Phytoplankton and Low (Fluctuating) DO Relationships

Jordan River TMDL DO Linkage Symposium
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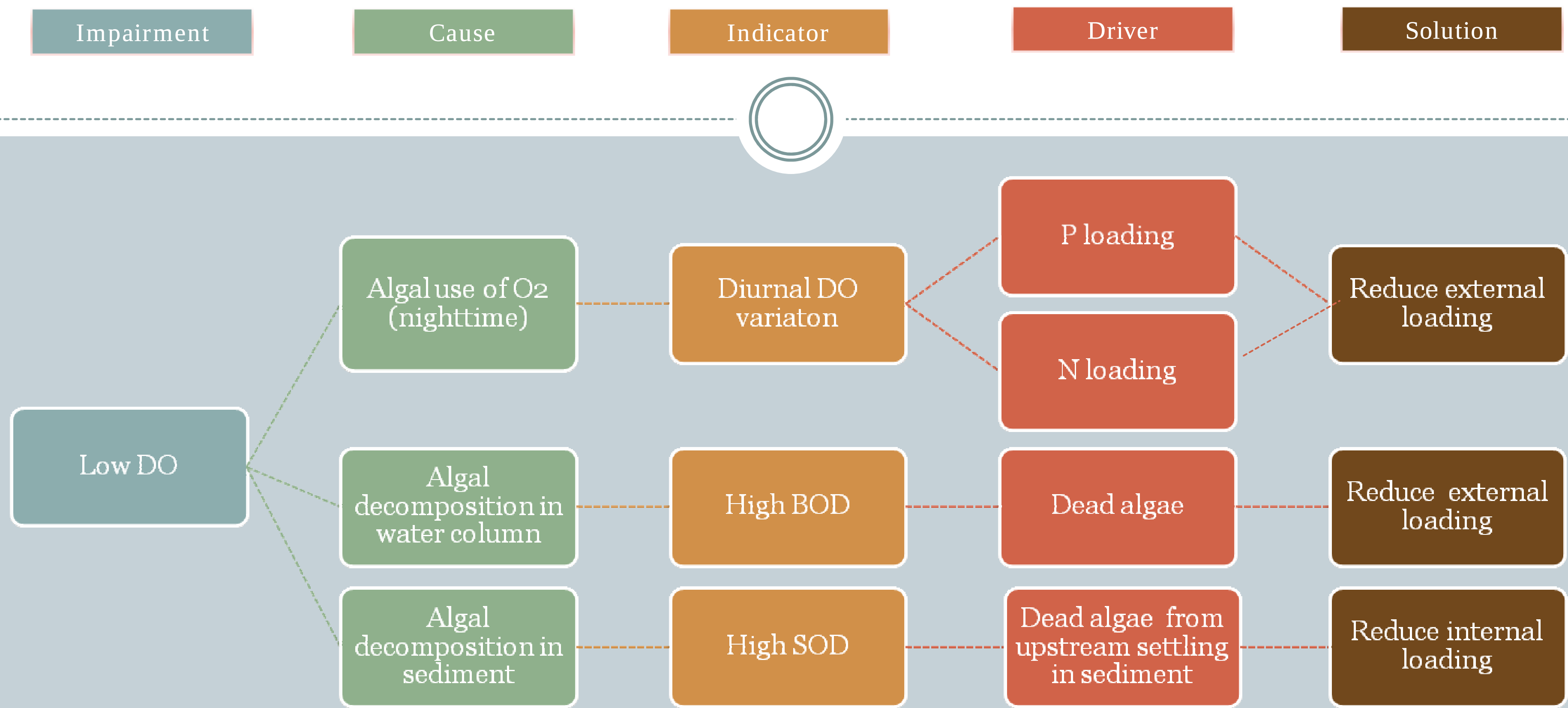
Sarah Rushforth, CIS
Sam Rushforth, PhD
Rushforth Phycology, LLC

