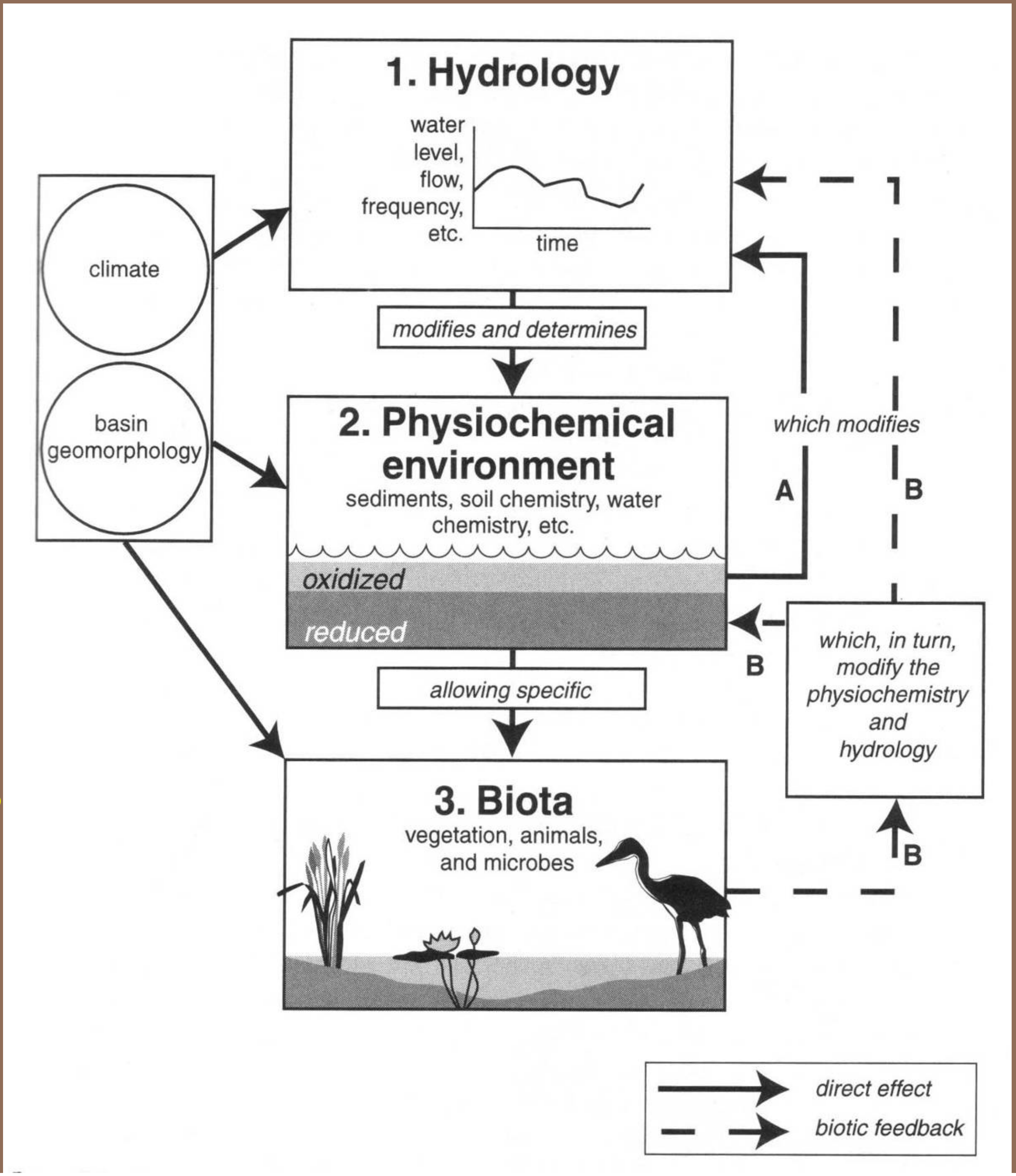
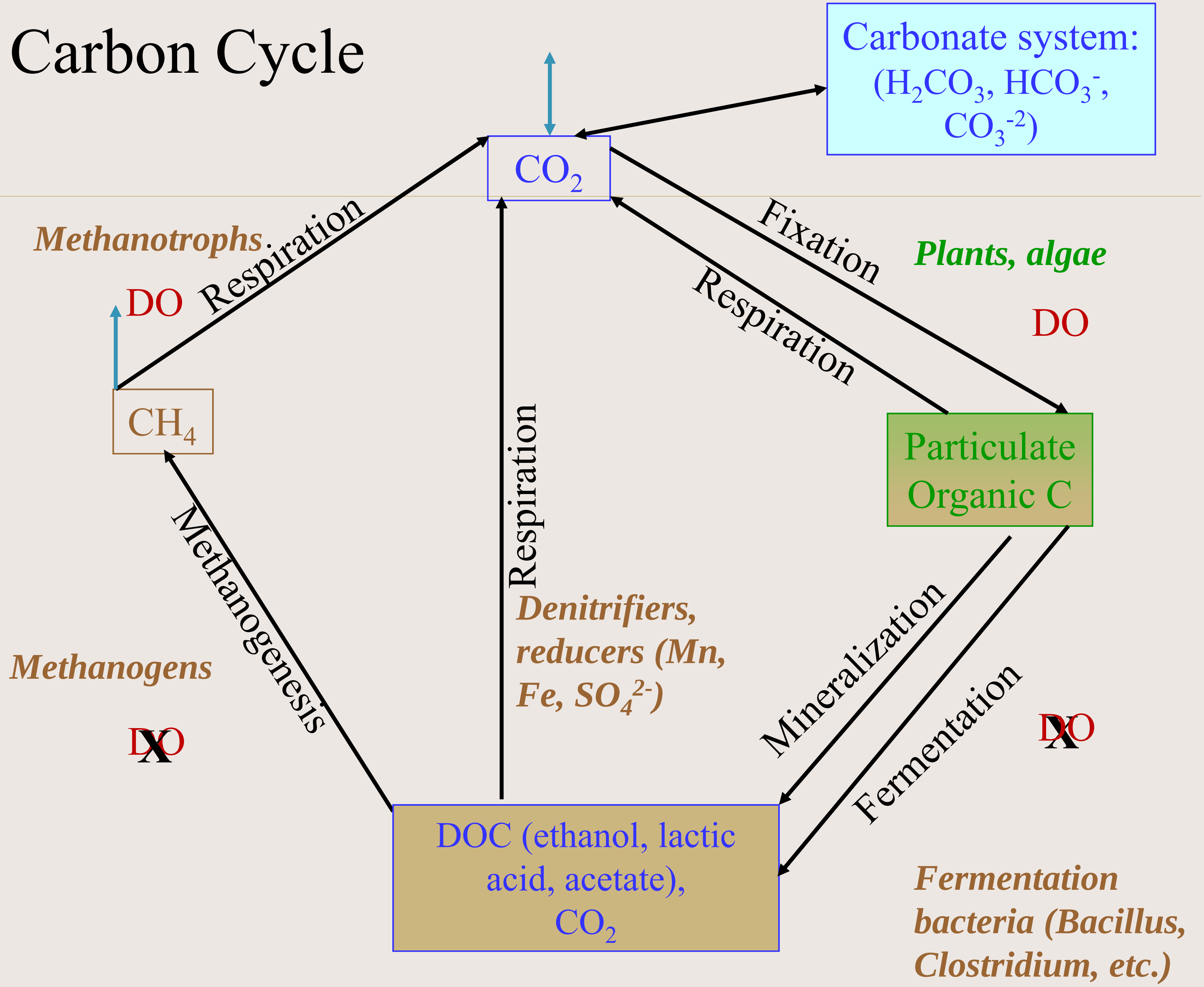
Structuring Elements of Wetlands

