Historical Patterns in the Deposition of Trace Metals to Lake Ontario Embayments

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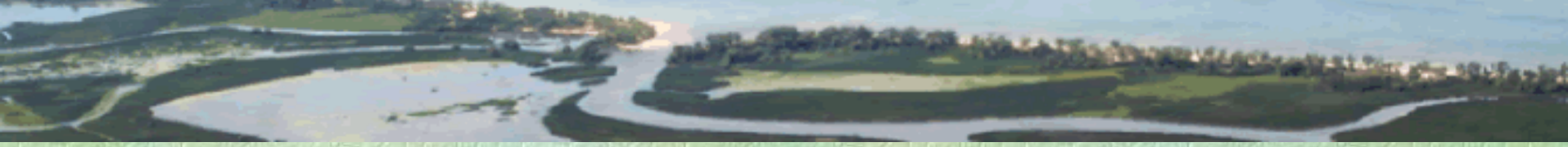
Outline

- Objectives
- Approach
- Study Site Locations
- Results
- Conclusions
- Questions



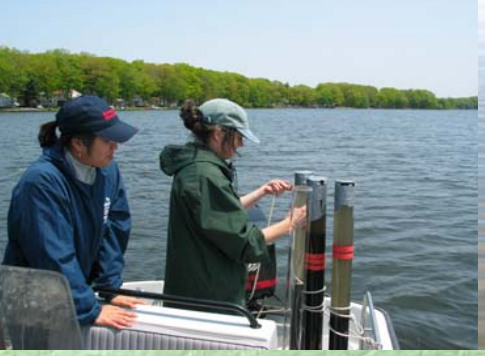
Objectives

To examine historical patterns in the deposition of trace metals and nutrients to embayments to Lake Ontario and relating these patterns to changes in:

-Atmospheric deposition

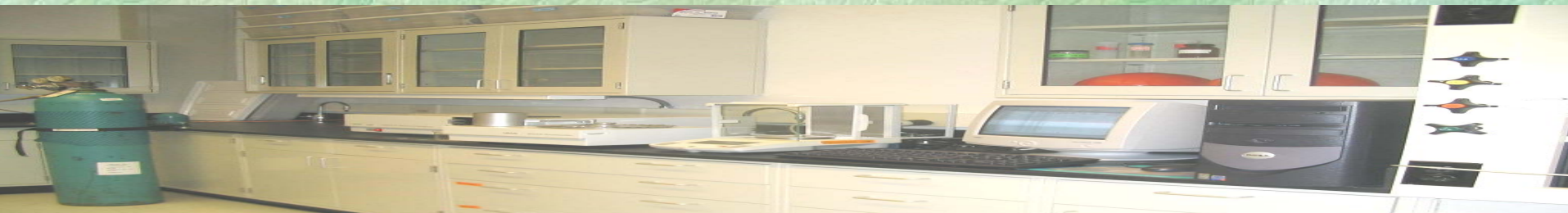
-Land-use

-Connectiveness to Lake Ontario

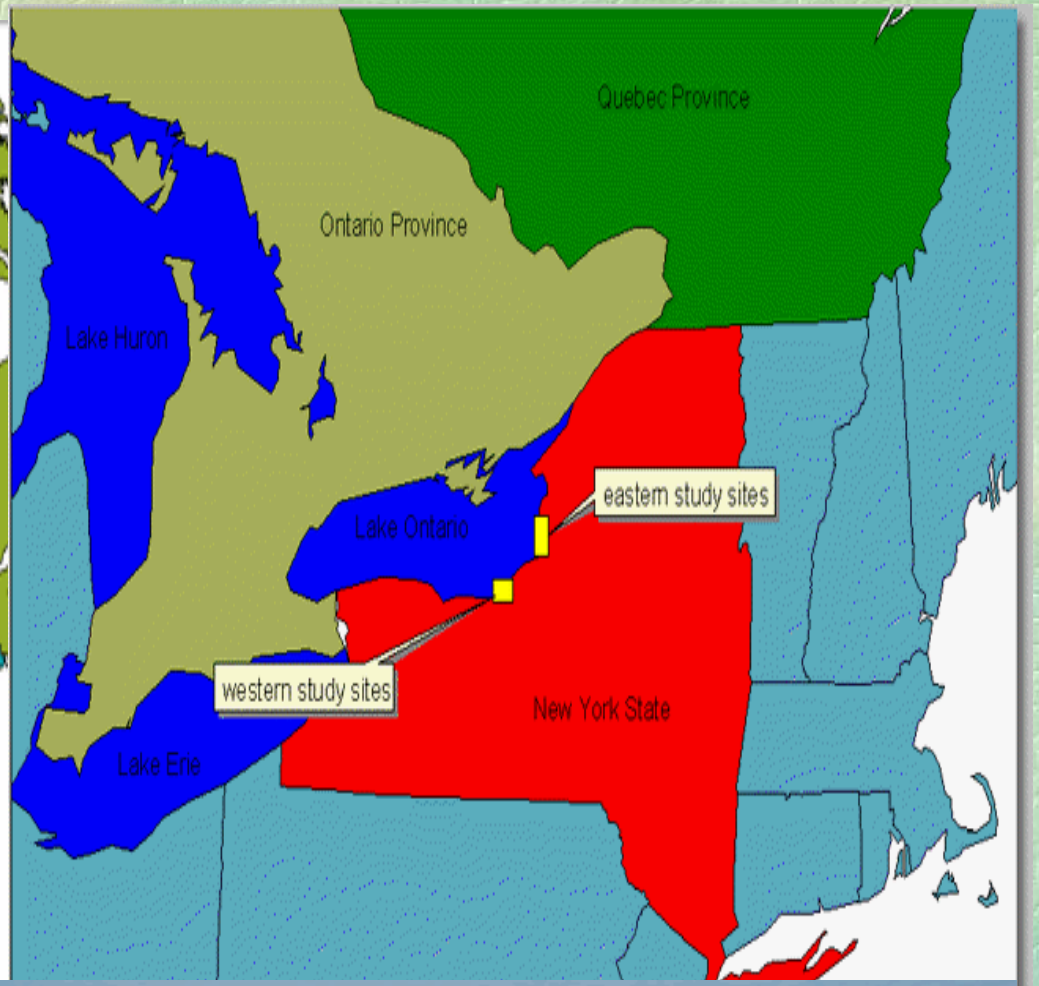


Approach

- Sediment cores collection from Juniper Pond, Little Sodus Bay and South Sandy Pond
- Sediment cores were sectioned by Cornell University
- Sediment cores were send to be Pb^{210} dated
- Sediment cores were analyzed for Hg, T-C,T-N, Al, As, B, Be, Cl, Cu, Fe, K, Mn, P, Pb, S, and Zn
- Others scheduled analysis:Hg Isotopes



