Trace metals, including mercury, in oyster tissues and sediments, New Hanover and Brunswick counties, North Carolina

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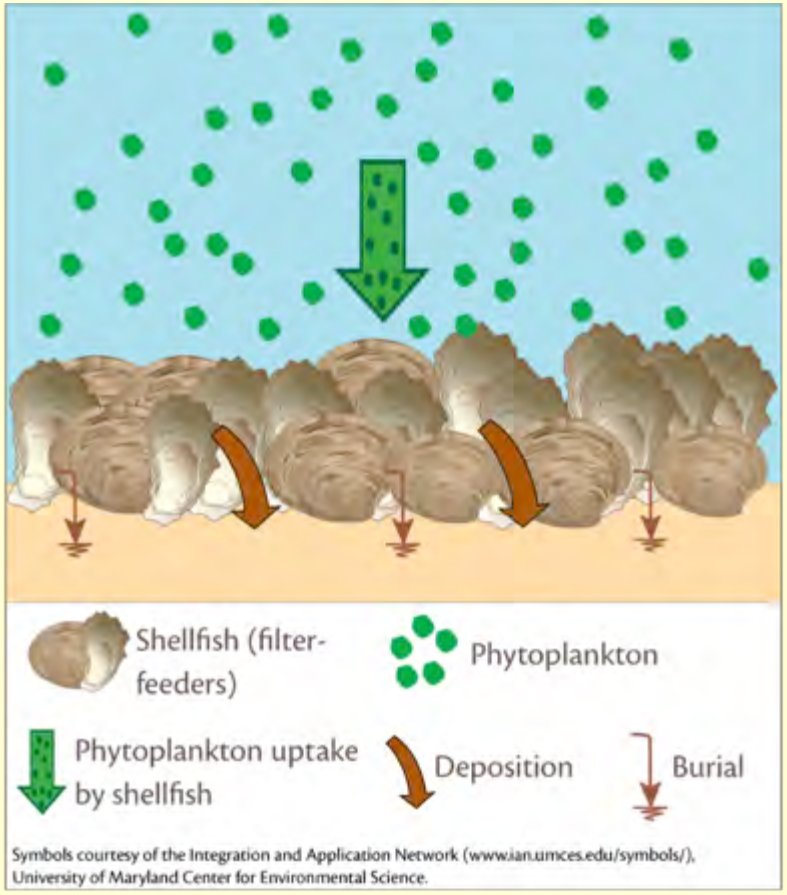
- UNCW

Oysters as environmental sentinels



Conceptual diagram illustrating the process of oyster feeding.
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Ecocheck

- Sessile
- Filter feeders
- Accumulate contaminants associated with suspended particles (sediments + phytoplankton)
- Integrate contaminant inputs with time
- Used for environmental monitoring; e.g., Mussel Watch, EMAPS, etc.

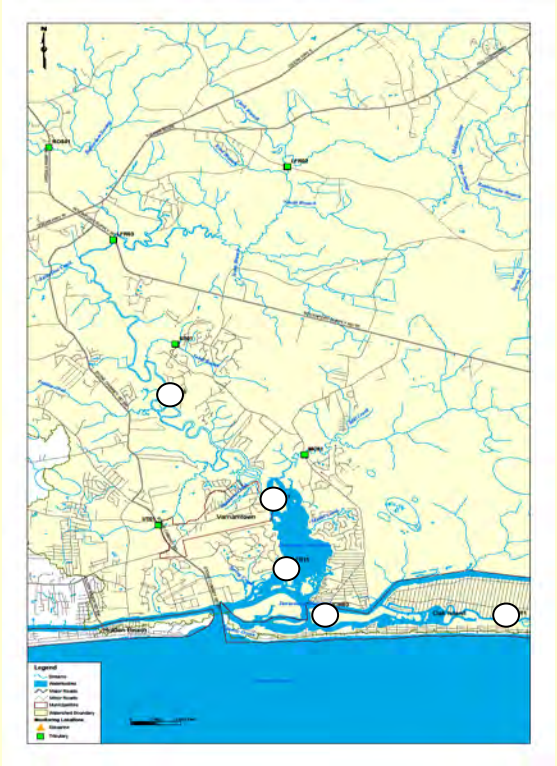
Image: Caroline Wicks, Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagelibrary/)