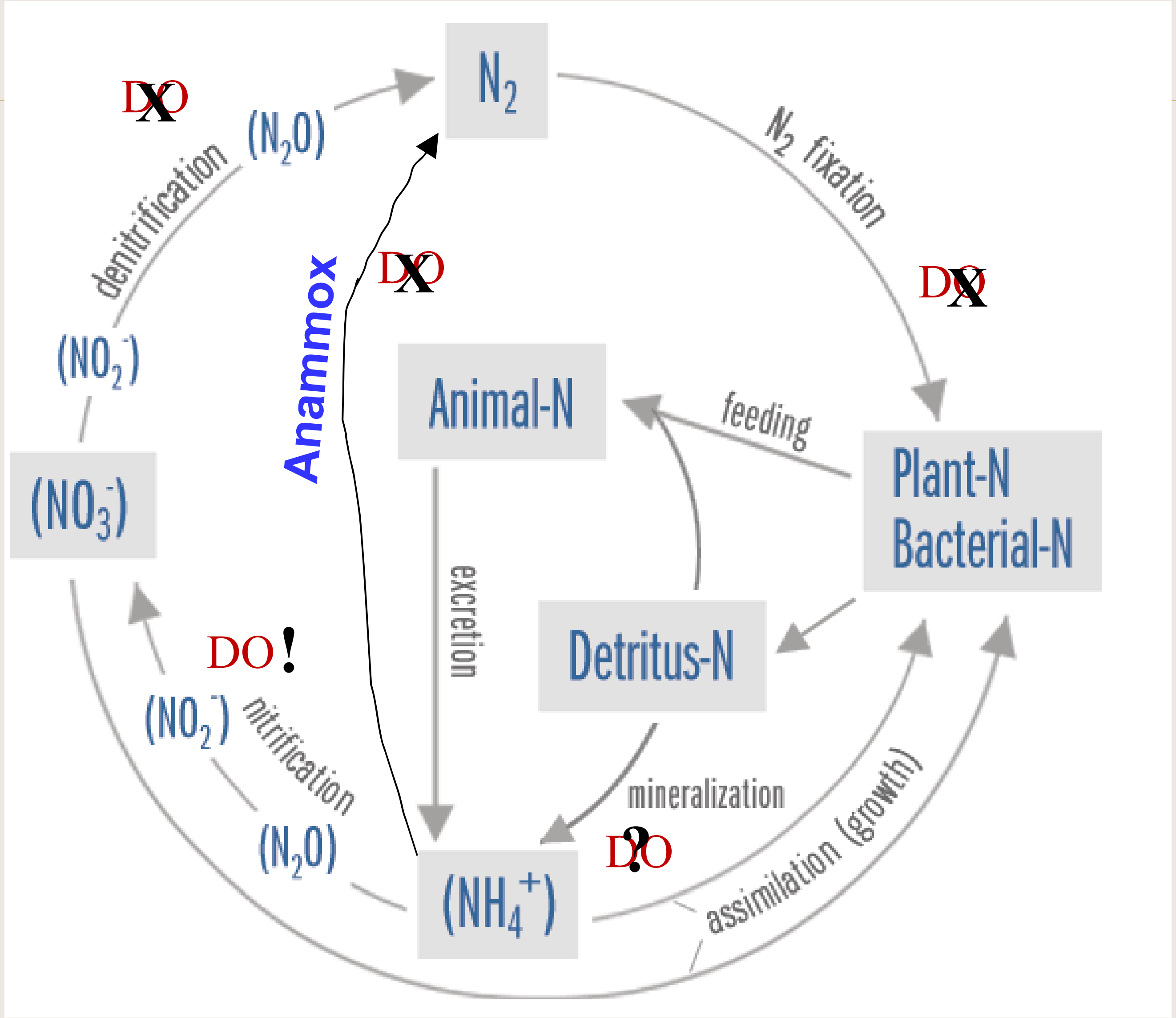


From: Mitsch & Gosselink, 2000, p 109.

