

Improving urban fisheries through remediation and restoration of aquatic habitat

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Quality of Urban Fisheries*

- Clean water, quality fishery
- Facilities and amenities
- Advertisement to community



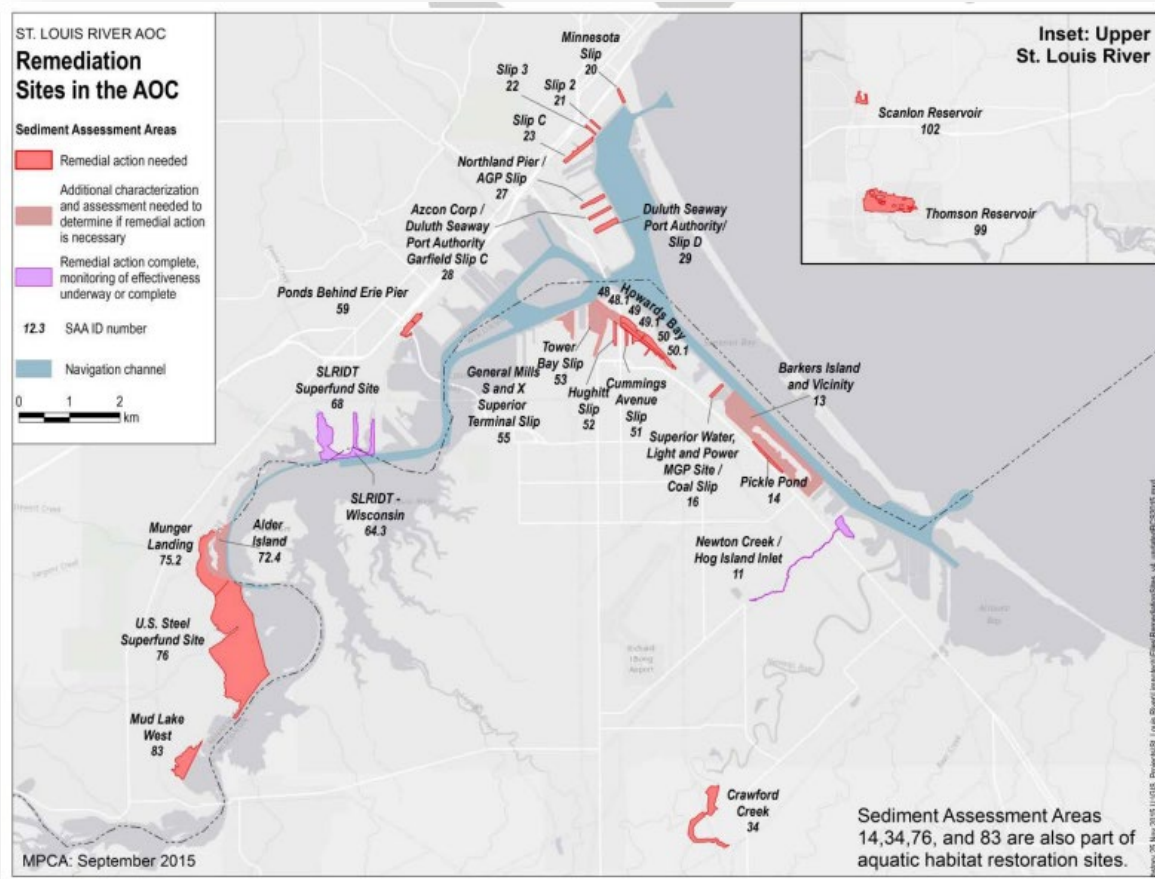
Problem of urban contaminants

- Fish contaminant burden: consumption advisory
- Postings: negative advertisement

* Balsam and Shoup 2008

Challenge for establishing an urban fishery

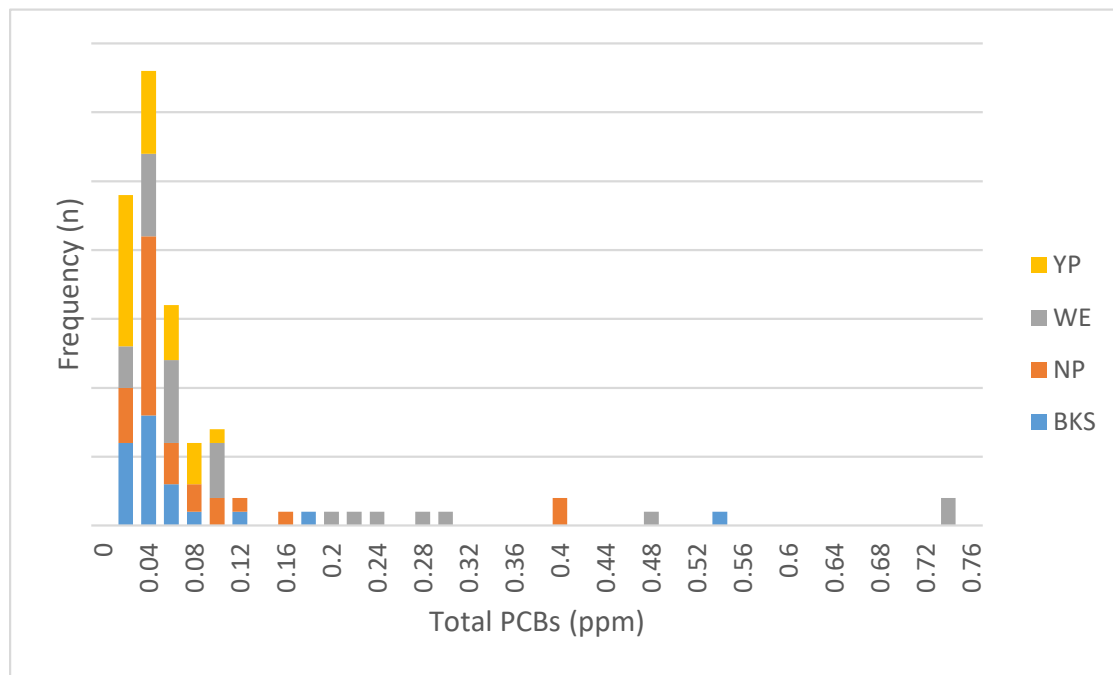
- Contaminants distributed heterogeneously
- Fish movements and diet will determine exposure and risk
- Challenging to present advisories to anglers
 - species-specific
 - size-specific
 - location-specific



