Spatial and temporal patterns of priority contaminants in sediments of the Huron-Erie Corridor

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Sediment Quality Assessments (1999-2014)

Geospatial Design:

-System-wide assessment (AOC or HEC)

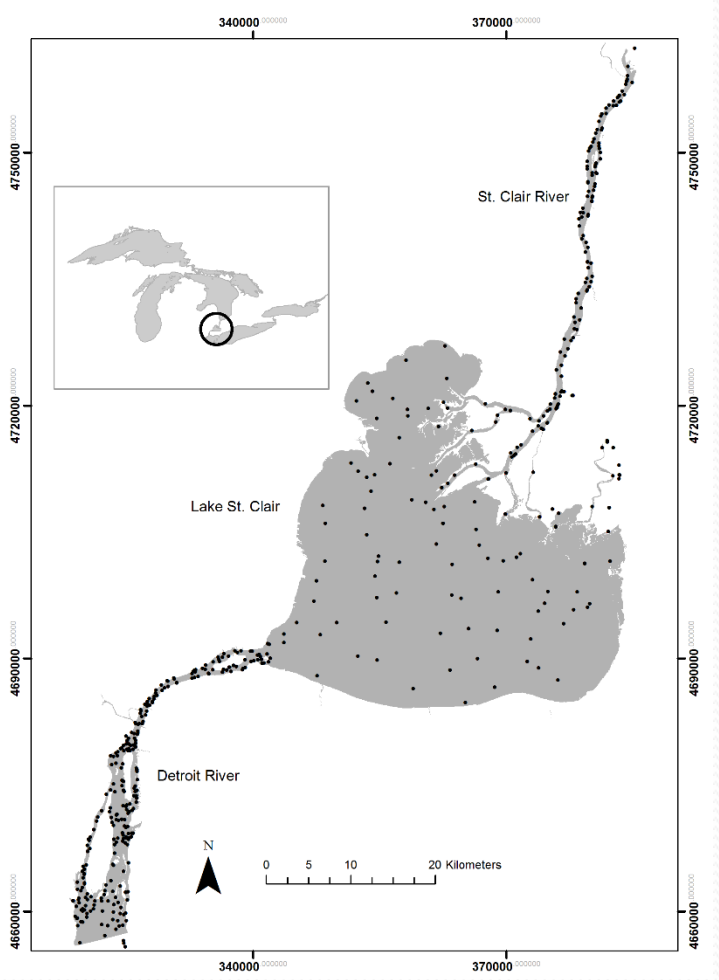
- *a priori,* randomized selection of sample sites
  - longitudinal zones (up/mid/downstream)
  - Equal sample intensity in Canada US waters
  - interspersion (>300 m in AOCs; > 1 km LSC)

-collect 2L for chemical analysis;

-grain size, LOI, %moisture,

-HCB, OCS, p,p'-DDE, transnonachlor, PCBs (40 congeners); PAHs (16 EPA)

-As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Zn



Sediment Quality Assessments (1999-2014); n= 665

Detroit River

-1999 n = 147 Stations

-2008/09 n = 73 Stations

Huron-Erie Corridor

-2004 n =104 Stations

(SCR=28; WD=23; LSC=36; DR=17)