Carbon Cycle

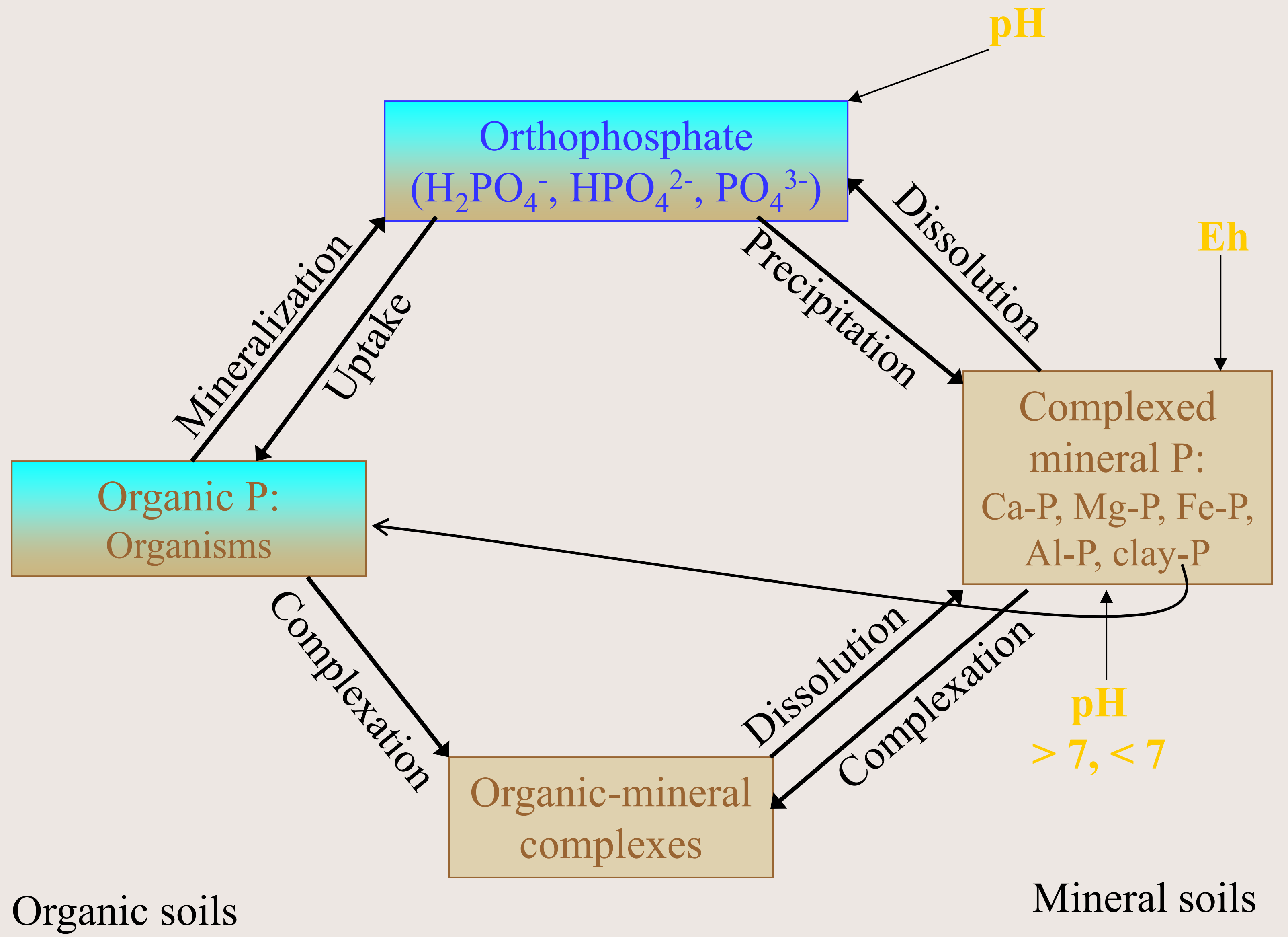


Nutrients- The Nitrogen Cycle

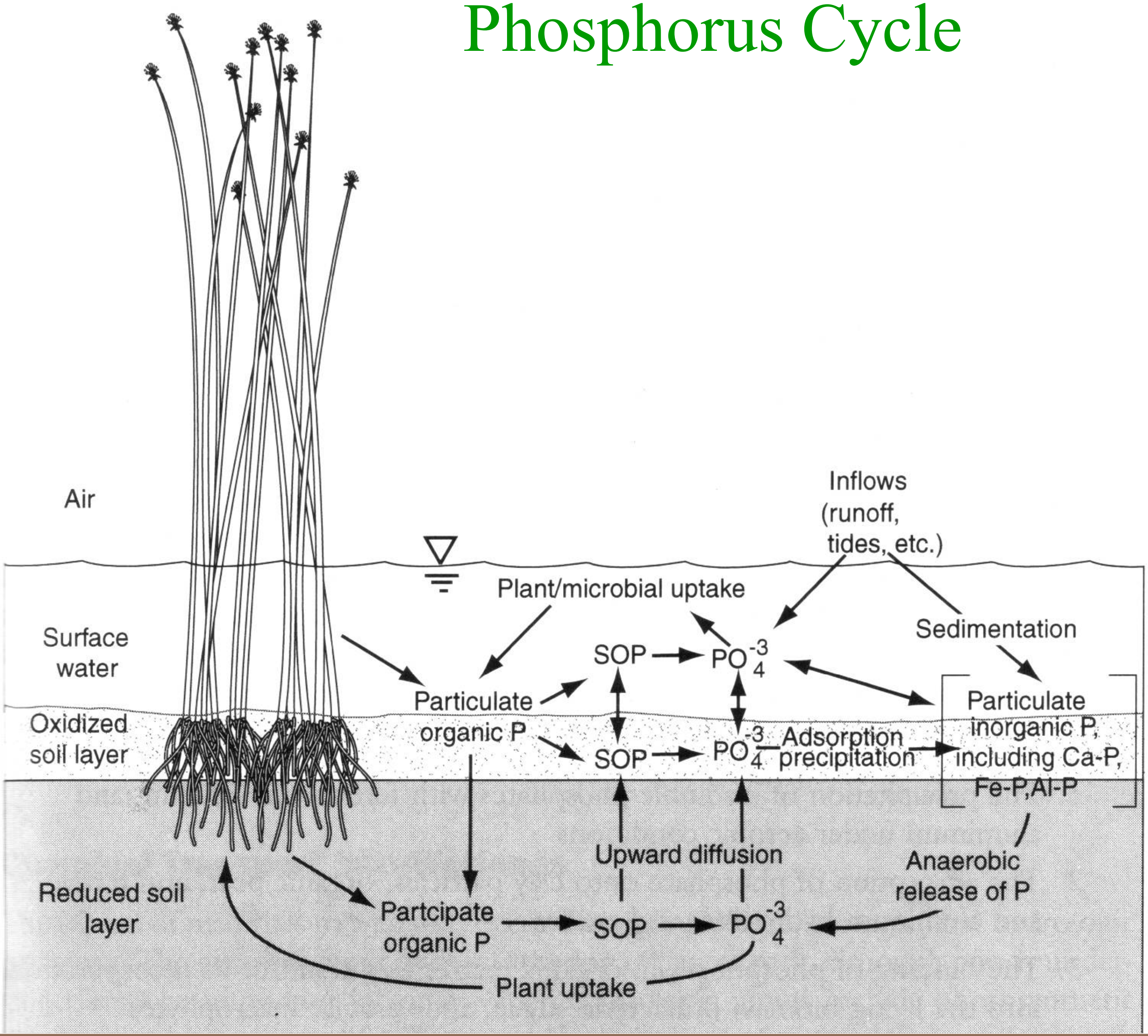


modified from Horne and Goldman. 1994. Limnology. McGraw Hill.