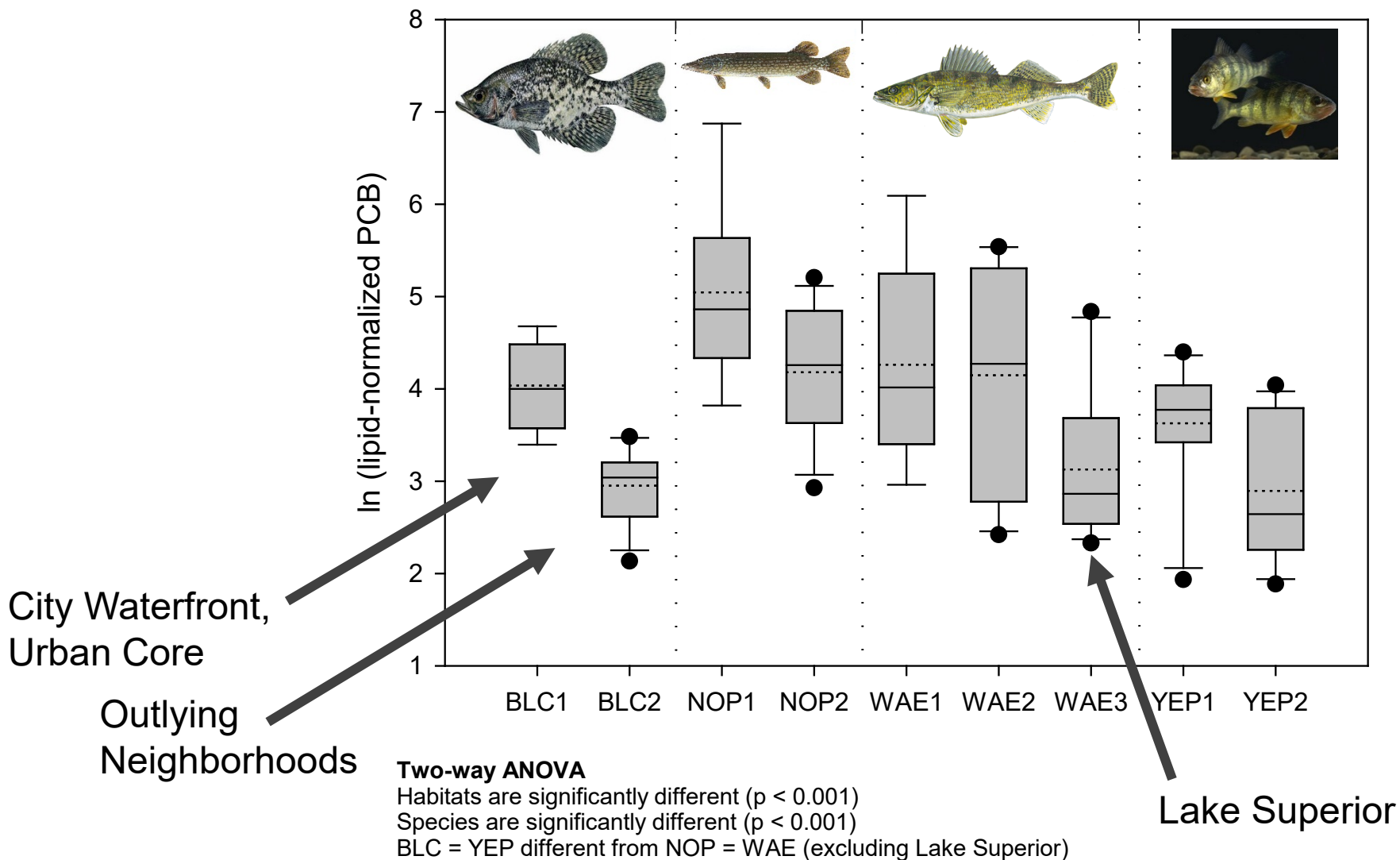
St Louis River Area of Concern (AOC) indicating sediment remediation and assessment needs (Sept 2015)

Total PCBs in Fish Tissue, 2013

Health Advisory	PCB range (ppm)	Black Crappie	Northern Pike	Walleye	Yellow Perch
safe	0 - 0.05	15	18	13	20
1 meal/wk	0.05 - 0.22	5	8	8	5
1 meal/mo	0.22 - 0.95	1	2	6	0
6 meal/yr	0.95- 1.89	0	0	0	0
NO	>1.89	0	0	0	0



1 = St. Louis Bay, Spirit Lake
 2 = Boy Scout, Superior Bay, Allouez Bay
 3 = Lake Superior



Research and Management Goals

To explicitly relate fish life-history (movements, diet, ontogeny) to contaminant exposure to predict fish tissue concentration

- Incorporate species behavior
- Spatially-explicit, small-scale

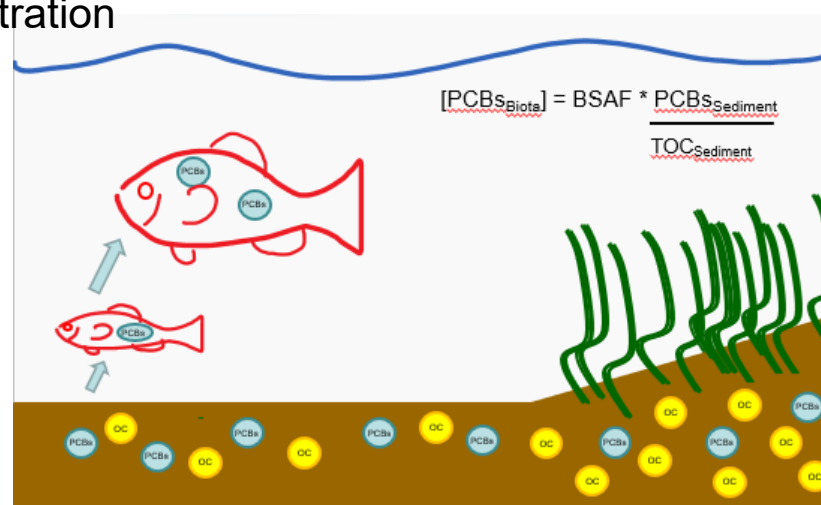
Support sediment remediation and habitat restoration decision-making in support of establishing urban fisheries

Modeling Approach

Biota-Sediment Accumulation Factor (BSAF) model

- Use BSAF model to predict fish tissue concentration

- From EPA BSAF database
 - 3.75 median value
 - 1.21 mean value for Fox River AOC
- Tissue lipid content = 1%
- Accounts for diet habit, trophic level



- Model surface sediment PCBs/TOC
- Tune model, initially for Yellow Perch (2013)
- Validate model (2016, 2018)

Easy to use, publicly available database:

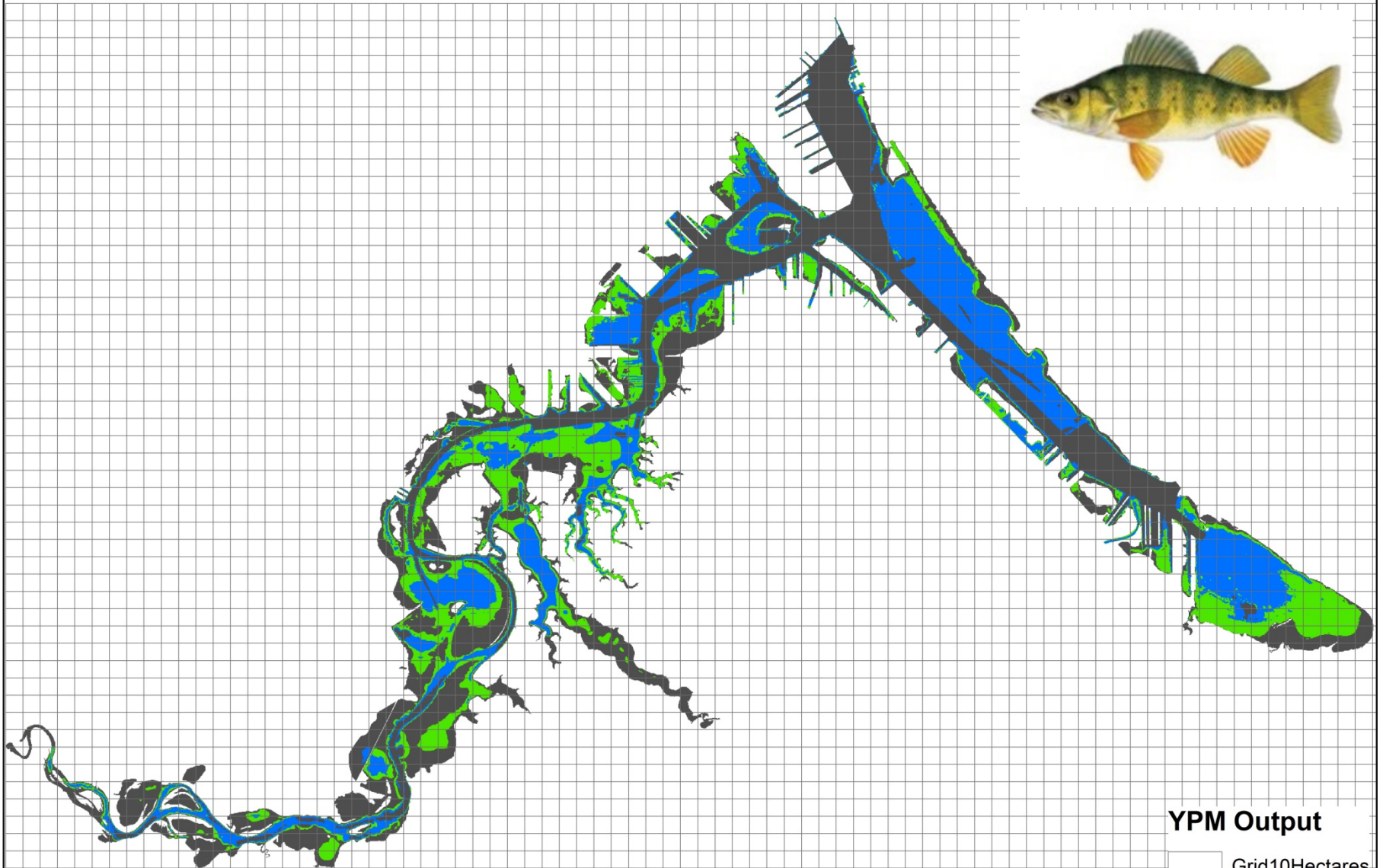
https://archive.epa.gov/med/med_archive_03/web/html/bsaf.html

Yellow Perch habitat

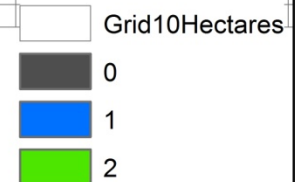
- Home range: 10 ha
- Exposure based on diet habit:
 - 50% vegetated habitat
 - 50% bare habitat (open water)
- Assigns fish optimum <4 m and 20-75% vegetation probability, excluding some cells from occupation:
 - deep (>4 m)
 - heavily vegetated ($>75\%$)
 - shallow (<1.5 m) and without vegetation ($<20\%$)
- Each computational cell is independent