Jordan River DO Impairment and Phytoplankton Relationship



Low DO — Algal use of O2 (nighttime) — Diurnal DO variation — P /N loading

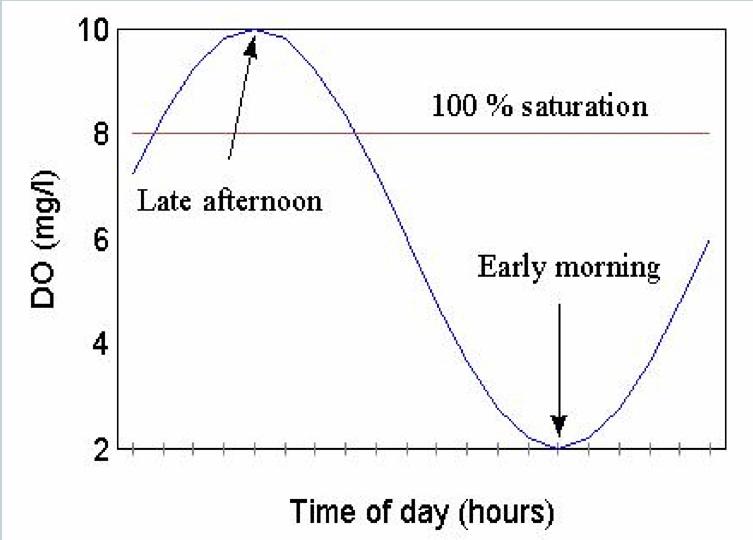
Phytoplankton and Diurnal Variation in Dissolved Oxygen (DO):

- Oxygen is a product of the photosynthetic process conducted by phytoplankton:

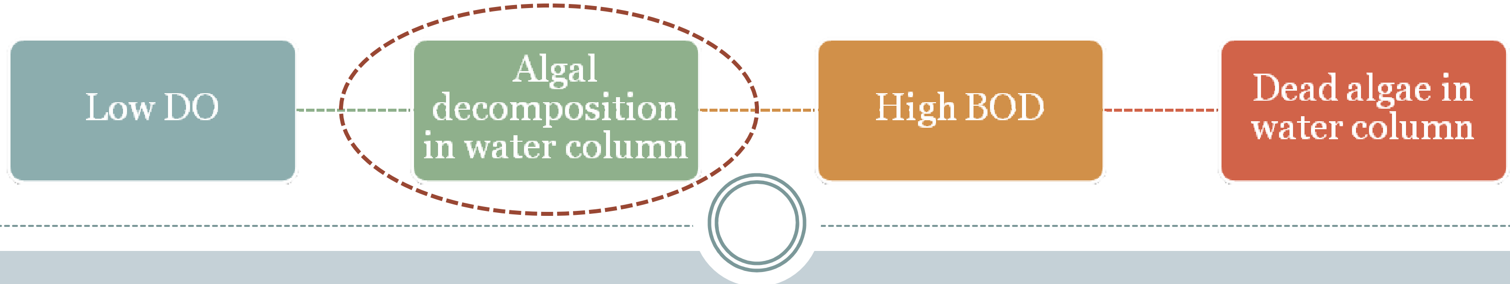
$$6\ CO_2 + 12\ H_2O + \text{light energy}\ >>\ C_6H_{12}O_6 + 6O_2 + 6H_2O$$

- Because this process relies on light energy, this production of O2 stops at night, and the phytoplankton respiratory process is active. DO levels measure lower at night than in daylight.

- Monitoring done in during daylight hours may measure higher DO levels than are actually representative of the system.



Graphic from: **Water Quality, Water Pollution, and Related Measurements**, Tom Catchcart (Agricultural & Biological Engineering).