Study Site Location



Lake Ontario Biocomplexity Project

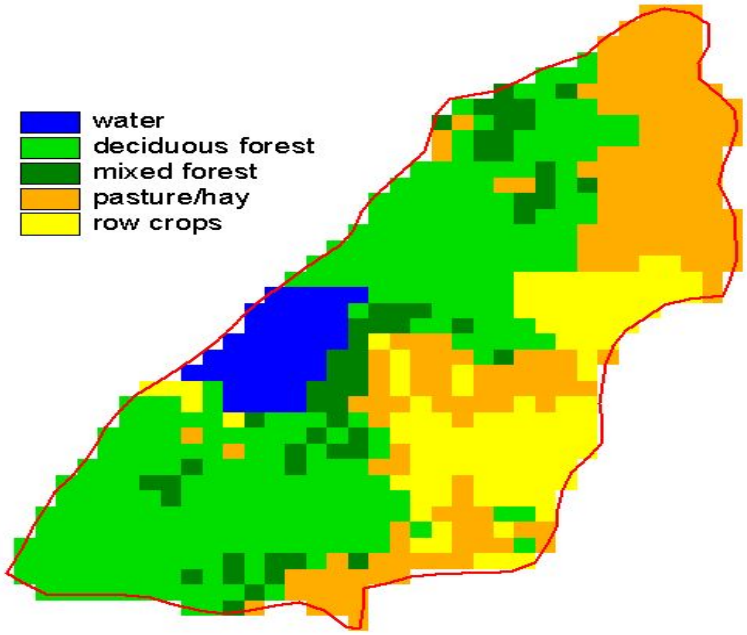
Study Site Location

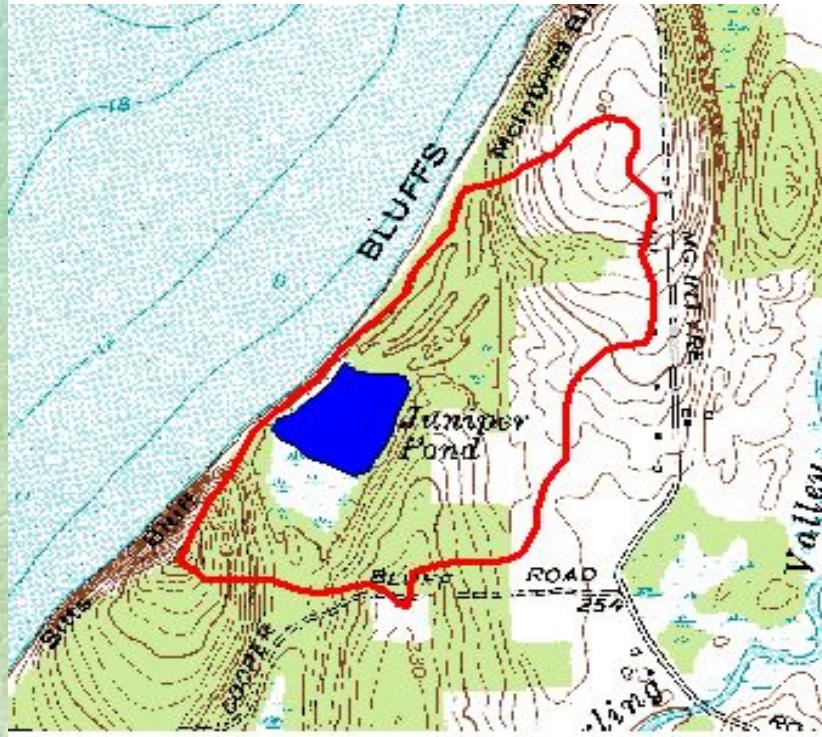
There are three embayments in the study:

- Two of which are located on the southern shore of Lake Ontario (western study sites-Little Sodus Bay and Juniper Pond)
- One of which is located on the eastern shore (eastern study sites-South Sandy Pond)

Juniper Pond

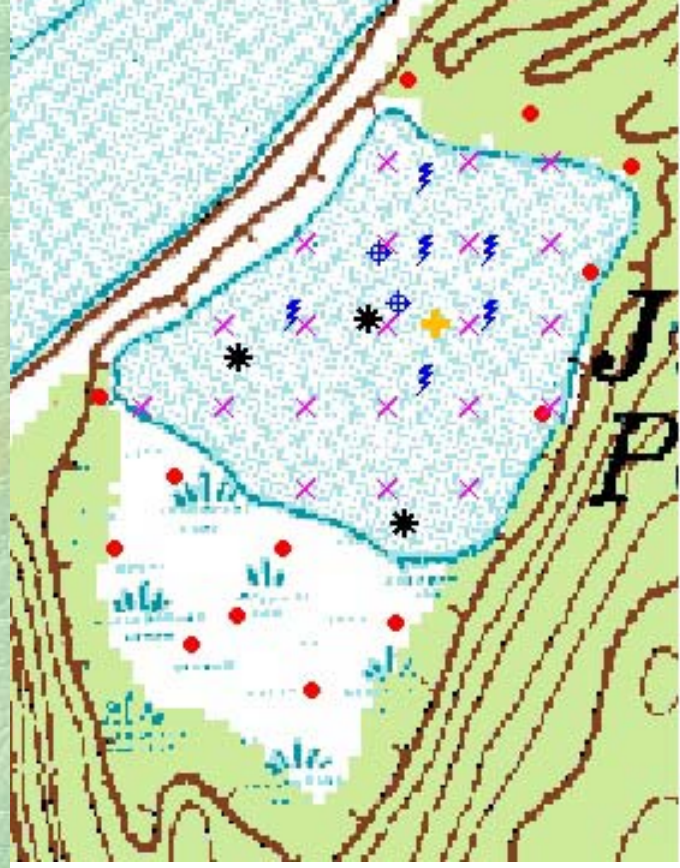
- Watershed area: 0.602 Km^2
- Area of bay: 0.0505 Km^2
- Land Coverage
  - Agriculture: 42.7 %
  - Wetland: 0 %
  - Forest: 51.2 %
  - % Open Water: 6.0 %
  - Urban activities: 0.04 %
- Deepest point: 2.74 m





Juniper Pond

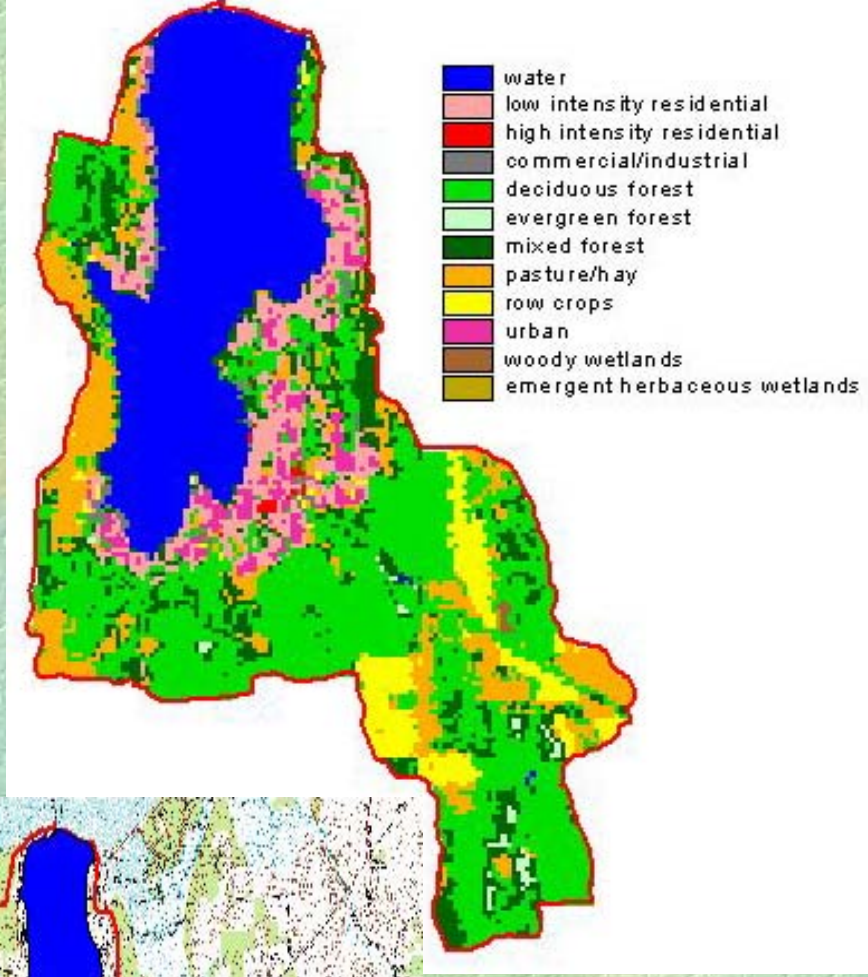
- Water Retention Time: 77.7 days
- Mean Daily Discharge: 0.01 m^3/sec
- Hydraulic Mixing:
  - Volume from drainage: 92 %
  - Volume from direct atmospheric deposition: 8.0 %
- Stream network: there are no perennial streams.
- Connection to Lake Ontario: Closed

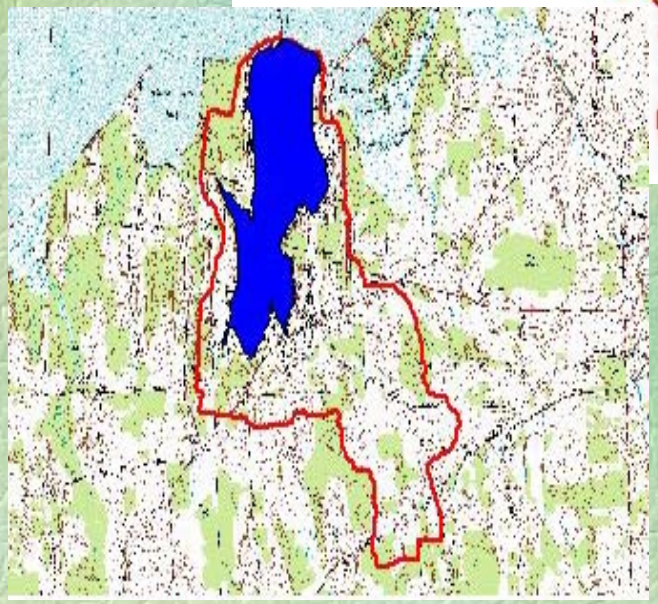


BAIN- Electrofishing
BAIN- Gill netting
BAIN- Invertebrates
HAIRSTON - Plankton/Zooplankton
JOHNSON - Macrophytes
LEOPOLD - Wetlands
LEOPOLD - Wetland survey point

Little Sodus Bay

- Watershed area: 8.58 Km^2
- Area of bay: 2.96 Km^2
- Land Coverage
  - Agriculture: 17.1 %
  - Wetland: 0.14 %
  - Forest: 46.9 %
  - % Open Water: 24.8 %
  - Urban activities: 11.2 %
- Deepest point: 11.3 m