Yellow Perch Model



YPM Output

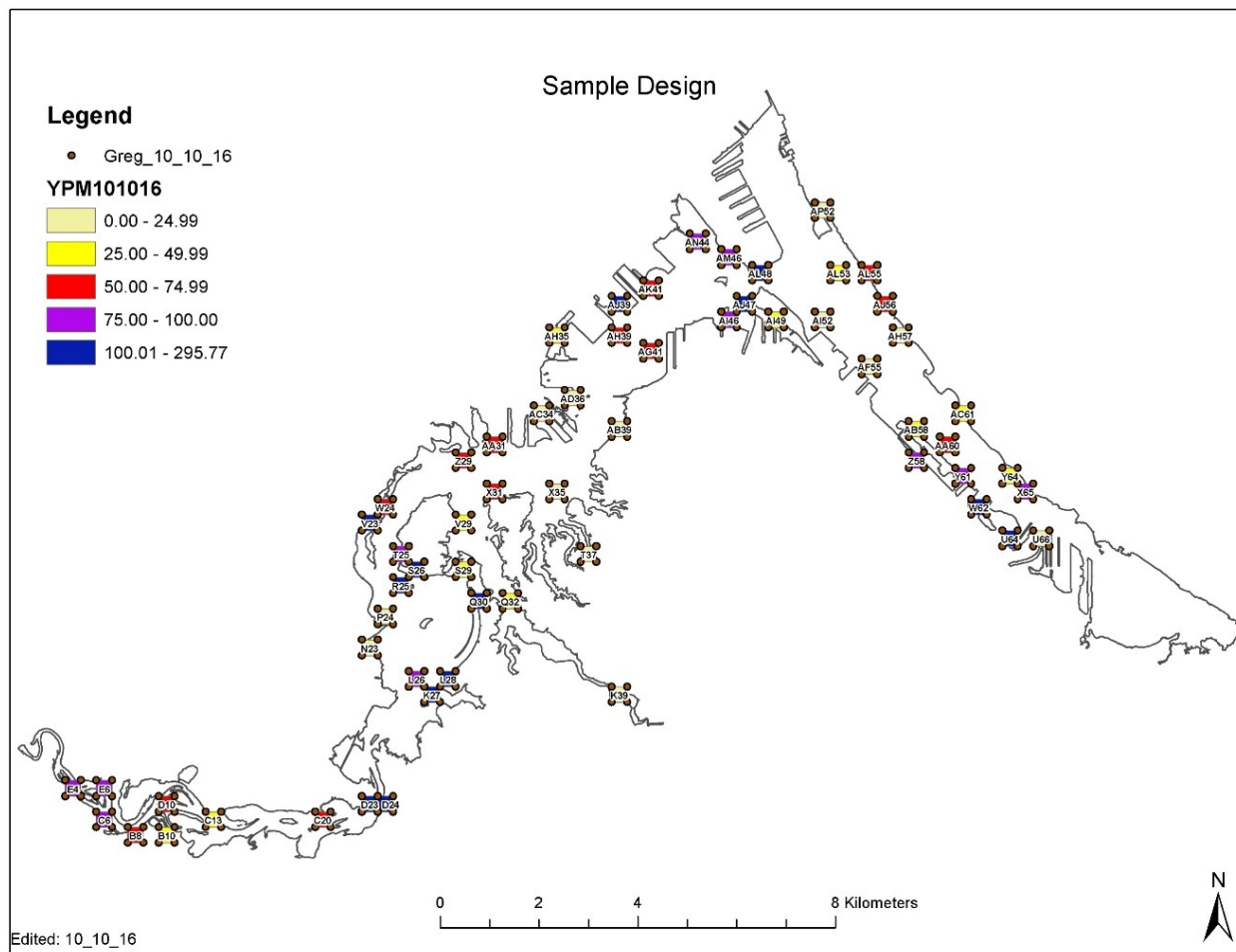


0 1 2 4 6 8 Kilometers

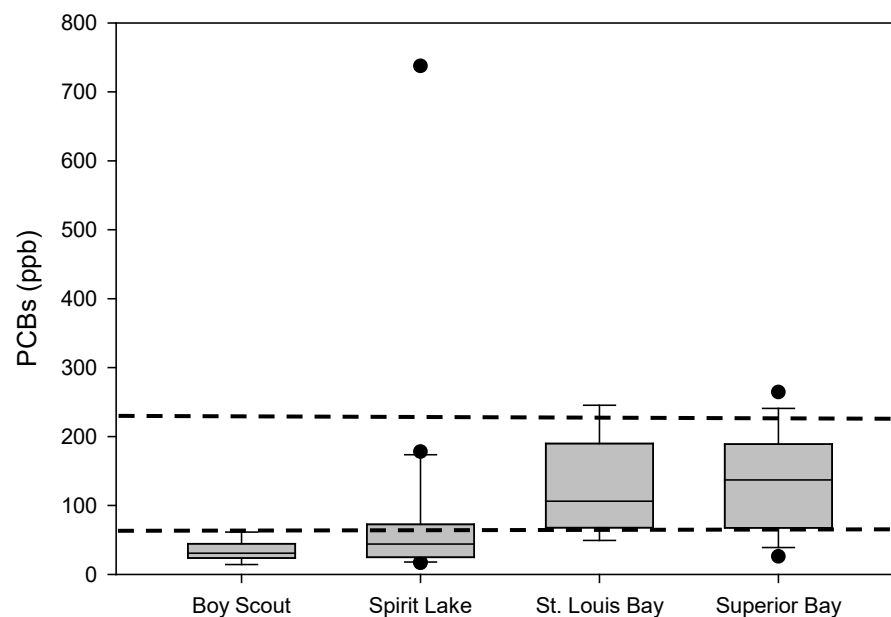
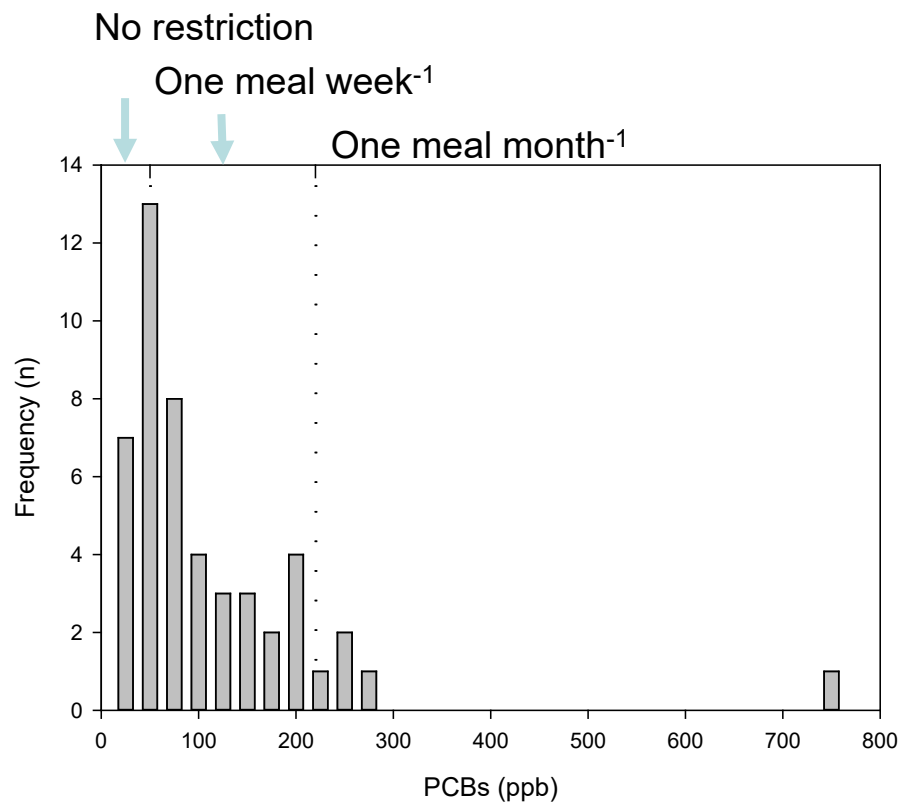


Model Validation (2016)

- Stratified by predicted concentration
- Targets
 - Three Yellow Perch (75-150 mm TL) per composite
 - Ten composites per stratum (randomly selected)