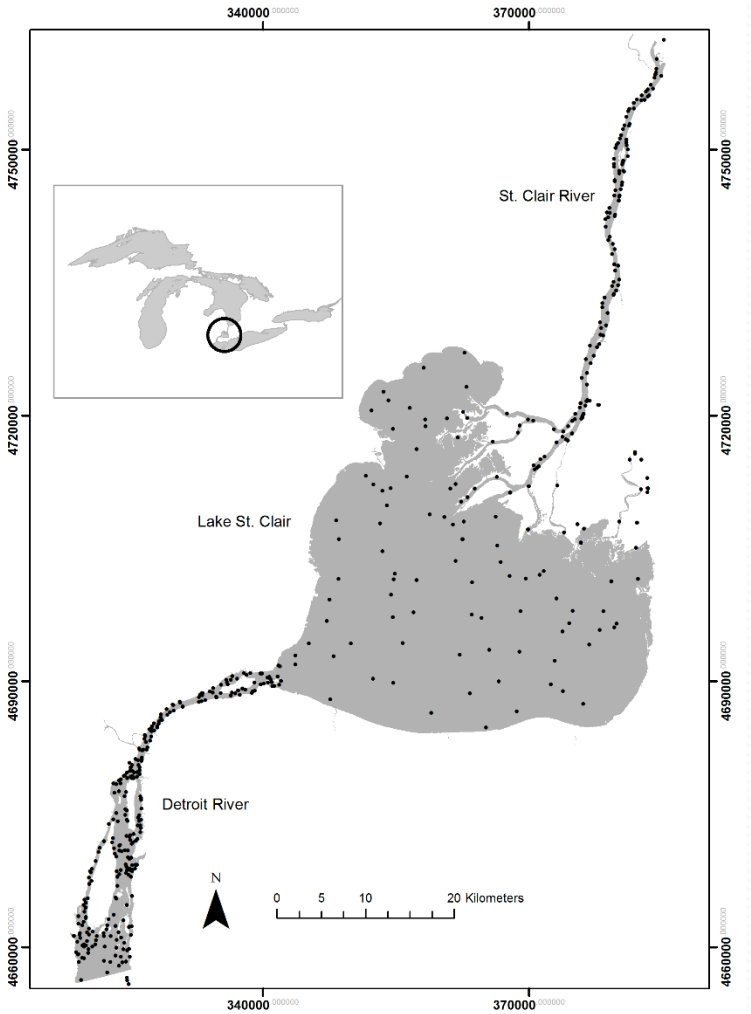
-2013/14 n = 241 Stations

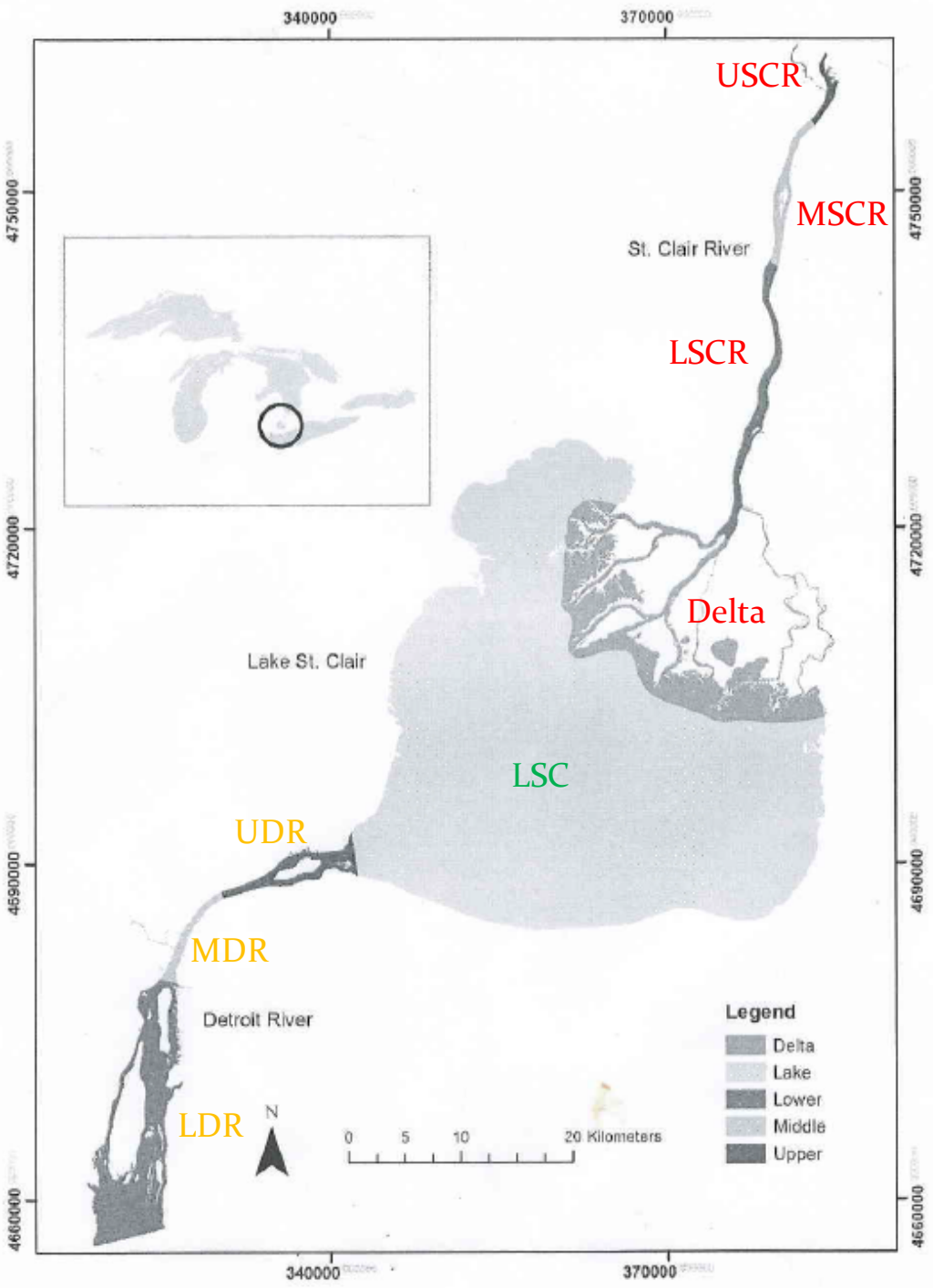
(SCR=119; WD=52; LSC=58; DR= 73)

Canadian Walpole Delta

-2005 – n = 39

-2012 – n = 61





Statistical Analysis

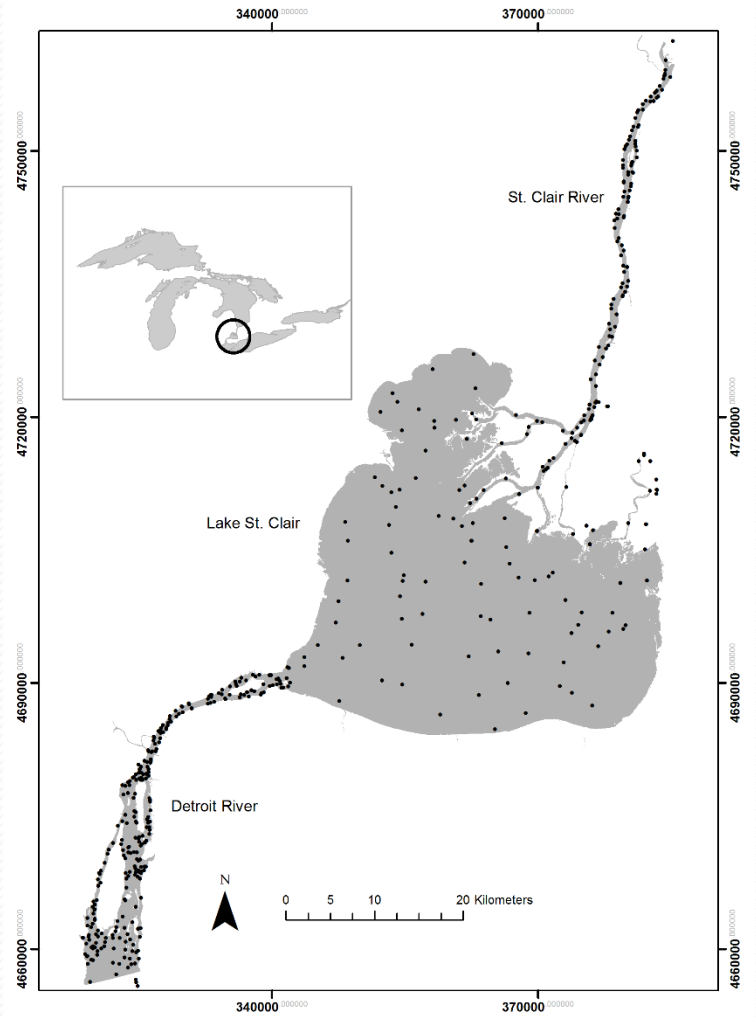
Time Series Contrasts:
Early (1995-2005)
Late (2008-2013)

By Waterbody:
St. Clair River vs. Lake St. Clair vs Detroit River:

By Country:
Canada vs. US

By Reach:
USCR, MSCR, LSCR, Delta
LSC, UDR, MDR, LDR

Data Reduction - PCA



13 Chemical variables x 618 truncated cases

First 3 PCA explained 70.5% of variation

Variable Loadings: (R > 0.6)

PCA 1: *TOC, sumPCB, sumPAH, Cd, Cr, Cu, Ni Pb, Zn (All with negative strong loads)*

