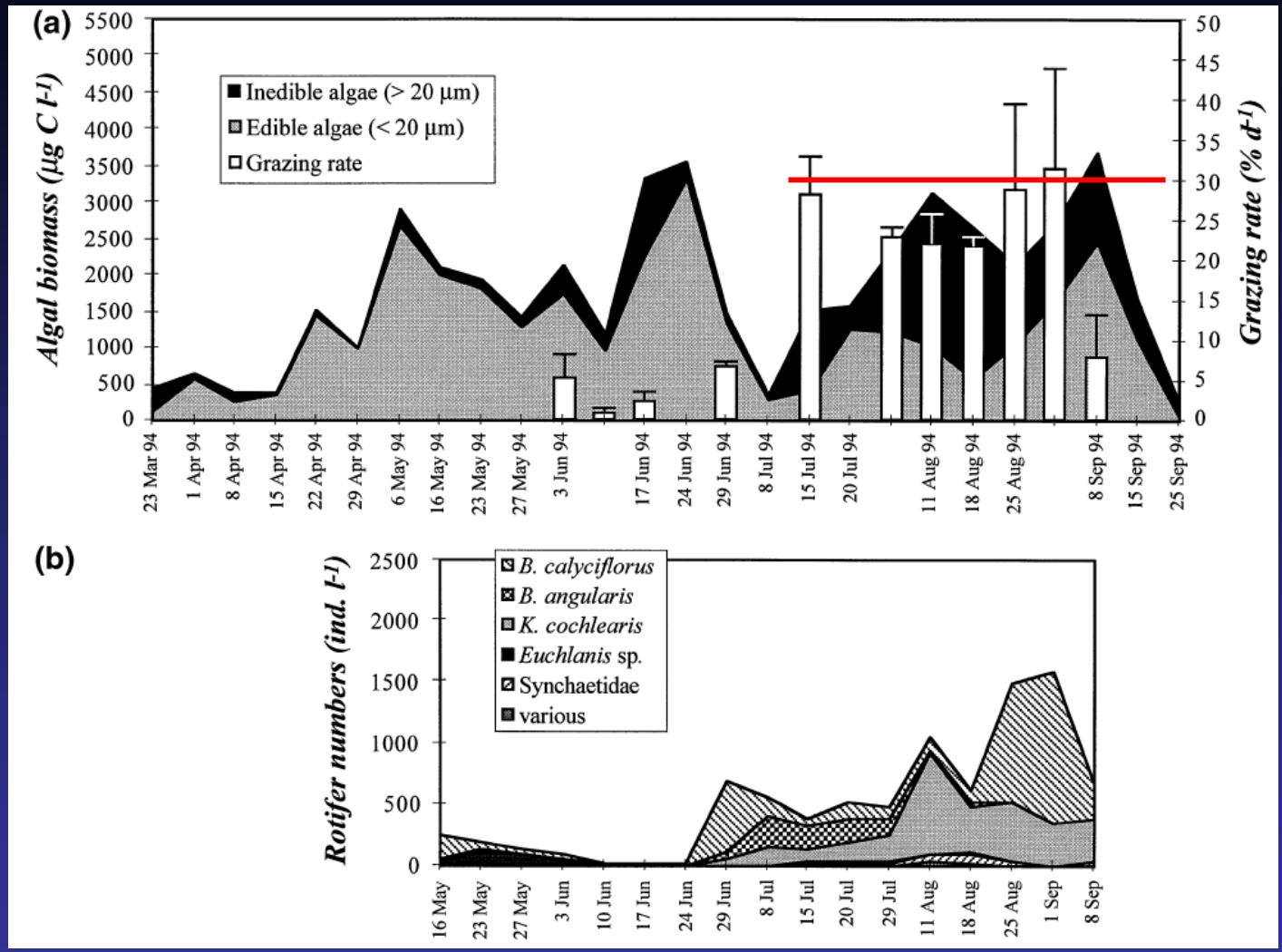
Equivalent to 5.6 to 11.1 mg O_2/L

Zooplankton Patterns




Rotifers
Cyclopoids

