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

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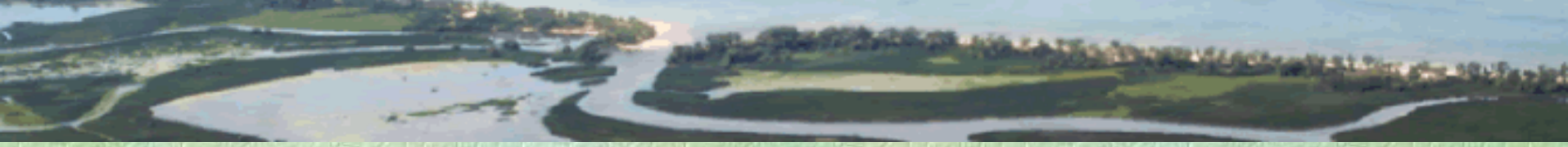
Outline

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



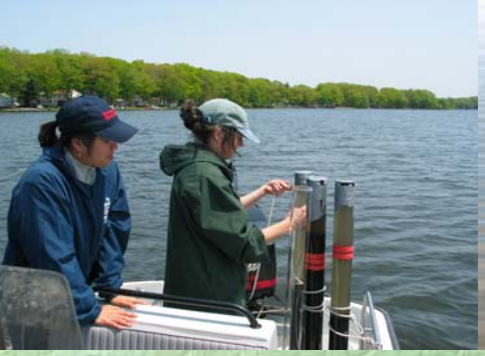
Objectives

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

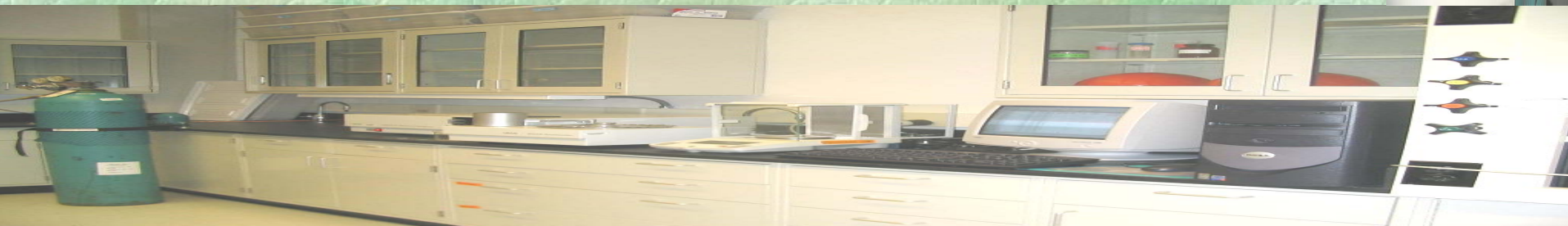
-Land-use

-Connectiveness to Lake Ontario

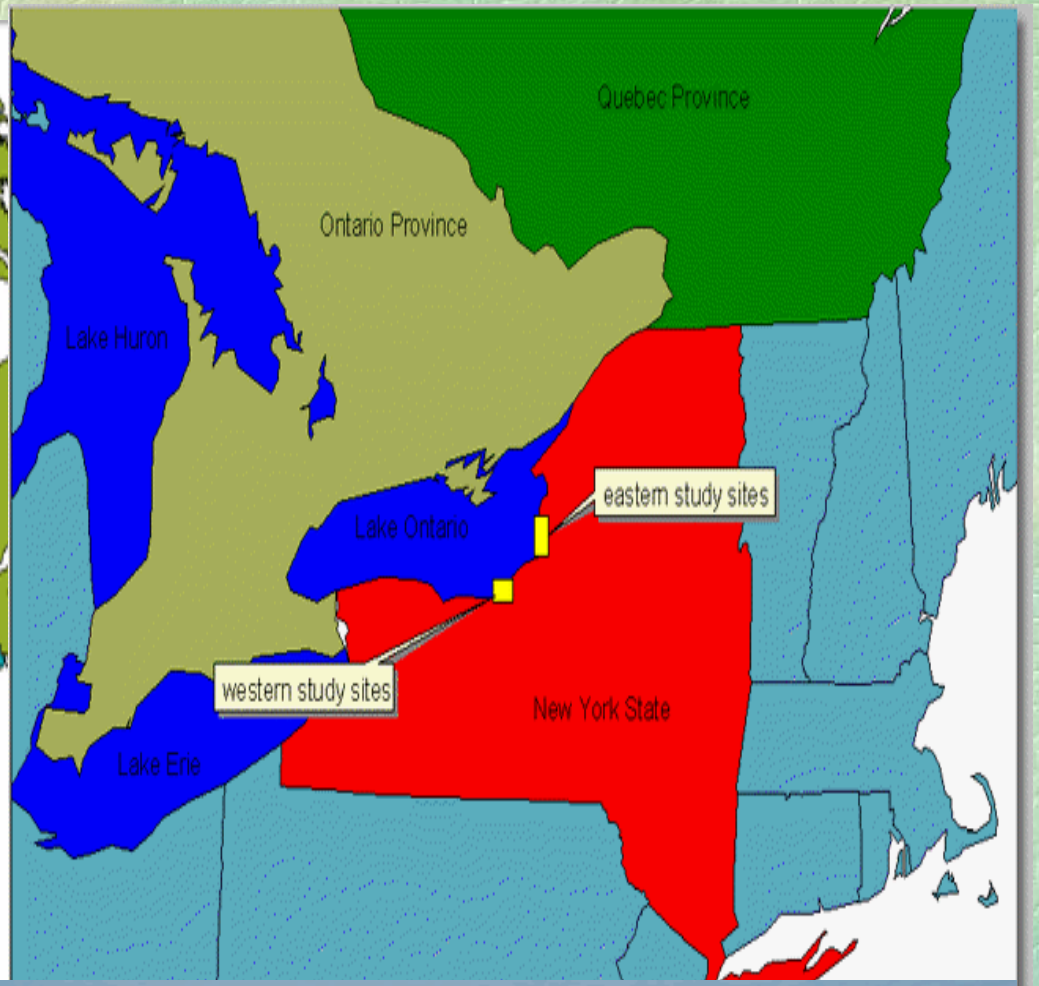


Approach

- 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 and T-N
- Others scheduled analysis: Al, As, B, Be, Cl, Cu, Fe, K, Mn, P, Pb,S, Zn, and Hg Isotopes



Study Site Location



Lake Ontario Biocomplexity Project

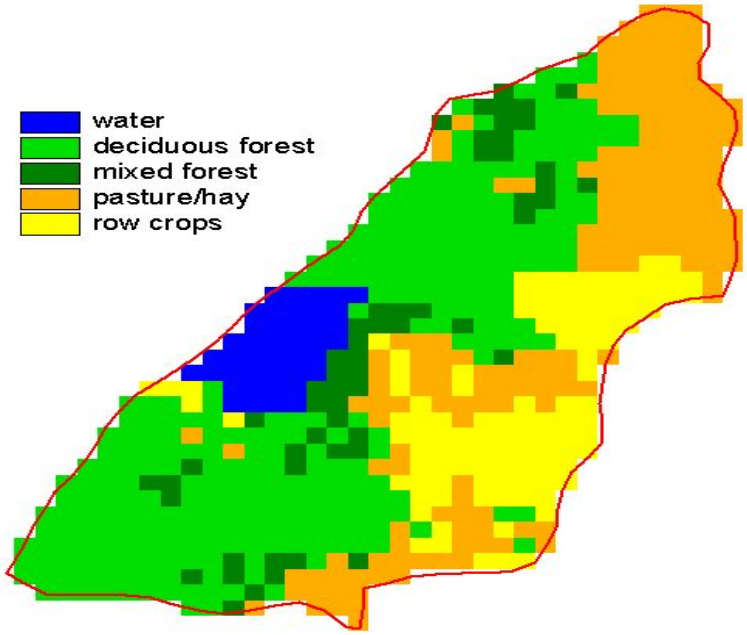
Study Site Location

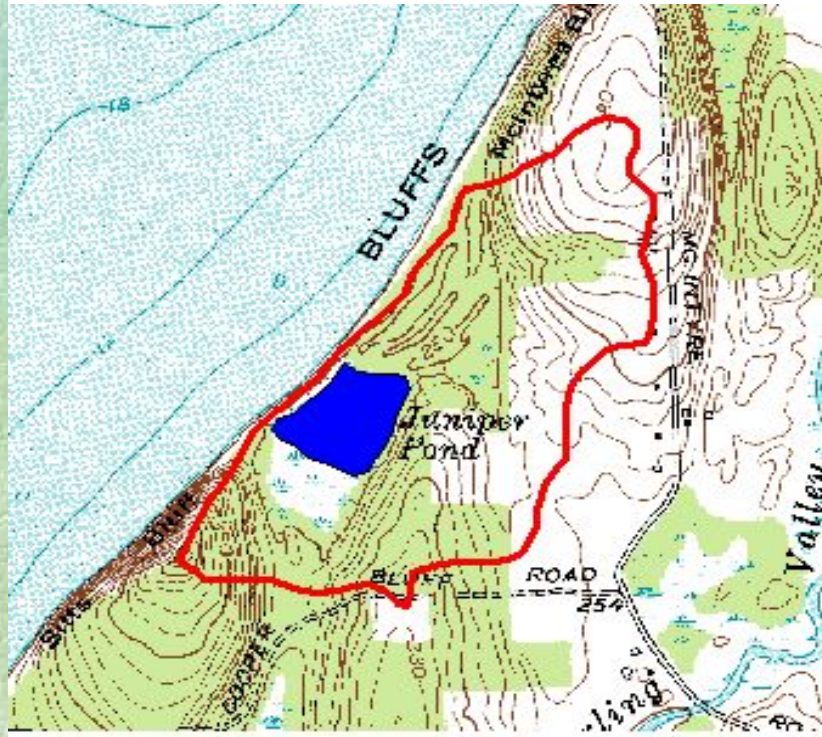
There are three embayments in the study:

- 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

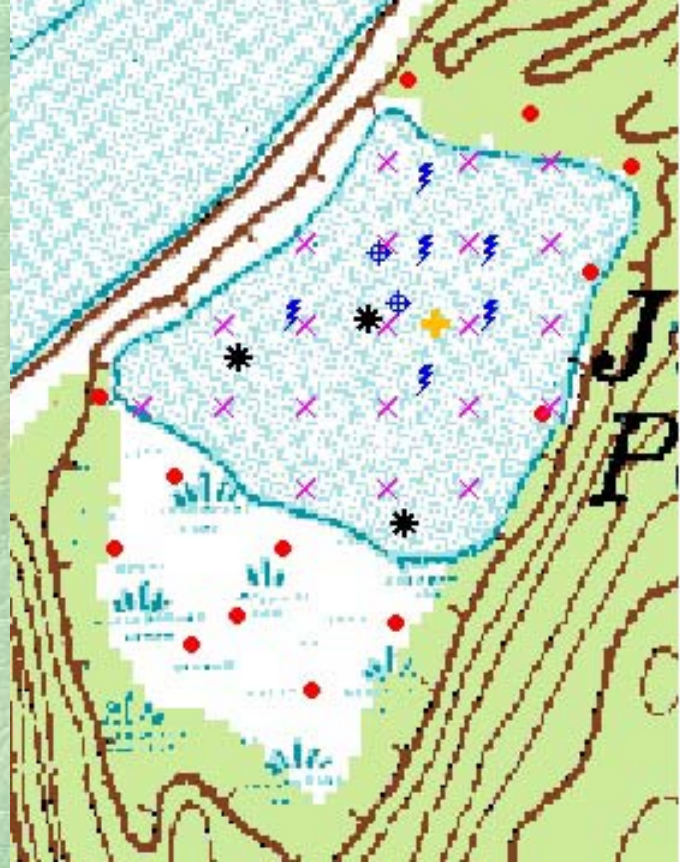
- Watershed area: 0.602 Km^2
- Area of bay: 0.0505 Km^2
- Land Coverage
  - Agriculture: 42.7 %
  - Wetland: 0 %
  - Forest: 51.2 %
  - % Open Water: 6.0 %
  - Urban activities: 0.04 %
- Deepest point: 2.74 m





Juniper Pond

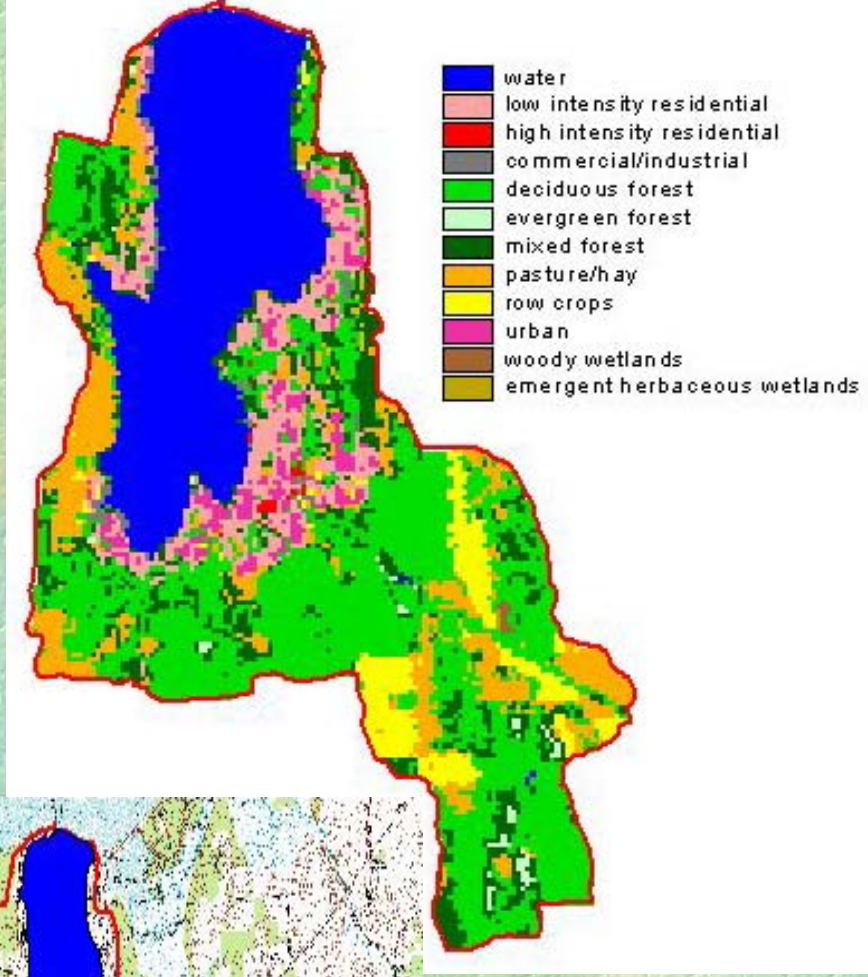
- Water Retention Time: 77.7 days
- Mean Daily Discharge: 0.01 m^3/sec
- Hydraulic Mixing:
  - Volume from drainage: 92 %
  - Volume from direct atmospheric deposition: 8.0 %
- Stream network: there are no perennial streams.
- Connection to Lake Ontario: Closed

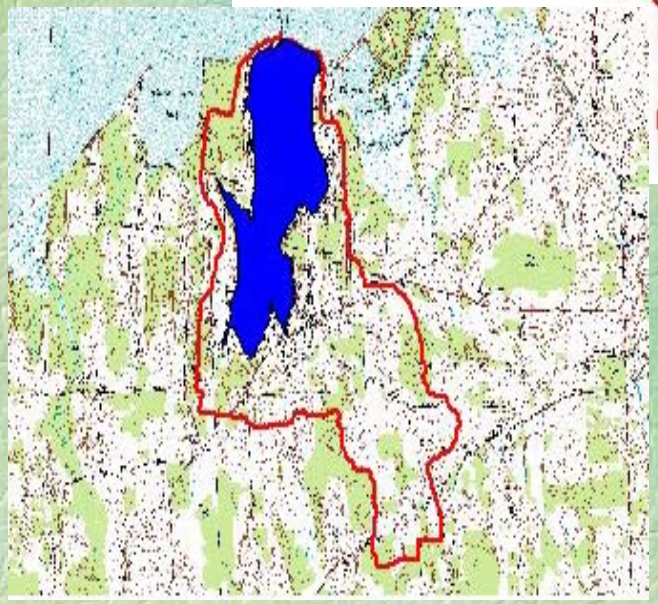


BAIN- Electrofishing
BAIN- Gill netting
BAIN- Invertebrates
HAIRSTON - Plankton/Zooplankton
JOHNSON - Macrophytes
LEOPOLD - Wetlands
LEOPOLD - Wetland survey point

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





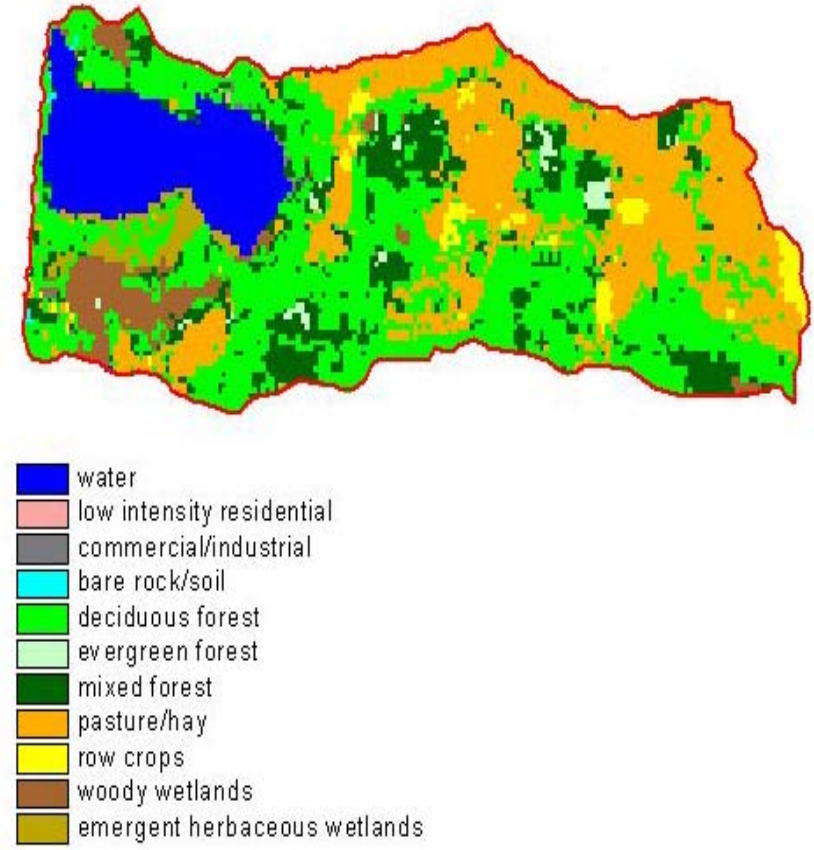
Little Sodus Bay

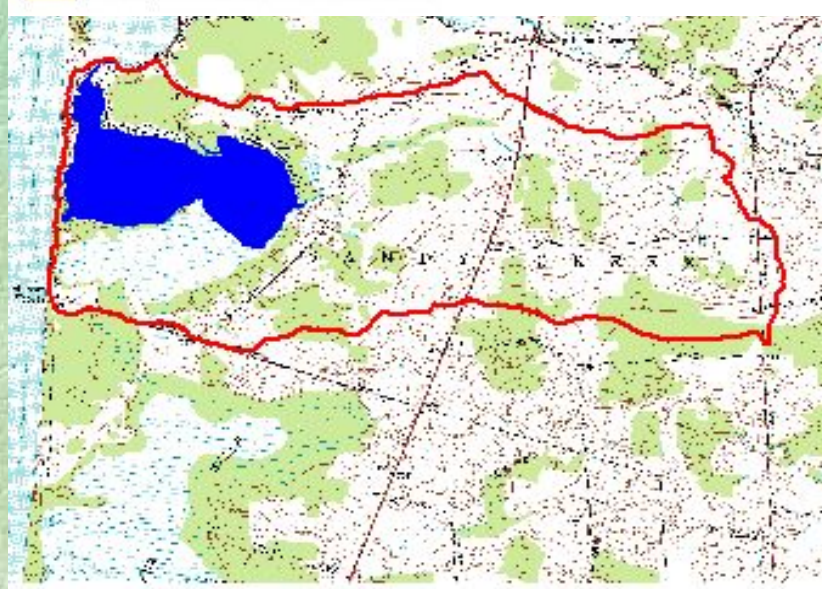
- Water Retention Time: 394 days
- Mean Daily Discharge: 0.154 m^3/sec
- Hydraulic Mixing:
  - Volume from inlet: 3.8 %
  - Volume from Lake Ontario: 96.2 %
- Stream network: there are no perennial streams.
- Connection to Lake Ontario: Opened