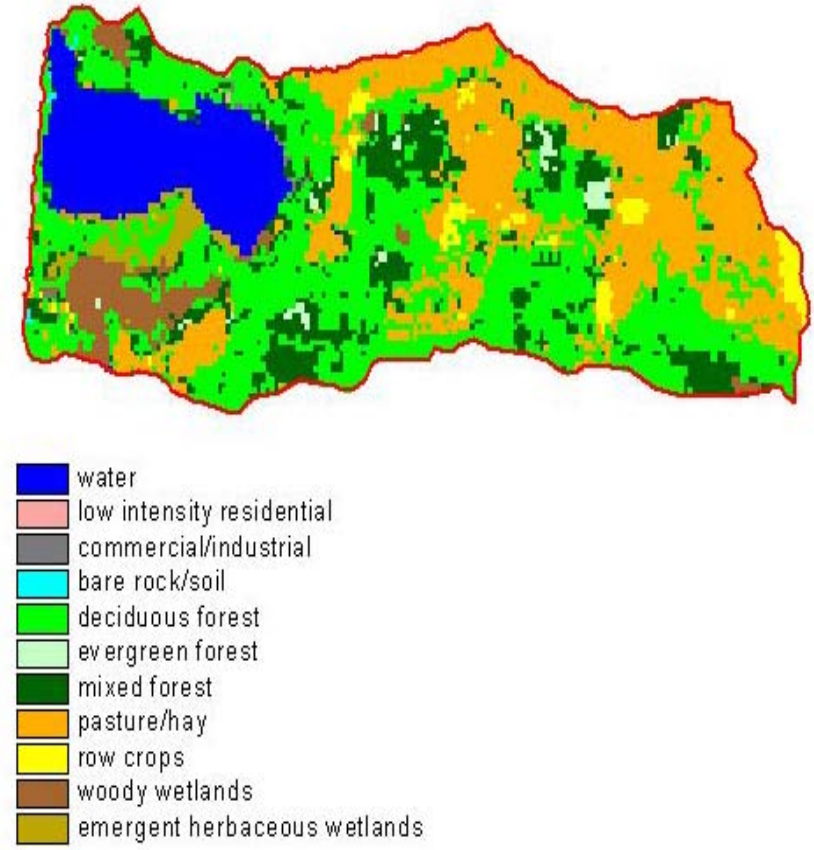
Little Sodus Bay

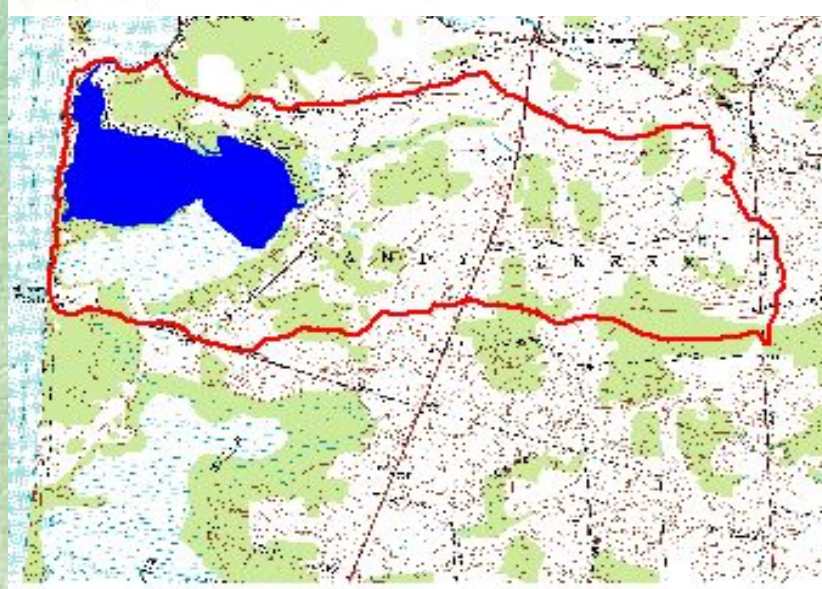
- Water Retention Time: 394 days
- Mean Daily Discharge: 0.154 m^3/sec
- Hydraulic Mixing:
  - Volume from inlet: 3.8 %
  - Volume from Lake Ontario: 96.2 %
- Stream network: there are no perennial streams.
- Connection to Lake Ontario: Opened

BAIN- Electrofishing
BAIN- Gill netting
BAIN- Invertebrates
HAIRSTON - Plankton/Zooplankton
JOHNSON - Macrophytes
LEOPOLD - Wetlands
LEOPOLD - Wetland survey point

South Sandy Pond

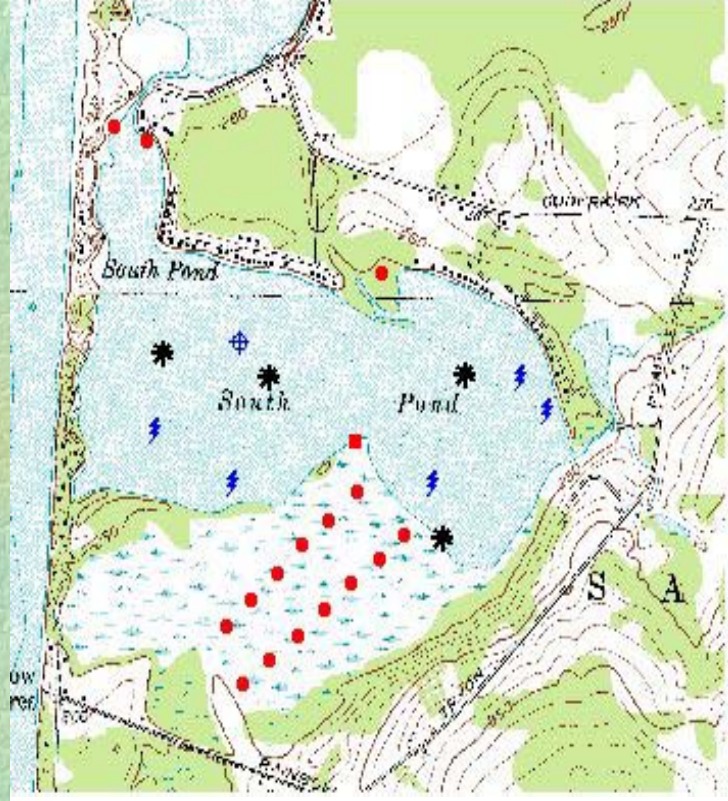
- Watershed area: 8.26 Km^2
- Area of bay: 1.23 Km^2
- Land Coverage
  - Agriculture: 29.5 %
  - Wetland: 6.4 %
  - Forest: 51.5 %
  - % Open Water: 12.1 %
  - Urban activities: 0.3 %
- Deepest point: 6.4 m





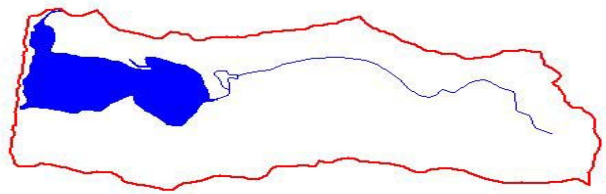
South Sandy Pond

- Water Retention Time: 105 days
- Mean Daily Discharge: 0.194 m^3/sec
- Hydraulic Mixing:
  - Volume from inlet: 96 %
  - Volume from direct atmospheric deposition: 4 %
- Stream network: Total stream length: 454 Km
- Connection to Lake Ontario: Closed, but opened to North Sandy Pond