Contaminant effects on oysters

- Correlations between parasites and pathologies and metals and other contaminants (Kim et al., 2008)
- Embryotoxicity and genotoxicity of copper and cadmium (Mai et al., 2012)
- Cadmium effects on mitochondria and gene expression (Sokolova et al., 2005)
- Likelihood of synergistic effects on toxicity between metals and organic contaminants (e.g., PAHs, pesticides) (Ringwood et al., 1999; Geffard et al., 2003; Kim et al, 2008)
- Larvae, embryos more sensitive to toxic effects than adults

New Hanover and Brunswick counties: Active sites of oyster reefs and restoration

Map of Lower Cape Fear River estuary/Atlantic Intracoastal Waterway complex, showing sites of oyster studies and/or restoration by various UNCW researchers and NC Coastal Federation. (Google Earth image)



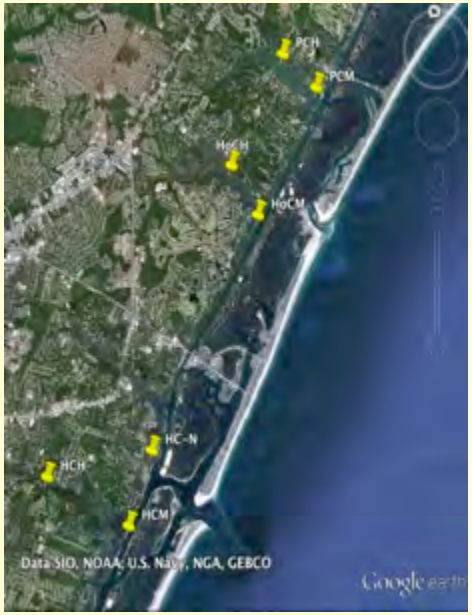
Map of Lockwood Folly River estuary, showing estuarine sampling sites used by the North Carolina Coastal Federation in their recent Section 319-funded water quality monitoring and restoration project (http://www.nccoast.org/southeast/current-issues-lockwood.asp).

Project objectives

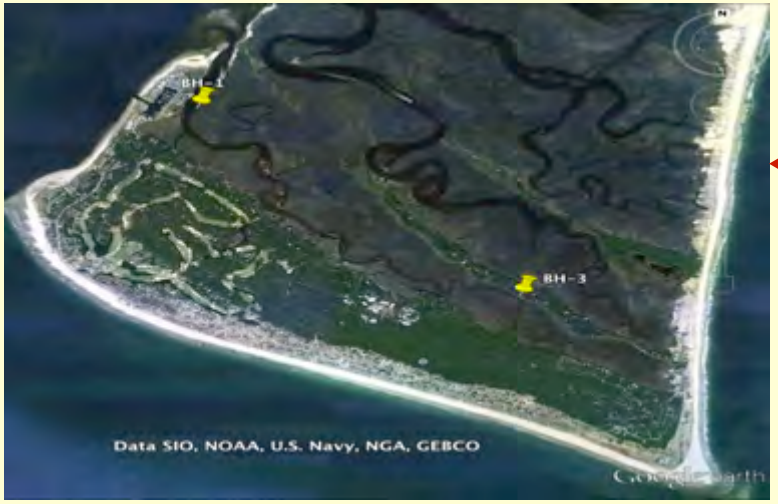
- Collect oysters and sediments from active reefs in New Hanover and Brunswick counties
- Analyze for a suite of trace metals (this talk) and organic contaminants (Mead talk)
- Examine relationships between sediment and oyster tissue concentrations
- Put results in context with other studies
- Develop Web-based application for results

10 oysters/19 sites/9 metals ≈ 200 oysters analyzed
+ sediments at each site. Some analyses still in progress