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

South Sandy Pond

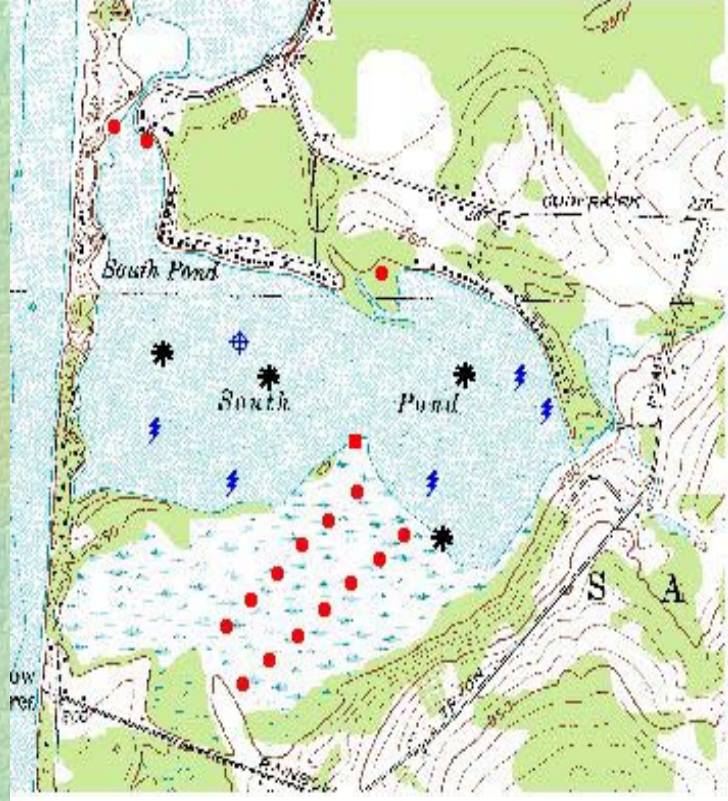
- Watershed area: 8.26 Km^2
- Area of bay: 1.23 Km^2
- Land Coverage
  - Agriculture: 29.5 %
  - Wetland: 6.4 %
  - Forest: 51.5 %
  - % Open Water: 12.1 %
  - Urban activities: 0.3 %
- Deepest point: 6.4 m





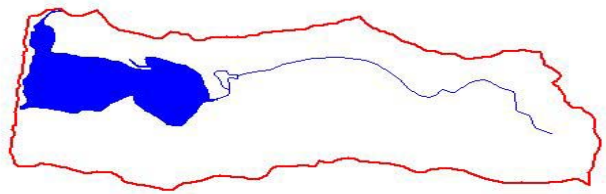
South Sandy Pond

- 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

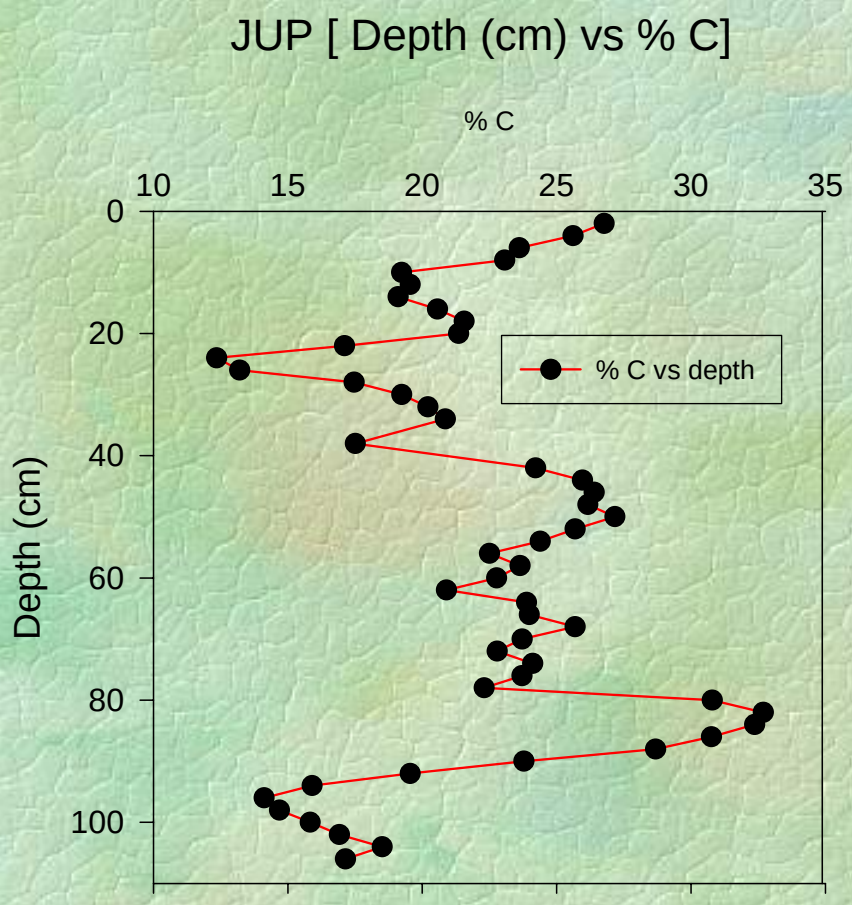


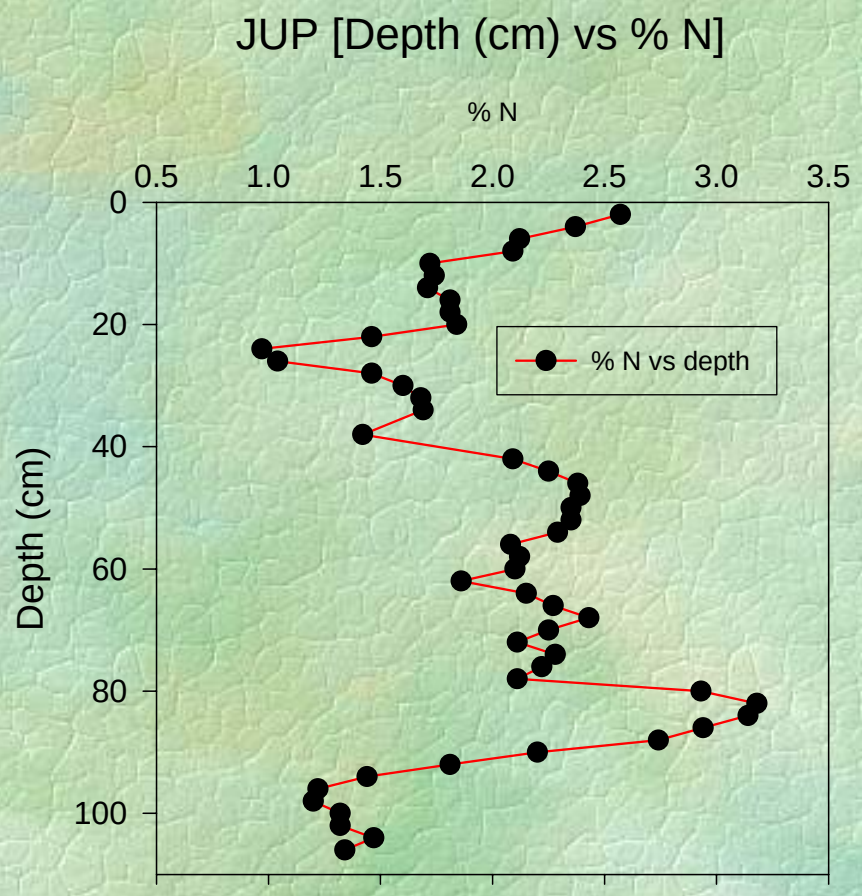
BAIN- Electrofishing
BAIN- Gill netting
BAIN- Invertebrates
HAIRSTON - Plankton/Zooplankton
JOHNSON - Macrophytes
LEOPOLD - Wetlands
LEOPOLD - Wetland survey point

