Measurement of methyl mercury released from constructed wetlands and comparison with data collected from natural stream reaches

Mae Gustin

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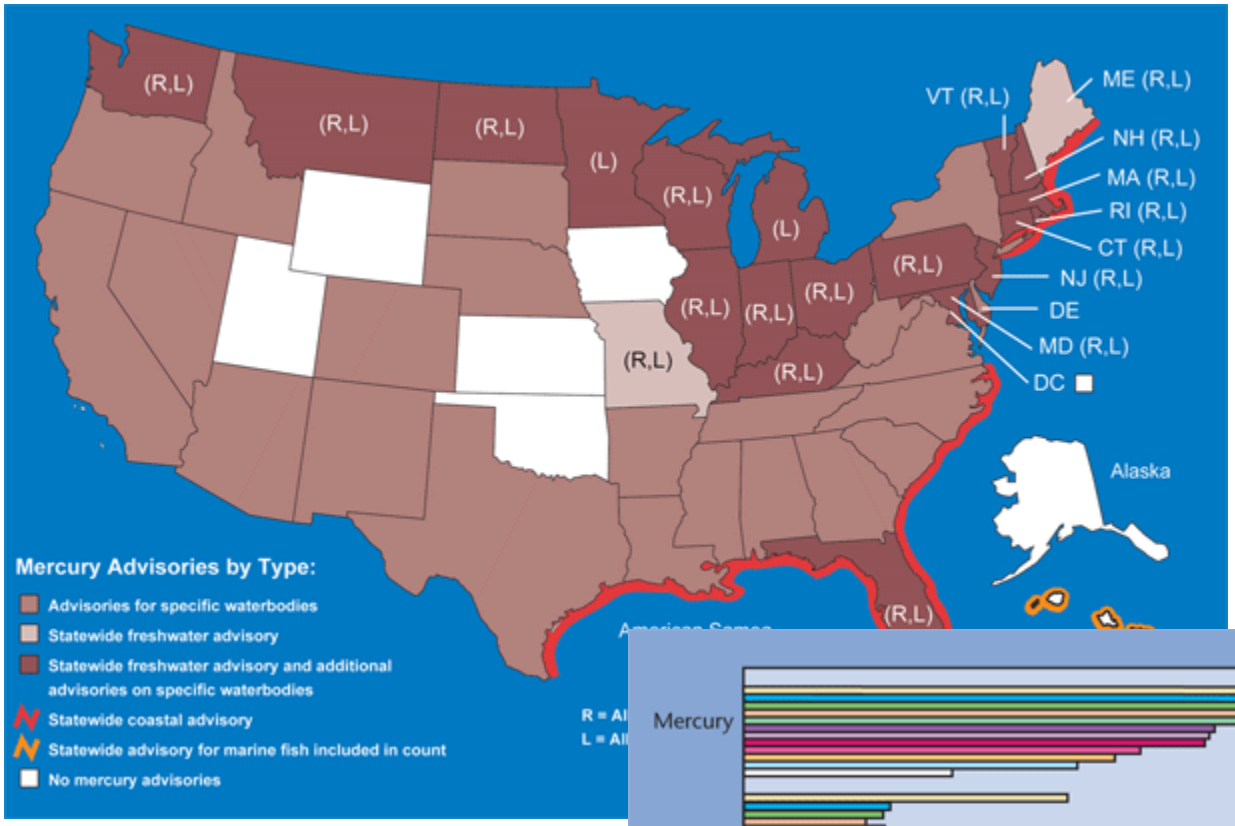
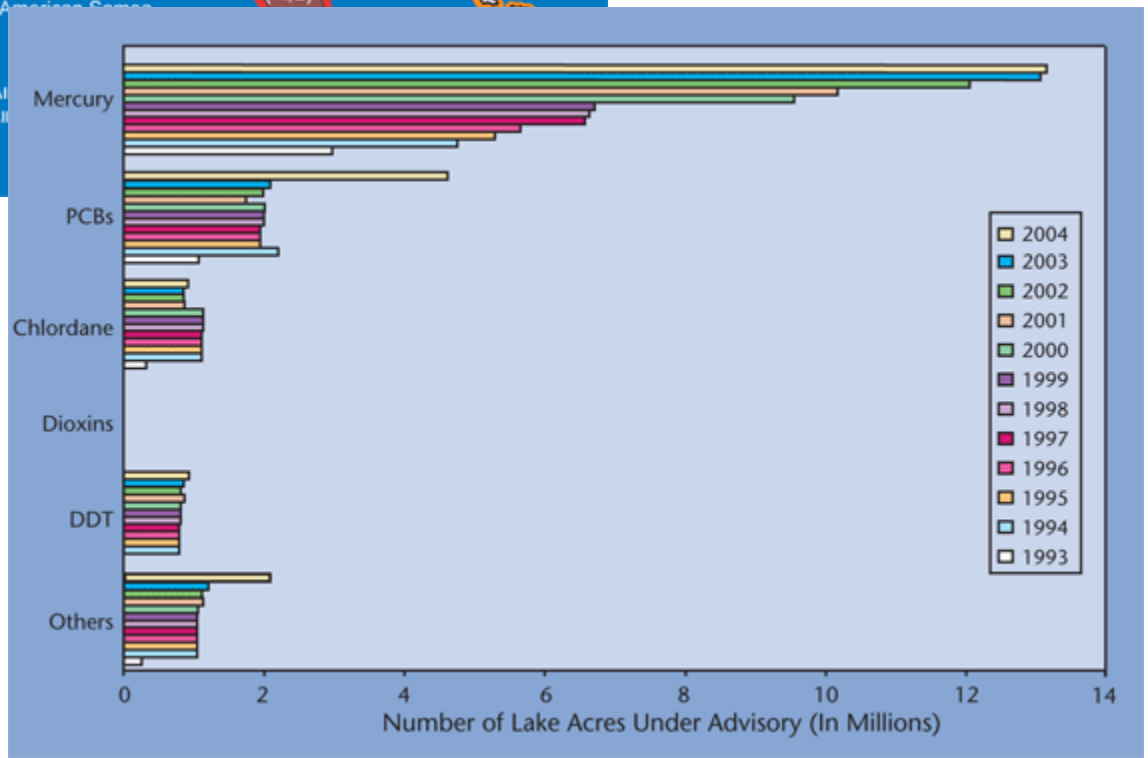
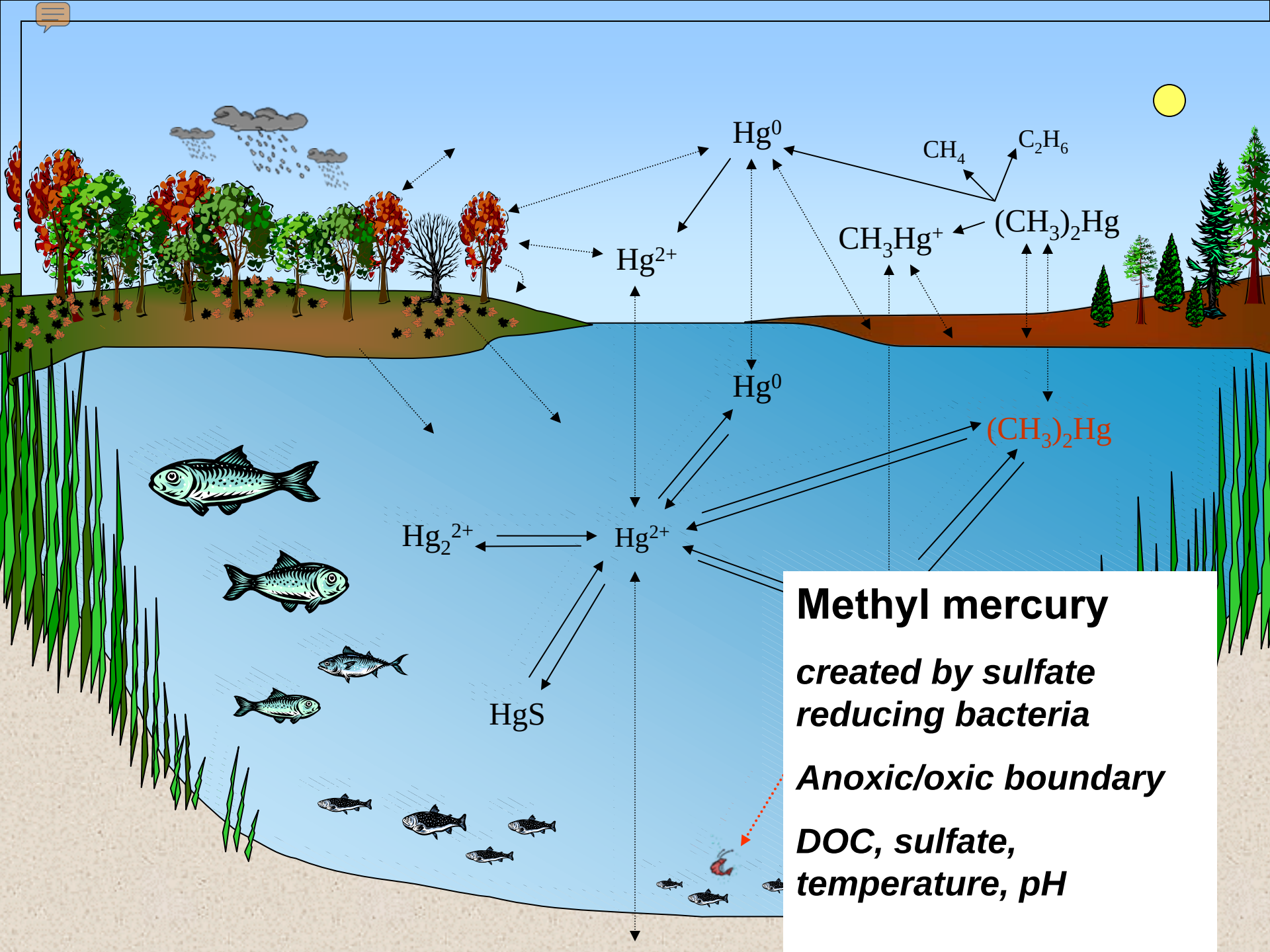
  - Cities of Reno and Sparks, NV
  - Nevada Division of Environmental Protection
  - Truckee Meadows Water Reclamation Facility
  - Washoe County Regional Water Planning Commission
  - Citizens and Fisherman