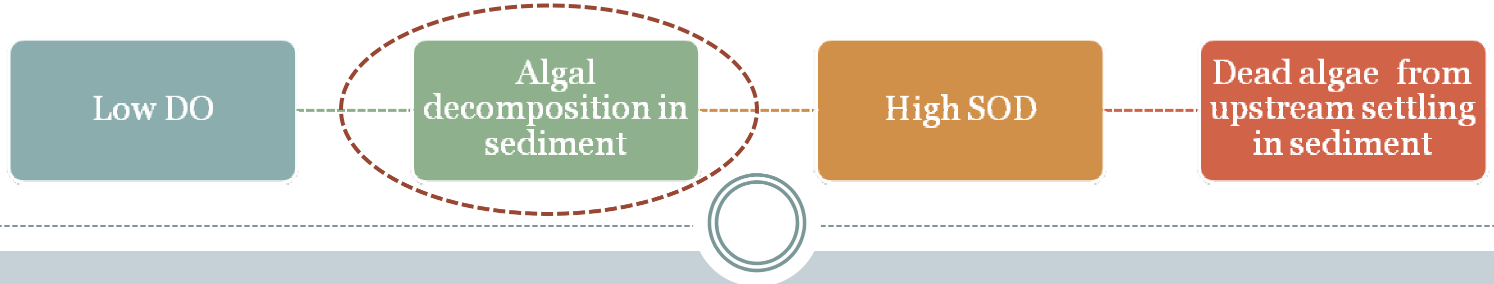
Phytoplankton and Biological Oxygen Demand (BOD), Low Dissolved Oxygen (DO) :

- Although phytoplankton produce O2 in photosynthesis, cells stay near the surface to optimize light, and O2 is released into the atmosphere. Production of O2 by plankton does not counter low DO in deeper water.

- Phytoplankton has a rapid reproduction rate (under optimal conditions, biomass can be doubled in 24 hours). When maximum population density is reached, continuing growth is balanced by die offs.

- As bacteria and other decomposers feed on dying plankton, they consume O2. Large scale algae "kill offs" of algae to control low DO may add to the problem, because of bacterial decomposition of the dead organic matter.

- Introduction of other organic matter leads to low DO by providing nutrients that facilitate phytoplankton growth.



Phytoplankton and Sediment Oxygen Demand (SOD), Low Dissolved Oxygen (DO):

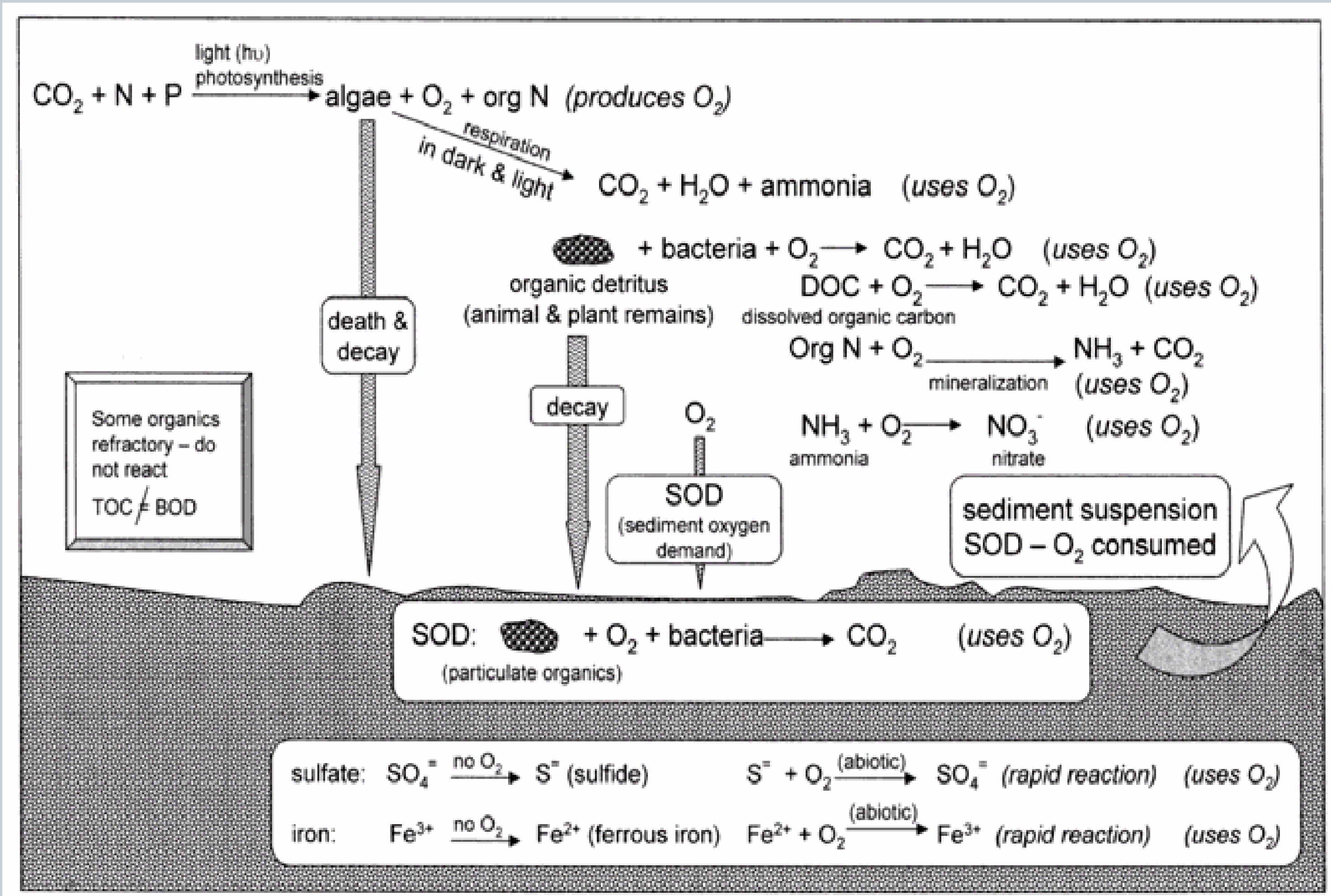
- DO consumption in a water body is increased by decomposing organic matter that has been deposited in bottom sediment. Dead and dying phytoplankton make up some portion of that organic matter.