Sample sites

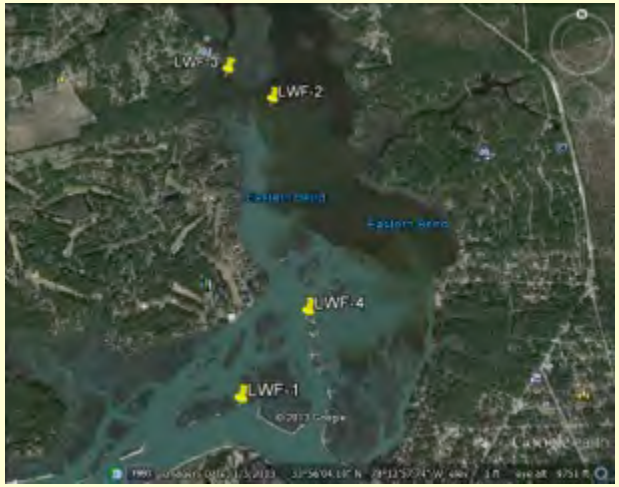


Wrightsville Beach, AIW, Bradley, Hewlett's, Howe, Pages, Whiskey creeks



Bald Head Isl.

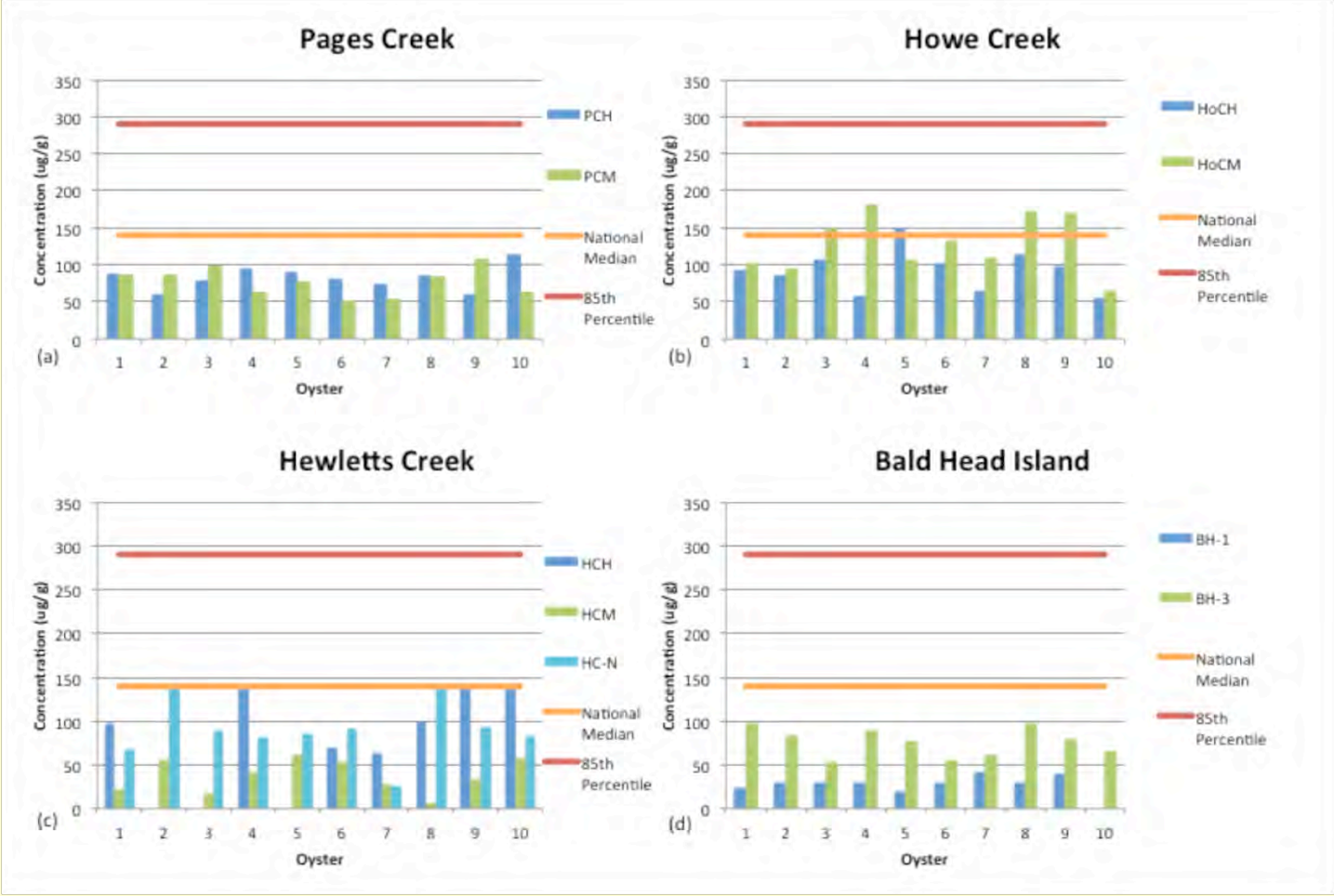
Lockwood Folly estuary



Focus today on a few key metals

- Copper (industry, runoff, antifouling paints)