http://www.epa.gov/waterscience/presentations/fish-2004/

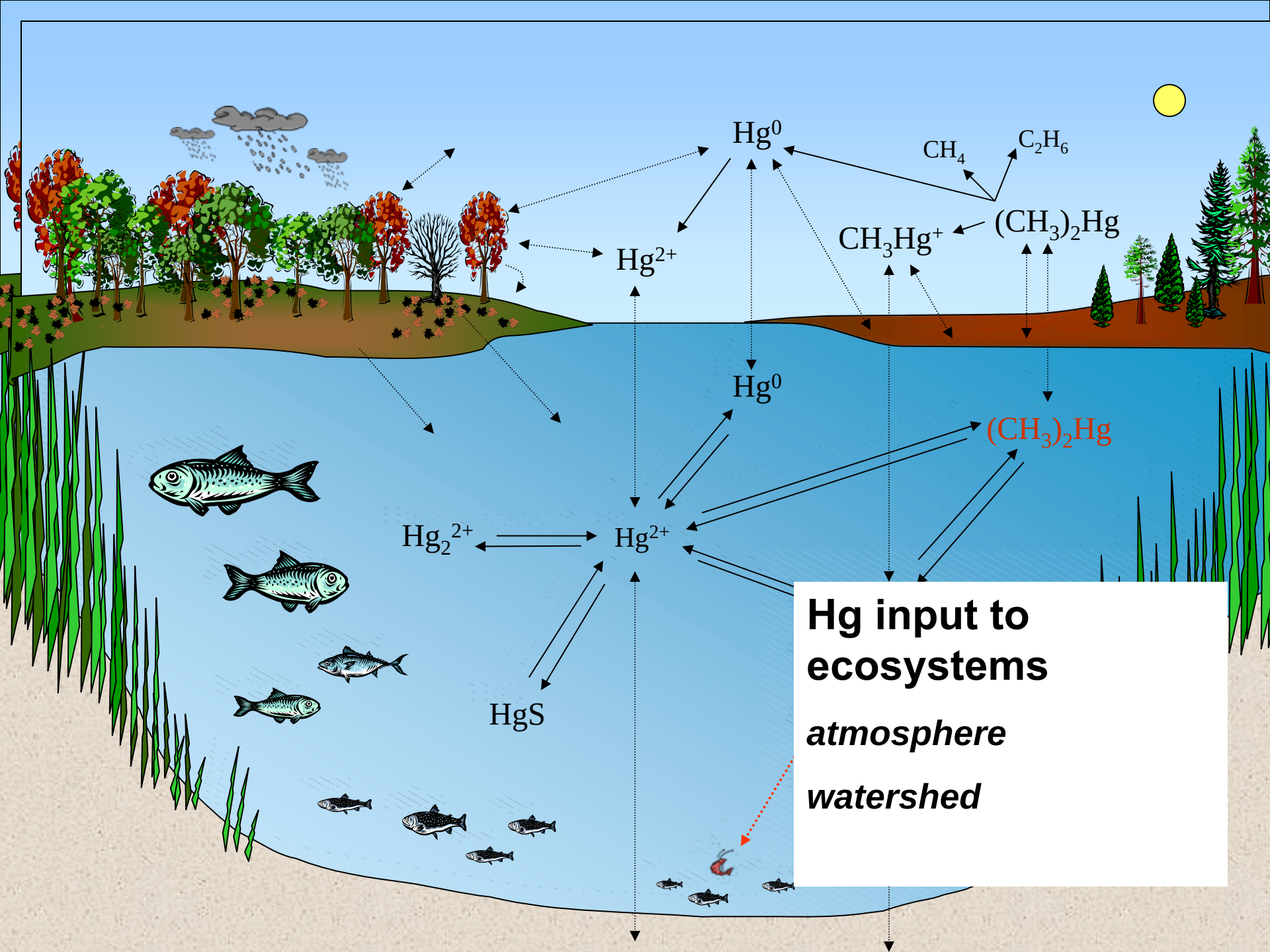


Methyl mercury

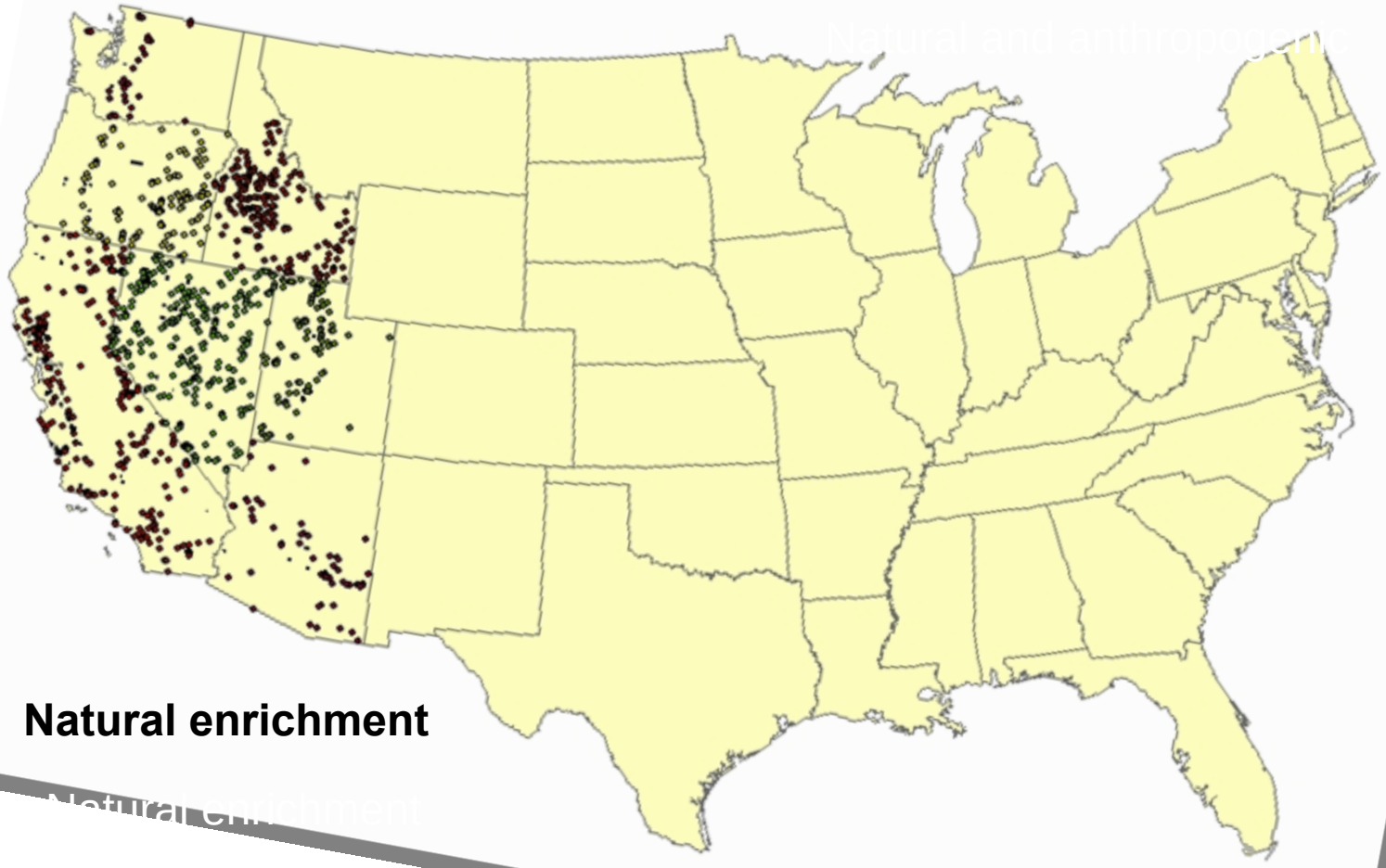
created by sulfate reducing bacteria

Anoxic/oxic boundary

DOC, sulfate, temperature, pH


Hg^0
CH_4
C_2H_6
$(CH_3)_2Hg$
CH_3Hg^+
Hg^{2+}
Hg^0
$(CH_3)_2Hg$
Hg_2^{2+}
Hg^{2+}
HgS
Hg input to ecosystems
atmosphere
watershed