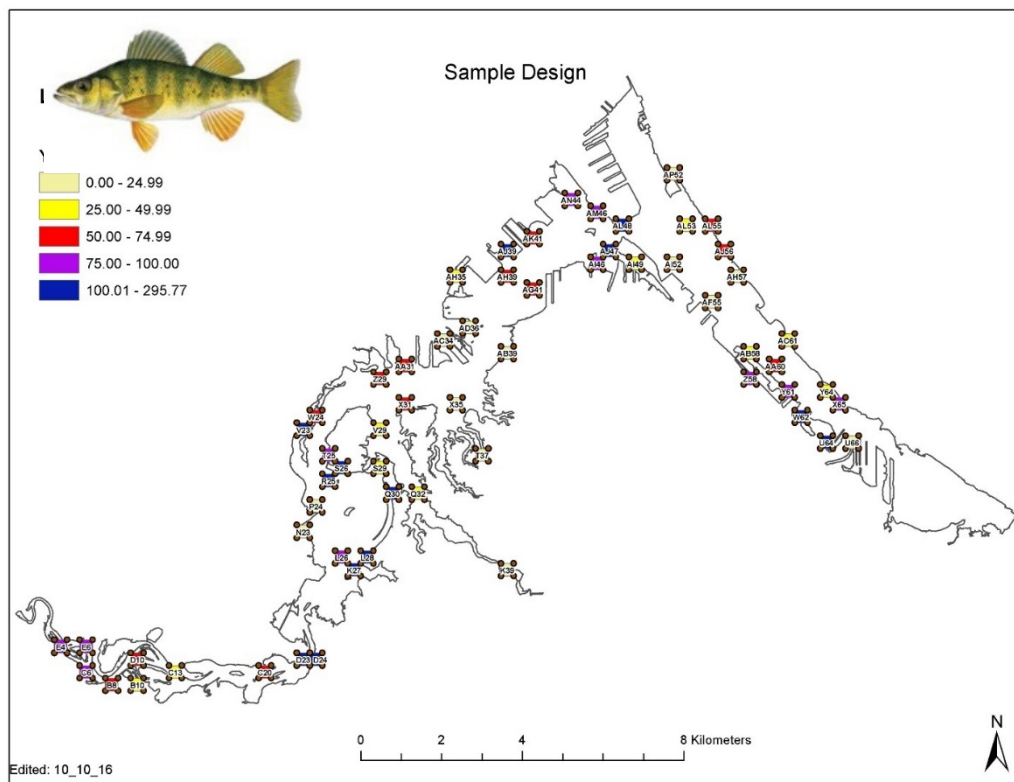


Results - Yellow Perch PCBs

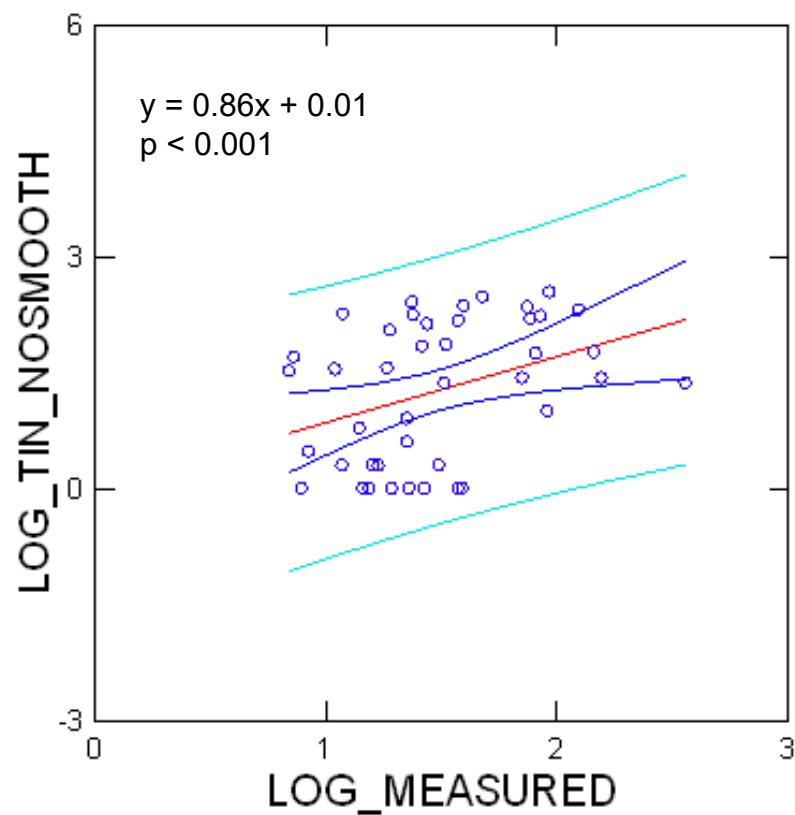


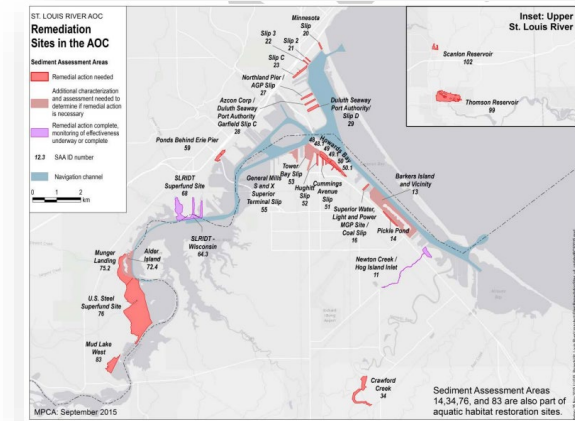
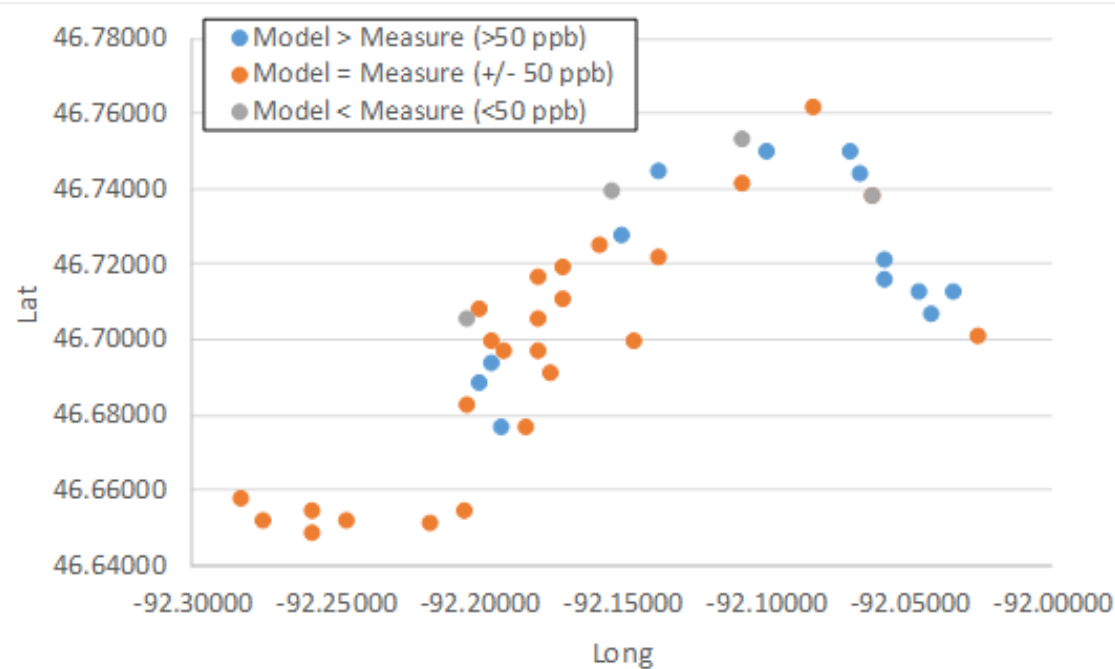
- Whole fish composites (3-5 per sample)
- Target fish 75-150 mm TL (~2-3 year-olds)