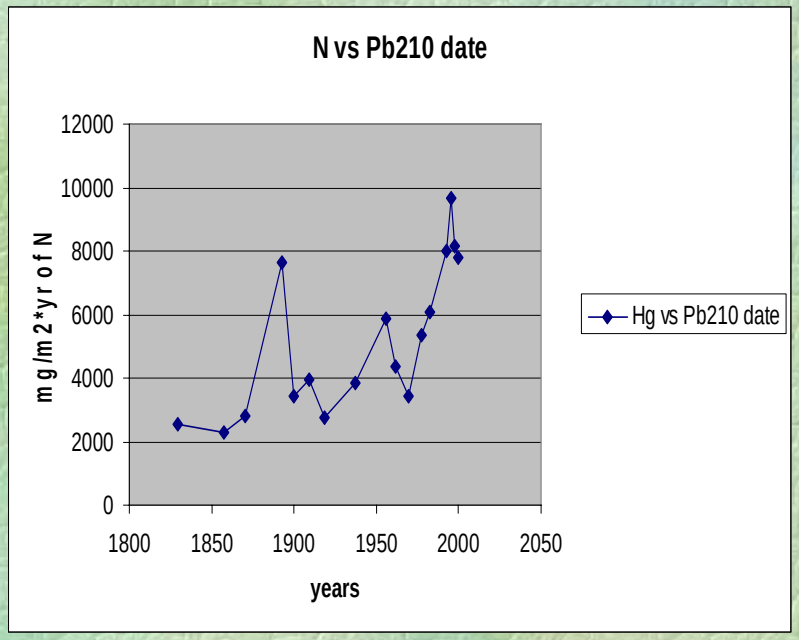


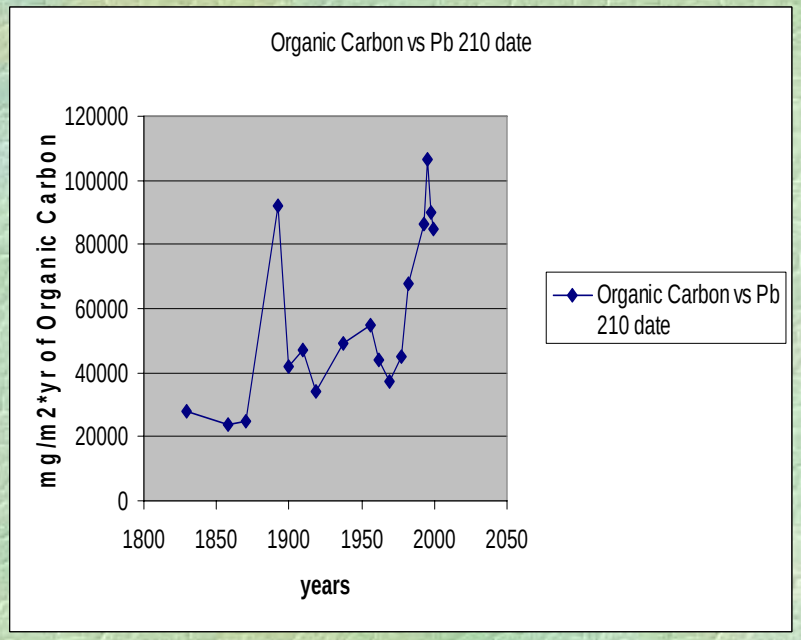
BAIN- Electrofishing
BAIN- Gill netting
BAIN- Invertebrates
HAIRSTON - Plankton/Zooplankton
JOHNSON - Macrophytes
LEOPOLD - Wetlands
LEOPOLD - Wetland survey point