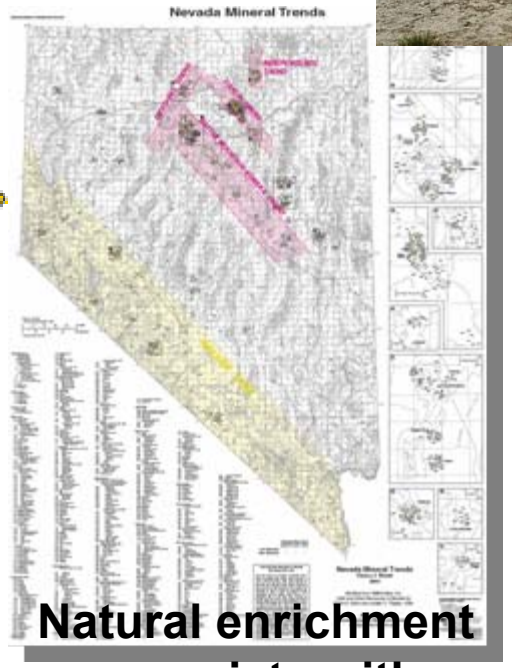
Mercury in western systems



Natural enrichment

Mercury in western systems

Anthropogenic contamination

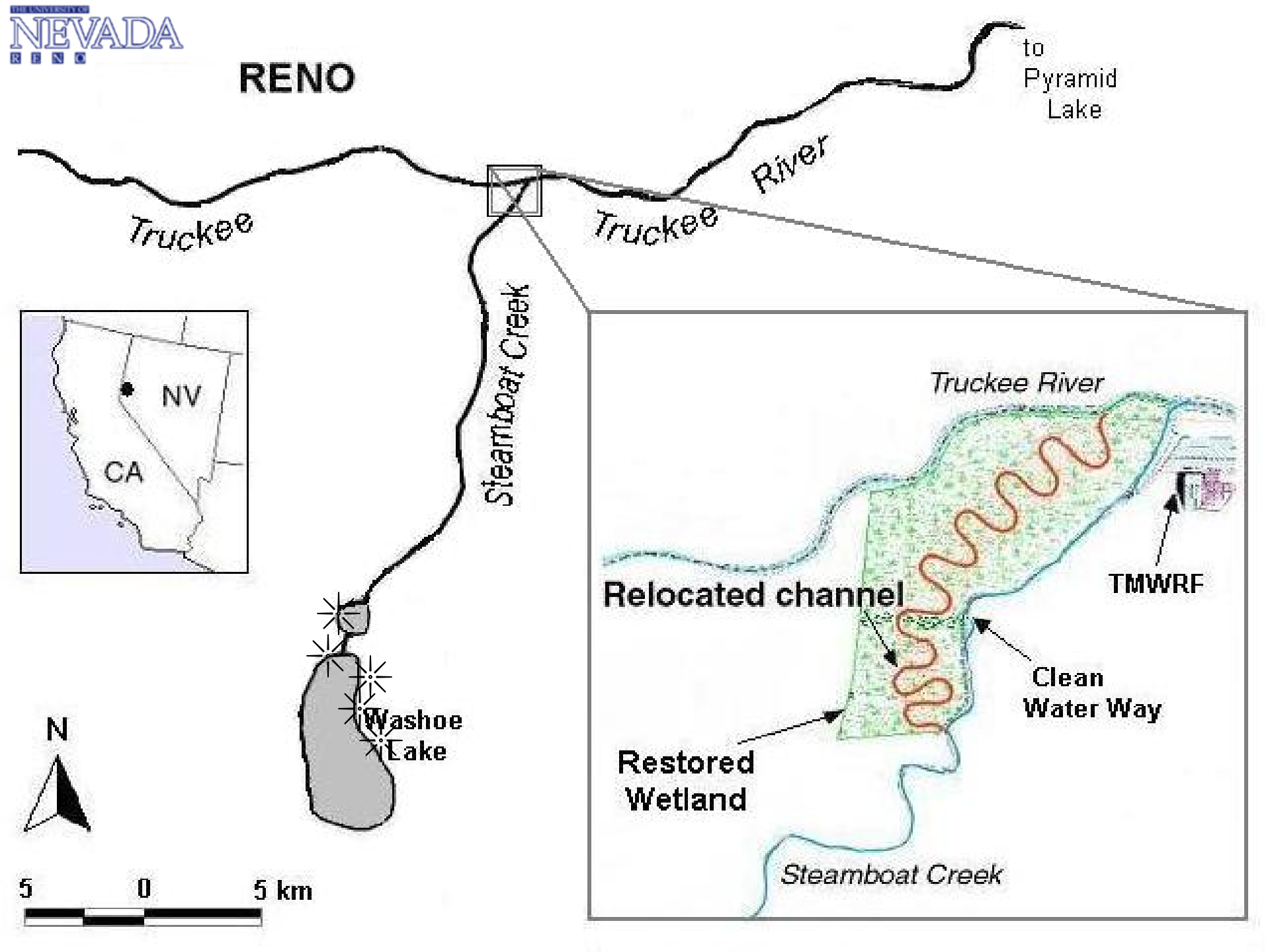


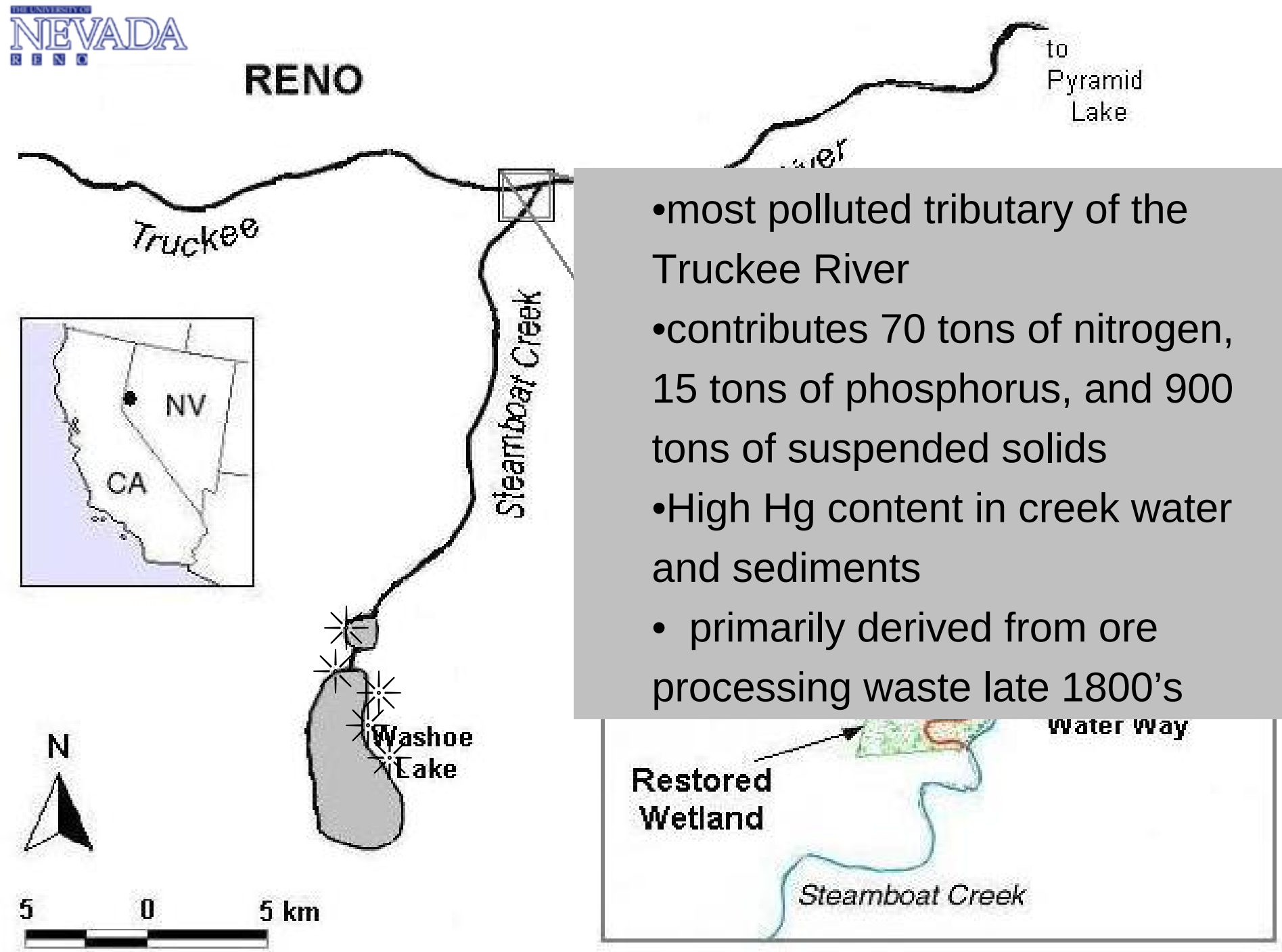
Natural enrichment associate with mineralization

Geothermal areas

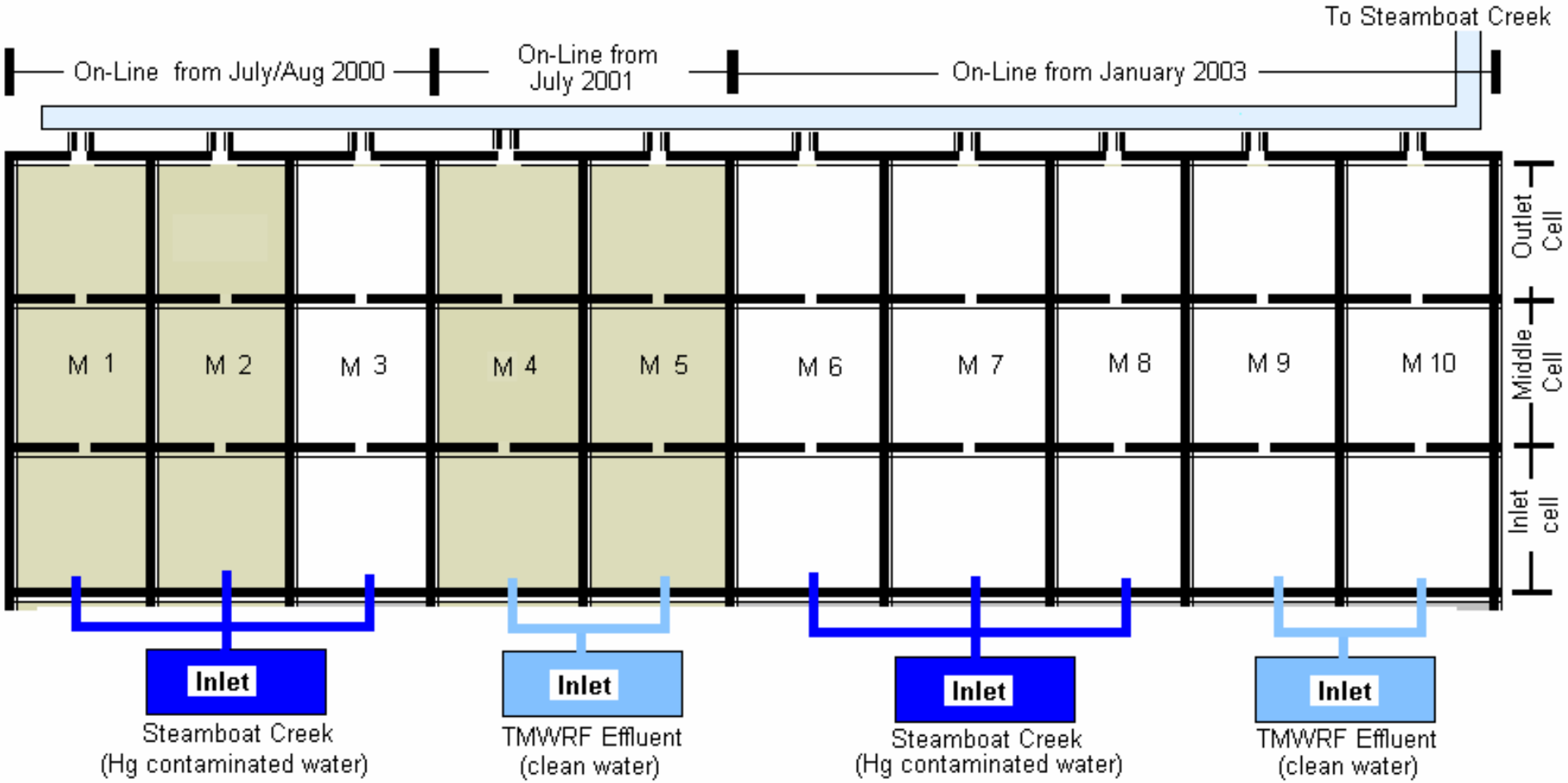
Wetlands are important in western systems