PCA 2: *HCB, OCS, total Hg (all strong – Loads)*

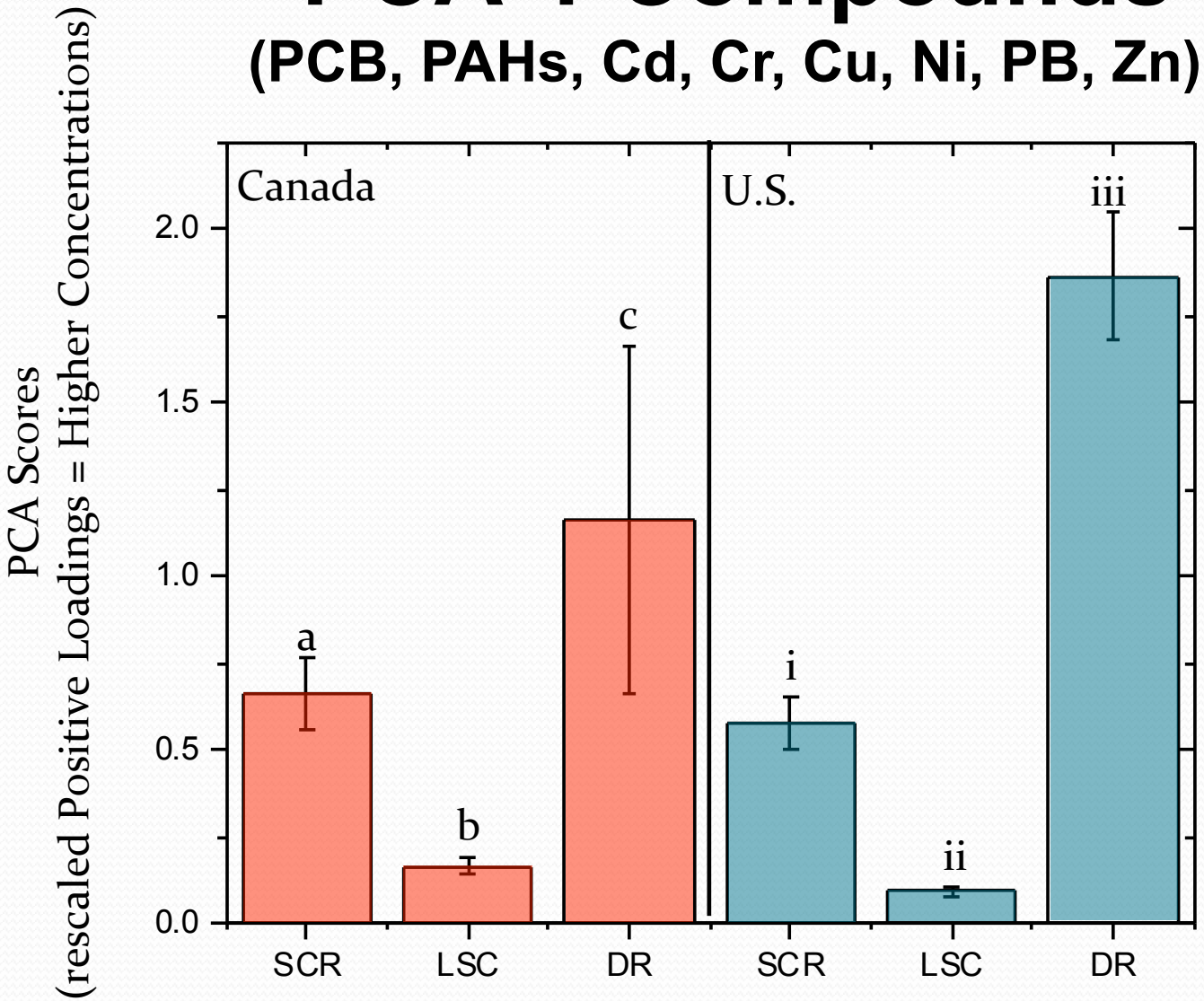
PCA 3: *p,p'-DDE (positive load = 0.59)*

PCA-1 Compounds
(PCB, PAHs, Cd, Cr, Cu, Ni, PB, Zn)

- ANOVA (PCA1-scores)
  - No Sig. Effect of time (early 1999-2005 vs late 2008-2014)
  - Highly Sig. Effect ($p<0.001$) of waterbody
    - Each Waterbody (SCR, LSC, DR) Sig. Different from each other
  - Highly Sig. Effect ($p<0.001$) between reaches
  - Highly Sig. Effect ($p<0.001$) between countries
  - Highly Sig. Effect ($p<0.001$) between reaches within each country

PCA-1 Compounds

(PCB, PAHs, Cd, Cr, Cu, Ni, PB, Zn)



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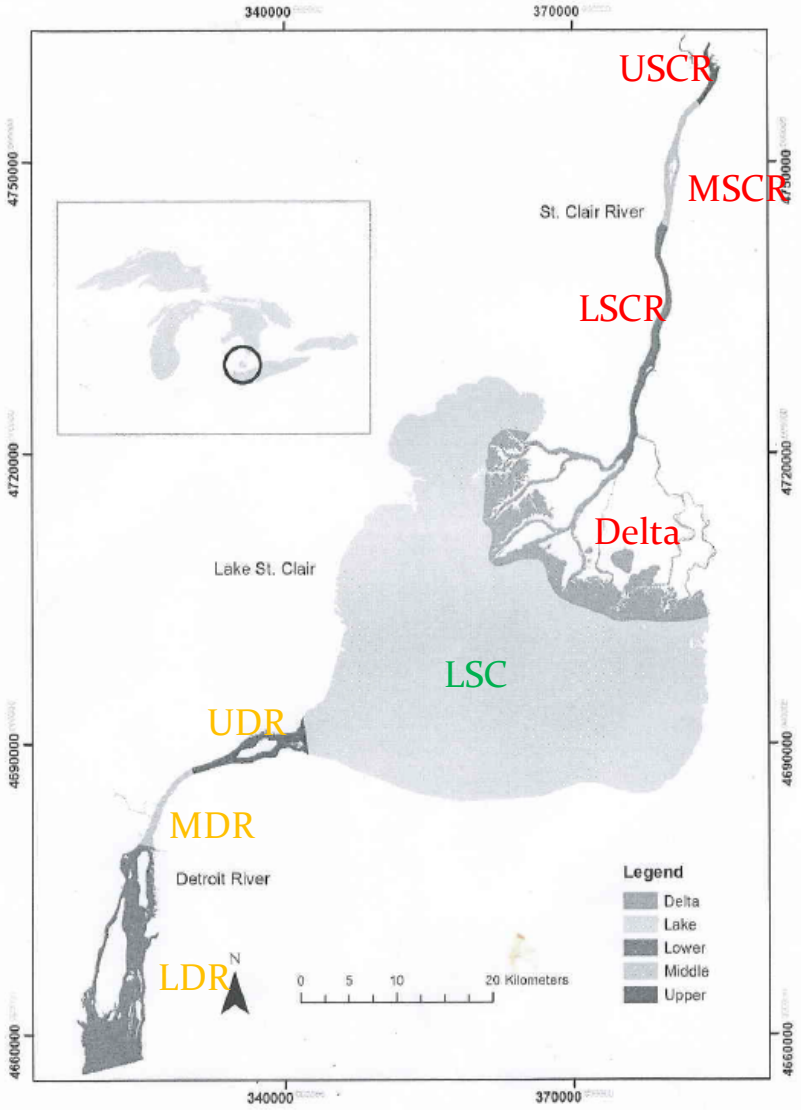
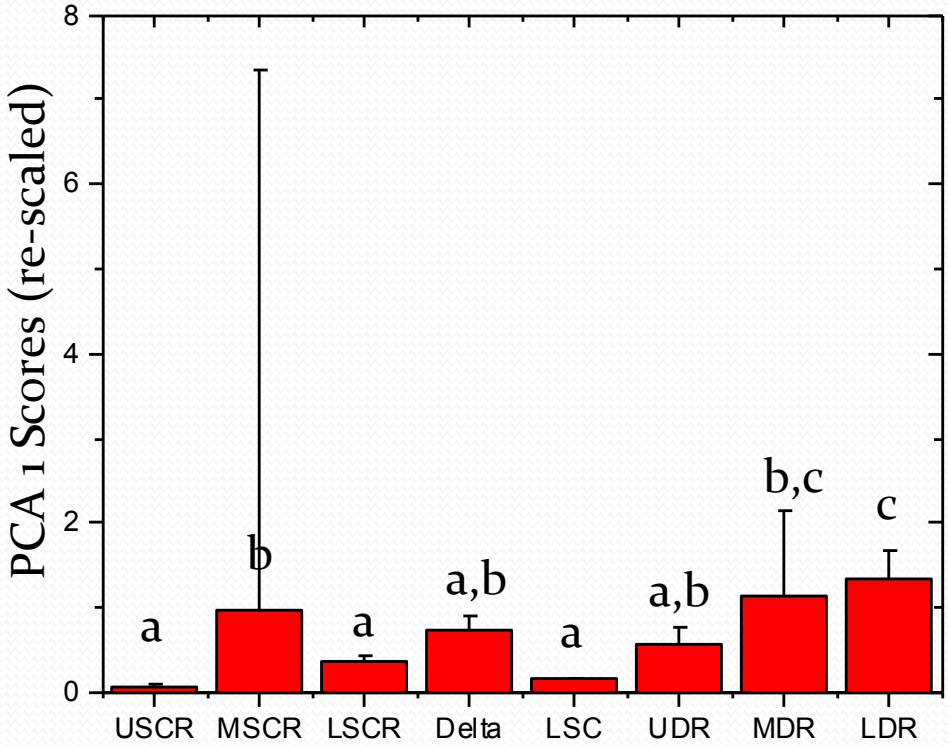