SOUTH POND STREAM NETWORK

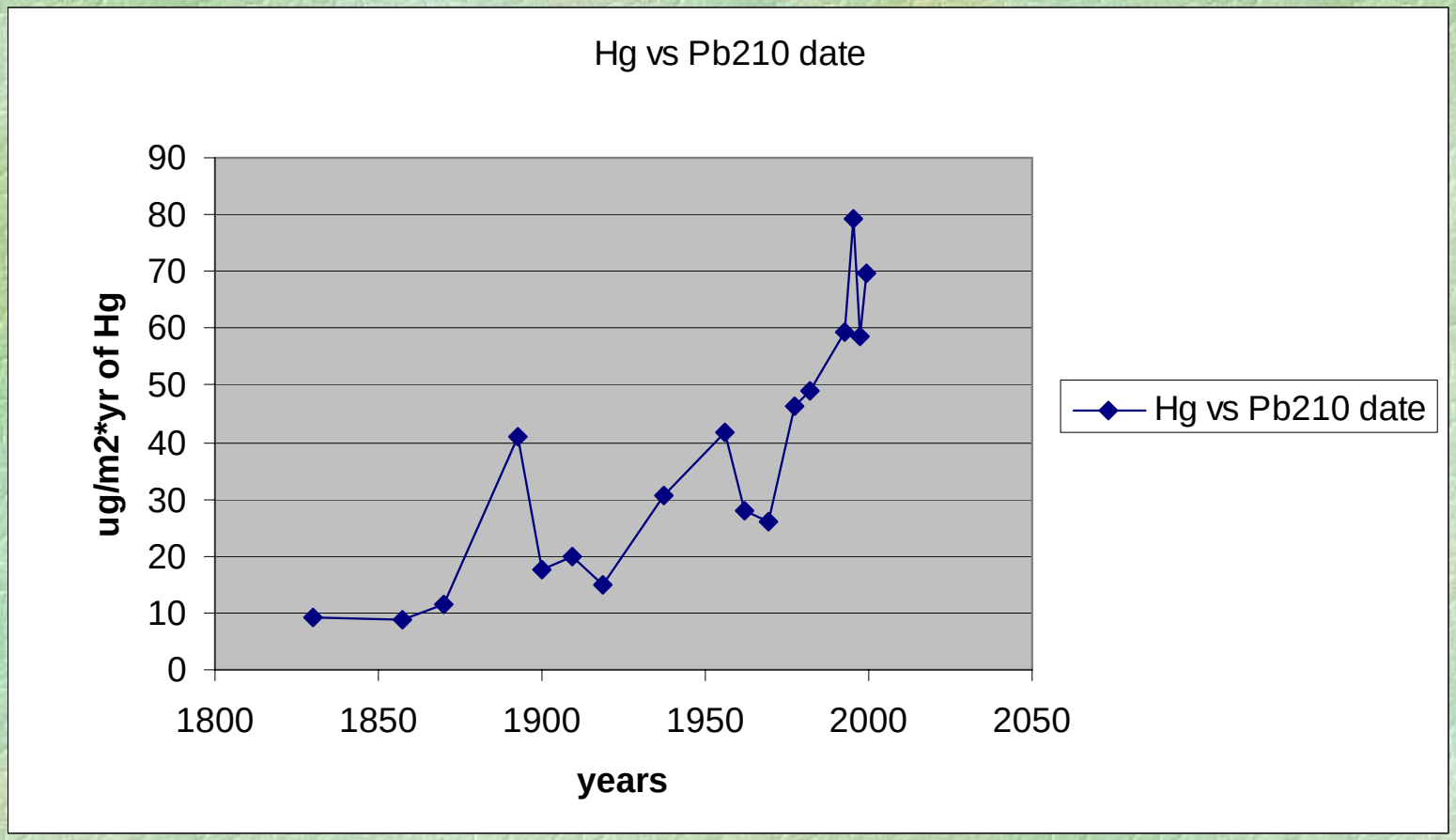


Juniper Pond Results

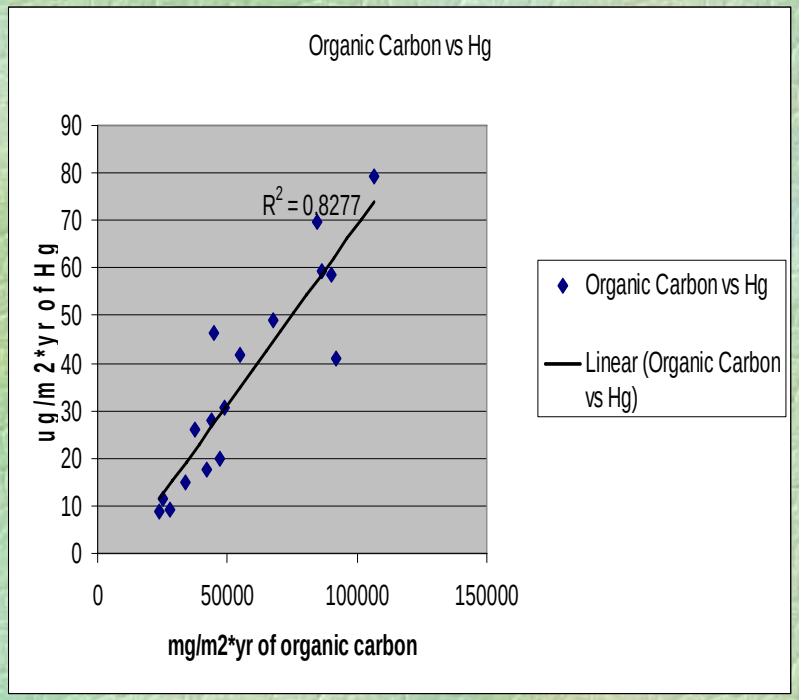


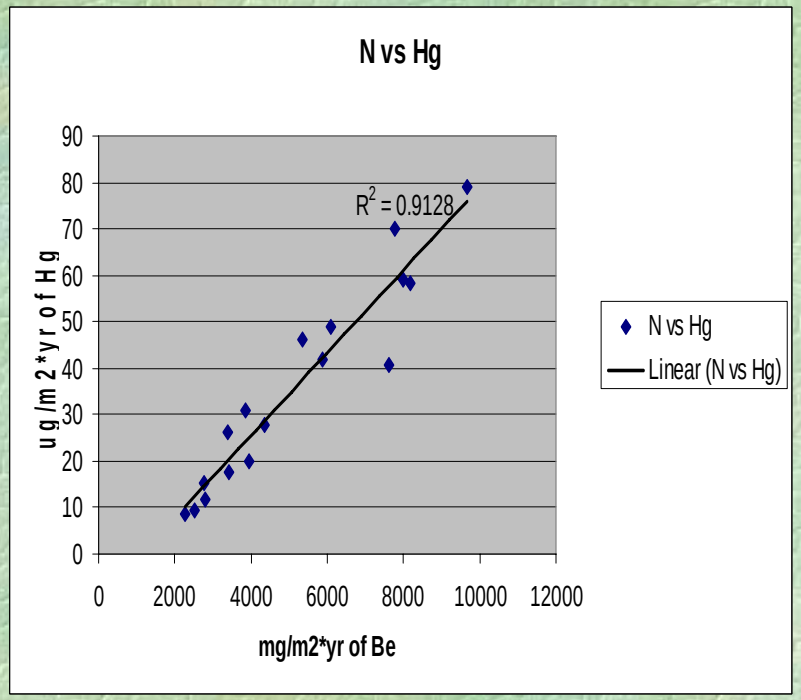


Juniper Pond Results

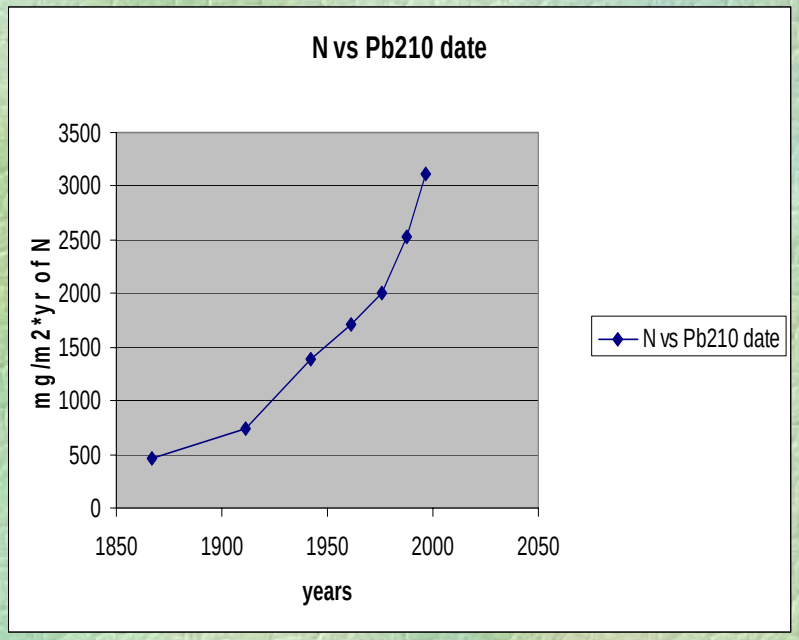


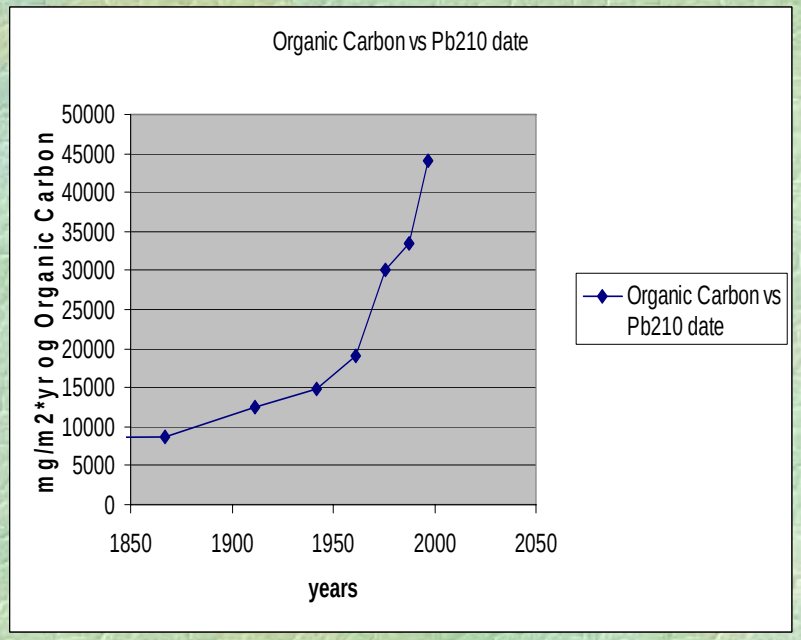
Juniper Pond Results