- Habitat and water!
- Important for nutrient reduction and reduction of total suspended sediment loads
- Sites of methyl mercury production
- Can we mitigate methyl mercury production while maximizing benefits?


NEVADA
RENO
RENO
to
Pyramid
Lake
Truckee
River
Truckee
Steamboat Creek
NV
CA
Washoe
Lake
N
5
0
5 km
Truckee River
Relocated channel
TMWRF
Clean
Water Way
Restored
Wetland
Steamboat Creek



- most polluted tributary of the Truckee River
- contributes 70 tons of nitrogen, 15 tons of phosphorus, and 900 tons of suspended solids
- High Hg content in creek water and sediments
- primarily derived from ore processing waste late 1800's



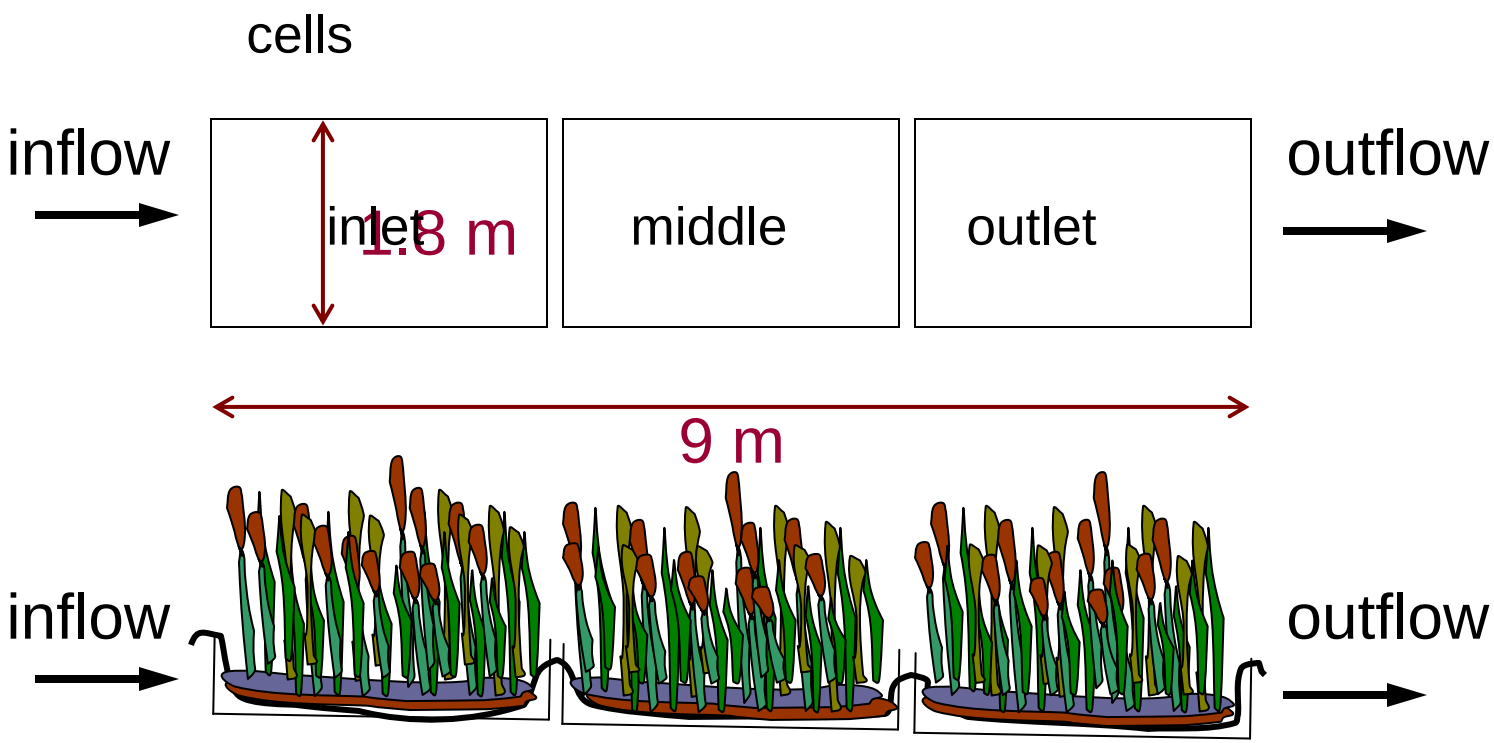
Mesocosms (M) with Hg contaminated sediments

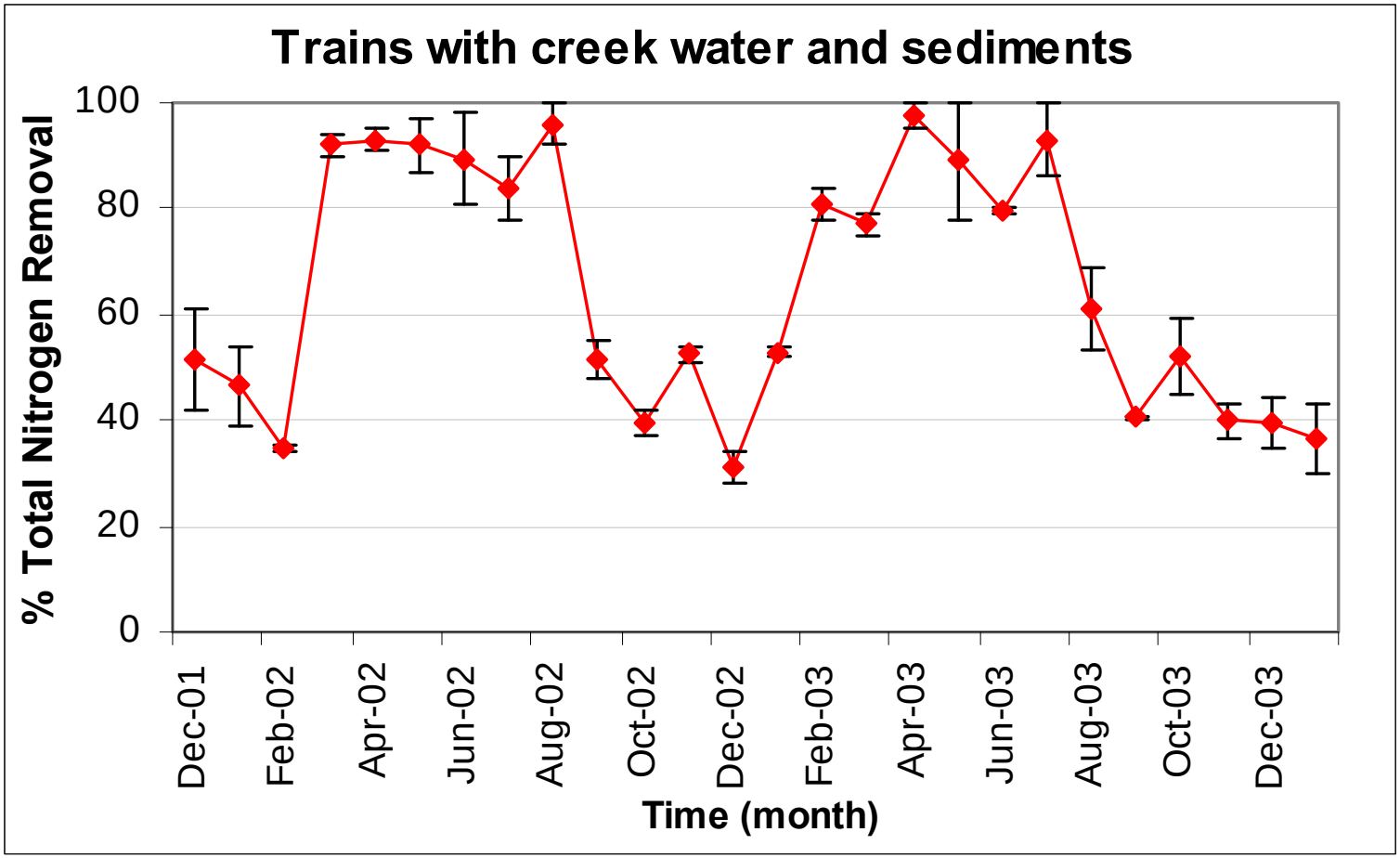
Mesocosms with clean sediments

Type	Water [Hg]	Sediments [Hg]
Creek	25 - 320 ng Hg/L	0.35 - 1.4 µg Hg/g
Clean	4 - 16 ng Hg/L	0.05 - 0.3 µg Hg /g