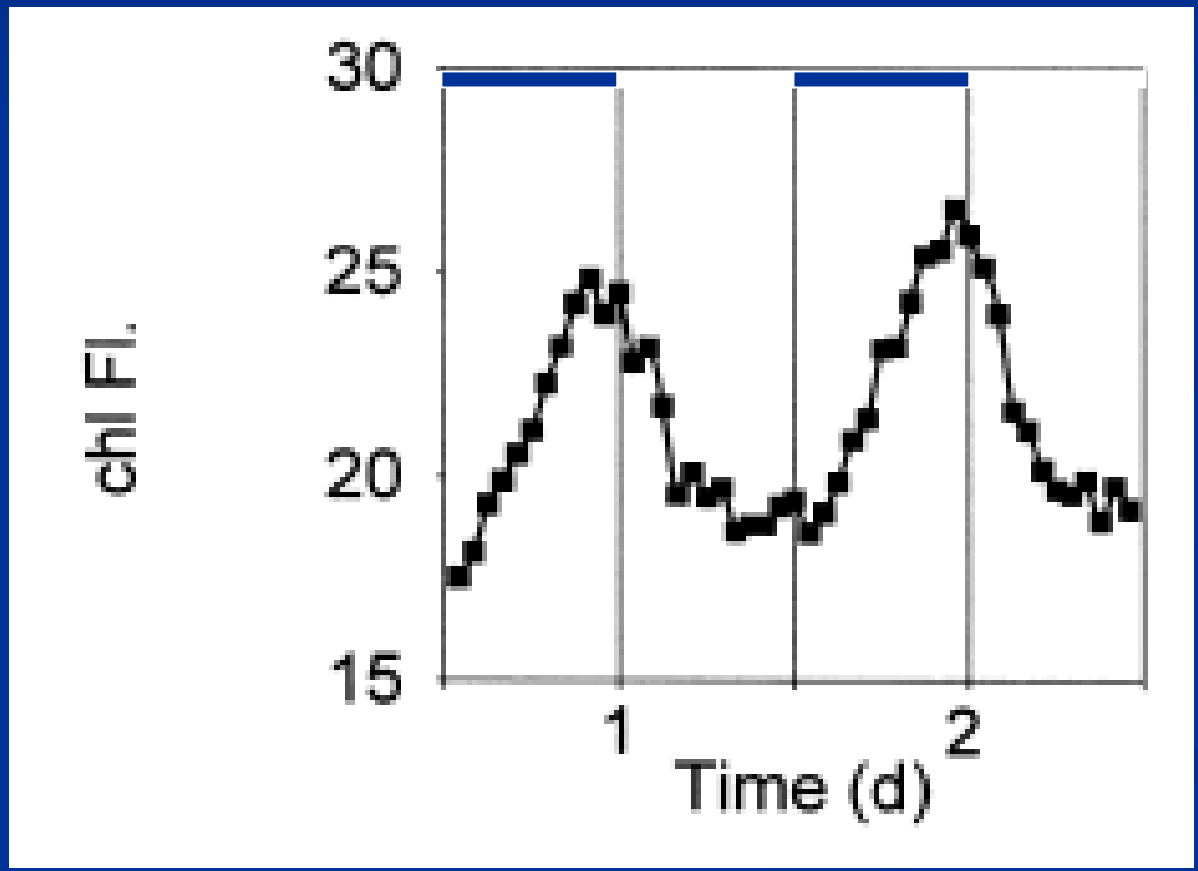
Grazing Rates in River Meuse, Belgium

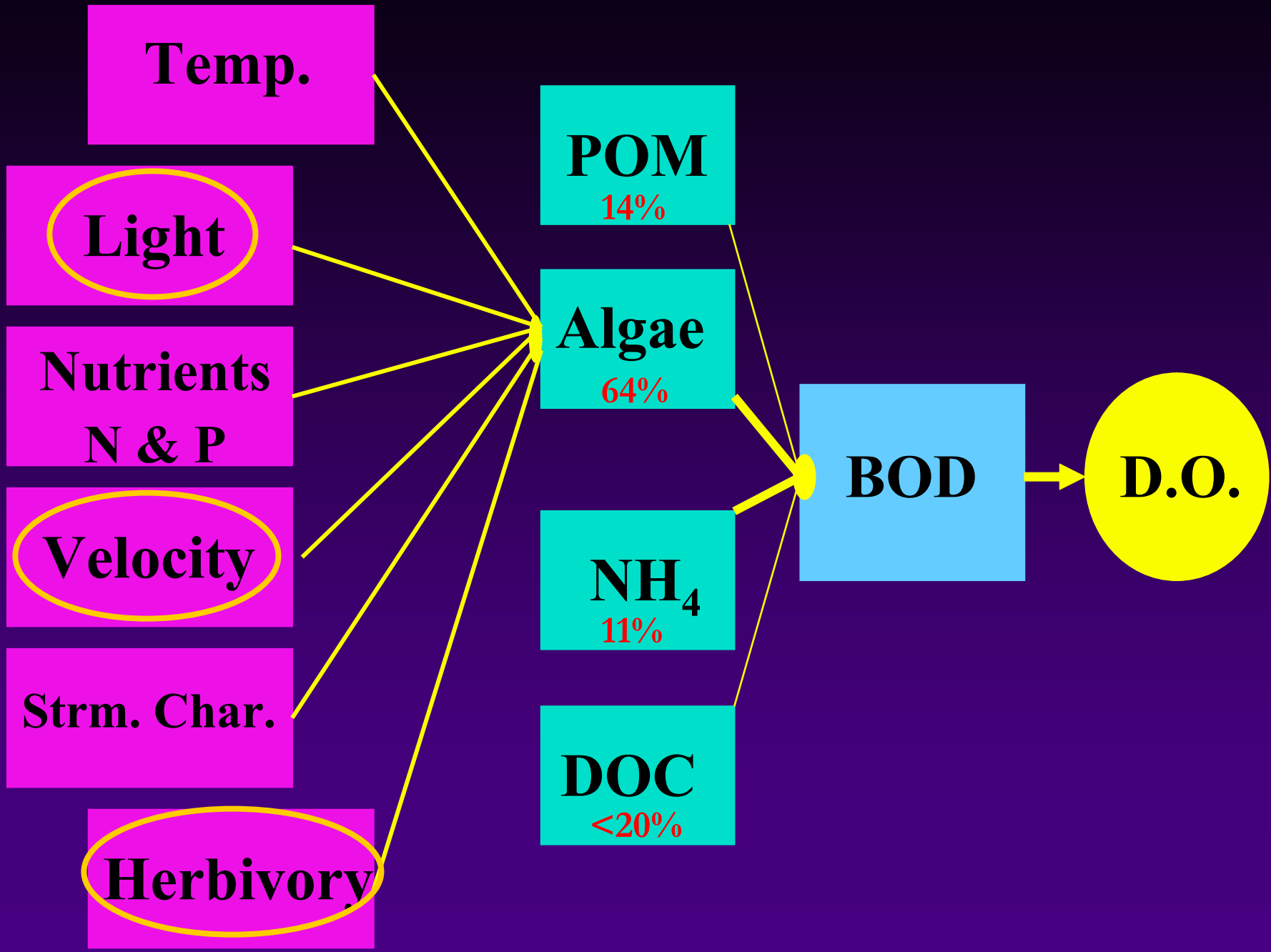


Gosselain, Viroux and Descy
Freshwater Riology (1998) 39:9-24

Cell Division

Cell division has been shown to induce a diel fluorescence signal under laboratory conditions