- Zinc (industry, runoff, antifouling paints)
- Arsenic (bedrock, historical pesticide use?)
- Mercury (industry, coal burning, waste combustion)

Relatively high variability among oysters at each site

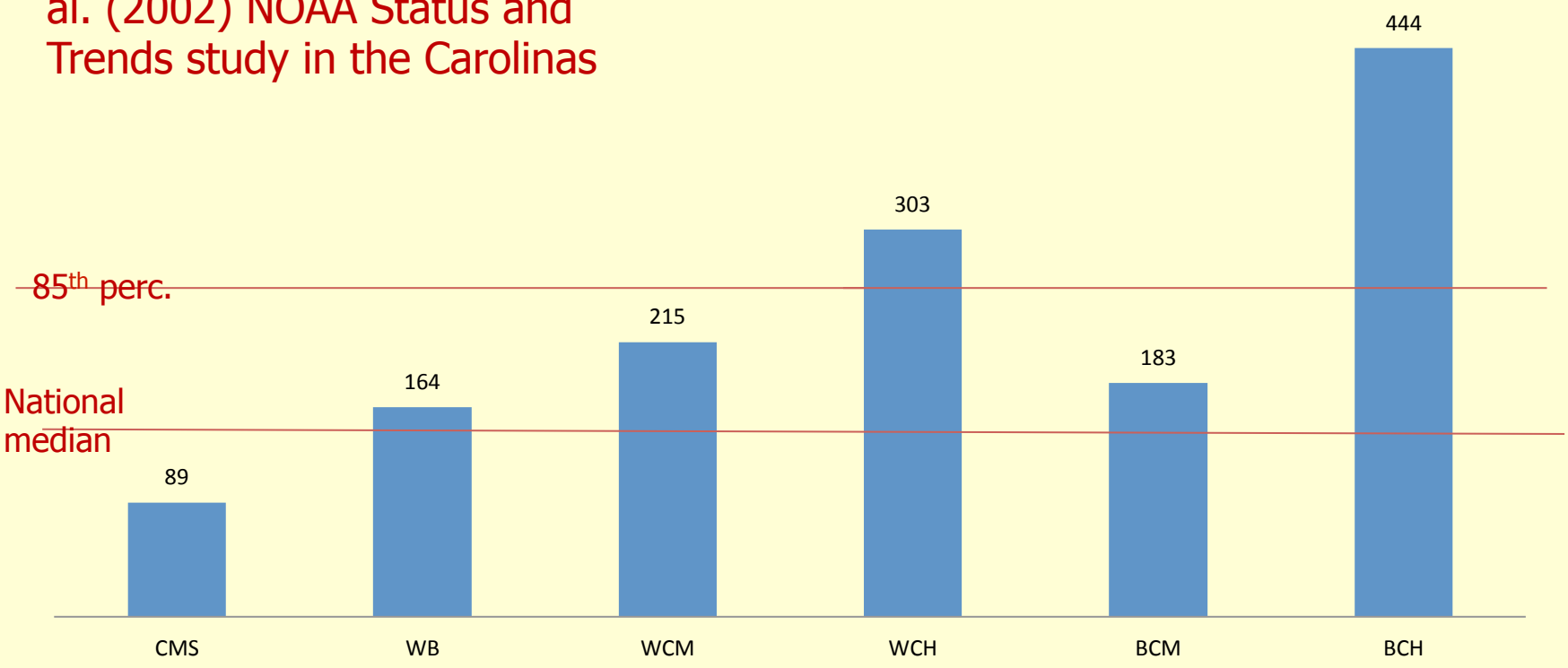


- Copper as an example
- Hard to follow pattern so will use composite concentrations henceforth