Canadian Reaches



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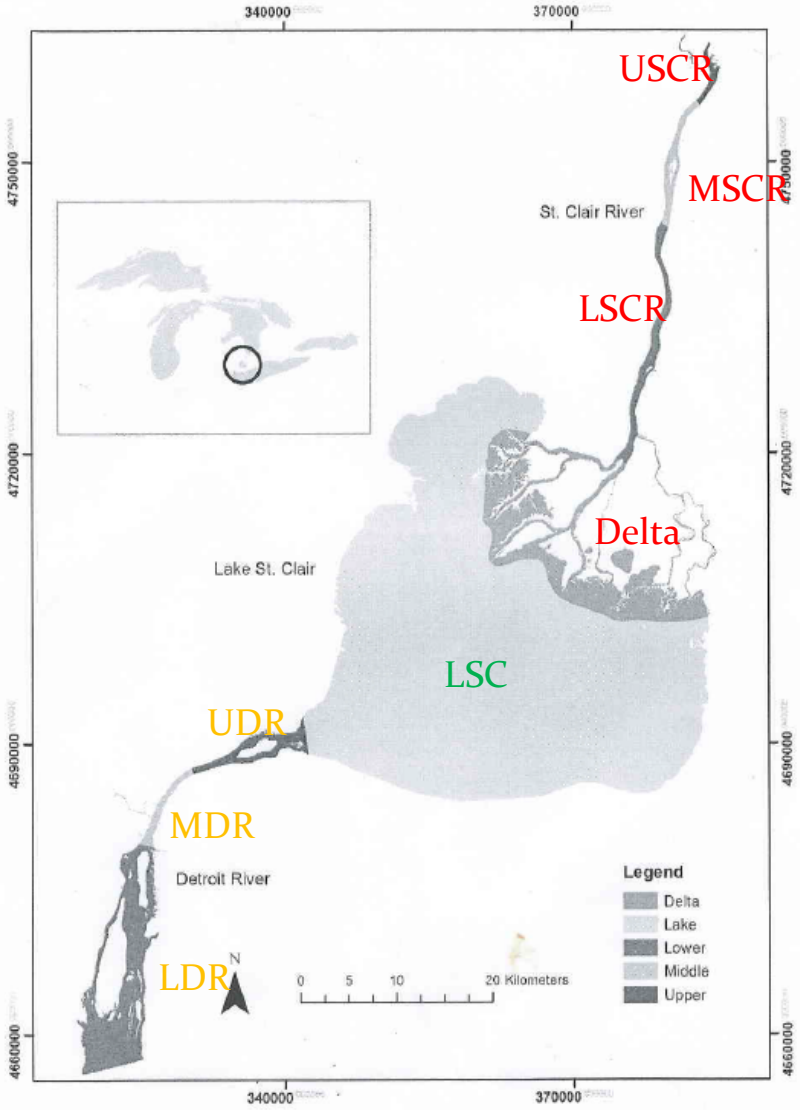
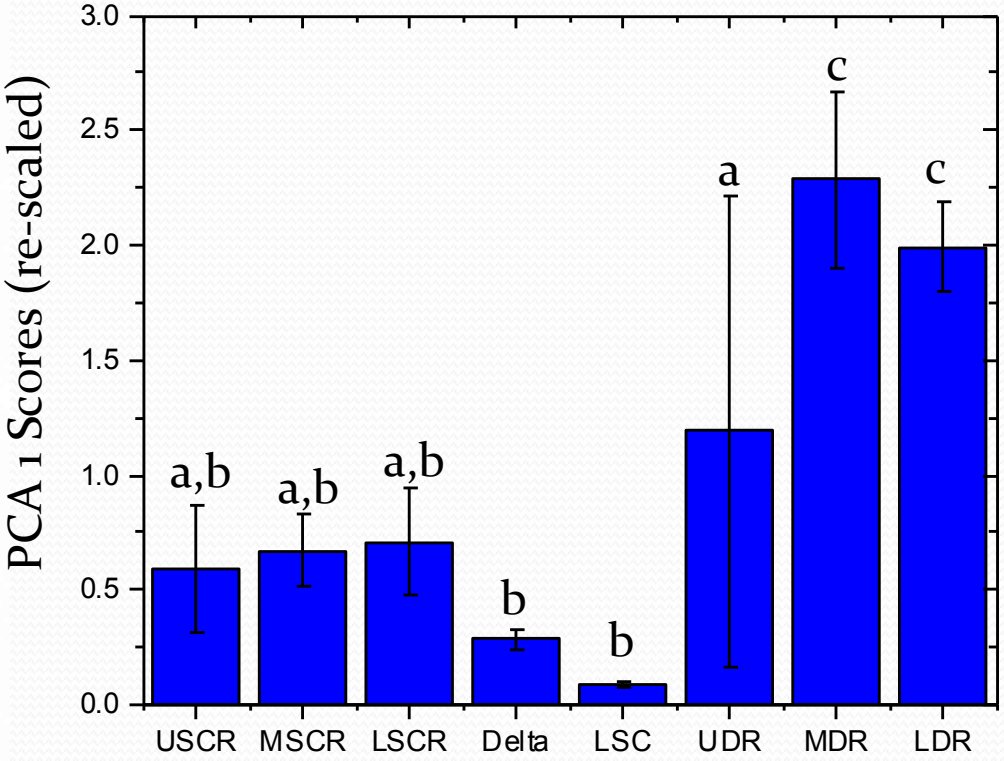
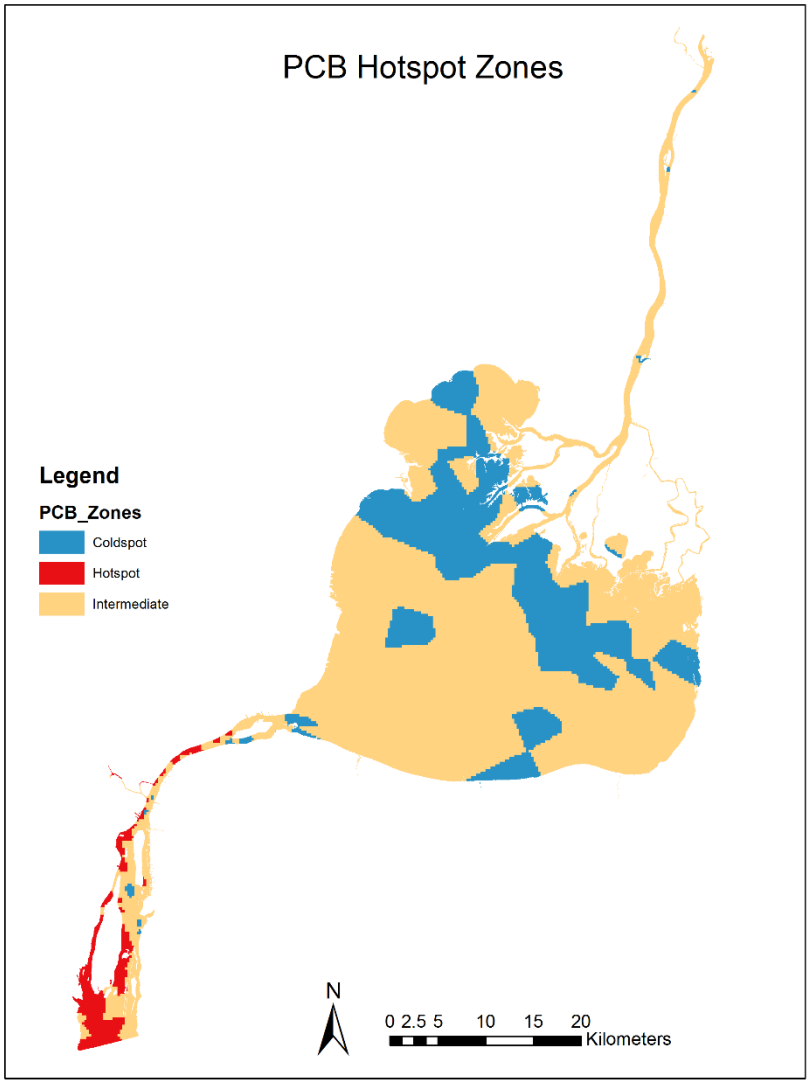
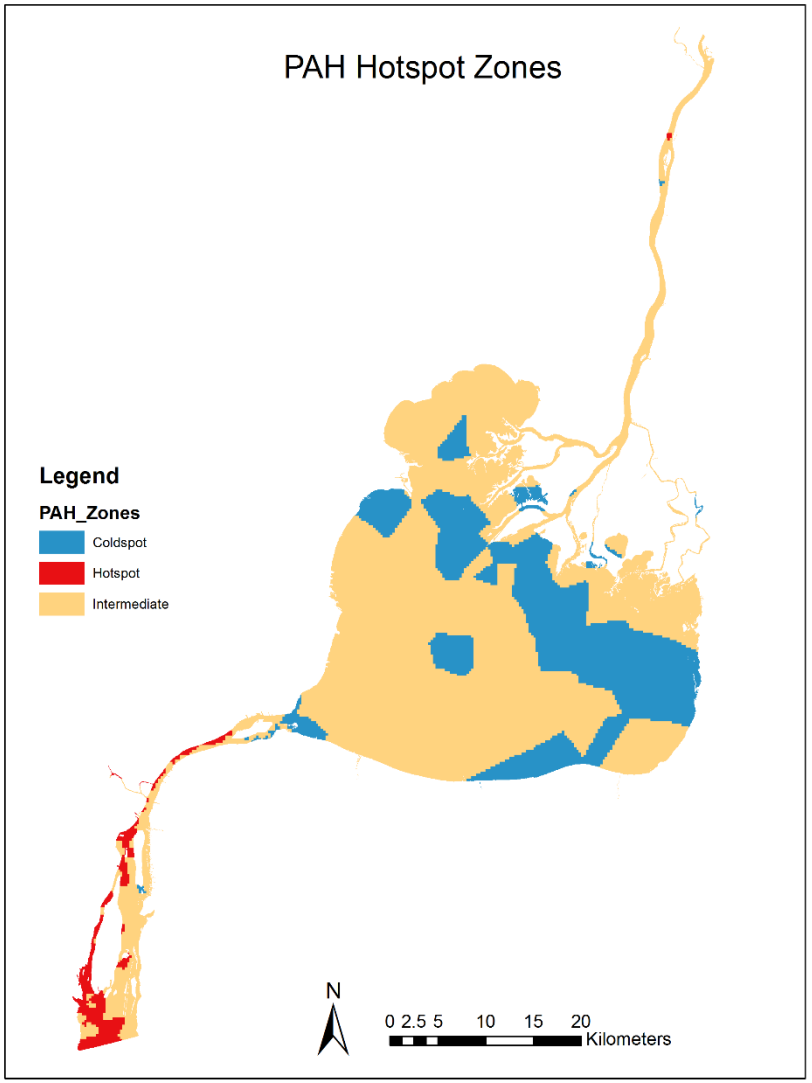