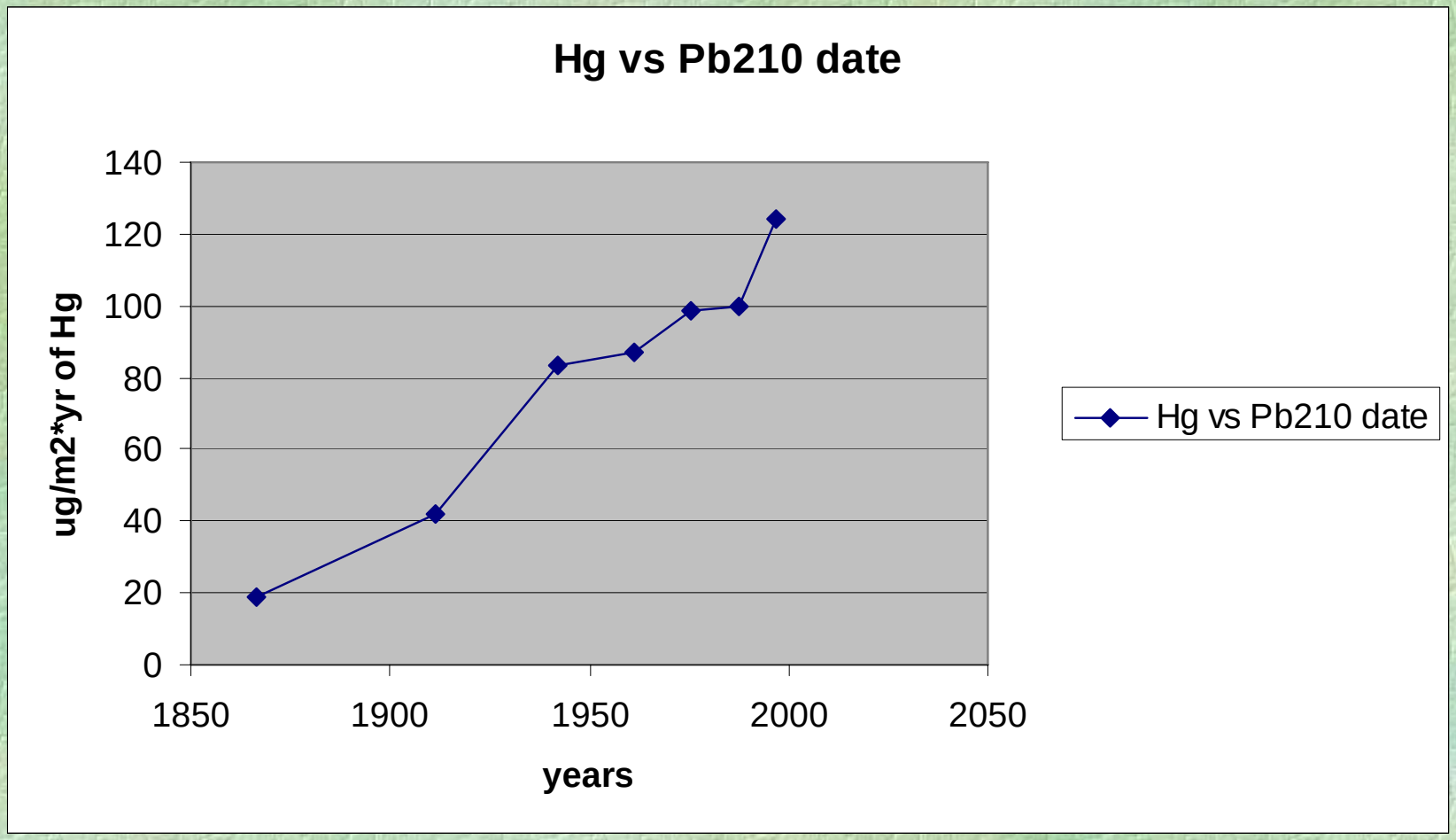


Little Sodus Bay Results





Little Sodus Bay Results



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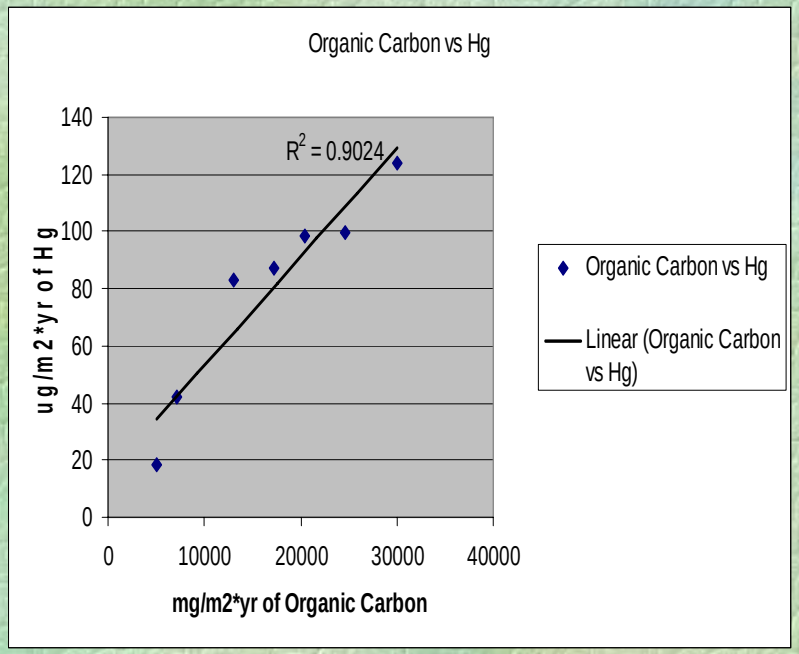
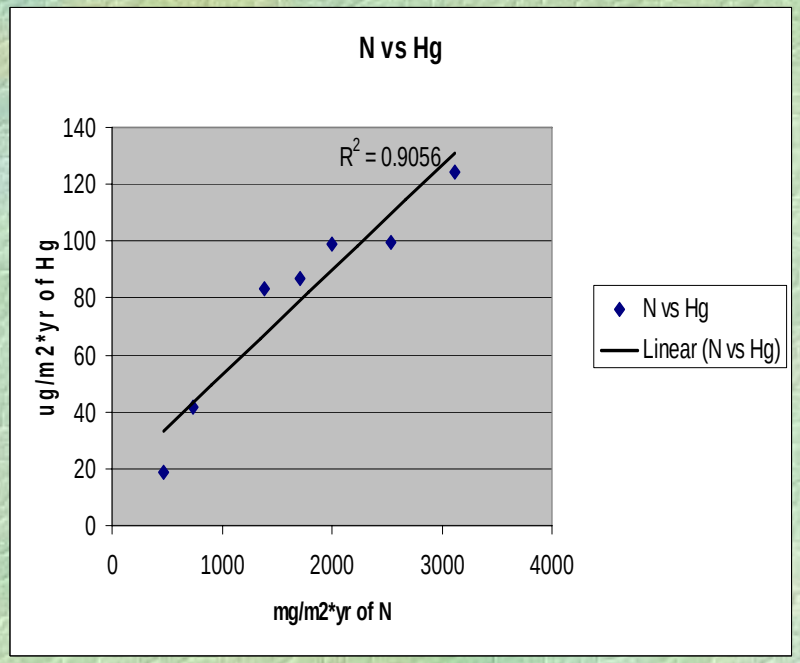
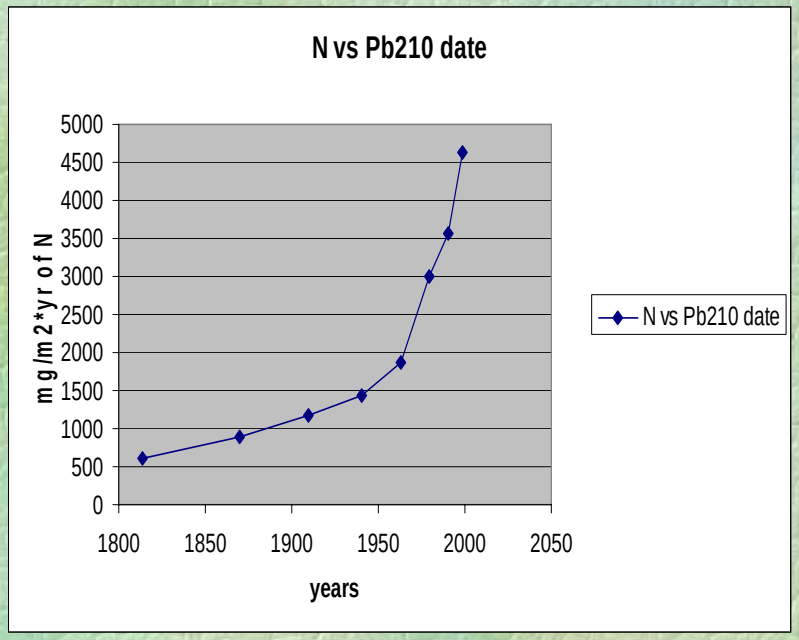
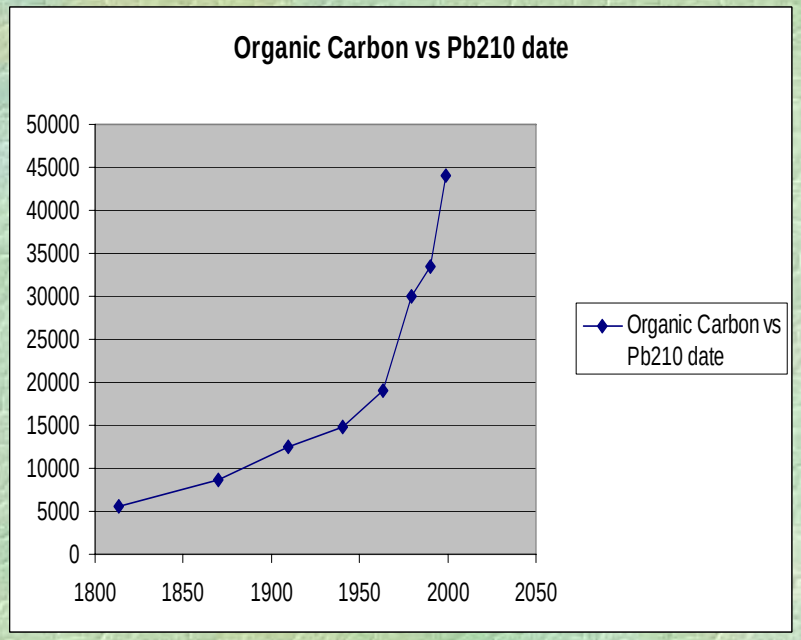