Copper in oyster tissues

(AIW, Wrightsville Beach and Whiskey and Bradley creeks)

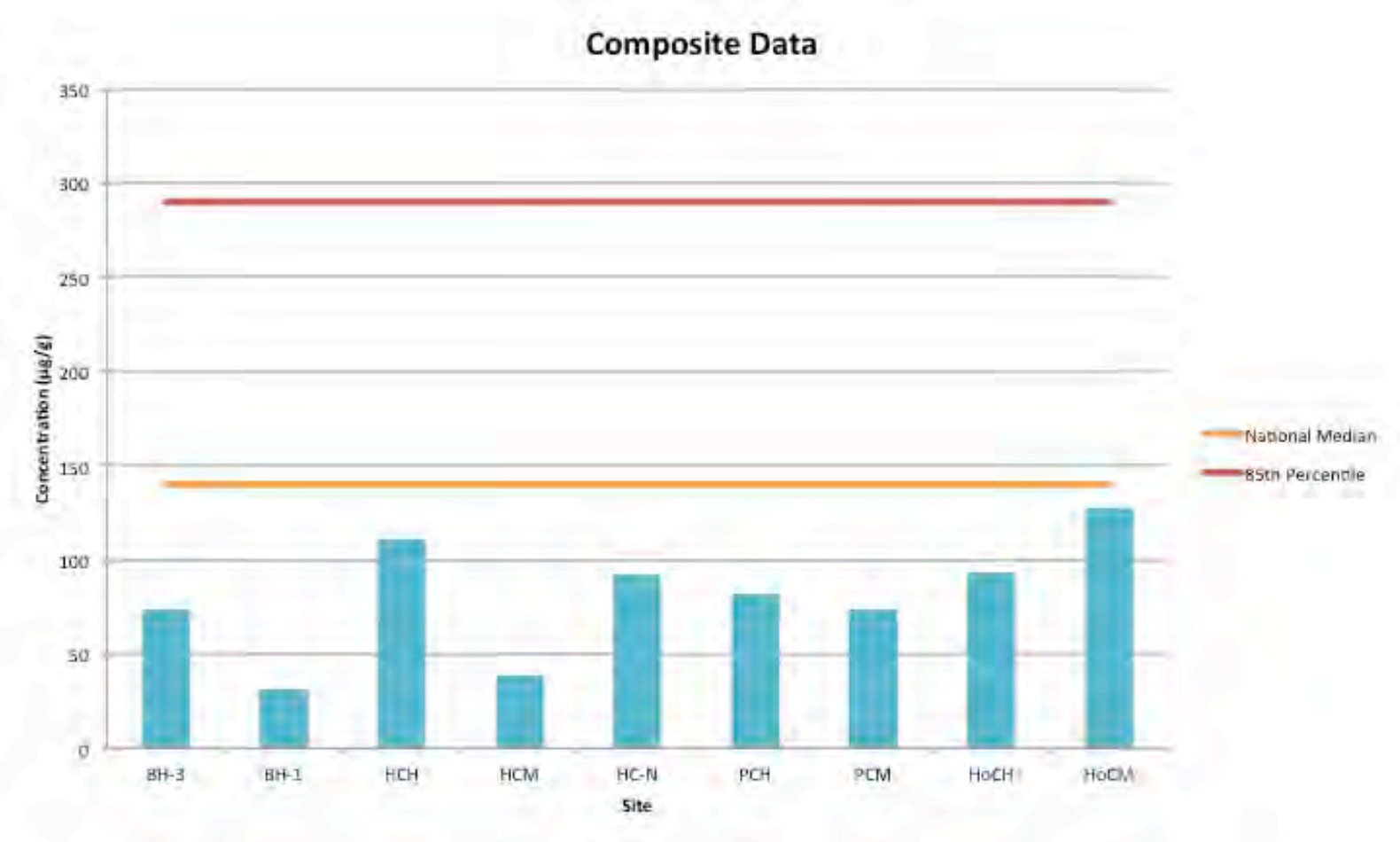
National median and 85th percentiles from Lauenstein et al. (2002) NOAA Status and Trends study in the Carolinas