Phosphorus Cycle



Phosphorus Cycle

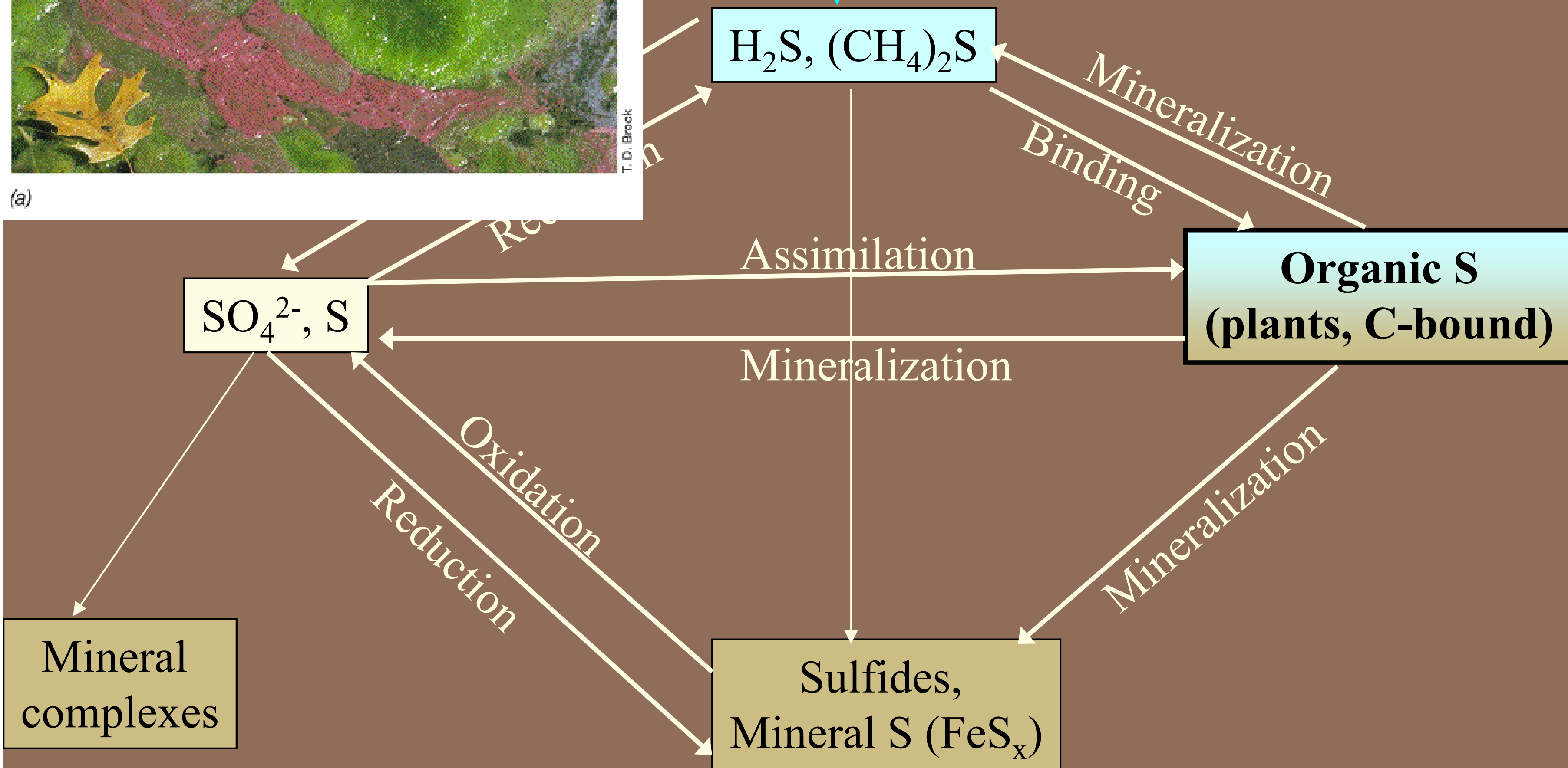


Oxidation-reduction process

Terminal e- acceptor	Reduction Reaction
Oxygen	$O_2 + 4e^- + 4H^+ \rightarrow 2H_2O$
Nitrate	$2NO_3^- + 10e^- + 12H^+ \rightarrow N_2 + 6H_2O$
Manganese Oxides	$MnO_2 + 2e^- + 4H^+ \rightarrow Mn^{2+} + 2H_2O$
Iron Oxides	$Fe(OH)_3 + e^- + 3H^+ \rightarrow Fe^{2+} + 3H_2O$
Sulfate	$SO_4^{2-} + 8e^- + 10H^+ \rightarrow H_2S + 4H_2O$
Carbon Dioxide	$CO_2 + 8e^- + 8H^+ \rightarrow CH_4 + 2H_2O$

Vepraskas & Faulkner. 2001. In Richardson & Vepraskas, eds. Wetland soils.

Sulfur Cycle



Mineral soils

Reductions by obligate anaerobes
Oxidations by autotrophs

Sulfur Cycle

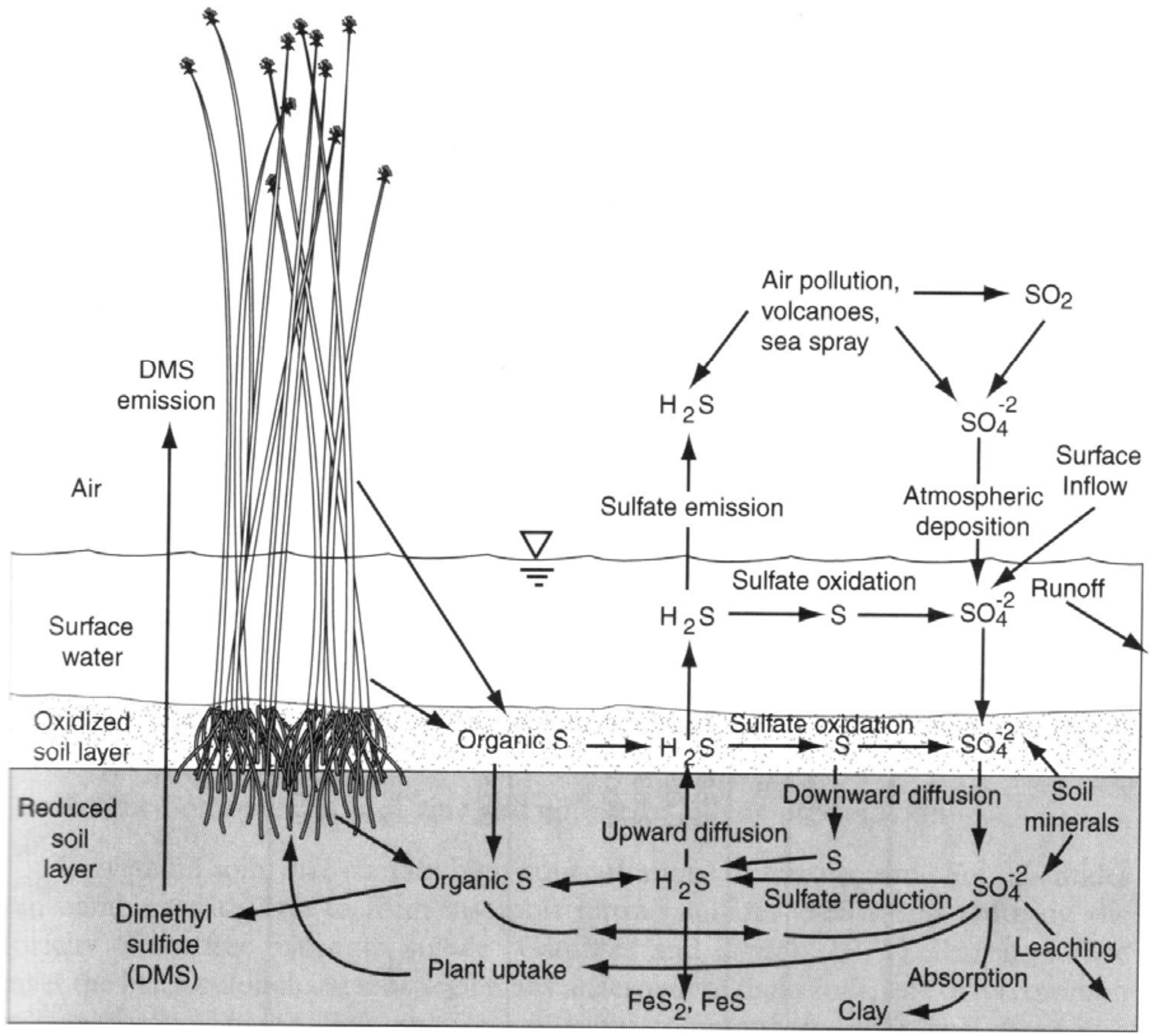


Figure 6-12 Sulfur transformations in wetlands. DMS indicates dimethyl sulfide.

Iron Redox

$Fe(OH)_3 + e^- + 3H^+ \rightarrow Fe^{2+} + 3H_2O$

Ferrous vs. ferric

$4Fe^{2+} + O_2 + 4H^+ \rightarrow 4Fe^{3+} + 2H_2O$

$Fe(OH)_3$	a mineral form; color:
$Fe(OH)_2$	a mineral form; color:
Fe^{2+}	ion form; colorless, water-soluble

There are many ferric iron minerals; they vary in their susceptibility to reduction.

Iron is oxidized by chemosynthetic (autotrophic) bacteria when oxygen is available.

MN's Wild Rice Sulfate (SO_4) Standard *(Sep 2017 draft)*

https://www.pca.state.mn.us/sites/default/files/wq-s6-43v.pdf

https://www.pca.state.mn.us/water/protecting-wild-rice-waters

MBLR120 Sulfate = 0.0000121 x TOC-1.197 x TEFe 1.923 (equation 2)

where sulfate is expressed as mg/L, TOC as percent dry weight, and TEFe as mg/kg.