SOUTH POND STREAM NETWORK

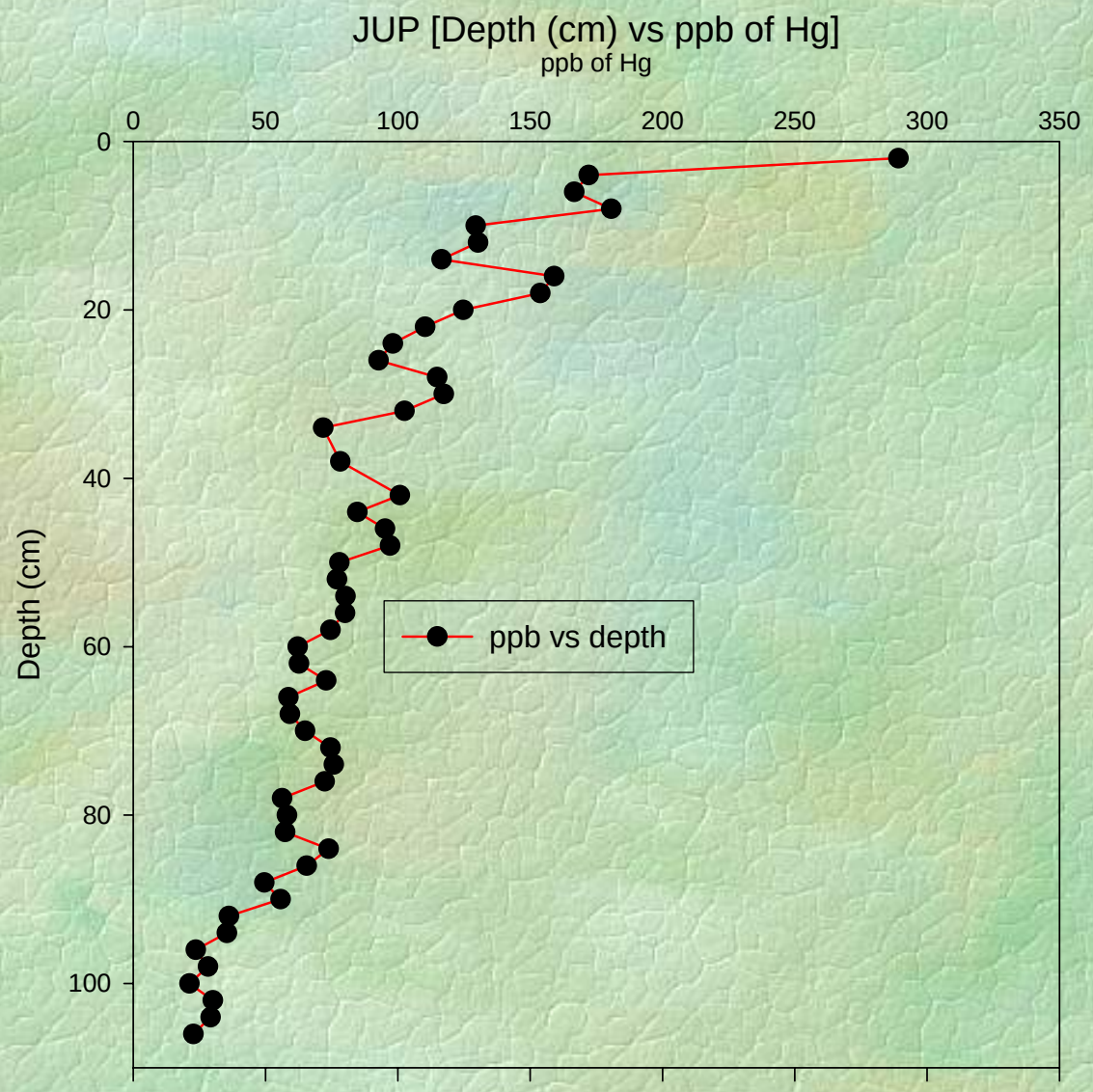


Juniper Pond Results

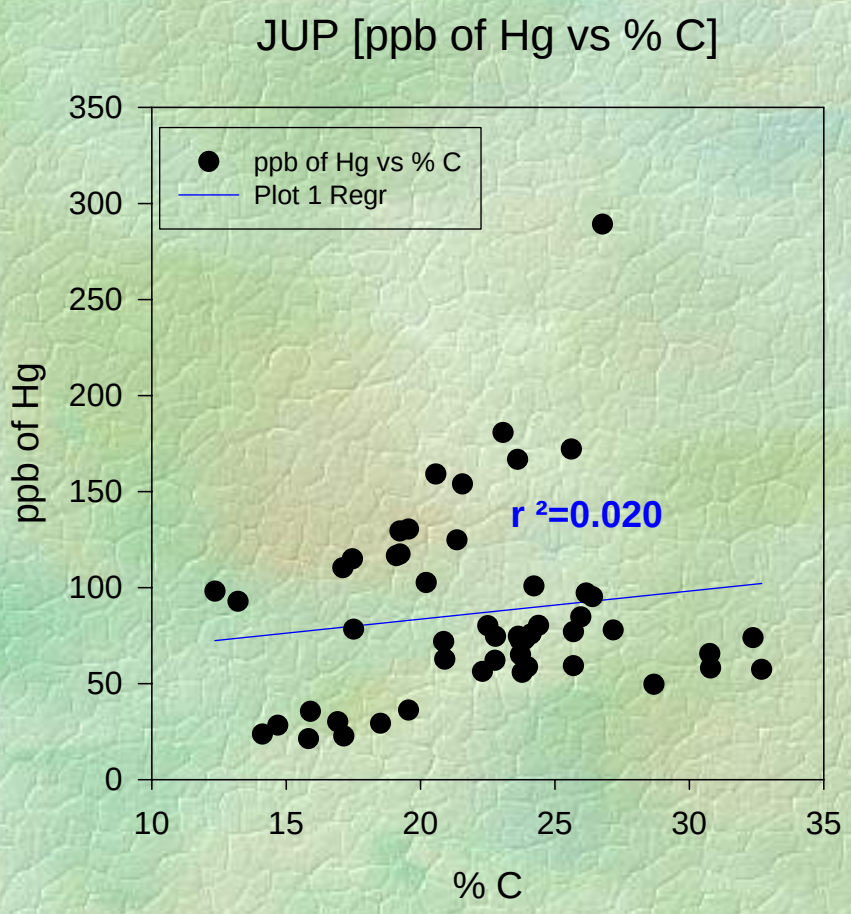


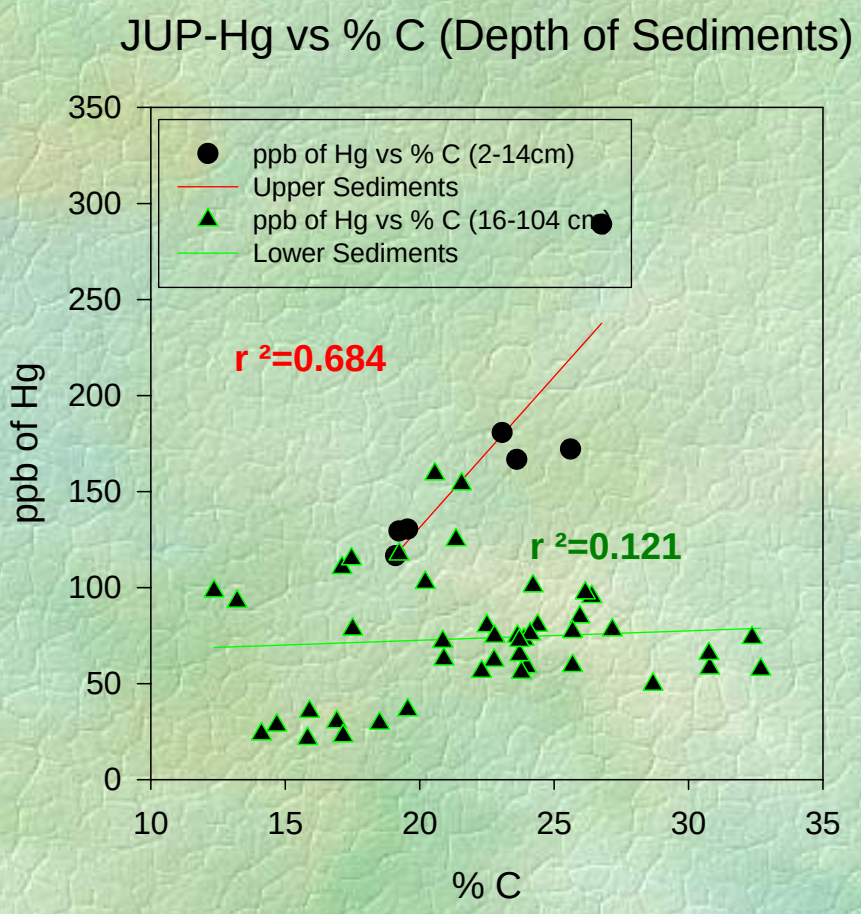


Juniper Pond Results