Model Fit

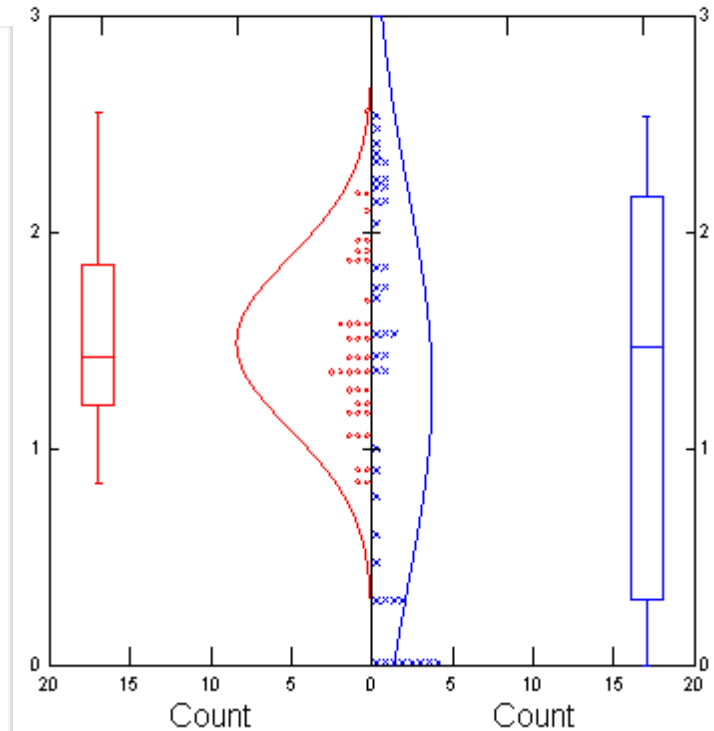


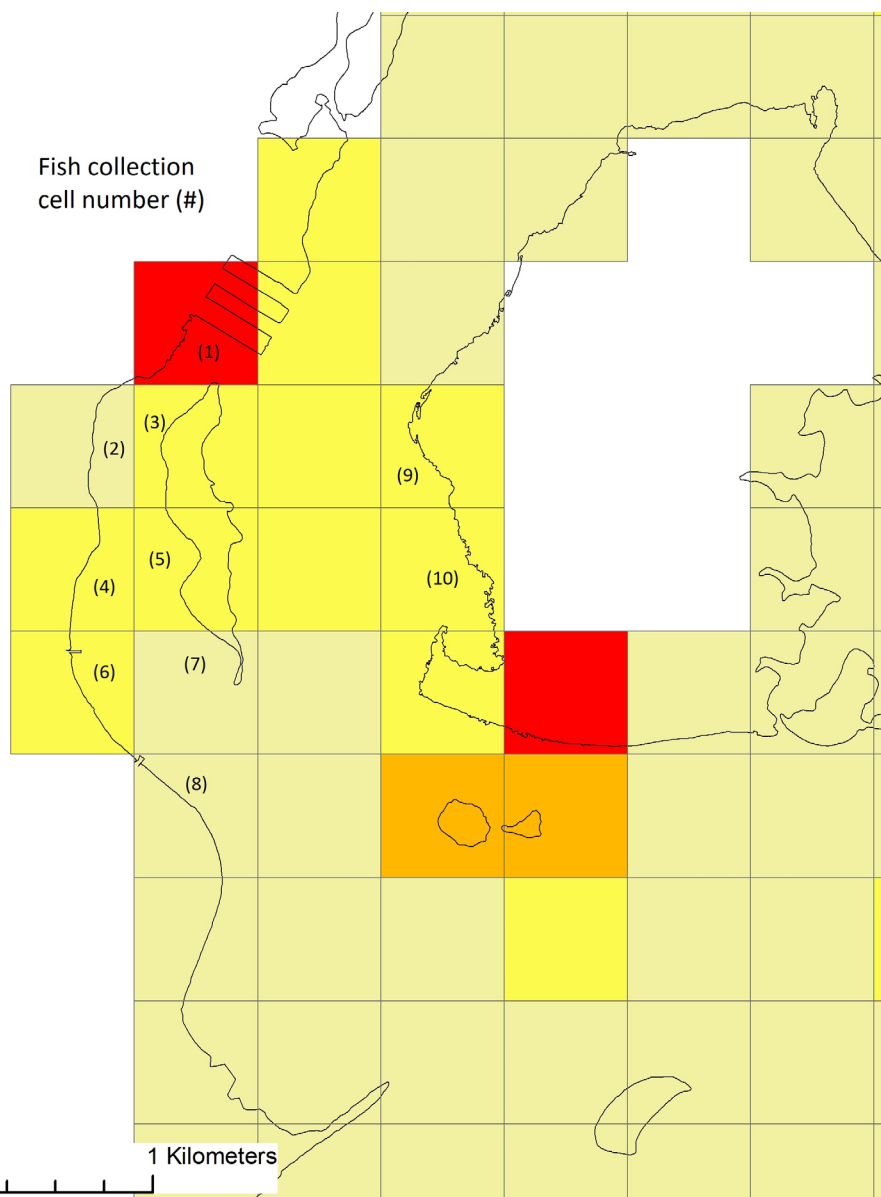
Confidence Interval and Prediction Interval





Two-Sample t-Test



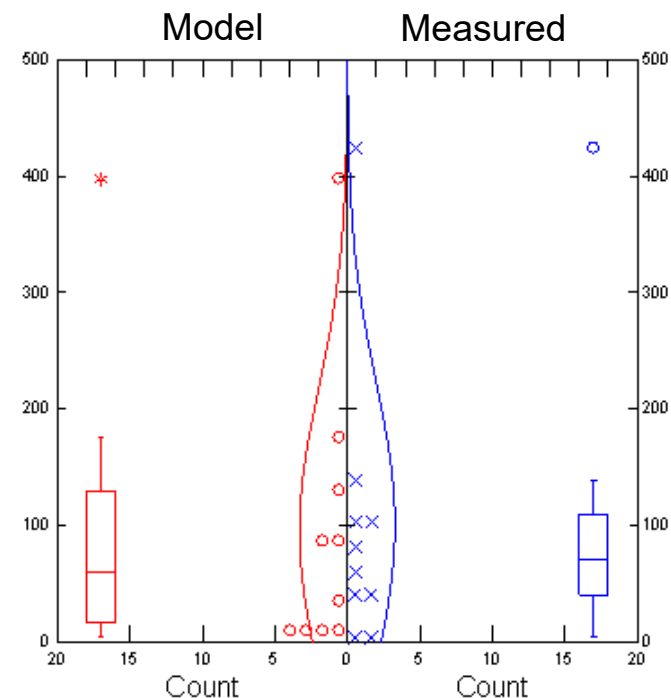


Validation (2018 sampling)