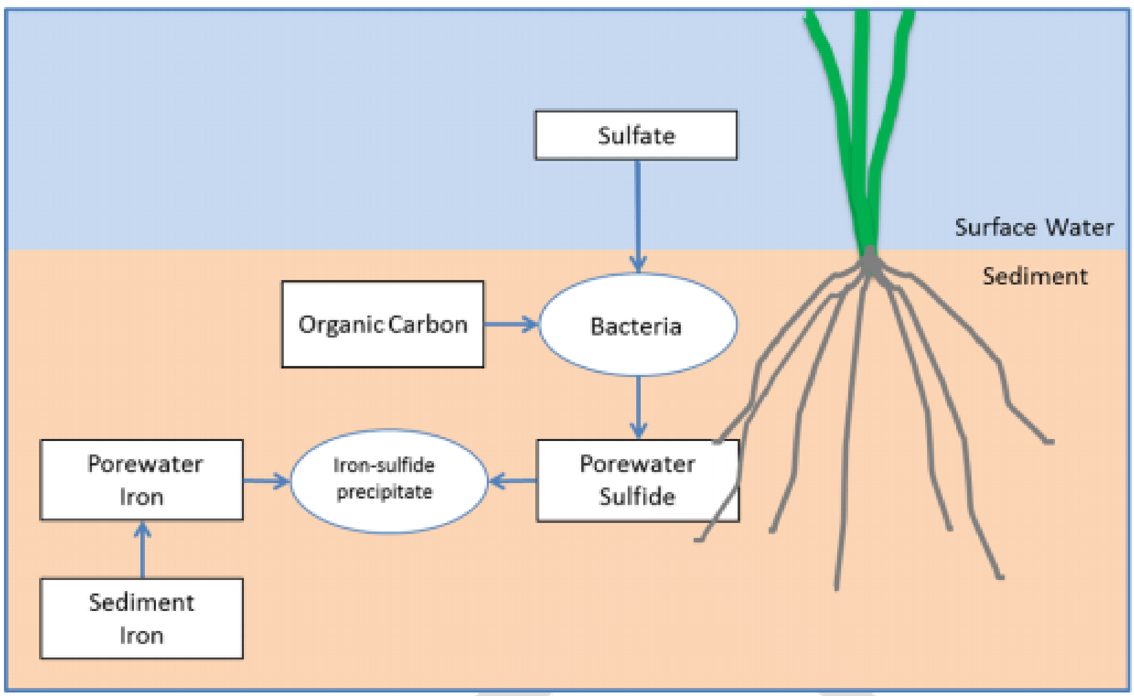
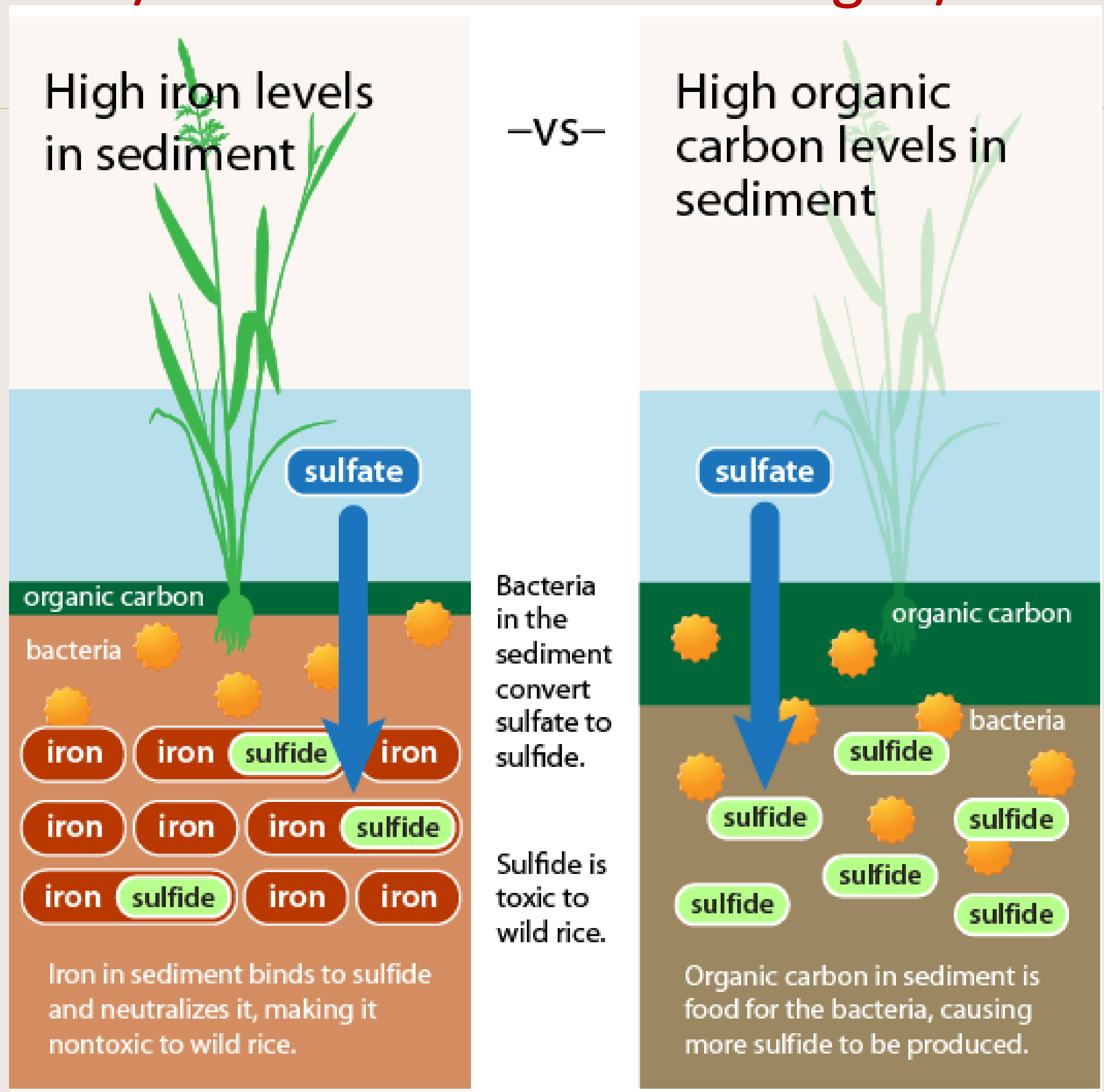