- When algal blooms are frequent, especially in shallow nutrient rich waters, decomposition of settled detritus leads to high levels of SOD.

- High levels of dead phytoplankton in sediment contribute to high SOD in turn to low DO. Resulting oxygen depletion can be significant enough to cause fish-kills, etc.

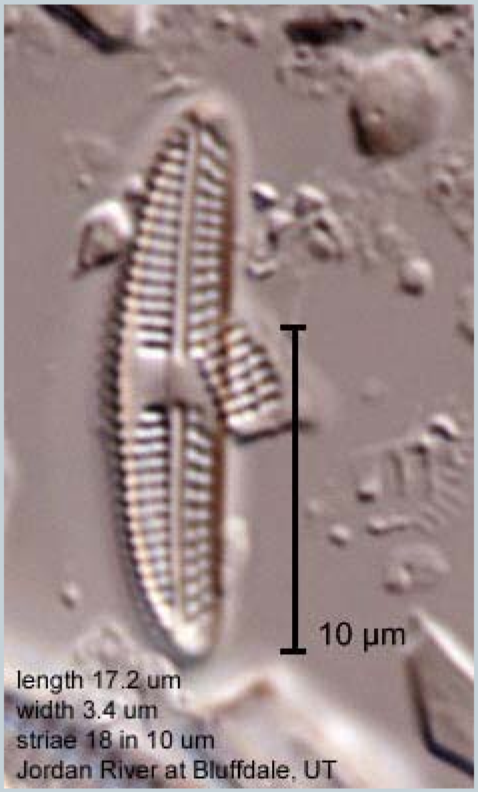
- SOD is frequently an important aspect of a water body's DO budget. Dead algae deposited in sediment

Phytoplankton and Sediment Oxygen Demand (SOD)



From: Role of Aquatic Plant Nutrients in Causing Sediment Oxygen Demand
G. Fred Lee, PhD, PE, DEE and Anne Jones-Lee, PhD (G. Fred Lee & Associates)