Experimental Setting

Small surface-flow wetlands consisted of 10 parallel trains, each having:

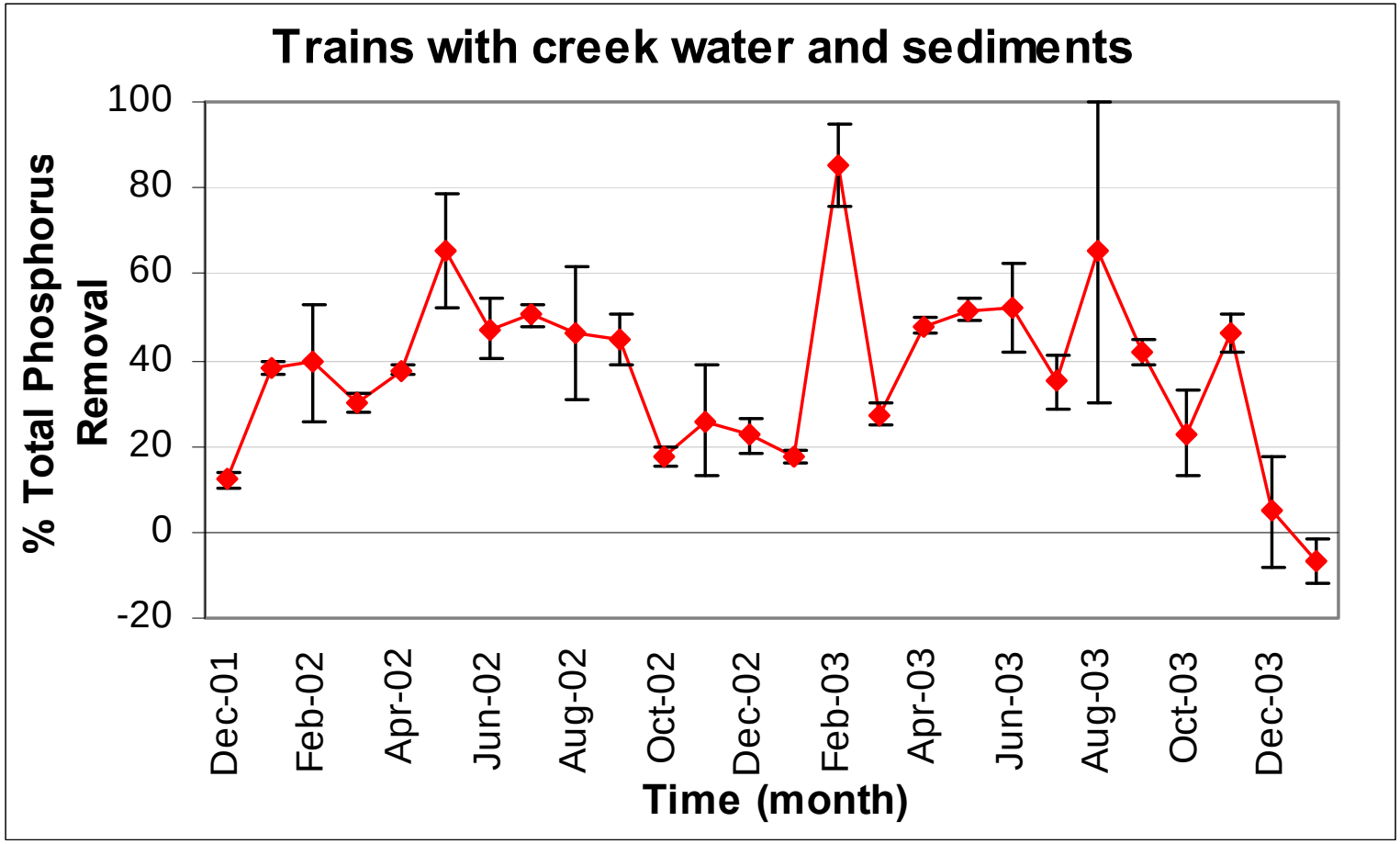




Nitrogen removal

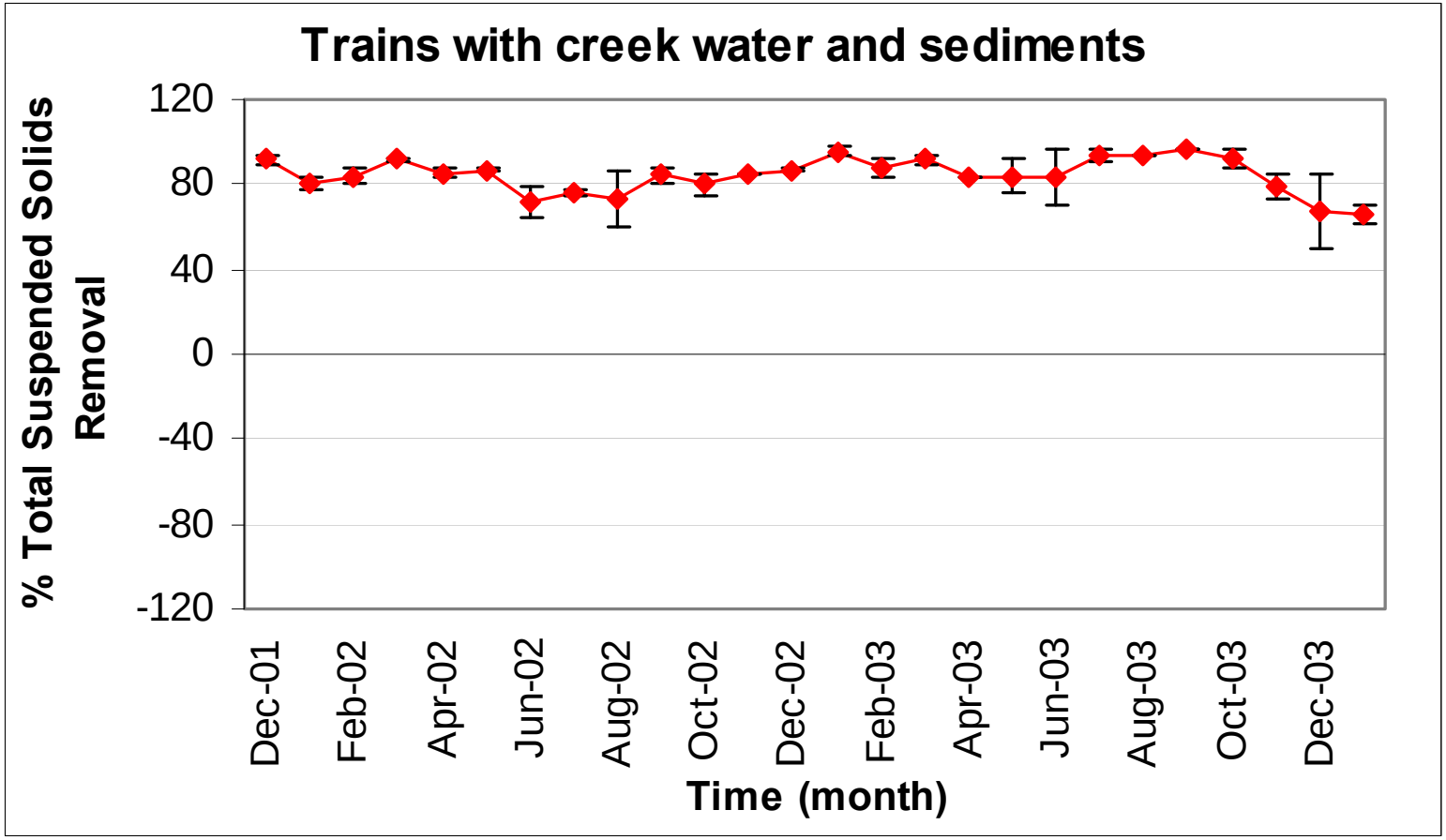
Results and Discussion

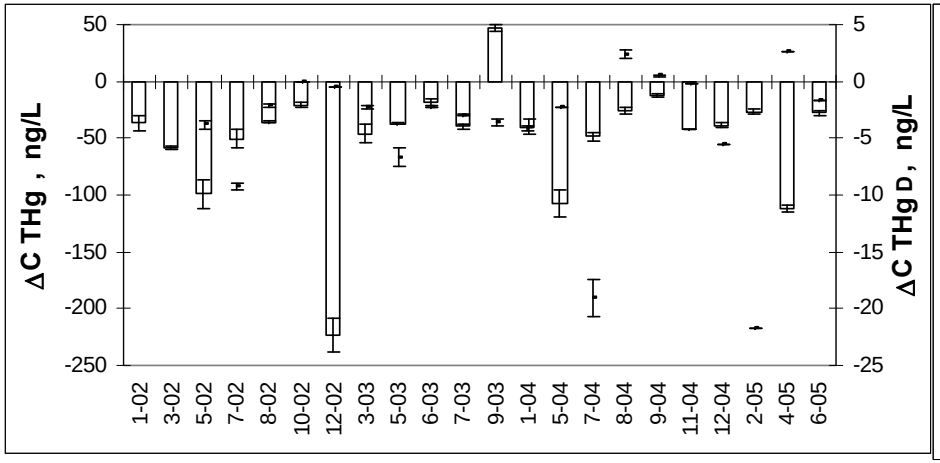
Total Phosphorus (TP):