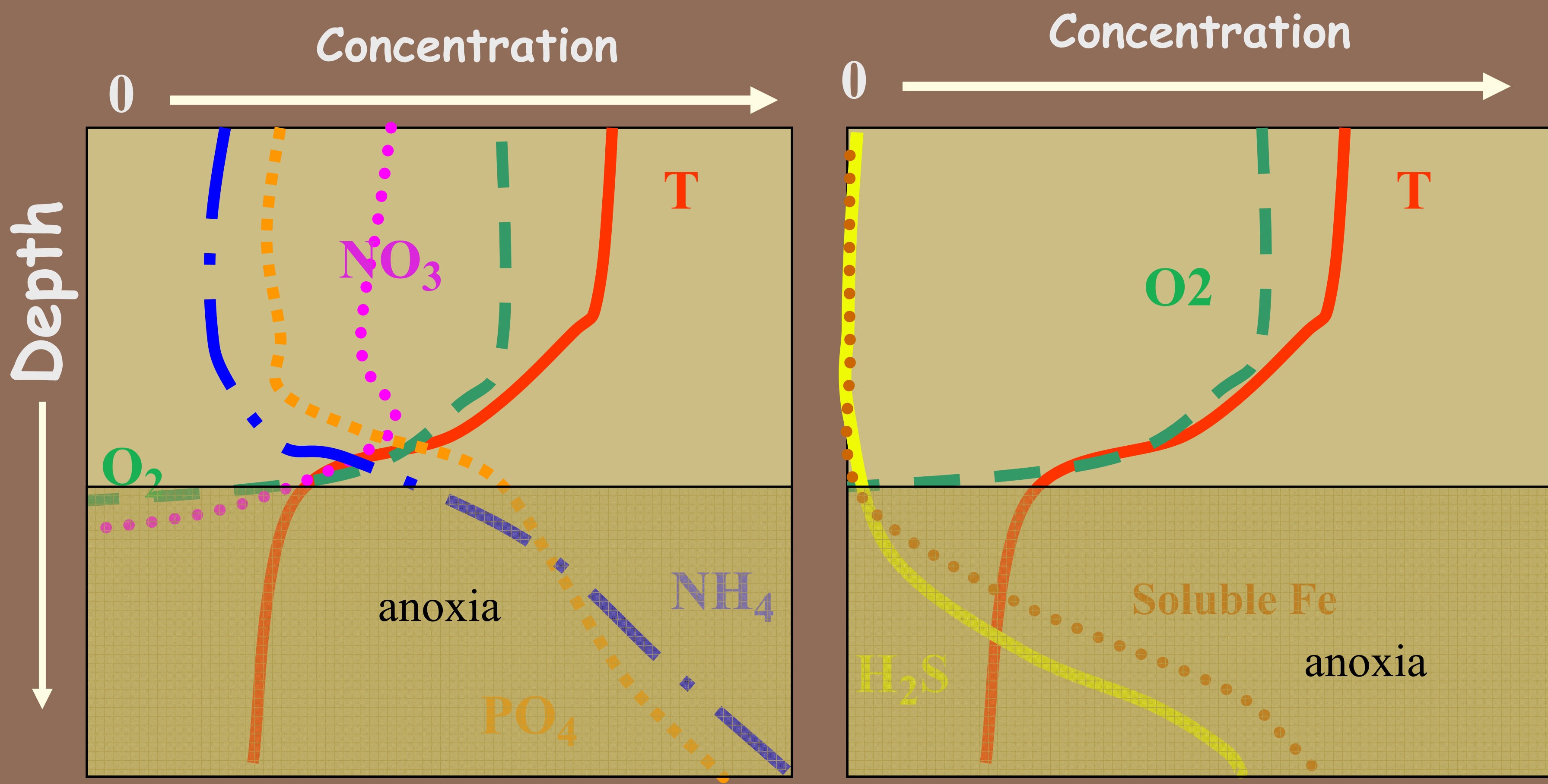
Figure 2-8. Conceptual model of the primary variables affecting the relationship between surface water sulfate and porewater sulfide. As bacteria utilize the energy in organic carbon, they respire sulfate, releasing sulfide. If iron is available, iron-sulfide precipitates form, which detoxifies the sulfide.

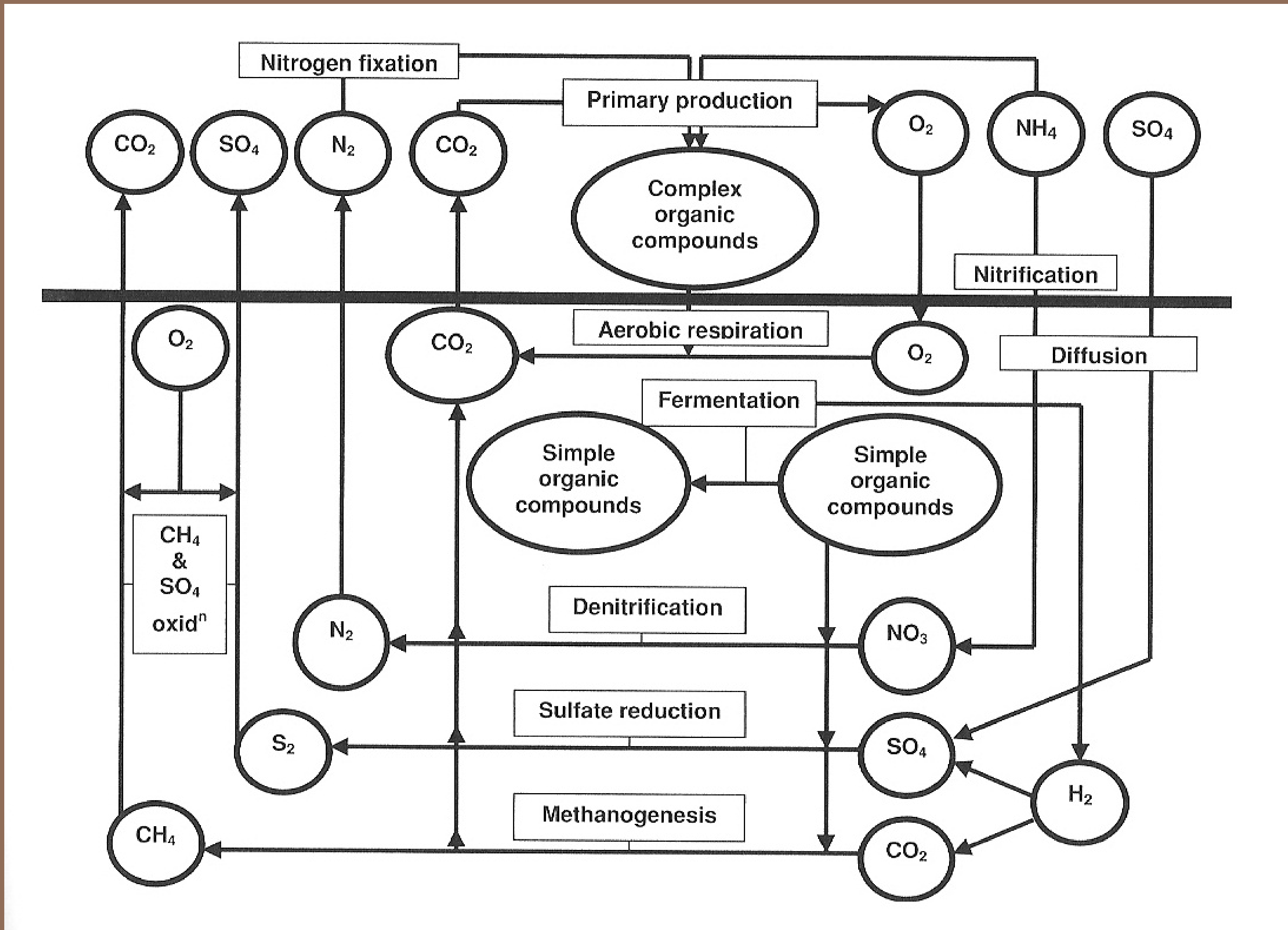
The proposed new WQ standard replaces the 10mg $SO4^{-2}$/L standard with a 120 ugS^{-2}/L standard