US Reaches



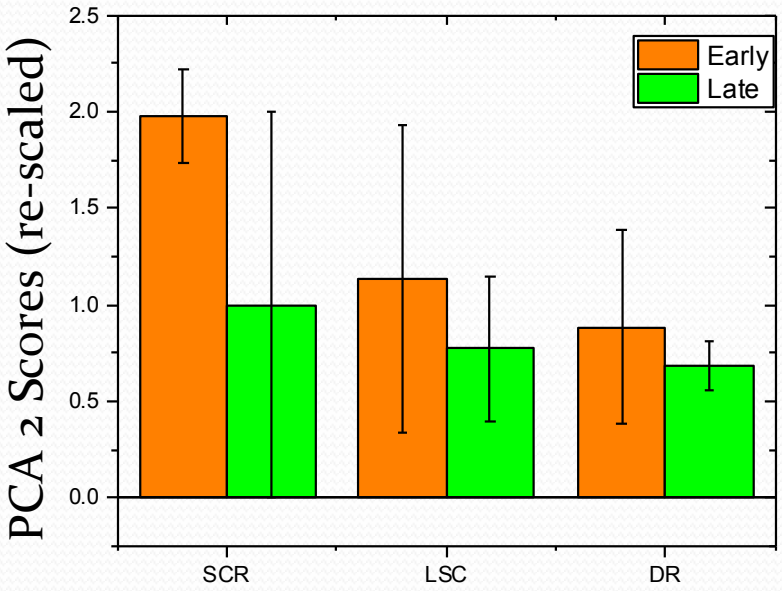
Getis-Ord Hot and Cold Spots





PCA-2 Compounds
(total Hg, HCB, OCS)

- ANOVA (PCA1-scores)
  - Highly Sig. Effect of time (early vs late); p<0.001
    - Significant Interaction Term (Time x Waterbody)
    - Concentrations of PCA-2 Compounds Improved with Time in each Water body, but at different rates



PCA-2 Compounds (2008-14)