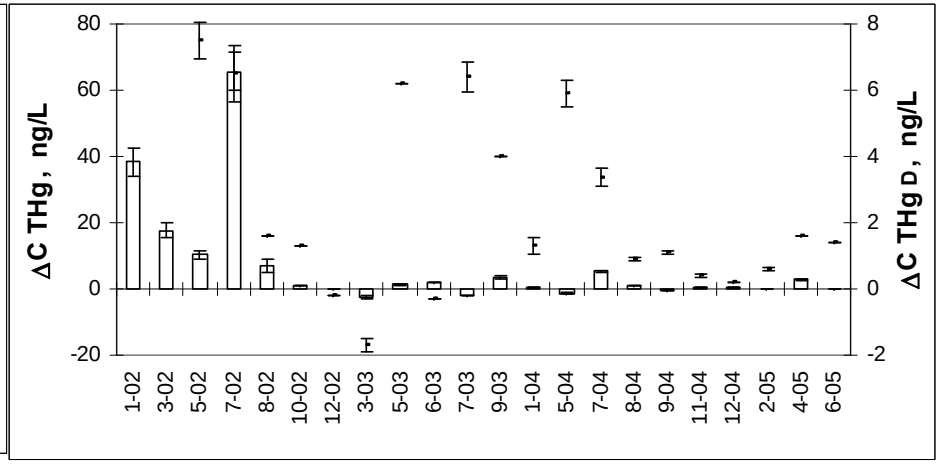
Results and Discussion

Total Suspended Solids (TSS):