Temp.
Light
Nutrients
N & P
Velocity
Strm. Char.
Herbivory
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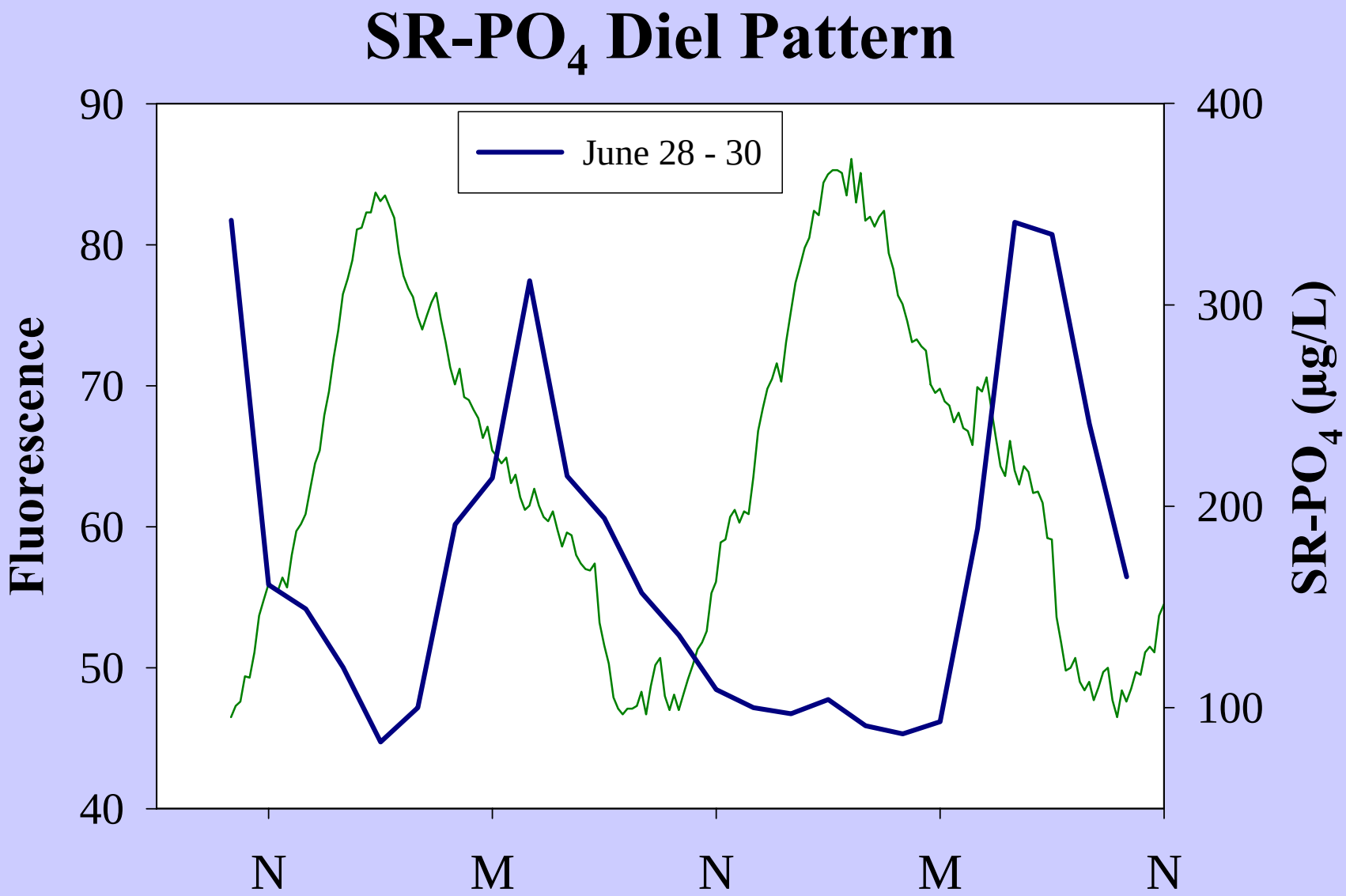
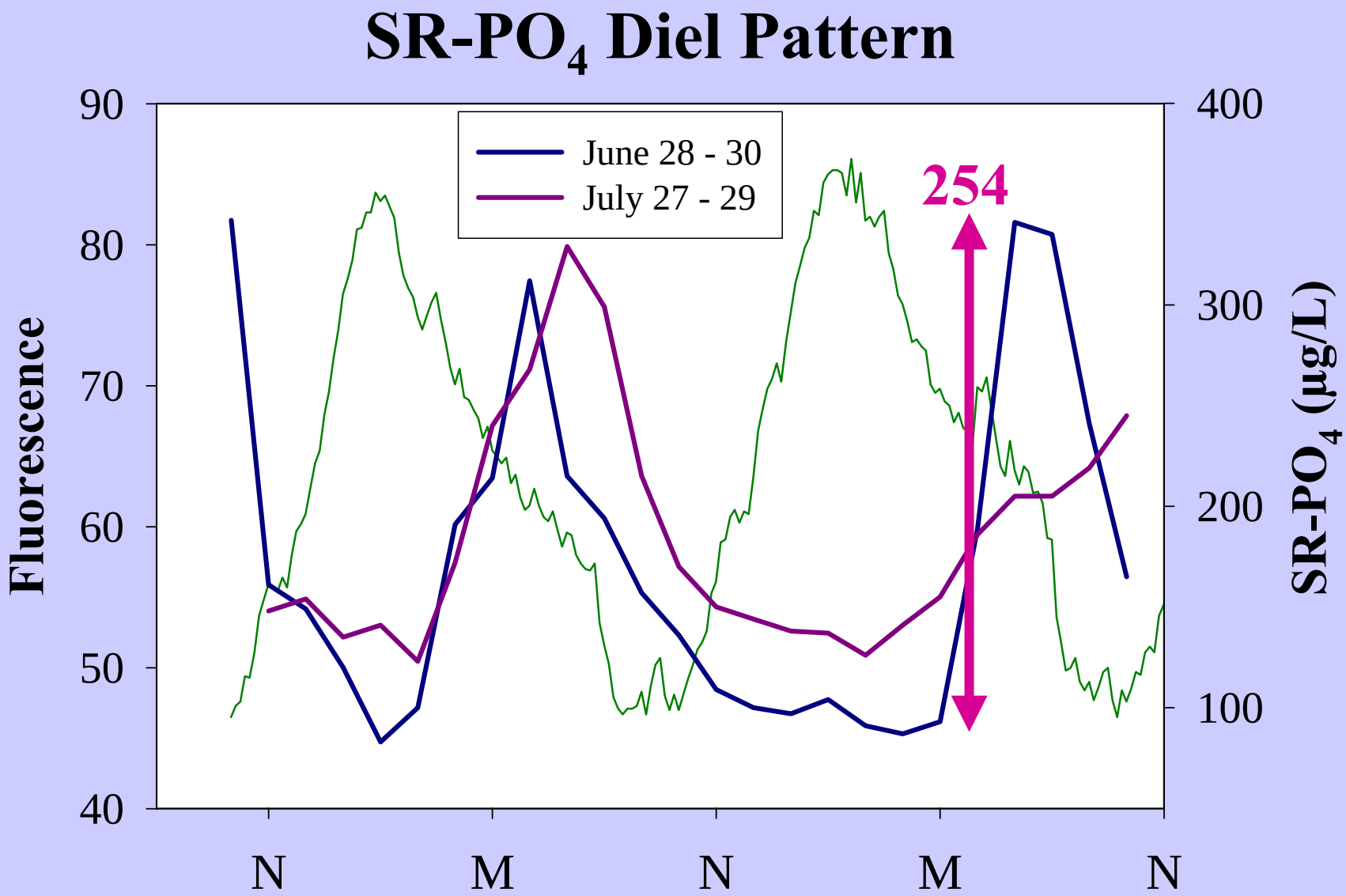