South Sandy Pond Results





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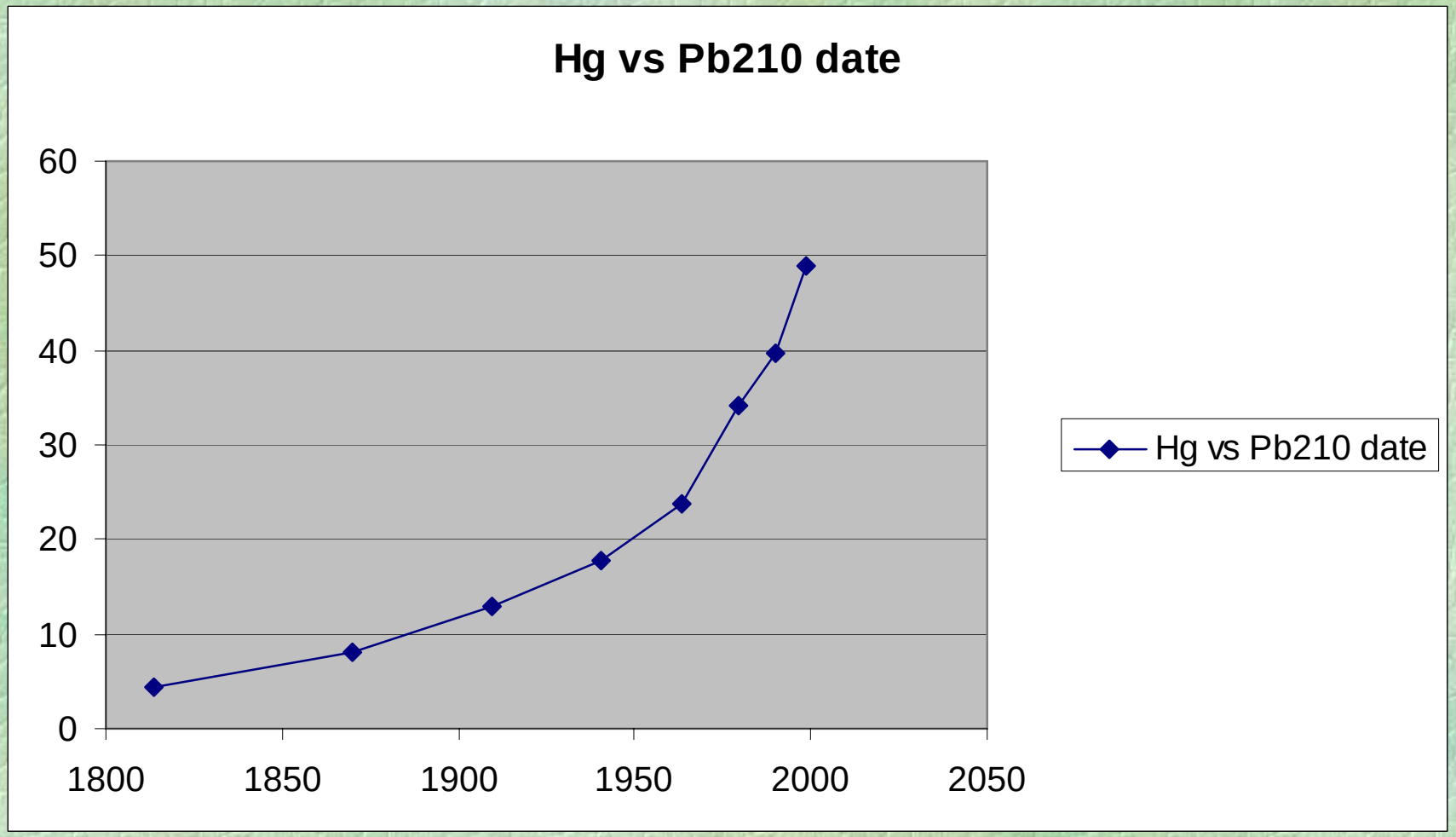
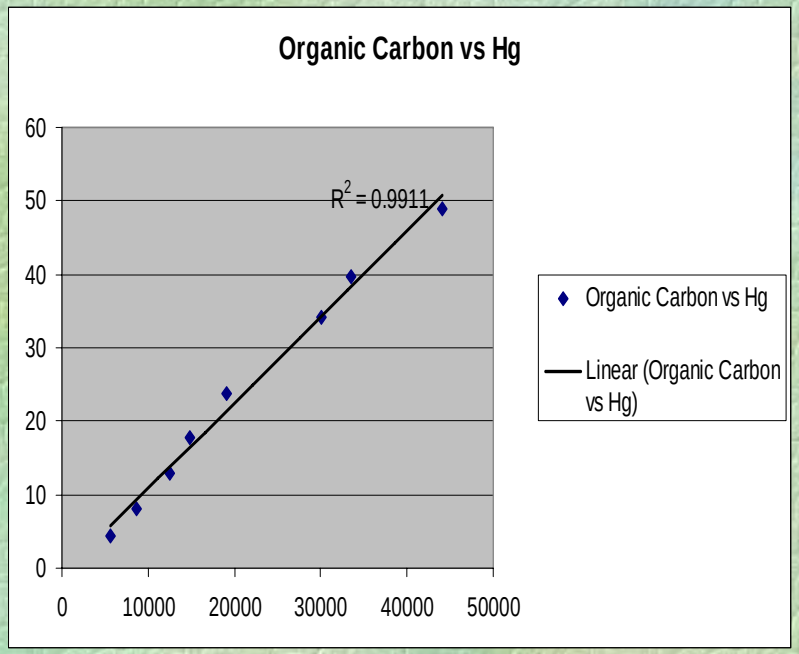
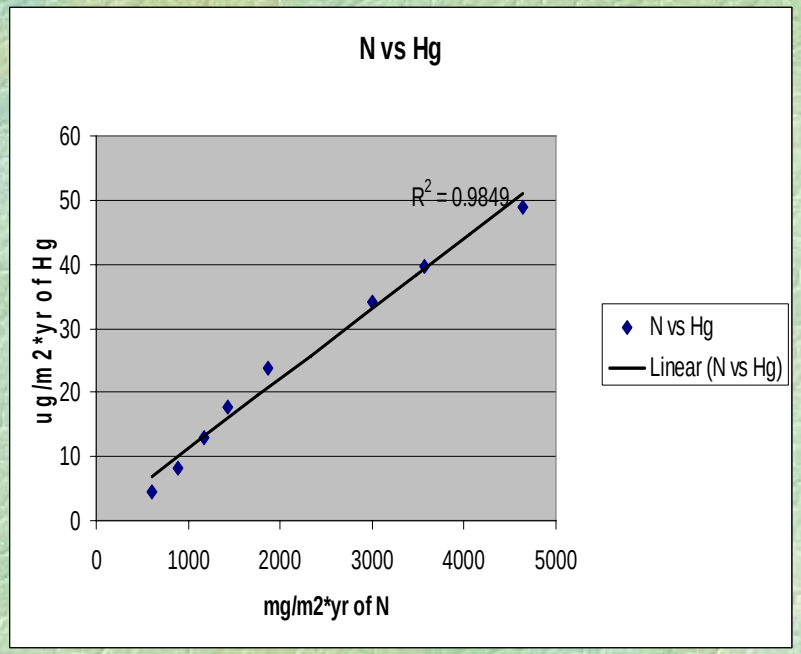
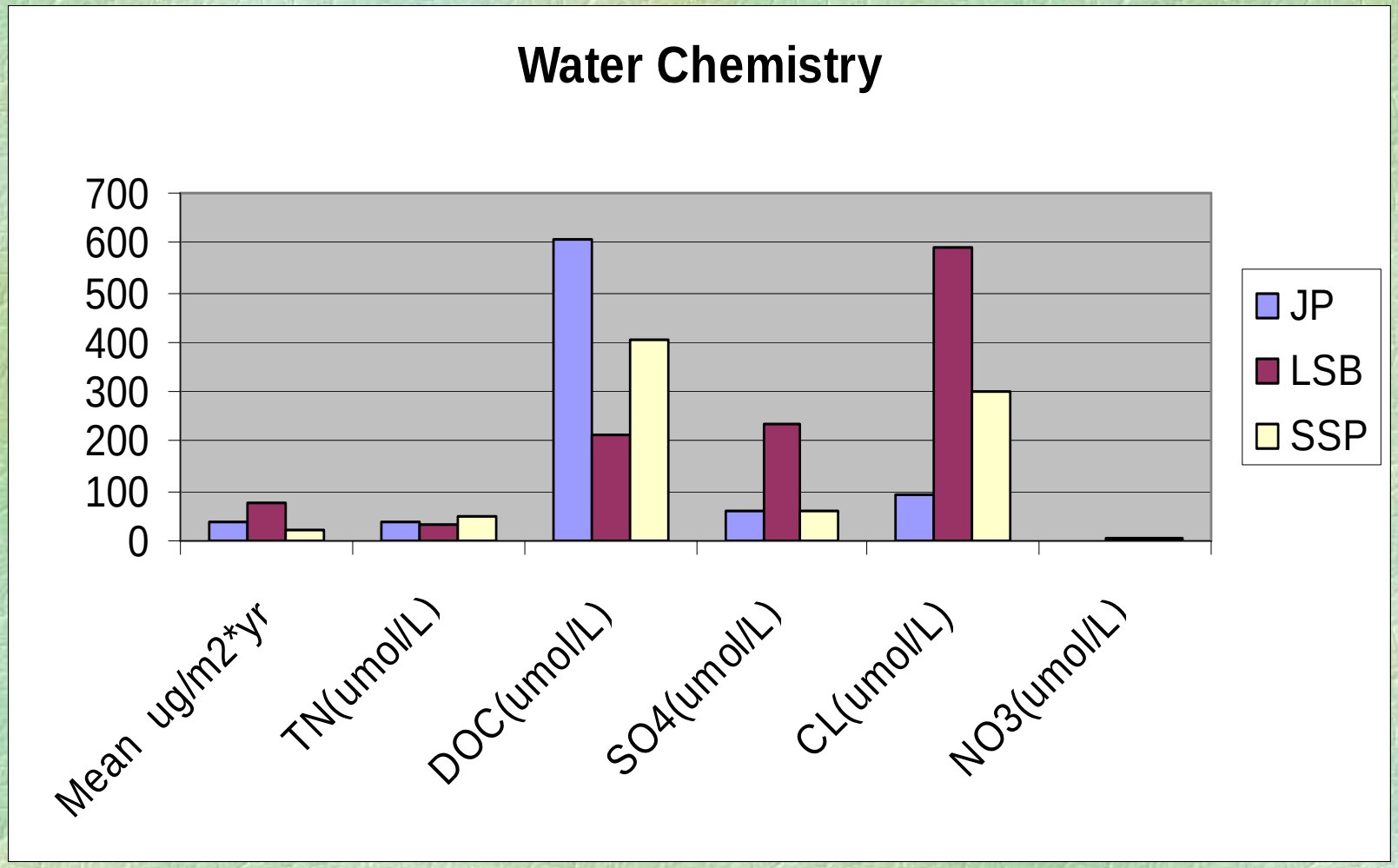
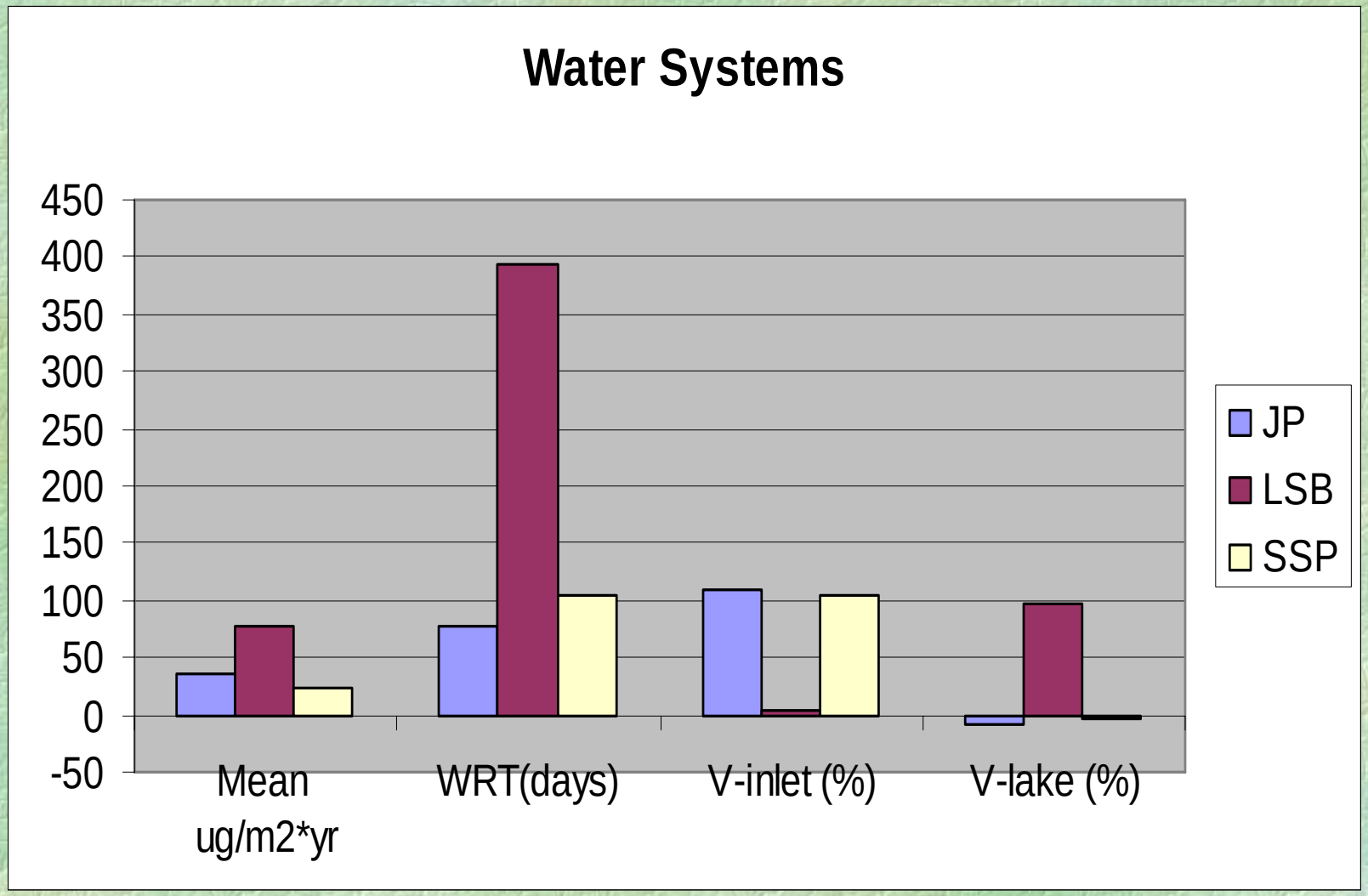