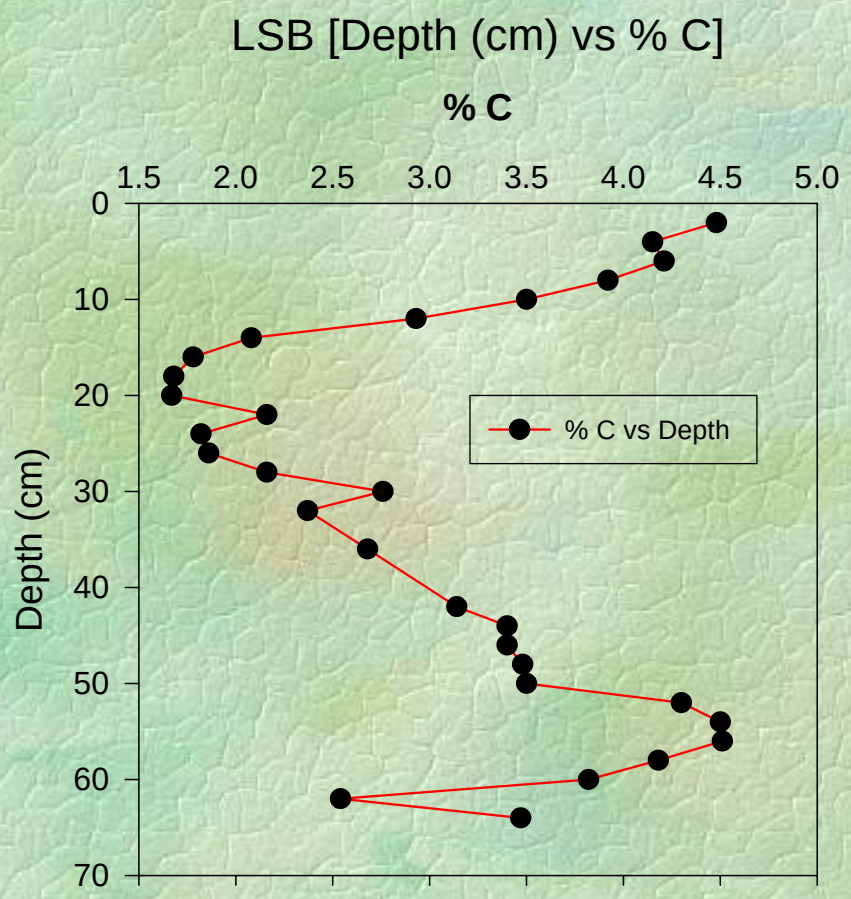


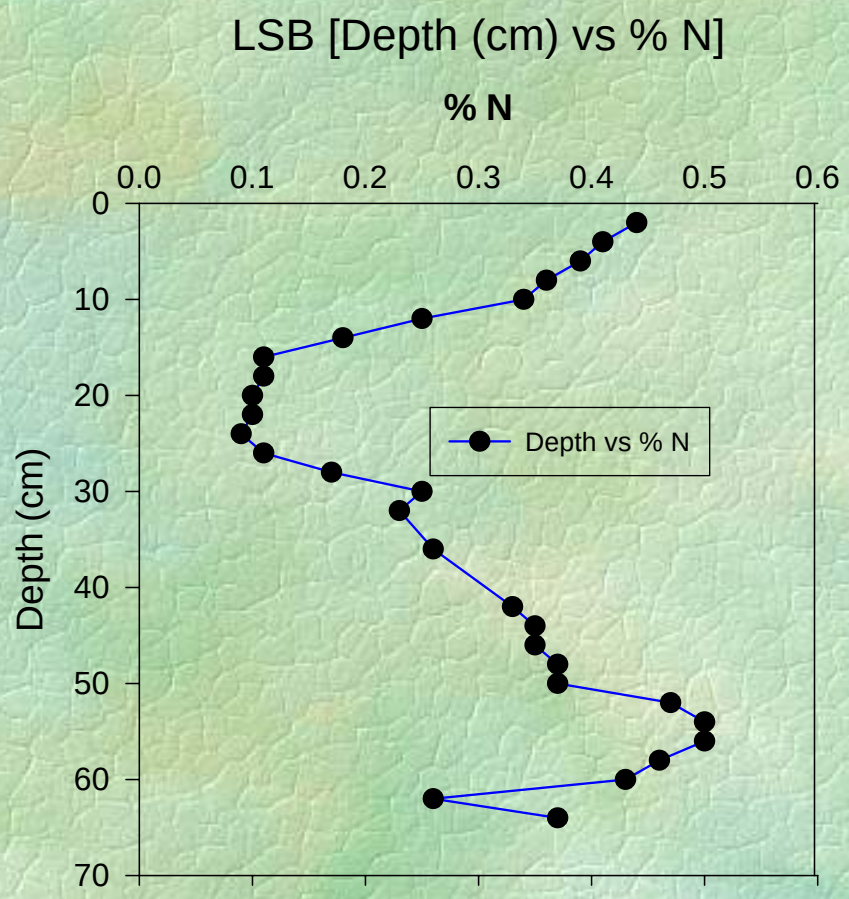
Juniper Pond Results



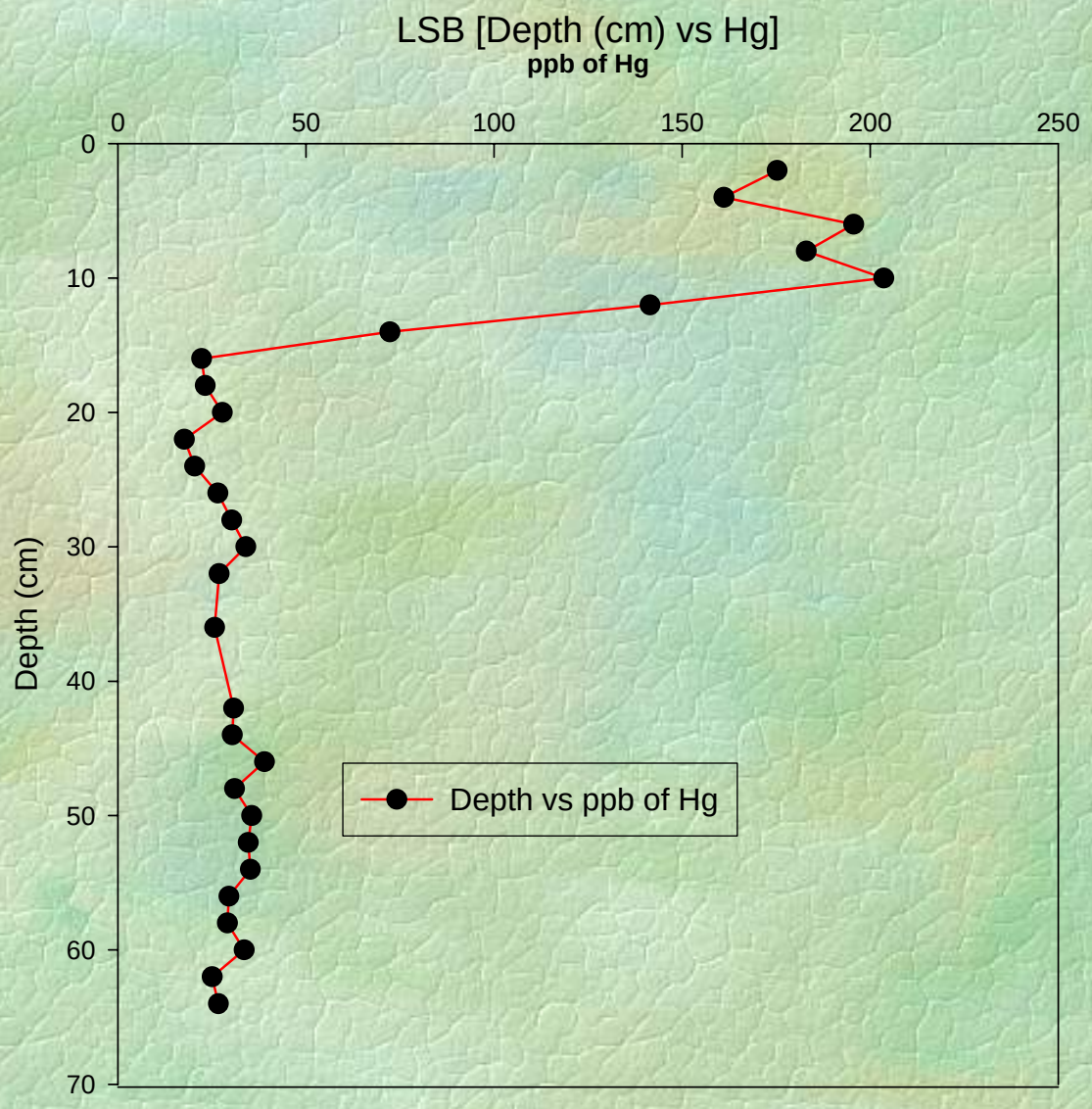


Little Sodus Bay Results





Little Sodus Bay Results