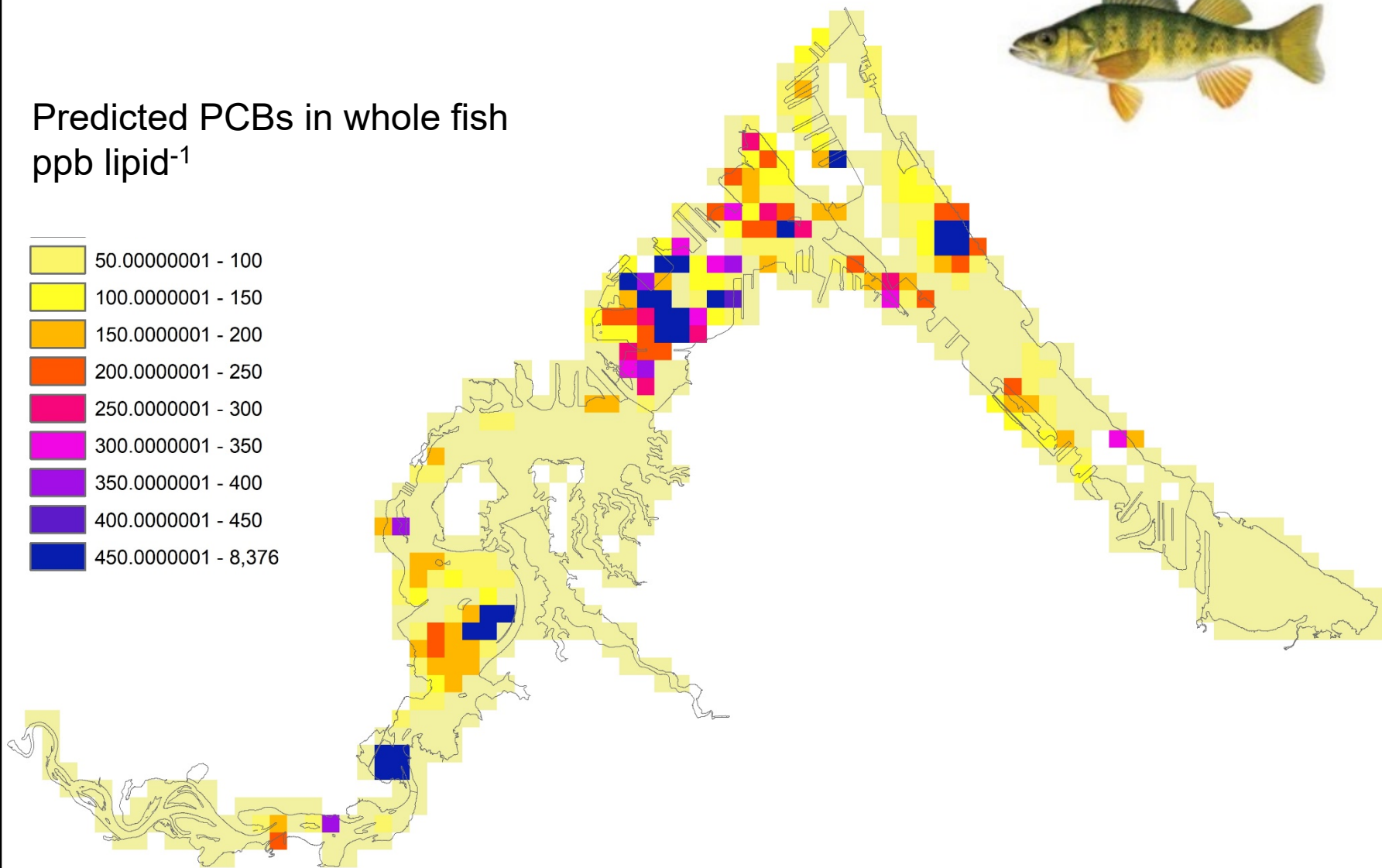
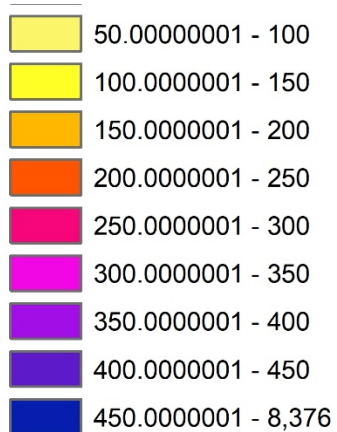
- whole fish composites
- 3-5 fish per composite
- Sampled 10 area grids
- Small (75-100 mm TL)
- Medium (125-175 mm TL)
- Max 9.2 ppm (1.4 lipid⁻¹)

T-test (p=0.93)

Two-Sample t-Test



Predicted PCBs in whole fish ppb lipid⁻¹







Updated July 2019

0 2 4 8 Kilometers













Legend

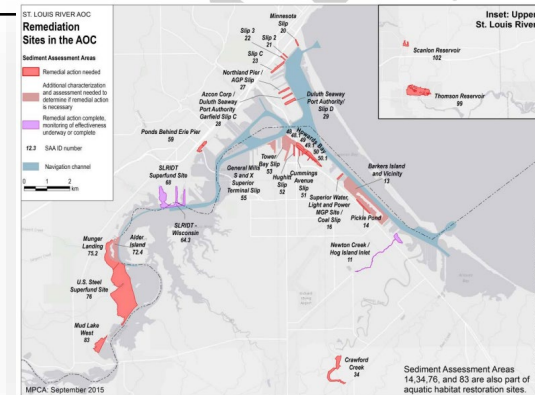
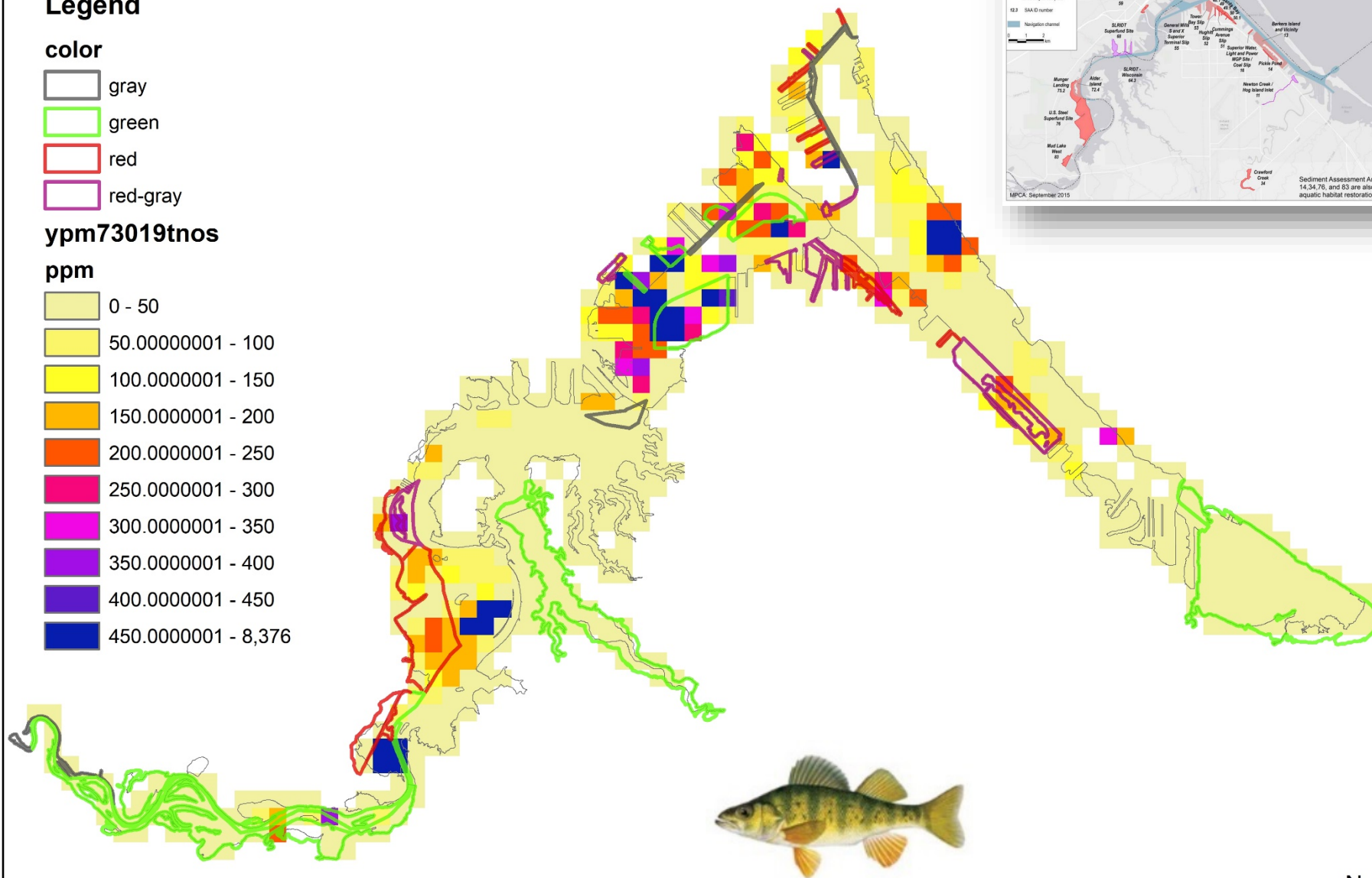
color