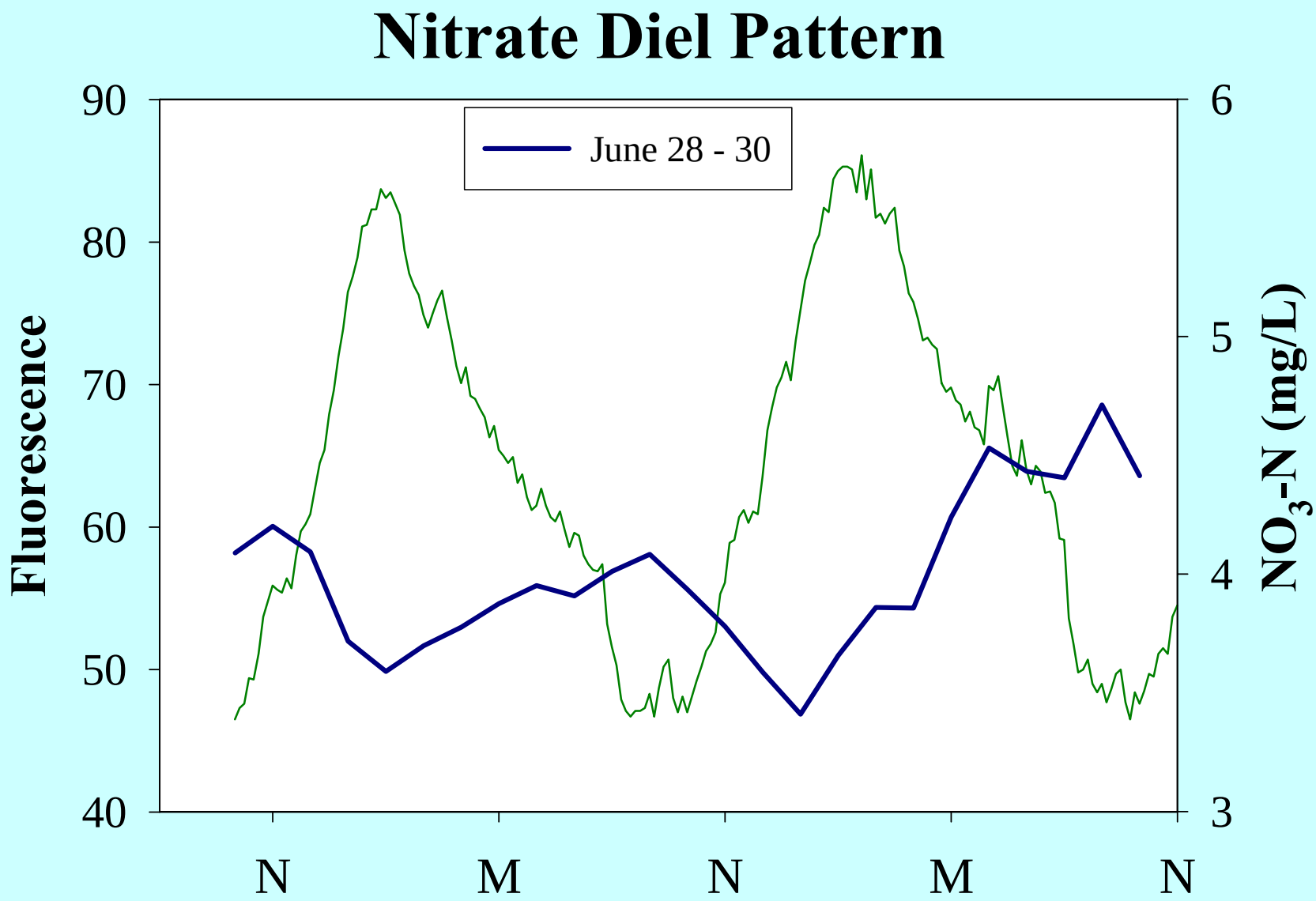
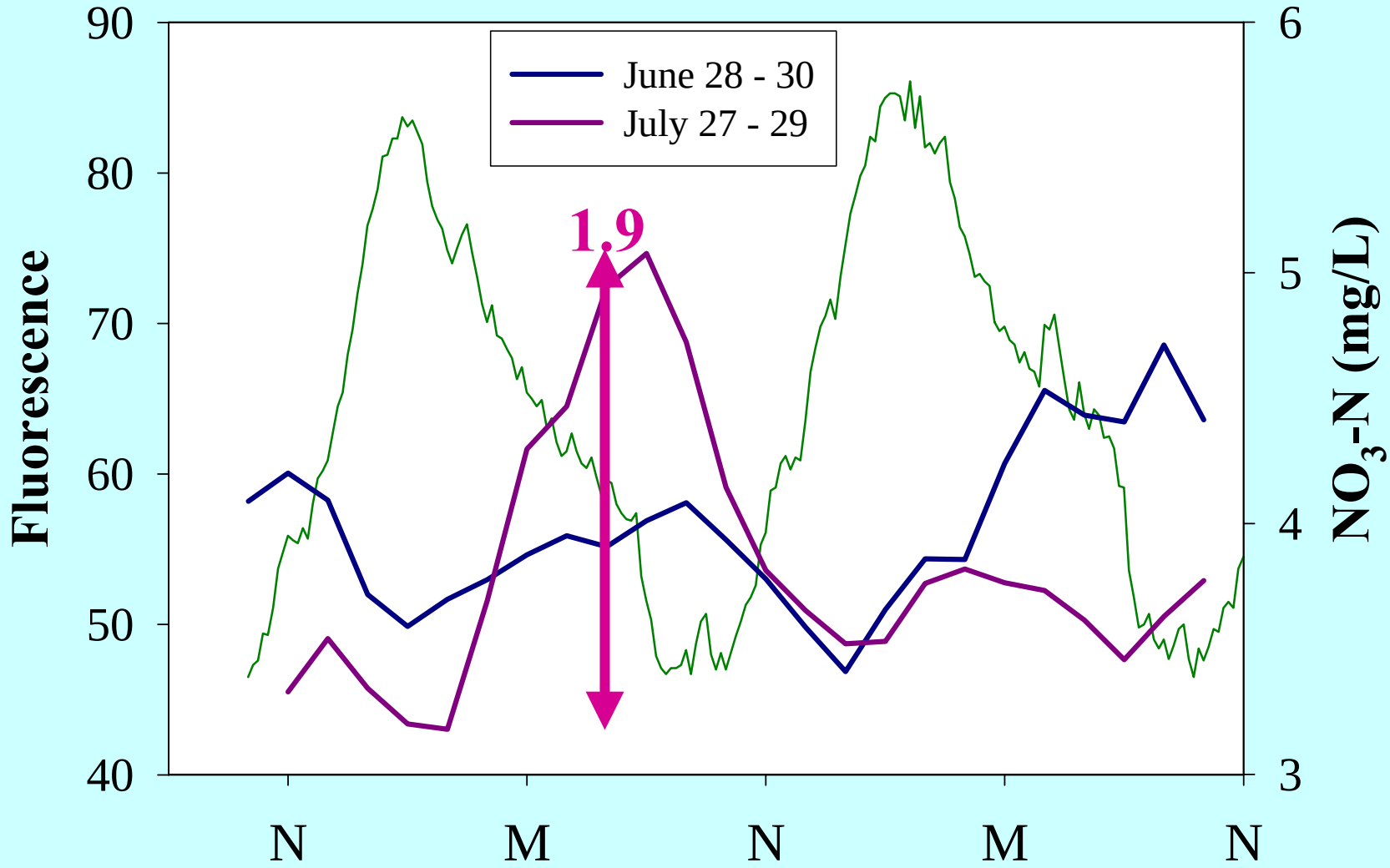
14%
Algae
64%
NH4
11%
DOC
<20%
BOD
D.O.