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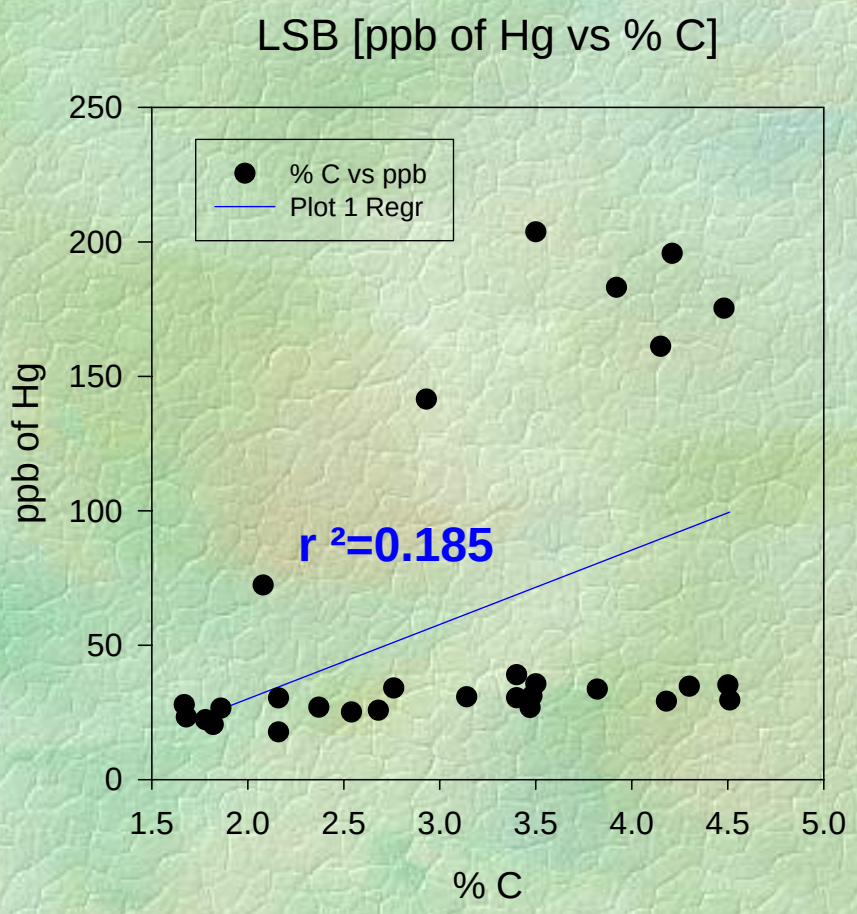
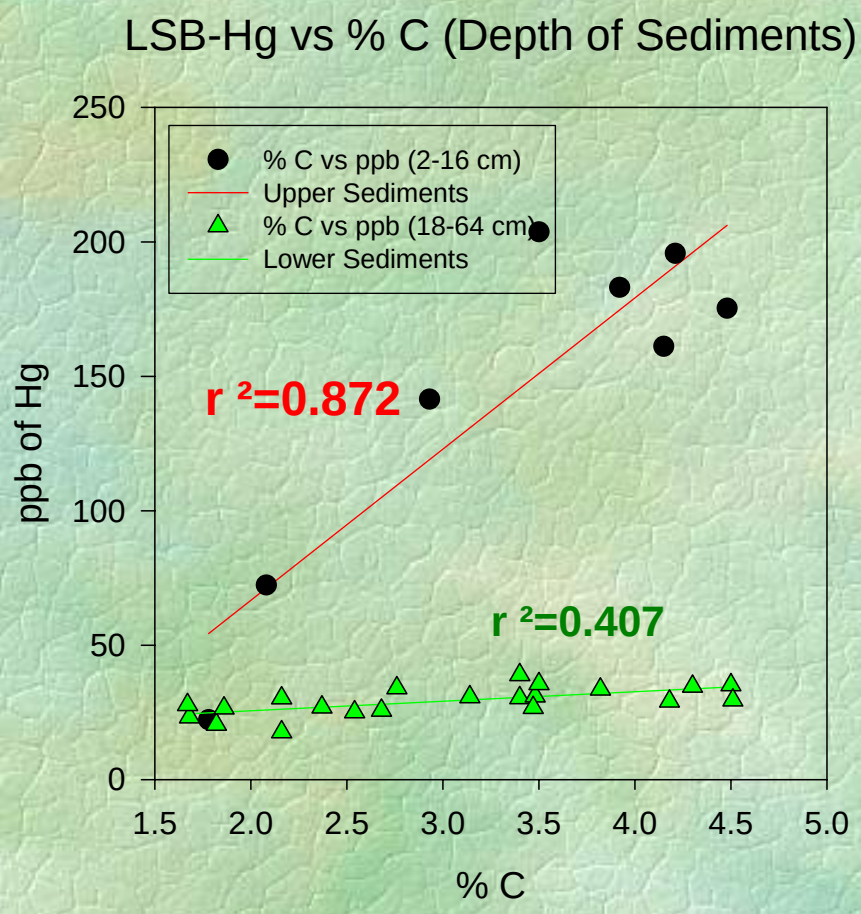
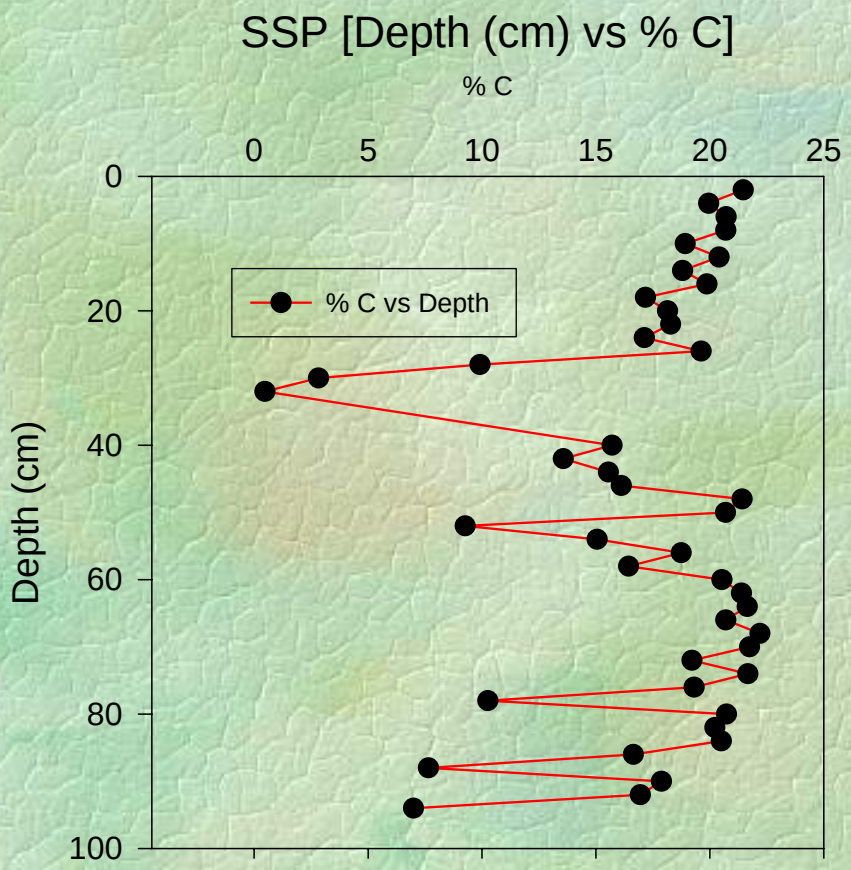
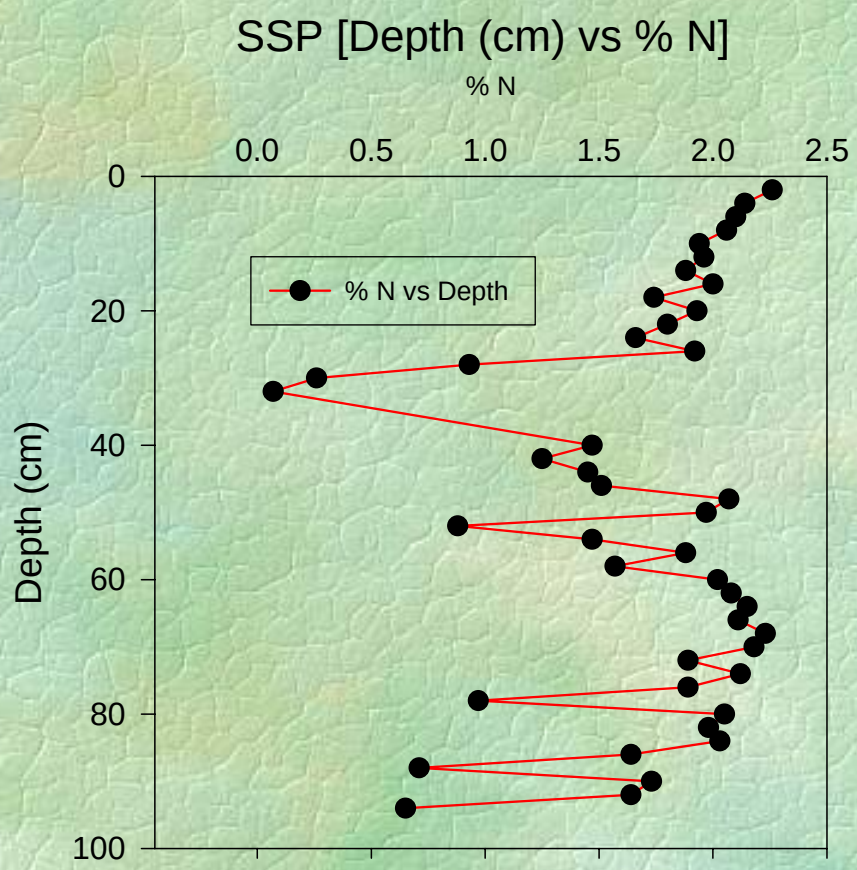