-  gray
-  green
-  red
-  red-gray

y_{pm73019}tnos

ppm

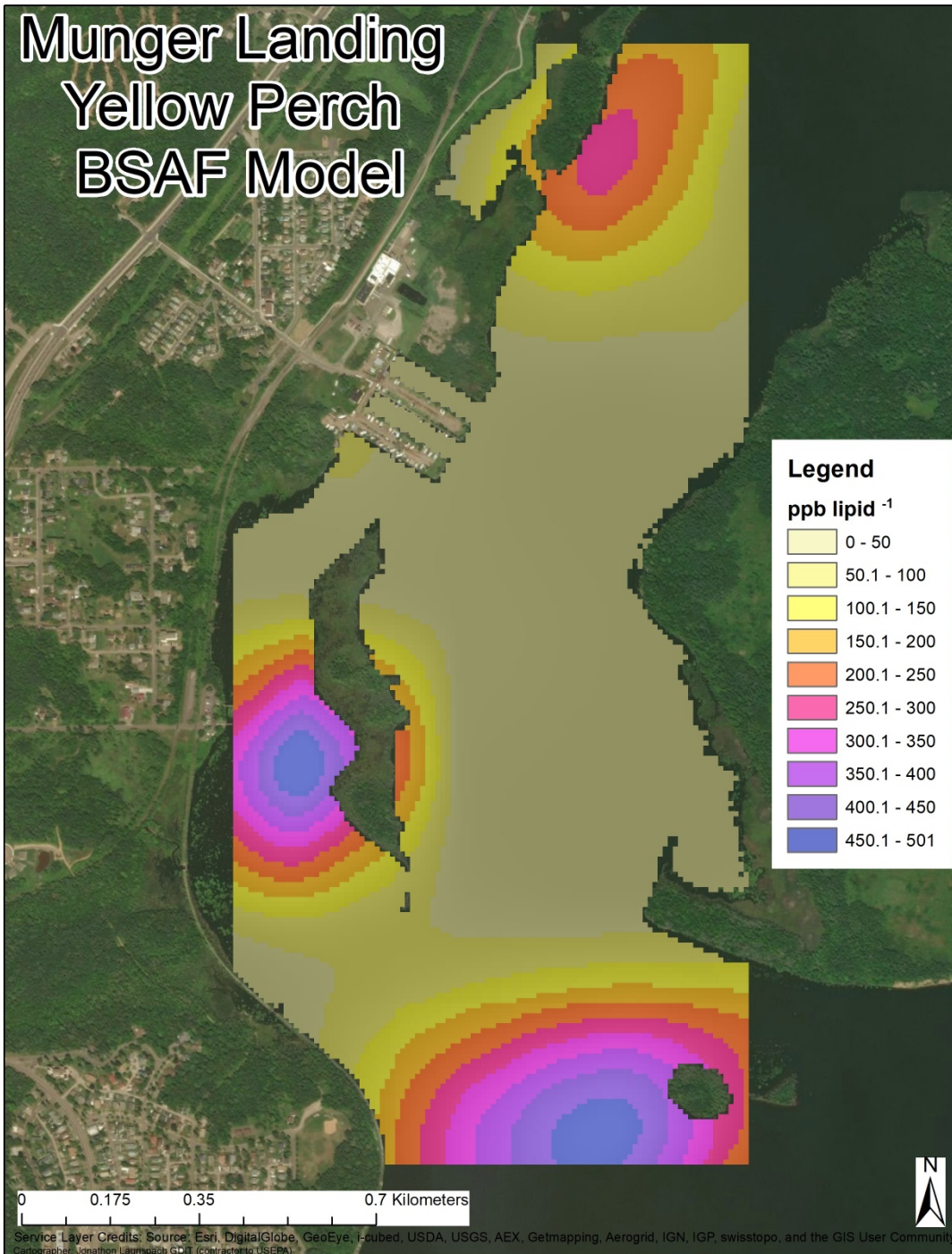
-  0 - 50
-  50.00000001 - 100
-  100.00000001 - 150
-  150.00000001 - 200
-  200.00000001 - 250
-  250.00000001 - 300
-  300.00000001 - 350
-  350.00000001 - 400
-  400.00000001 - 450
-  450.00000001 - 8,376



0 2 4 8 Kilometers



Munger Landing Yellow Perch BSAF Model



High-Resolution Simulation

- 1,024 runs
- Randomly varied computational grid
- Re-sampled at 10m grid
- Mean of 1,024 runs

Remedy and Restoration Support to Improve Urban Fishing at Munger Landing

- High-resolution model is available for Munger Landing
 - Estimate current conditions
 - Determine remediation targets
 - Design post-remedy monitoring



Conclusions

- Consumption advisory is warranted; PCBs in fillets from AOC fish are within consumption advisory ranges
- Differences in migration, habitat use, and diet habit are associated with differences in PCB residues
- BSAF model accurately predicts fish tissue residues; proxy for fish consumption advisory
- The BSAF model identified popular fishing locations that are a concern
- Next Steps:
 - Remedy and Restoration Design (ongoing)
 - Measure Improvement (post-project)
 - Screening (2021?)