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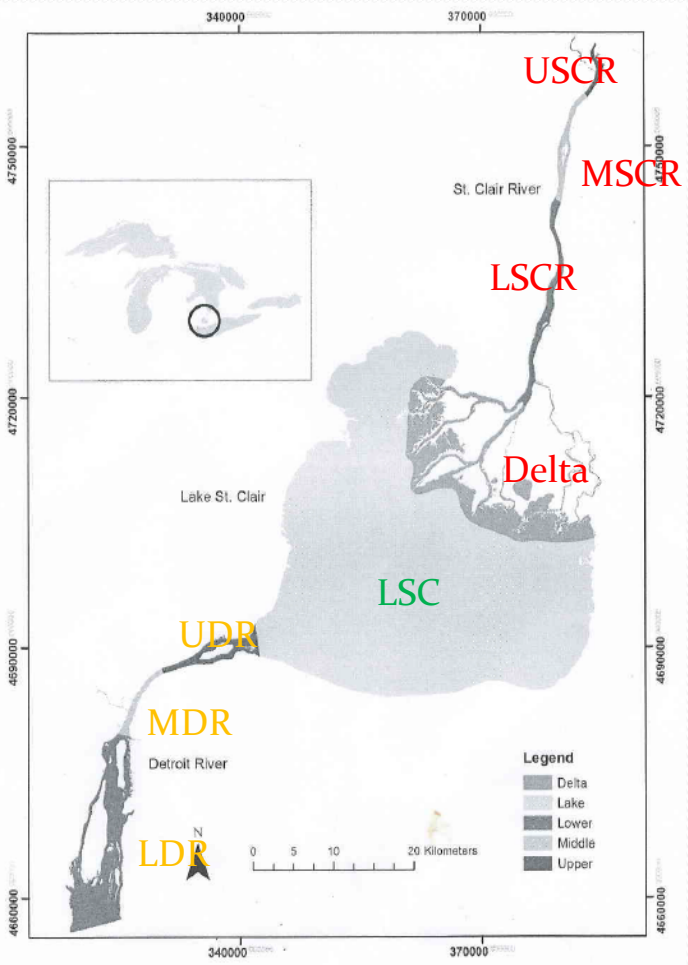