South Sandy Pond Results





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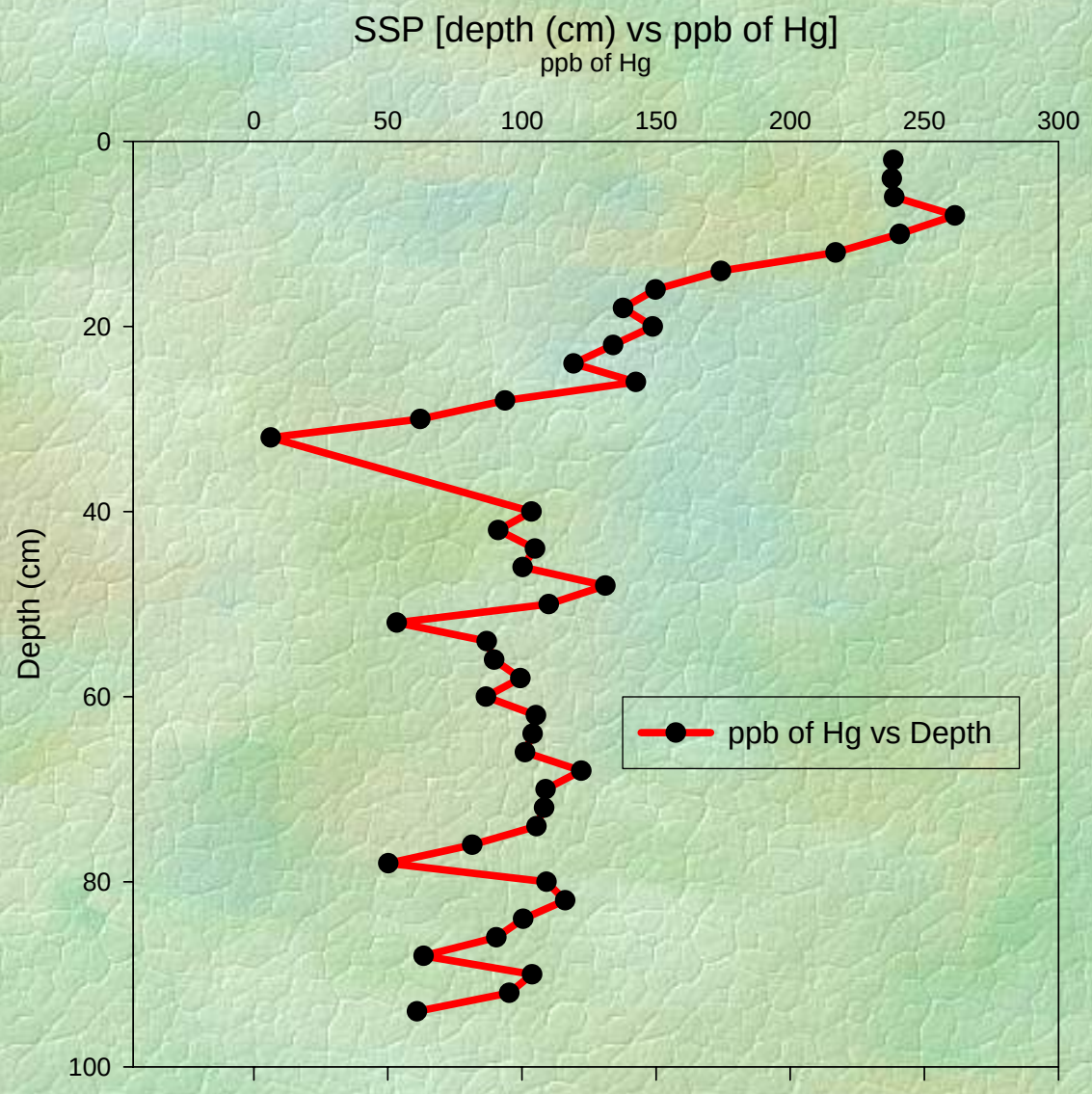
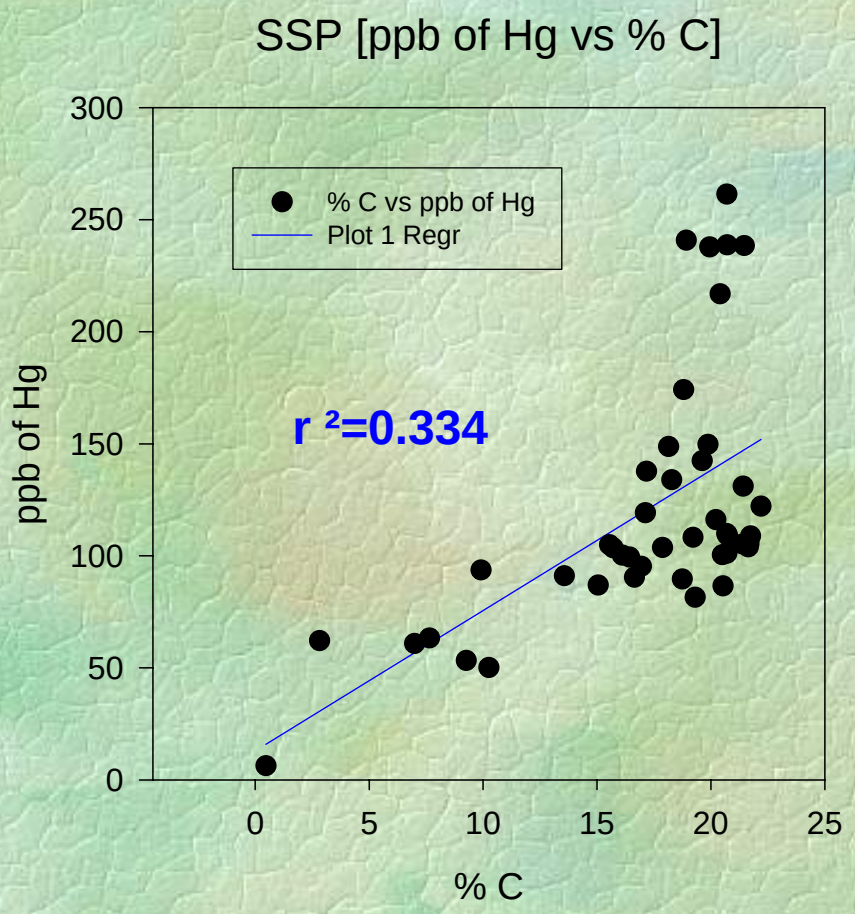
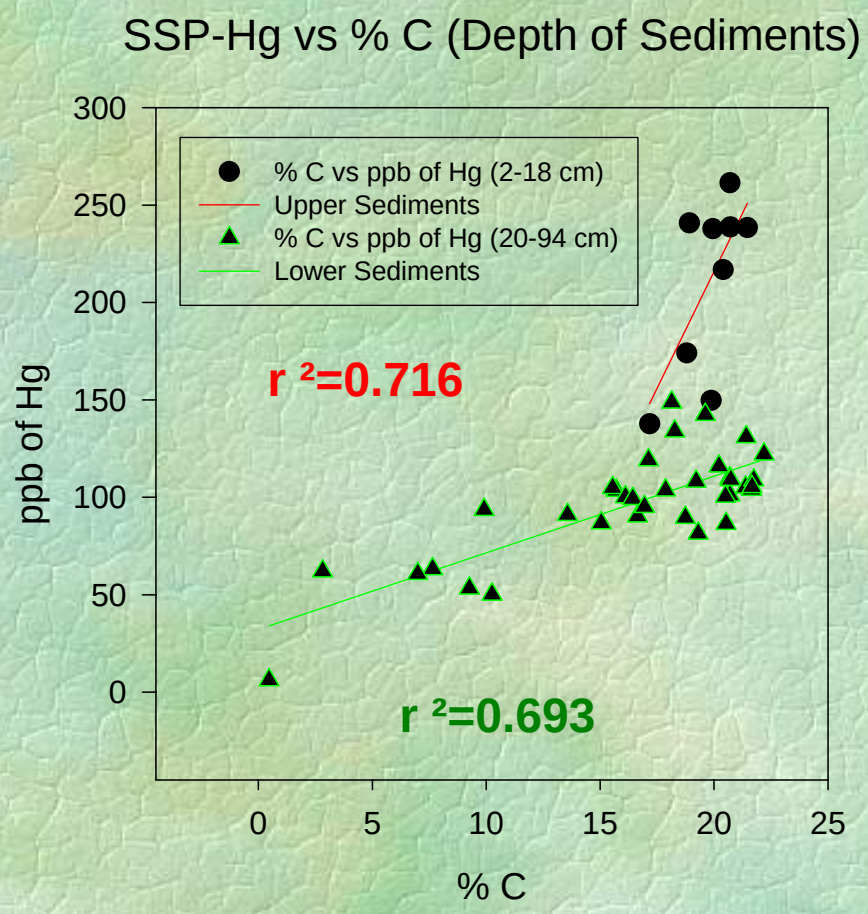
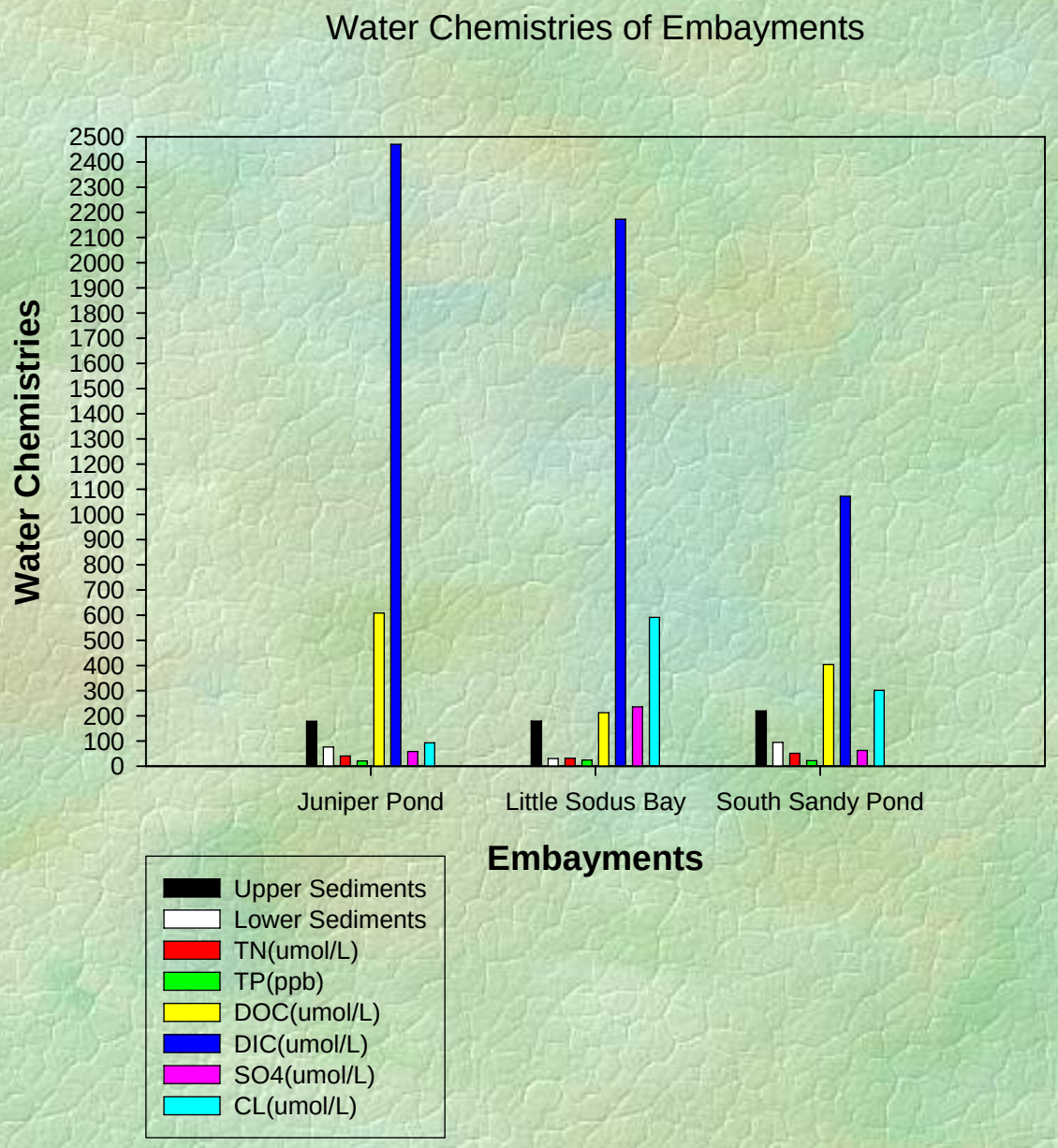