• Head vs. mouth pattern • Marina effect • Antifouling paints

Copper in oyster tissues

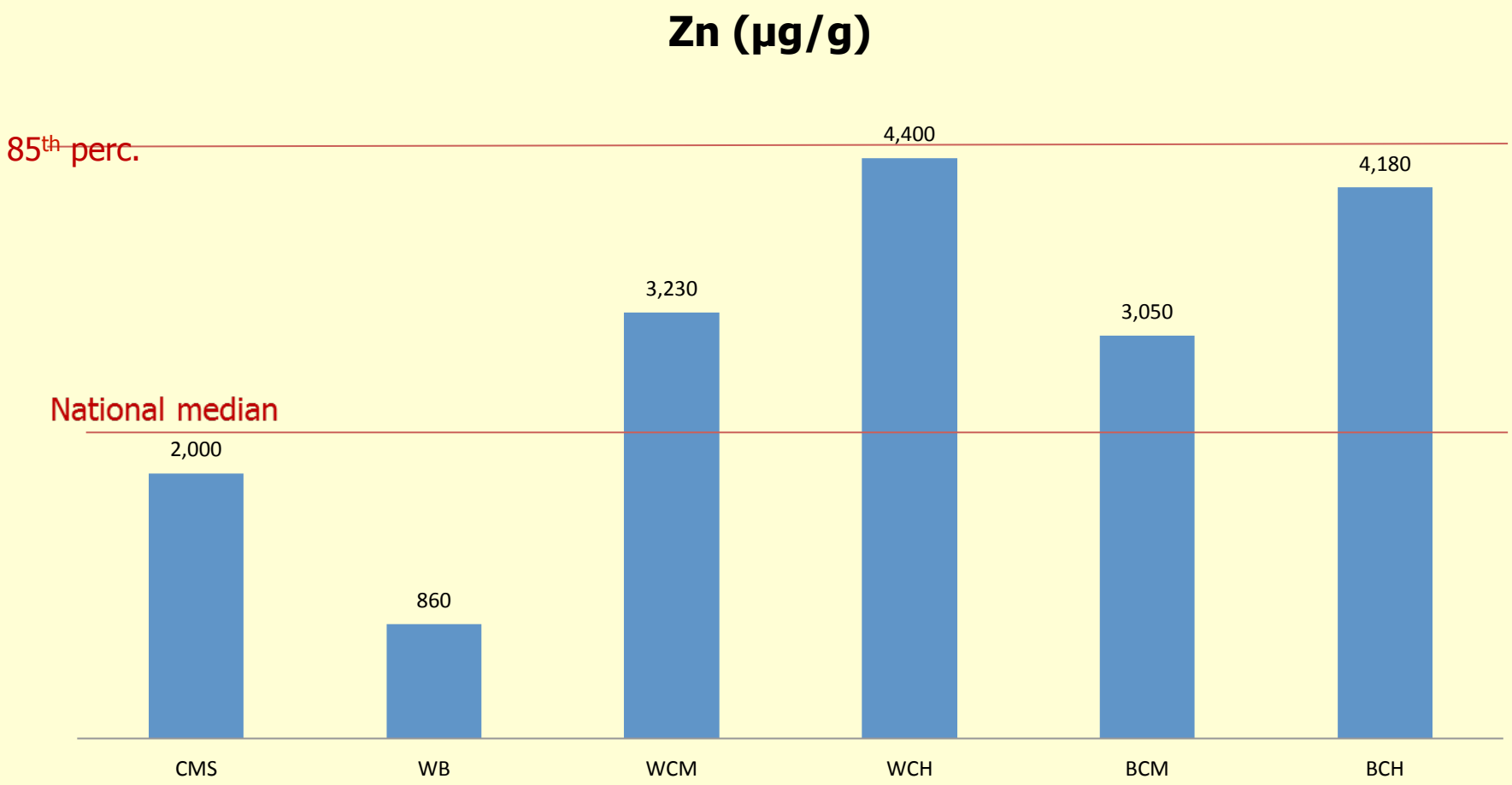
(Bald Head Island and Hewlett's, Howe, and Pages creeks)