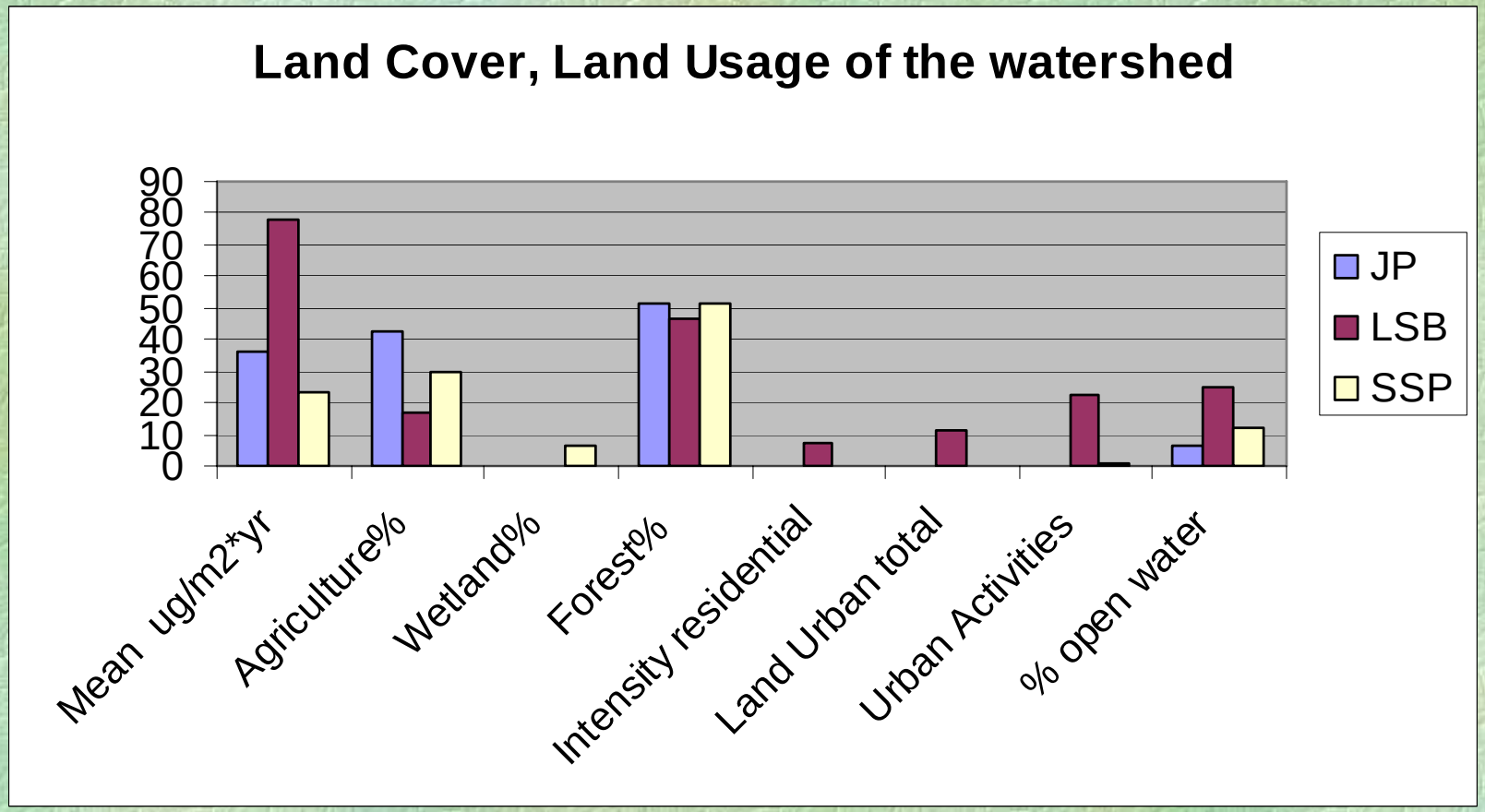
South Sandy Pond Results






Water Chemistry
700
600
500
400
300
200
100
0
Mean ug/m2*yr
TN(umol/L)
DOC(umol/L)
SO4(umol/L)
CL(umol/L)
NO3(umol/L)
JP
LSB
SSP


Water Systems
450
400
350
300
250
200
150
100
50
0
-50
Mean ug/m2*yr
WRT(days)
V-inlet (%)
V-lake (%)
JP
LSB
SSP


Land Cover, Land Usage of the watershed
90
80
70
60
50
40
30
20
10
0
Mean ug/m2*yr
Agriculture%
Wetland%
Forest%
Intensity residential
Land Urban total
Urban Activities
% open water
JP
LSB
SSP

Conclusion

Juniper Pond:

- Average deposition of Hg from 1826-present of 36 ug/m2*yr with a continue increase of rate of deposition
- Temporarily event that breached or connected to Ontario lake before 1890 and 1950
- A good correlation between Hg-Nutrients
- Water Chemistry:
  - High DIC, and DOC
  - Low Cl and S04
- Short Water Retention Time
- Mostly covered by agriculture and forest, and a very small coverage of urban activities.

Conclusion

Little Sodus Bay:

- Average deposition of Hg from 1826-present of 78 ug/m2*yr with a continue increase of rate of deposition sediments
- A good correlation between Hg-nutrients
- Water Chemistry:
  - High DIC, S04 and Cl
  - Low T-N and DOC
- Long Water Retention Time
- High urban activities, forest and % open water

Conclusion

South Sandy Pond:

- Average deposition of Hg from 1826-present of 23 ug/m2*yr with a continue increase of rate of deposition Great difference between upper sediments and lower sediments
- An excellent correlations between Hg-nutrients.
- Water Chemistry:
  - Low DIC, and S04
  - Medium values DOC and Cl
- Short Water Retention Time
- Mostly covered by agriculture and forest, **a large watershed**, and a very small coverage of urban activities with a perennial stream

Conclusion

- Spatial and temporal increase in C and N content in sediments
- Mercury content increases in recent sediments reflecting increased atmospheric deposition
  - High values in Little Sodus Bay reflect anthropogenic activities
  - Medium values of Juniper Pond reflect atmospheric deposition with the occasional addition of water from Ontario Lake
  - Low values in South Sandy Pond reflect the effect of the wetland and the stream inlet

Questions