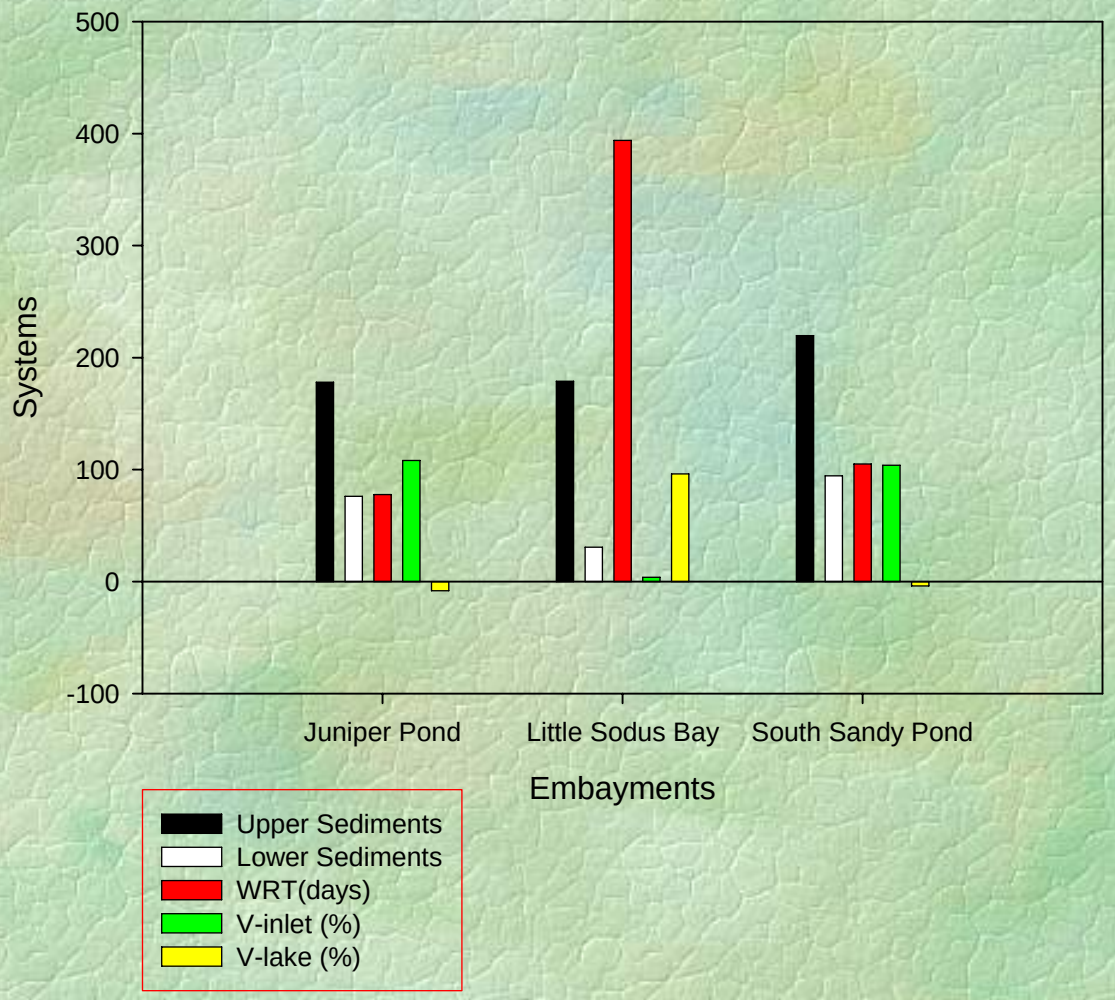
South Sandy Pond Results



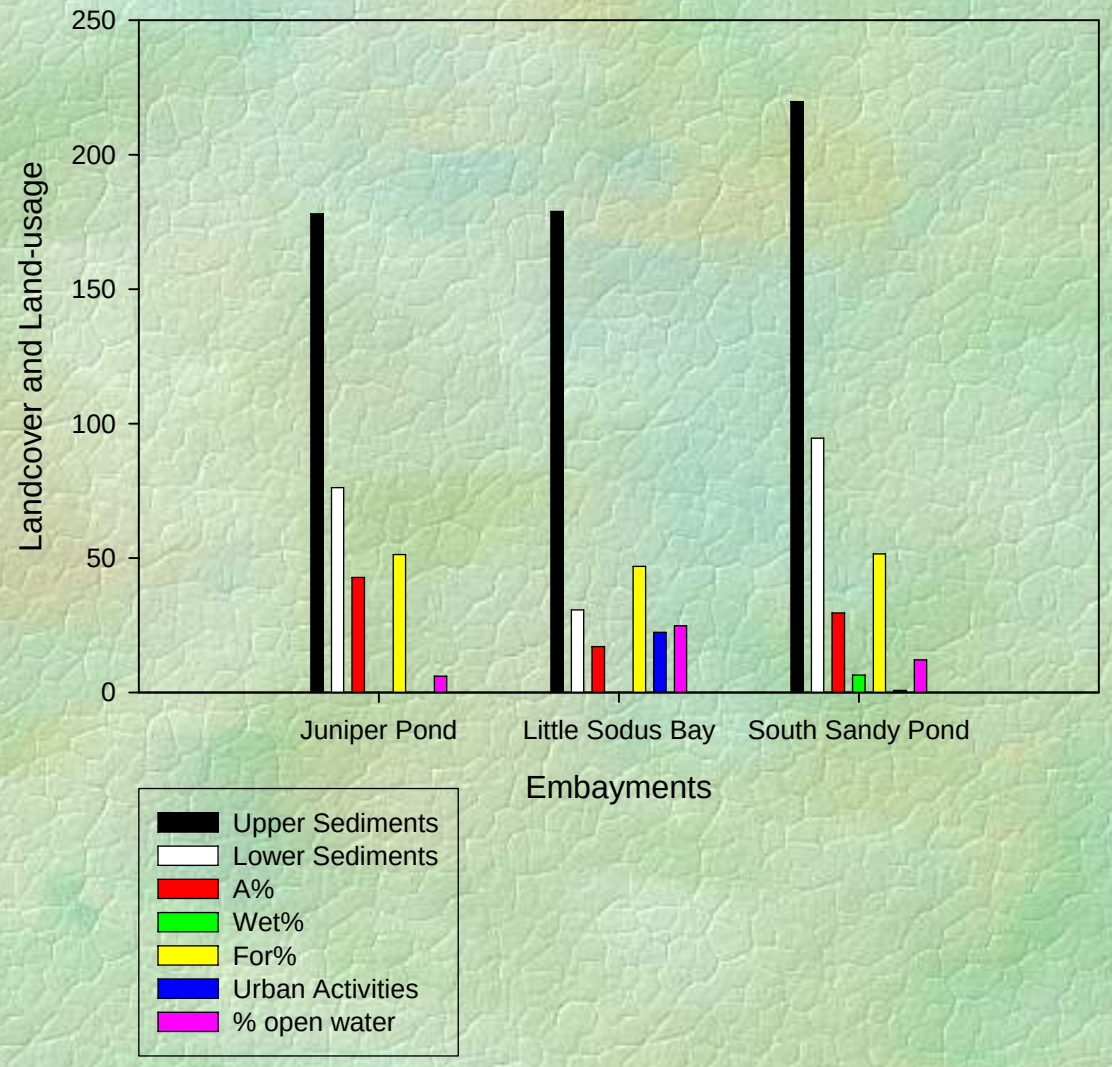



Water Chemistries of Embayments
Water Chemistries
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Juniper Pond
Little Sodus Bay
South Sandy Pond
Embayments
Upper Sediments
Lower Sediments
TN(umol/L)
TP(ppb)
DOC(umol/L)
DIC(umol/L)
SO4(umol/L)
CL(umol/L)

Water Systems



Lancover and Land-usage of the Watersheds



Conclusion

Juniper Pond:

- Great difference between upper sediments and lower sediments
- A pattern of increasing Hg concentrations in the lower sediments
- A good correlation between Hg-C in the upper sediments(2-14 cm). No correlation in lower sediments
- 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:

- Great difference between upper sediments and lower sediments
- A pattern of consistent low Hg concentrations in the lower sediments (mean = 30.7 ppb of Hg)
- A good correlation between Hg-C in the upper sediments(2-16 cm). No correlation in lower sediments
- 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:

- Great difference between upper sediments and lower sediments
- A consistent pattern of high Hg concentration in the lower sediments with intermittent drops of Hg concentrations
- Good correlations between Hg-C in the upper sediments(2-18 cm) and lower sediments
- Water Chemistry:
  - Low DIC, and S04
  - Medium values DOC and Cl
- Short Water Retention Time
- Mostly covered by agriculture and forest, and a very small coverage of urban activities with a perennial stream

Conclusion

- Spatial and temporal variations in C and N content in sediments
  - Low values in Little Sodus Bay reflect mixing of largely inorganic particles from Lake Ontario
  - Periodic low C and N content at depths in South Sandy and Juniper reflect mixing events with Lake Ontario
- Mercury content increases in recent sediments reflecting increased atmospheric deposition

Questions