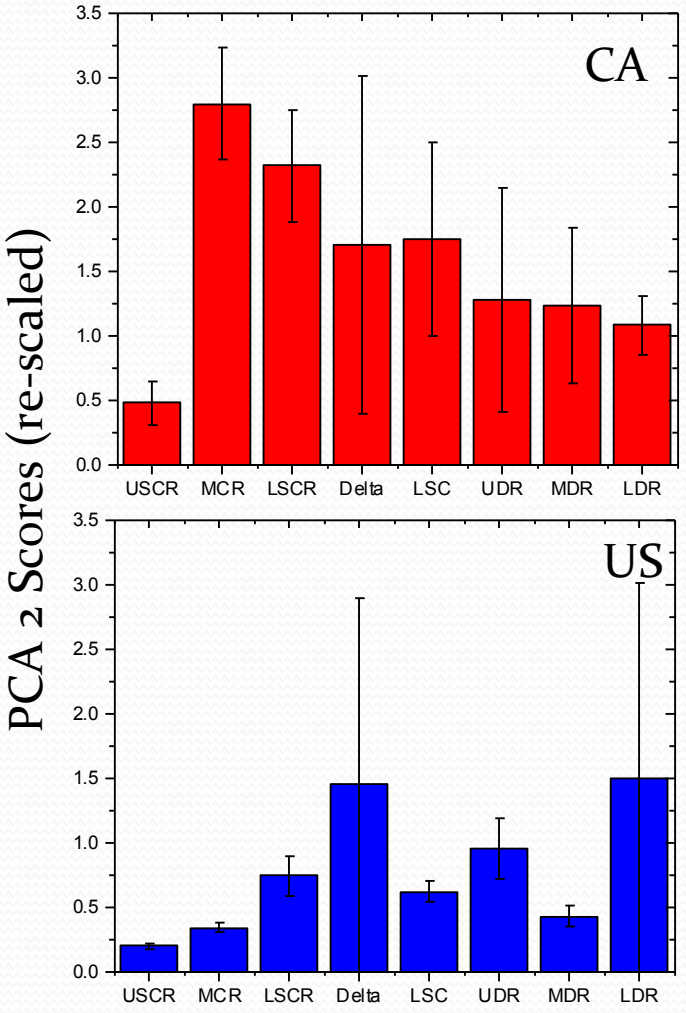
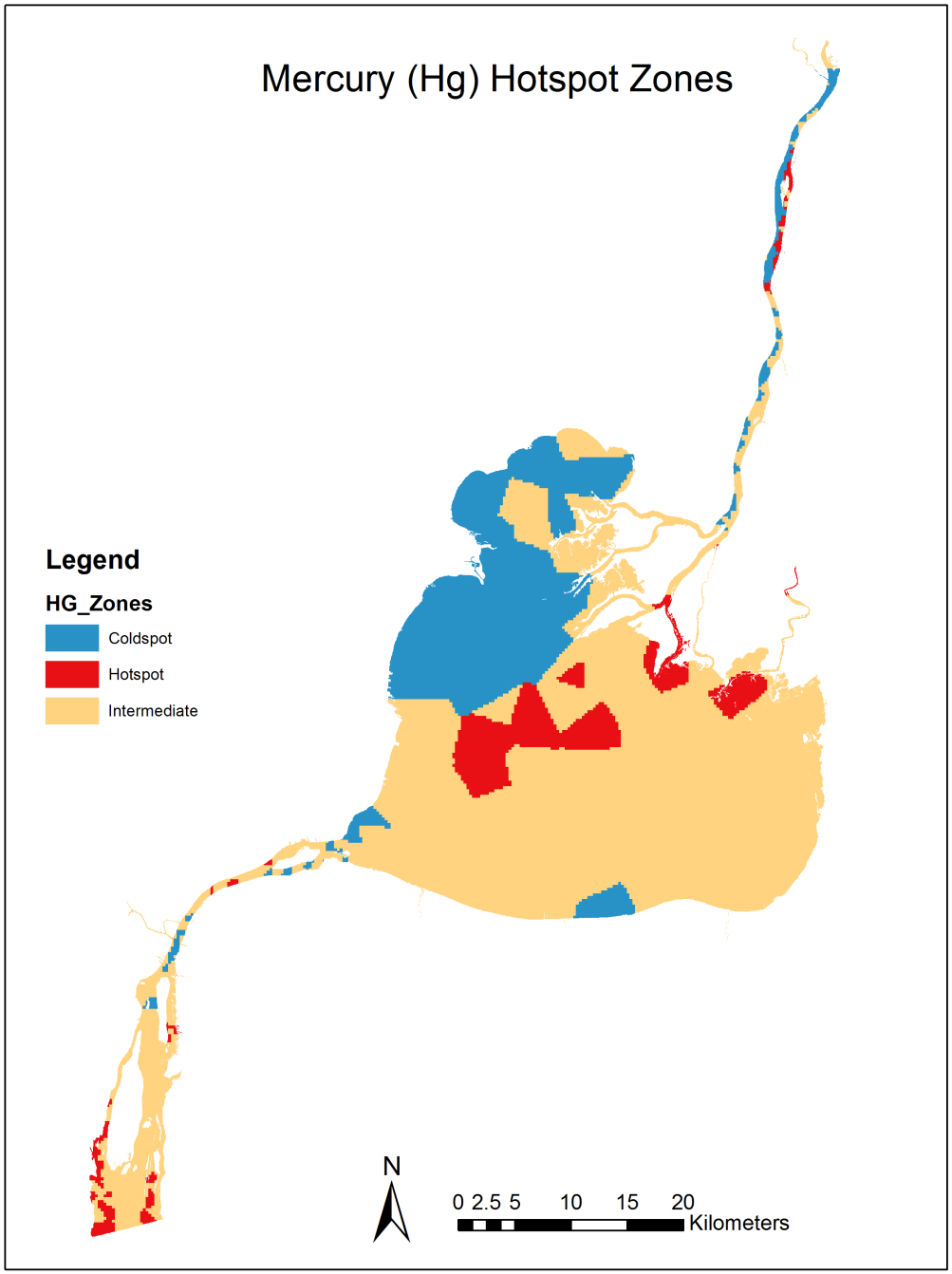
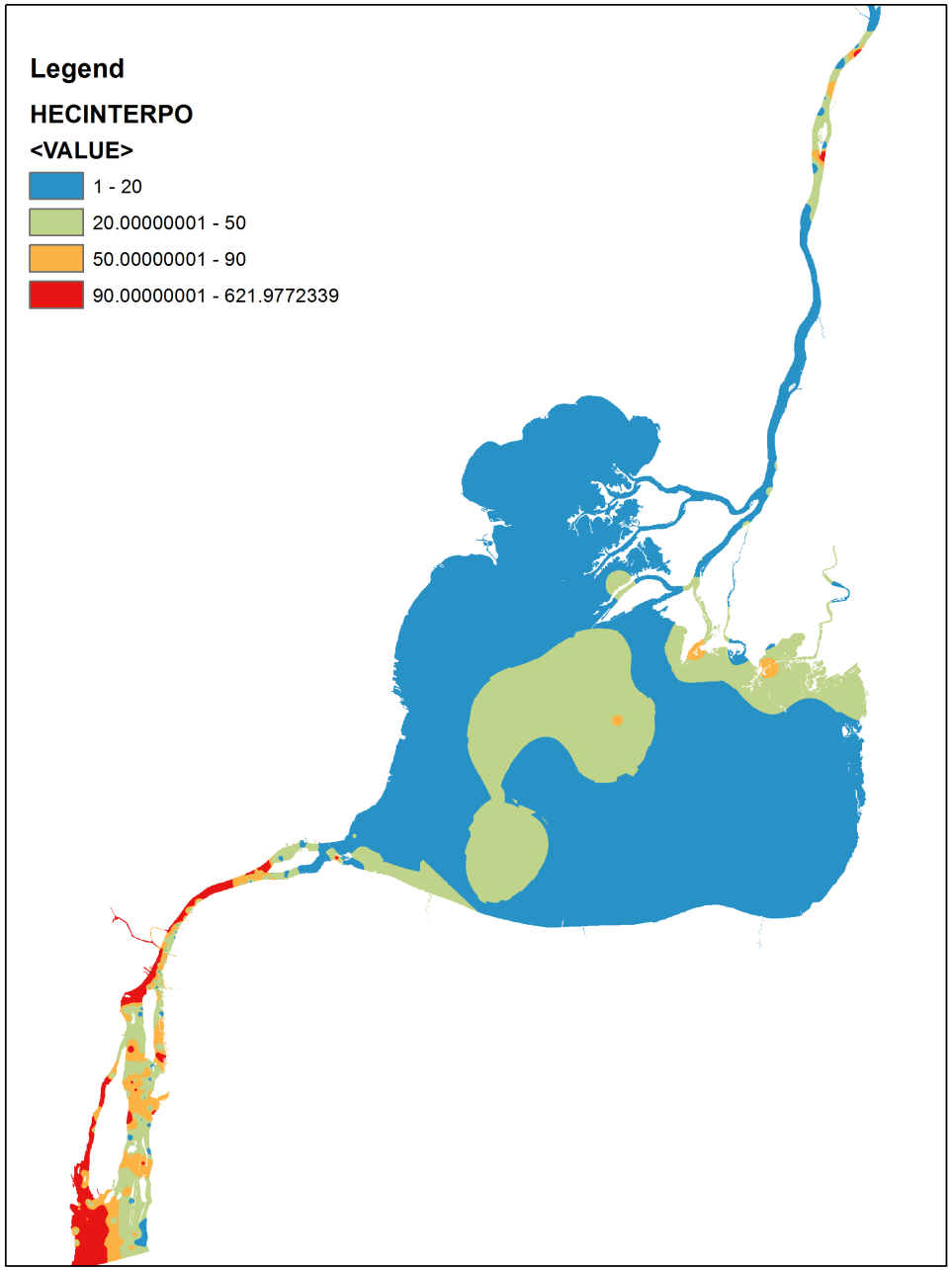