Depth profiles

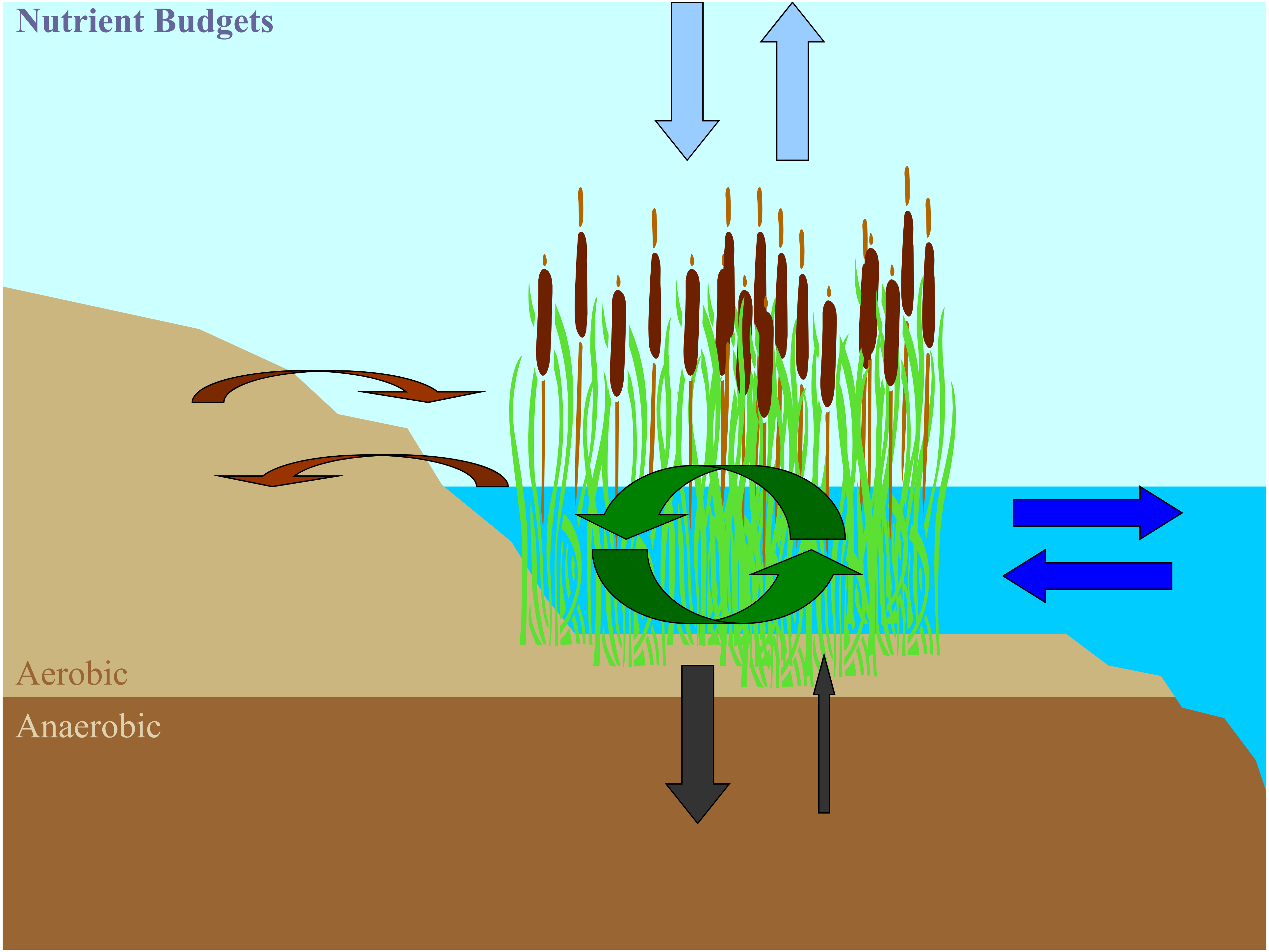
High O2 - *Eutrophic*





Summary of major wetland BGC cycles

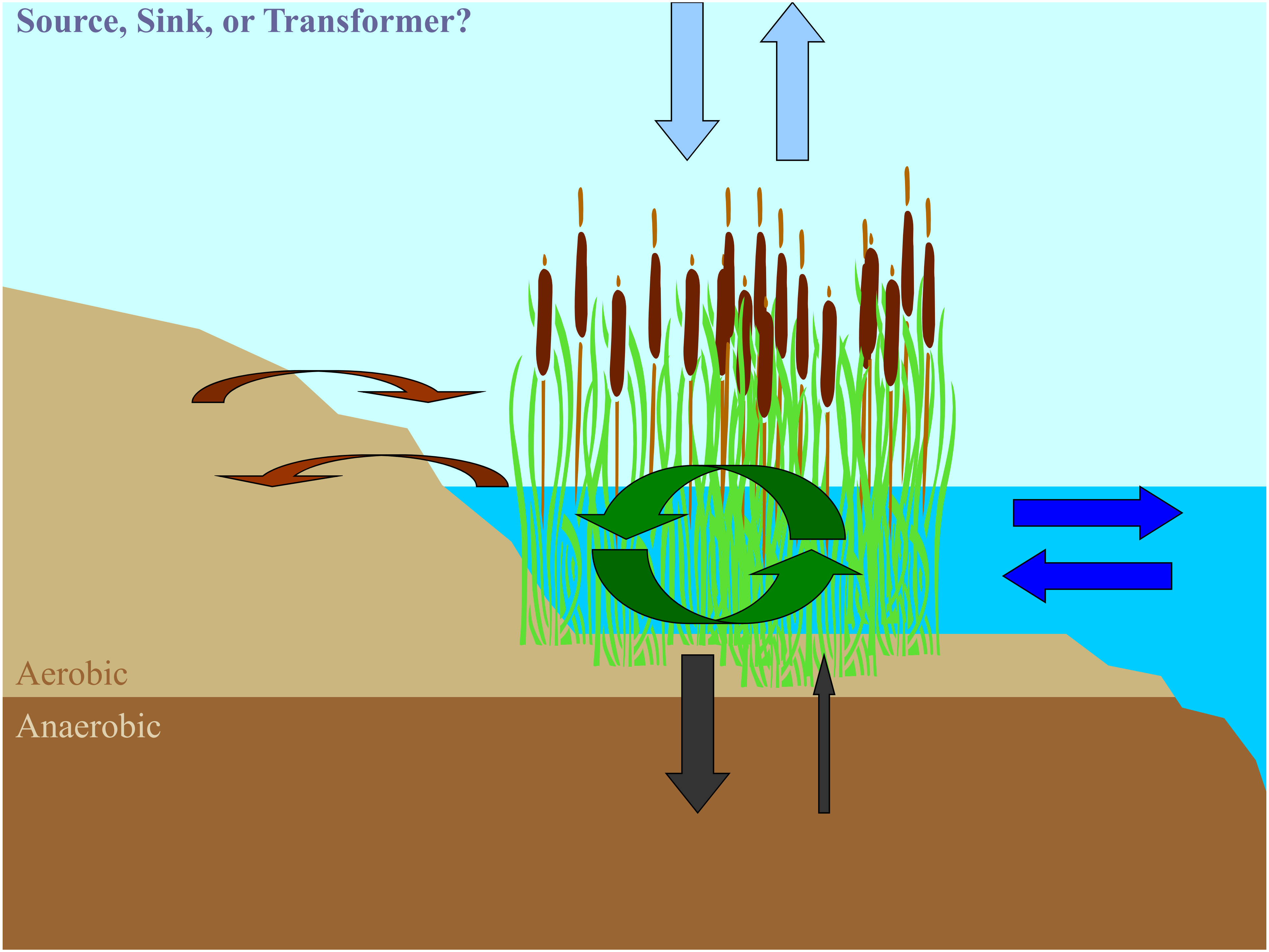
Boon 2006



Nutrient Budgets
Aerobic
Anaerobic

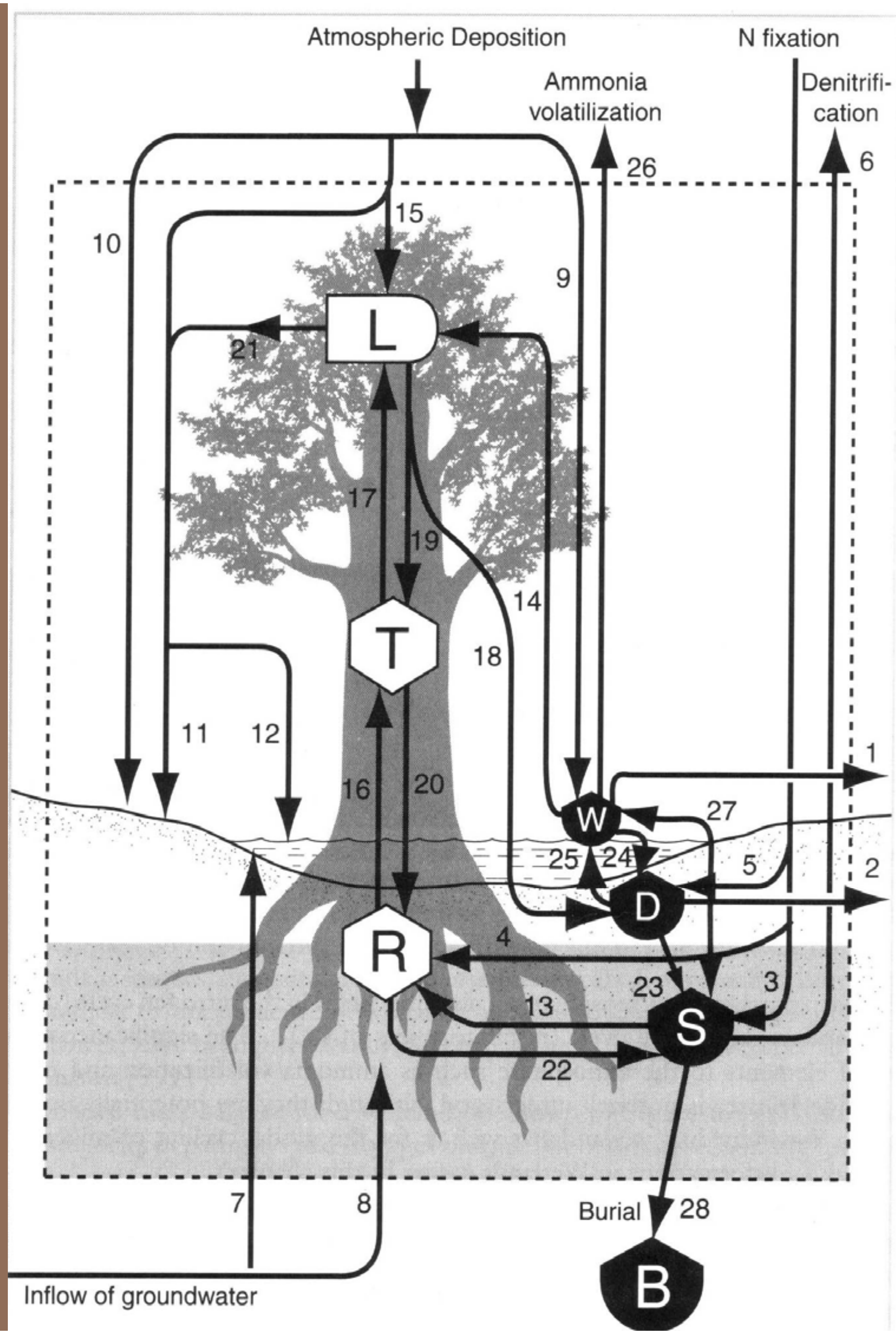
Chemicals in water (mg/L)

Chemical	Precipitation	River water	Sea water
Ca^{2+}	0.1 – 1.0	15	412
Mg^{2+}	0.04 – 0.05	4.1	1294
Na^{+}	0.1 – 5	6.3	10,773
K^{+}	0.06 – 0.3	2.3	400
NO^{3-}	0.26 – 1.5	0.2 (N)	0 – 5 (N)
NH^{4+}	0.2	-	-
Cl^{-}	0.1 – 9	7.8	19,334
SO_4^{2-}	1.4 – 2.6	11.2	2,712
P	0.01 – 0.02	0.02	0 – 0.07