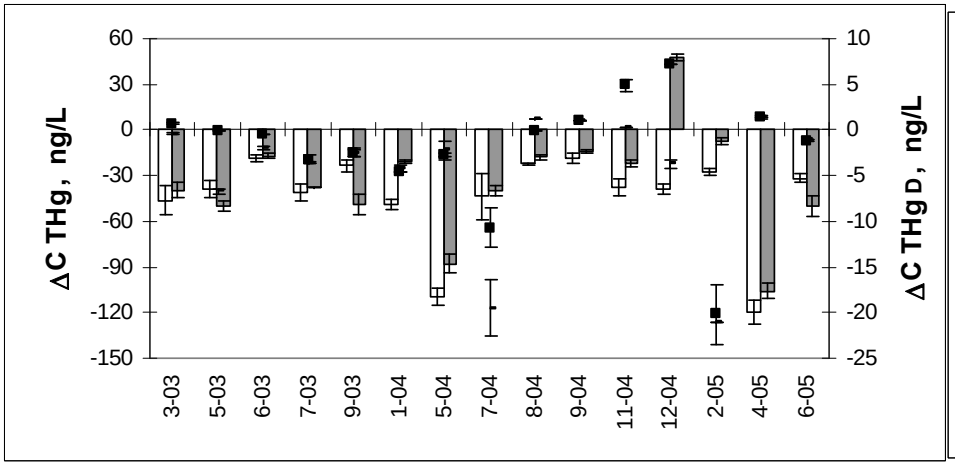




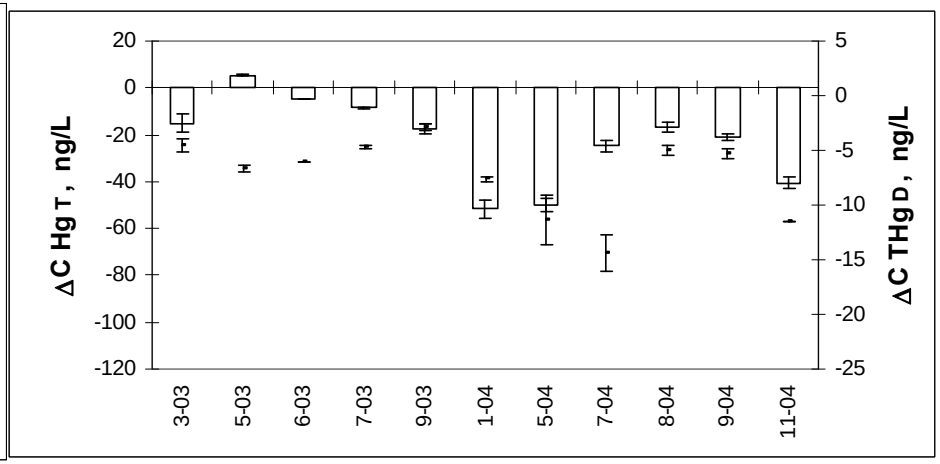
Creek water –Creek sediments



Plant effluent – Creek sediments



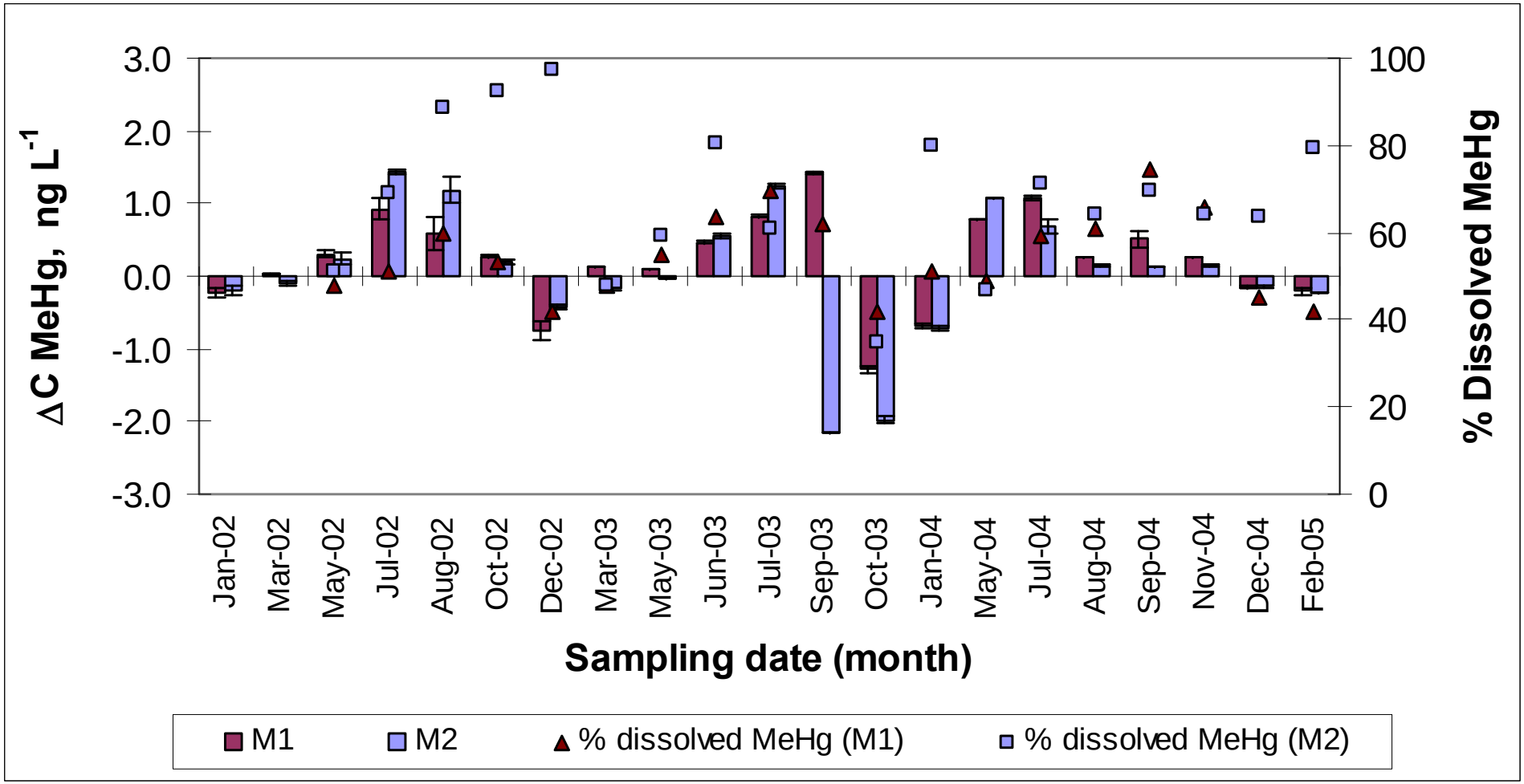
Creek water Clean sediments



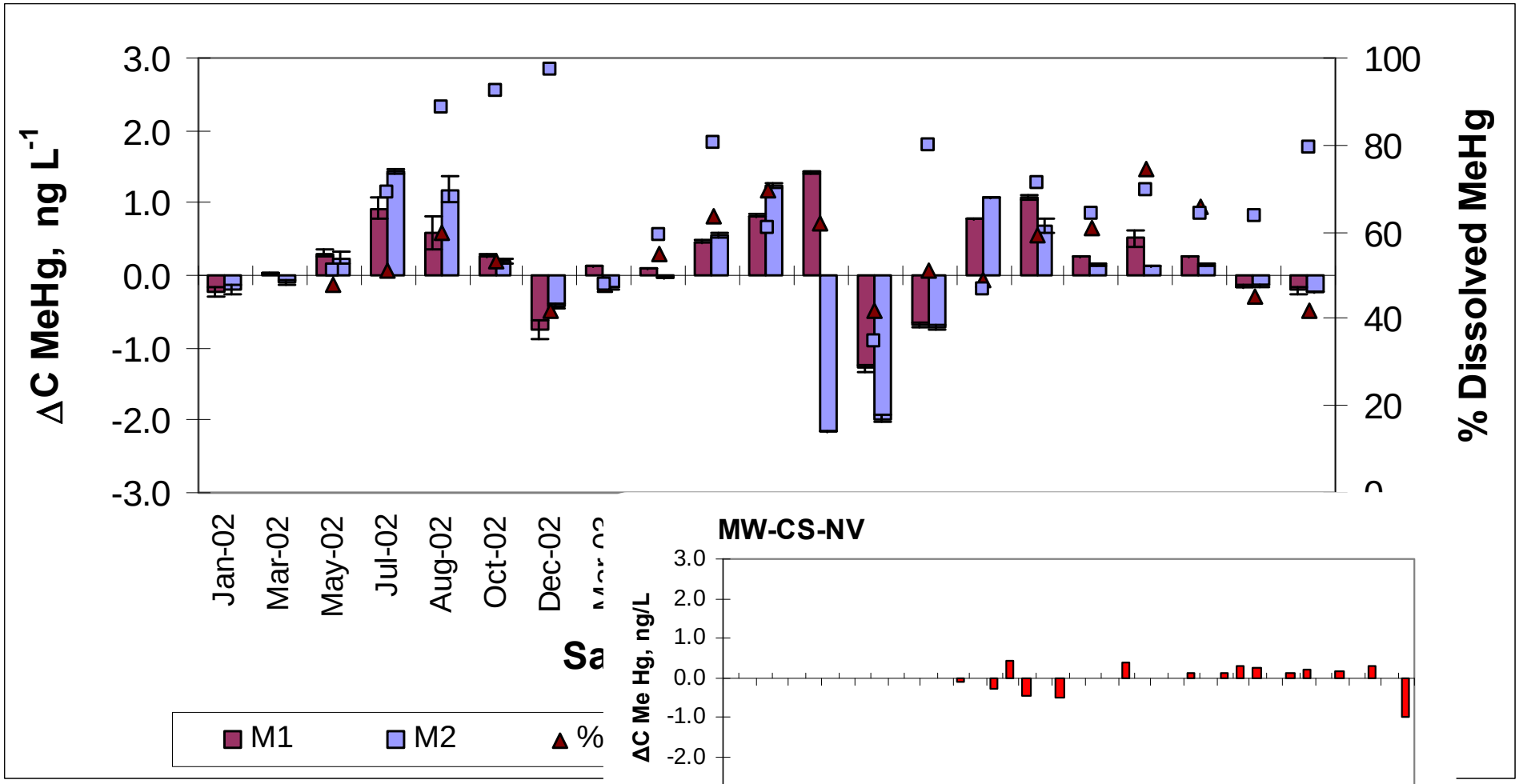
Plant effluent – Clean sediments

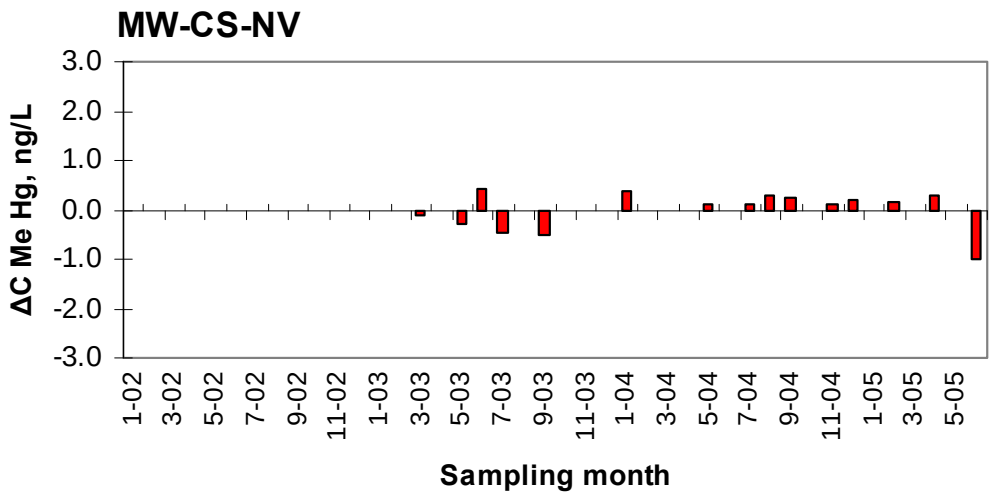
ΔC of total Hg in outlet waters- inlet

SBC water and sediments

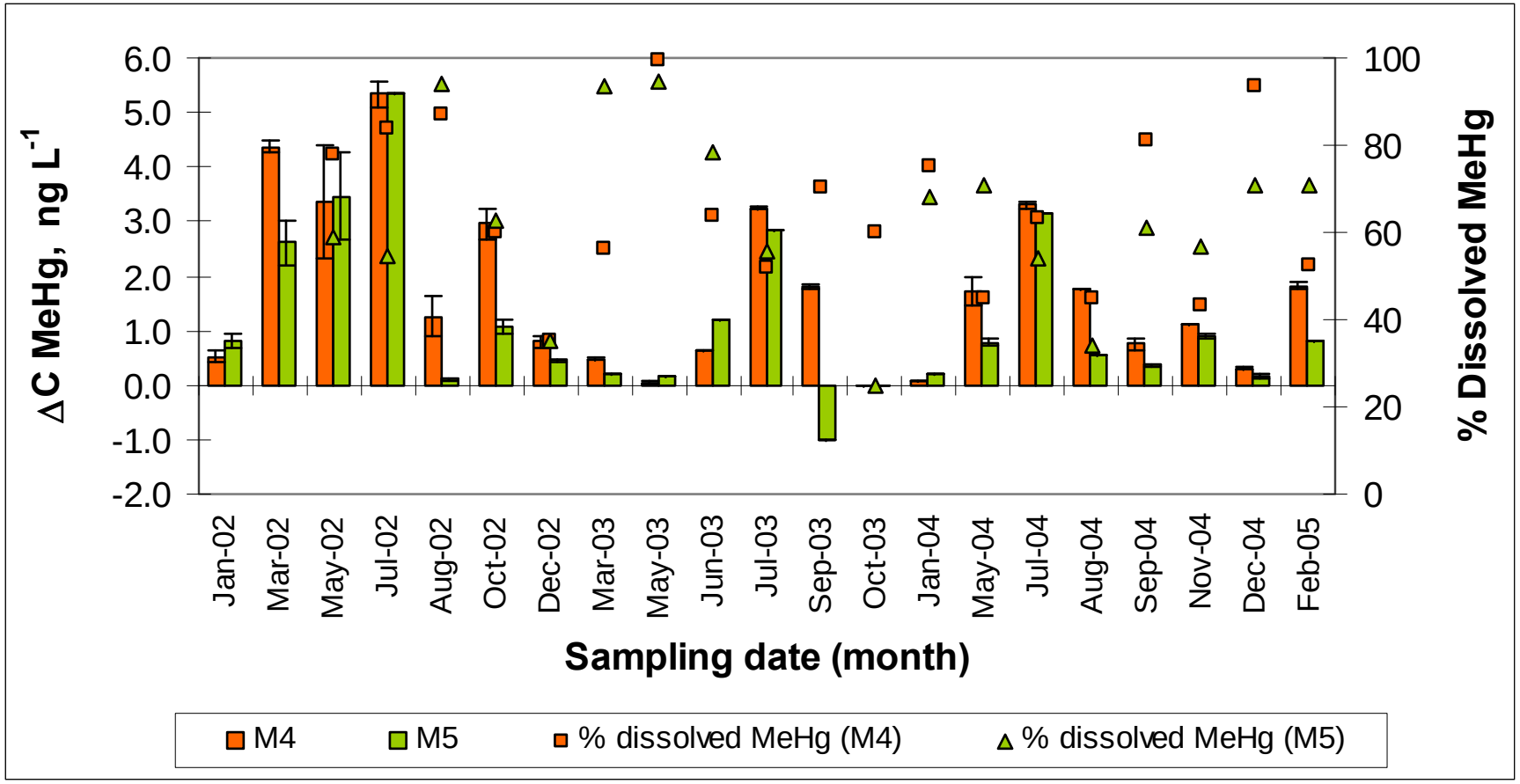


SBC water and sediments





TMWRF water and SBC sediments



Wetlands

- Sink for N, P, TSS and total Hg
- Contaminated sediments more methyl Hg production than clean sediments less
  - (but creek water is a constant source!)
- Clean water significantly increased meHg production
  - Warmer
  - Lower pH
  - Higher sulfate
  - Higher TOC

Take home message

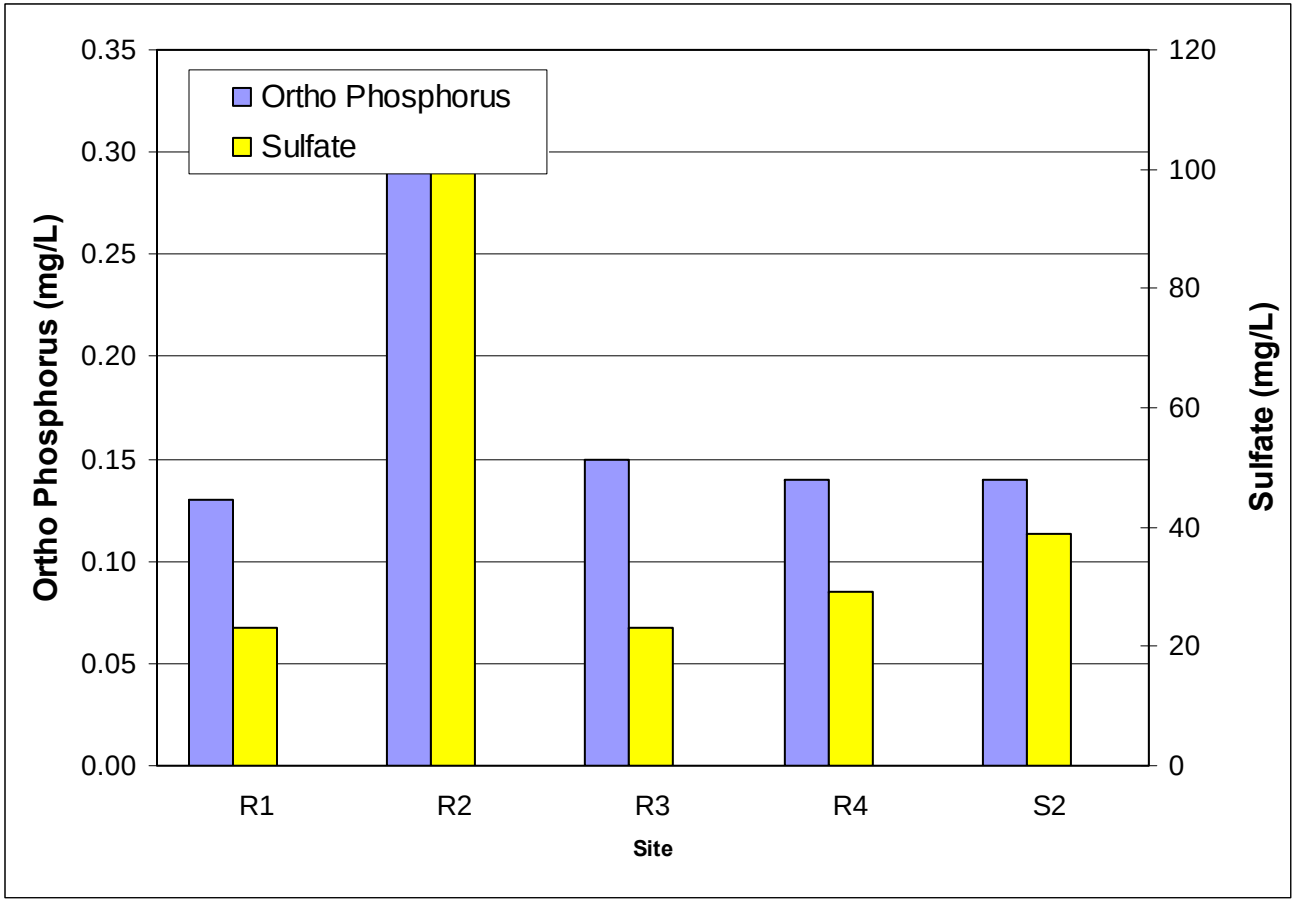
- Water source matters!
- Wetland design important
- Wetlands will make meHg but can mitigate it with open areas of water
- Experimental manipulations
  - Sulfate and temperature important controlling parameters
  - Drying and wetting caused meHg to be flushed
  - Nitrate addition did not influence meHg flux