Getis-Ord Hot and Cold Spots

Total Hg



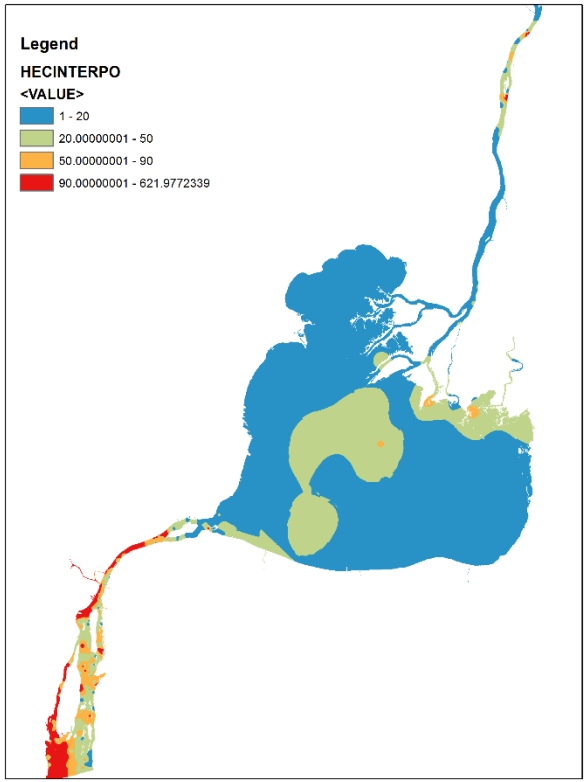
Hazard Score Metric based on MDEQ SQG's (LEL/PEL Integrated Score).

Red Zones = Multiple contaminants exceed PEL

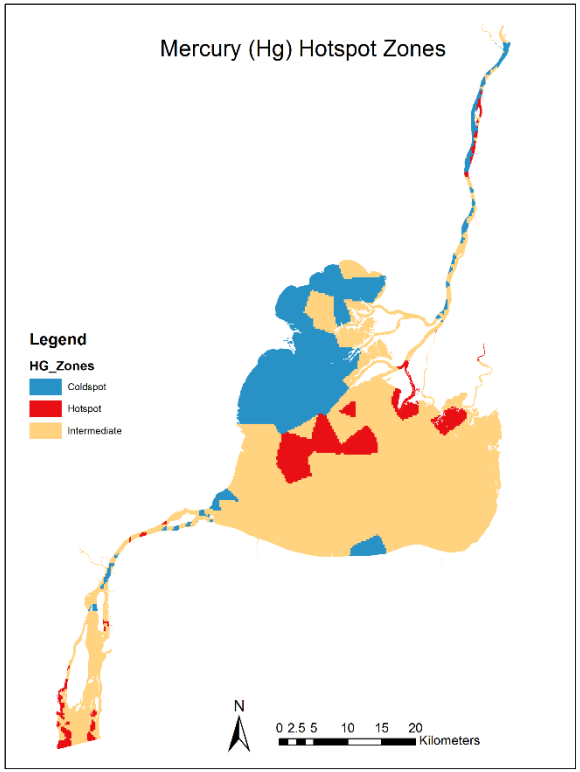
Green Zones – All Chemicals < PEL

Hazard Generated BY PCA-1 & 2 Chemicals

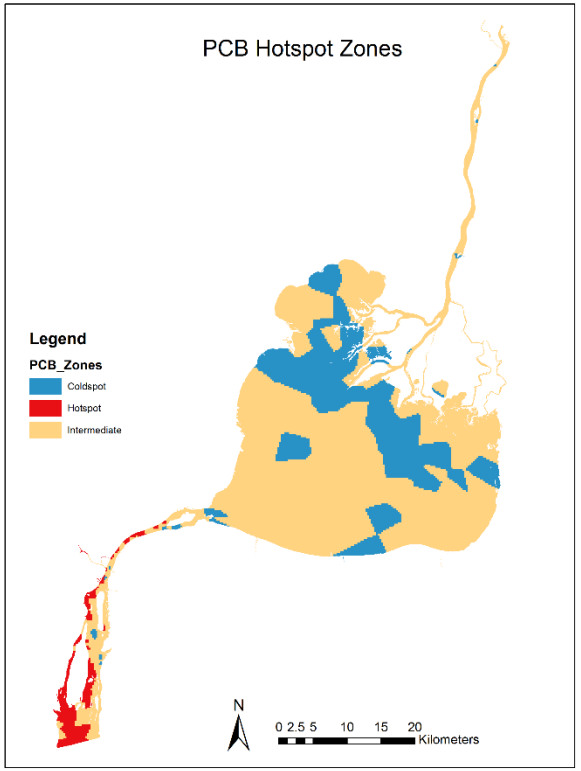
Sediment Hazard Score



Getis-Ord – PCA 2



Getis-Ord – PCA 1



Conclusions

- Geospatial Analysis of Priority Contaminants in Sediments of the HEC
  - 2 Chemical Groups
    - PCA 1 – PCBs, PAHs, Cd, Cr, Cu, Ni, Zn, Pb
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  - Group 1 Chemicals
    - No Sig. Change with Time
    - High Concentrations throughout U.S. Mid/Downstream DR Reaches
    - Localized High Values in CA Mid-SCR Reach (but generally lower in CA)

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    - PCA 2 – HCB, OCS, total Hg
  - Group 1 Chemicals
    - No Sig. Change with Time
    - High Concentrations throughout U.S. Mid/Downstream DR Reaches
    - Localized High Values in CA Mid-SCR Reach (but generally lower in CA)
  - Group 2 Chemicals
    - Sig Change with Time (Improving!)
    - Generally higher in CA, with Upstream-Downstream Dilution Effect
    - Localized High Values in US Delta and through Downstream DR Reach

Conclusions

- Geospatial Analysis of Priority Contaminants in Sediments of the HEC
  - Hazard Scores (Consider Concentrations Relative to SQL's across 13 priority pollutants)
    - Reveal highest concern in the mid- and downstream U.S. DR
    - Contributed by combination of Group 1 & 2 Chemicals

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