SR-PO4 Diel Pattern
June 28 - 30
Fluorescence
SR-PO4 (µg/L)
90
80
70
60
50
40
400
300
200
100
N
M
N
M
N

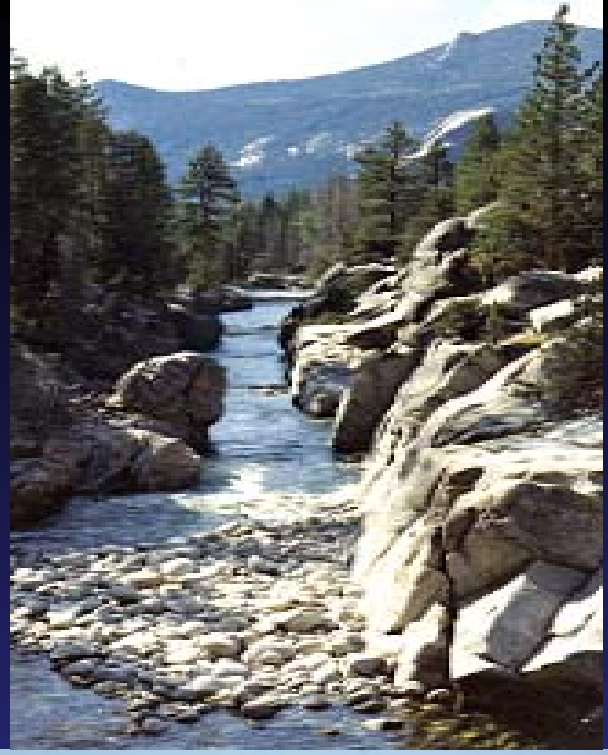

SR-PO4 Diel Pattern
June 28 - 30
July 27 - 29
254
Fluorescence
SR-PO4 (µg/L)
90
80
70
60
50
40
400
300
200
100
N
M
N
M
N


Nitrate Diel Pattern
June 28 - 30
Fluorescence
NO_3-N (mg/L)
90
80
70
60
50
40
6
5
4
3
N
M
N
M
N

Nitrate Diel Pattern



Wetland Treatment of Agricultural Return Flows



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