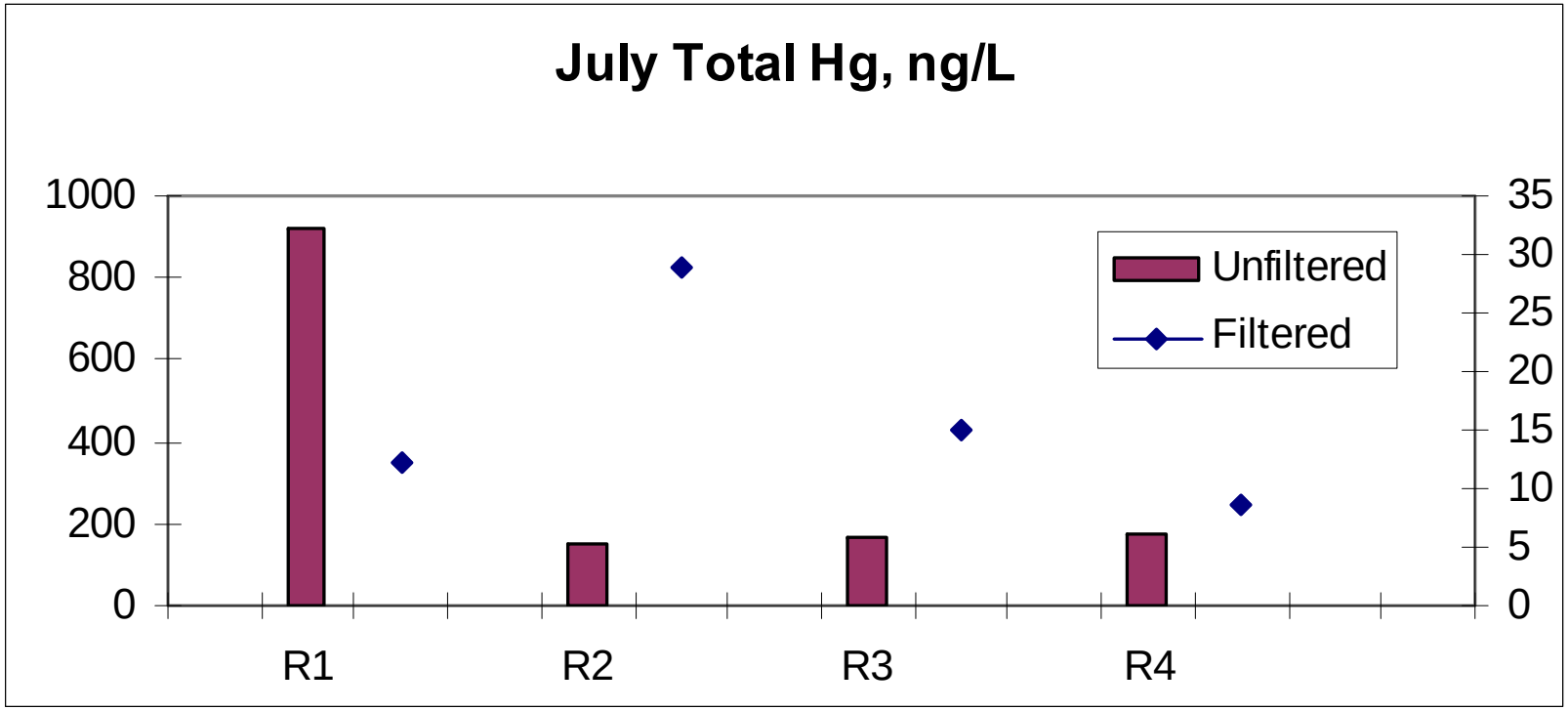
Measurement of meHg production in restored stream reaches

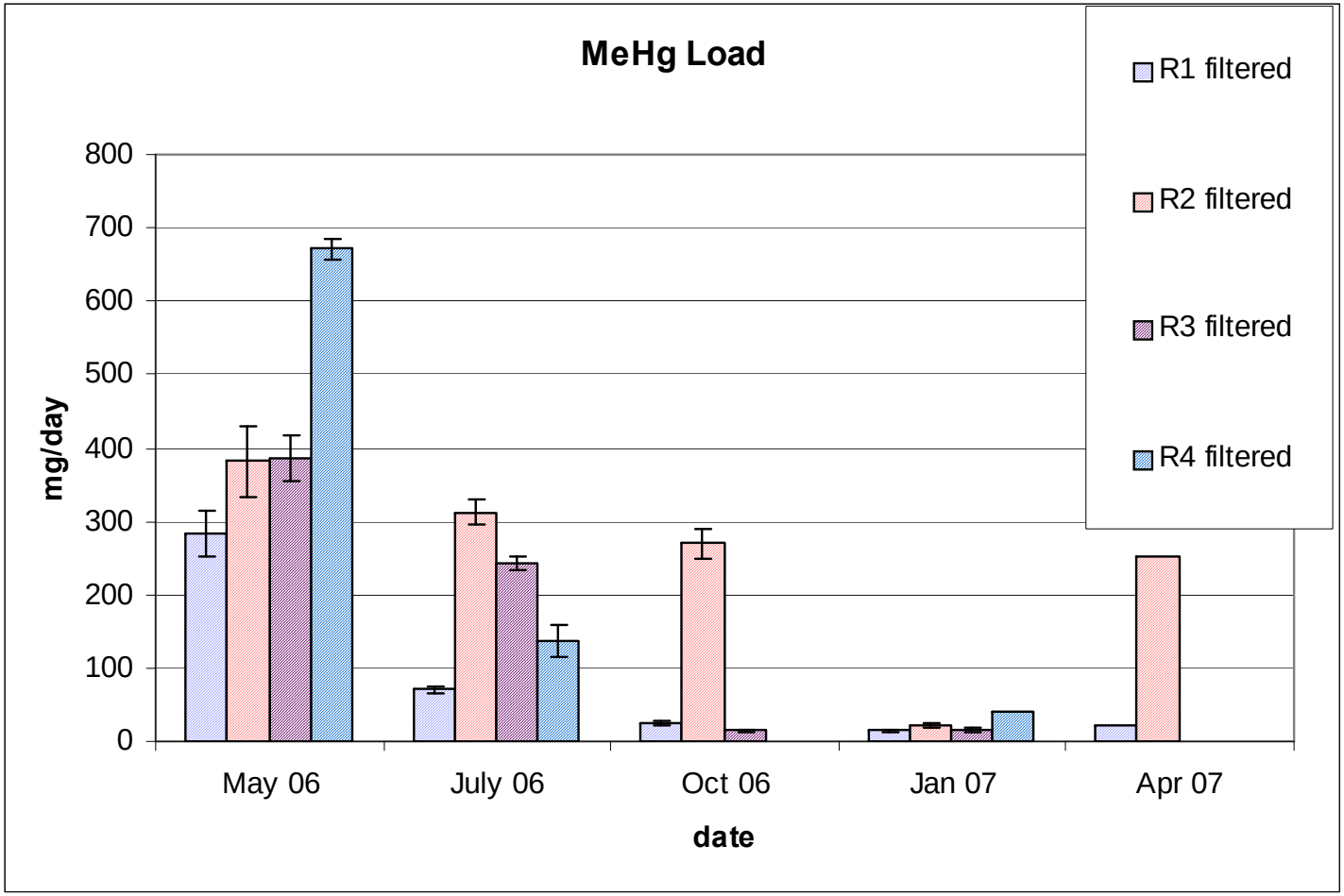
- Reach with riparian habitat and no standing water
- No meHg production, no water quality benefits

Riparian reach with wetlands

Riparian reach with wetlands


Ortho Phosphorus
Sulfate
Ortho Phosphorus (mg/L)
Sulfate (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
120
100
80
60
40
20
0
R1
R2
R3
R4
S2
Site


July Total Hg, ng/L
1000
800
600
400
200
0
35
30
25
20
15
10
5
0
Unfiltered
Filtered
R1
R2
R3
R4


MeHg Load
R1 filtered
R2 filtered
R3 filtered
R4 filtered
mg/day
800
700
600
500
400
300
200
100
0
May 06
July 06
Oct 06
Jan 07
Apr 07
date

Conclusions for Hg contaminated watershed

- Constructed wetlands
  - will generate methyl Hg
  - H2O quality benefits
  - Water source important!
- Restored riparian habitat
  - No meHg
  - No H2O quality benefits
- Instream wetland
  - Keep H2O moving
  - Open areas for photodegradation