Diatom Analysis
Ecological Factors
Jordan River at 1700 South
Rushforth Phycology
Slide Prep N 1



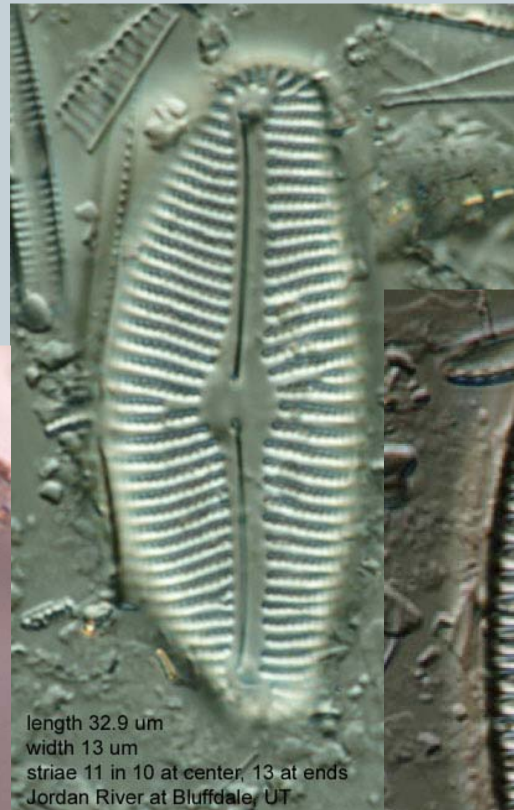
PREP. N°	1
Van Dam 1994	
PH	
1 acidobiontic	0
2 acidophilous	0
3 neutrophilous	138
4 alcaliphilous	815
5 alcalibiontic	22
6 indifferent	0
SALINITY	
1 fresh	4
2 fresh brackish	693
3 brackish fresh	263
4 brackish	17
N-Heterotrophie	
1 autotrophic sensibles	27
2 autotrophic tolerants	644
3 heterotrophic facultatifvely	247
4 heterotrophic obligately	26
Oxygen	
1 Continuously high100%sat)	89
2 fairly high (75% sat.)	420
3 O2 moderate (>50%)	330
4 O2 low (>30% sat.)	87
5 O2 very low(10% sat)	17
Saprobity	
1 oligosaprobous	17
2 ßmesosaprobous	523
3 alphamesosaprobous	326
4 alphameso ->polysabrobous	69
5 polysaprobous	13
Trophic state	
1 oligotraphentic	6
2 oligo mesotraphentic	0
3 mésotraphentic	6
4 meso-eutraphentic	94
5 eutraphentic	753
6 hypereutraphentic	28
7 oligo to eutraphentic	76
Moisture	
1 aquatic strict	132
2 aerophilous occas.	180
3 aquatic to subaerien	608
4 aerophilous strict	19
5 terrestre	0

PREP. N°	1
HOFMANN 1994	
TROPHIC CONDITIONS	
0 unknown	136
1 ot = Oligotraphent	0
2 ol-bmt = oligo-ß-mesotraphen	4
3 ol-amt = oligo alpha mesotra	0
4 am-eut = alpha meso-eutraphe	18
5 eut = eutraphent	481
6 tol = tolerant	323
7 ind = indifferent	3
8 sap = saprotroph	36
SAPROBIC CONDITIONS	
0 unknown	148
1 oligosaprob	0
2 ß-mesosaprob	6
3 ß-meso -ß-alpha meso.	3
4 ß-meso -ß-alpha meso.	73
5 ß-alpha mesosaprobt	577
6 ß-alpha-meso - alpha meso	3
7 alpha mesosaprob	130
8 alpha-meso polysaprob	12
9 polysaprob	49
LANGE-BERTALOT 1979	
1 most pollution tolerant	60
2a alpha-mesosaprobic a	102
2b alpha-mesosaprobic b	42
2c Ecological questionable	0
3a More sensible (abundant)	490
3b More sensible (less frequent)	15
Håkansson 1993 PH	
1 ACB => acidobiontic	0
2 ACPB => acidophilous to acidobiontic	0
3 ACP => acidophilous	0
4 INAC => indiff. to acidophilous	10
5 IND => indifferent	44
6 AKIN => alcaliphilous to indiff	71
7 AKP => alcaliphilous	573
8 AKPB=>alcaliphil. to alcalibion.	24
9 AKB => alcalibiontic	0
WATANABE 1990	
0 Indifferent	424
1 saprophile species	66
2 saproxene species	510