HCO_3^{-}/CO_3^{2-}		58.4	142
Fe	0	0.7	<0.01
SiO_2	0	13.1	<0.01 - >10
DOC	0	10 - 20	1 – 5



Source, Sink, or Transformer?
Aerobic
Anaerobic

Mass Balance Studies



P Budget

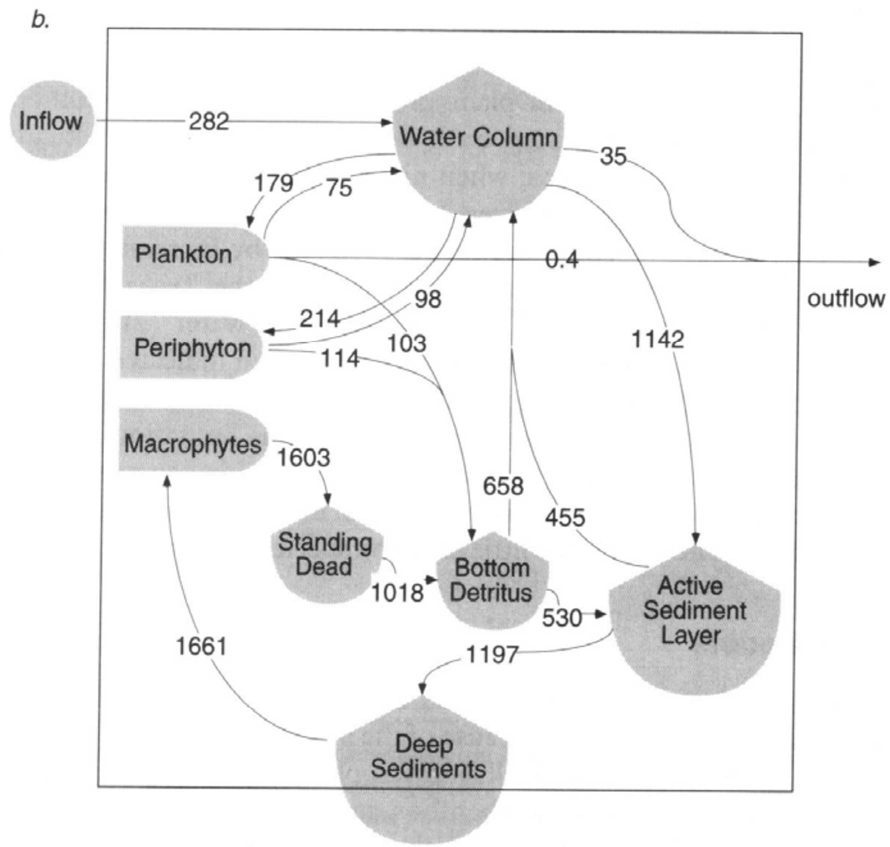


Figure 12-16 Estimated flow of phosphorus in created freshwater wetlands determined by a simulation model calibrated with several years' field data for **a.** high-flow and **b.** low-flow conditions. Site is in northeastern Illinois and inflow was pumped from adjacent Des Plaines River. Flows are in mg m^{-2} yr^{-1}. (*After Wang and Mitsch, in press*)