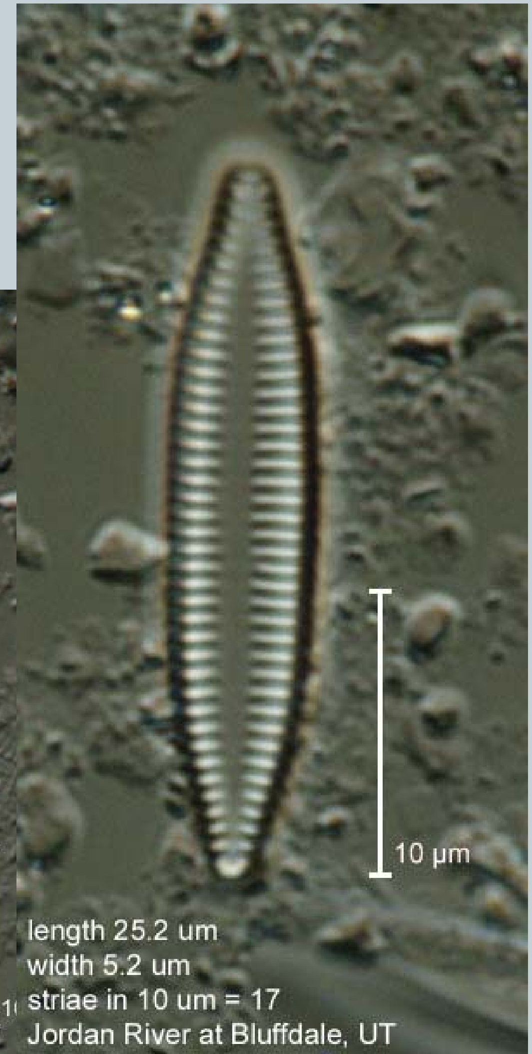
PREP. N°	1
Denys 1991	
LIFEFORM	
0 unknown	203
2 euplanktonic	39
3 tychoplanktonic epontic origin	602
4 tychoplanktonic, benthic origin	85
5 tychoplanktonic origine mixte	72
6 epontic	0
7 epontic and benthic	0
8 benthic	0
CURRENT	
0 unknown	225
1 irrelevant	0
2 rheobiontic	0
3 rheophilous	84
4 indifferent	692
5 limnophilous	0
Steinberg Schiefele 1988	
Trophication sensitivity	
1 most tolerant	28
2 st => highly tolerant	37
3 tt => tolerant	53
4 ws => less sensitive	175
5 eu => eutrophic	477
6 ss => sensitive	103
7 ol => oligosaprobic	3
o => unknown	125
ROTELISTE	
Lange-Bertalot & al. 1996	
0 disparu	0
1 menacé de disparition	0
2 fortement menacé	0
3 en danger	1
G risque existant	0
R très rare	3
V en régression	0
* risque non estimé	90
? non menacé	878
D données insuffisantes	13
• répandu	8

Jordan River Diatoms

Cymbella prostrata



Pseudostaurosira brevistriata



Surirella ovalis

Diatoma vulgaris

Research Suggestions

- Examine *phytoplankton* samples at multiple sites along the Jordan River.
  - Seasonal samples.
- Examine *bottom sediment* samples at selected sites along the river.
- Examine *phytoplankton* samples at selected sites from the Surplus Canal.
  - Seasonal samples.
- Examine *bottom sediment* samples from the Surplus Canal.
- Examine *phytoplankton* samples in tributary streams.