- Head vs. mouth effect at BHI, Hewletts, Pages creeks

Zinc in oyster tissues

(AIW, Wrightsville Beach, and Whiskey and Bradley creeks)



- High levels in developed watersheds
- Head vs. mouth effect
- Boat paints, runoff

Zinc in oyster tissues

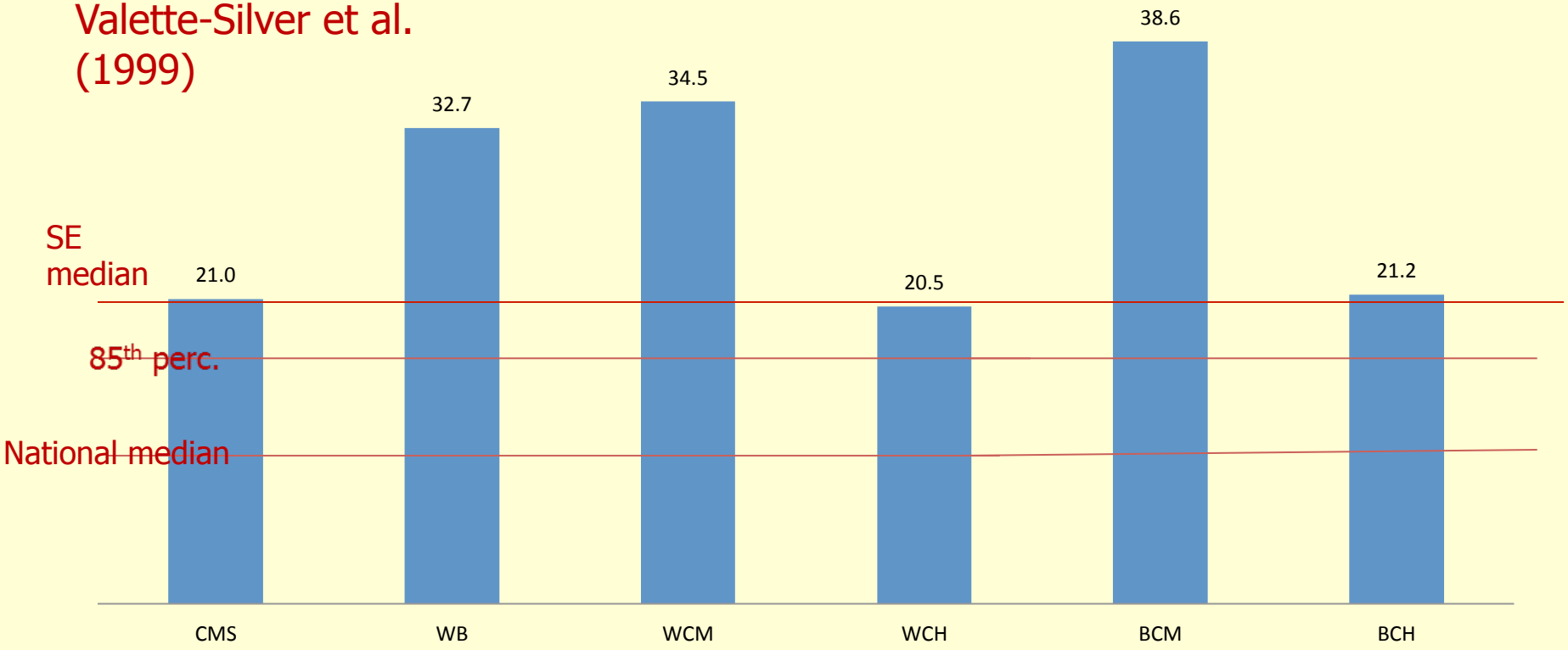
(Bald Head Island and Hewlett's, Howe, and Pages creeks)

- Head vs. mouth • Impacts of more developed watersheds

Arsenic in oyster tissues

(AIW, Wrightsville Beach and Whiskey and Bradley creeks)

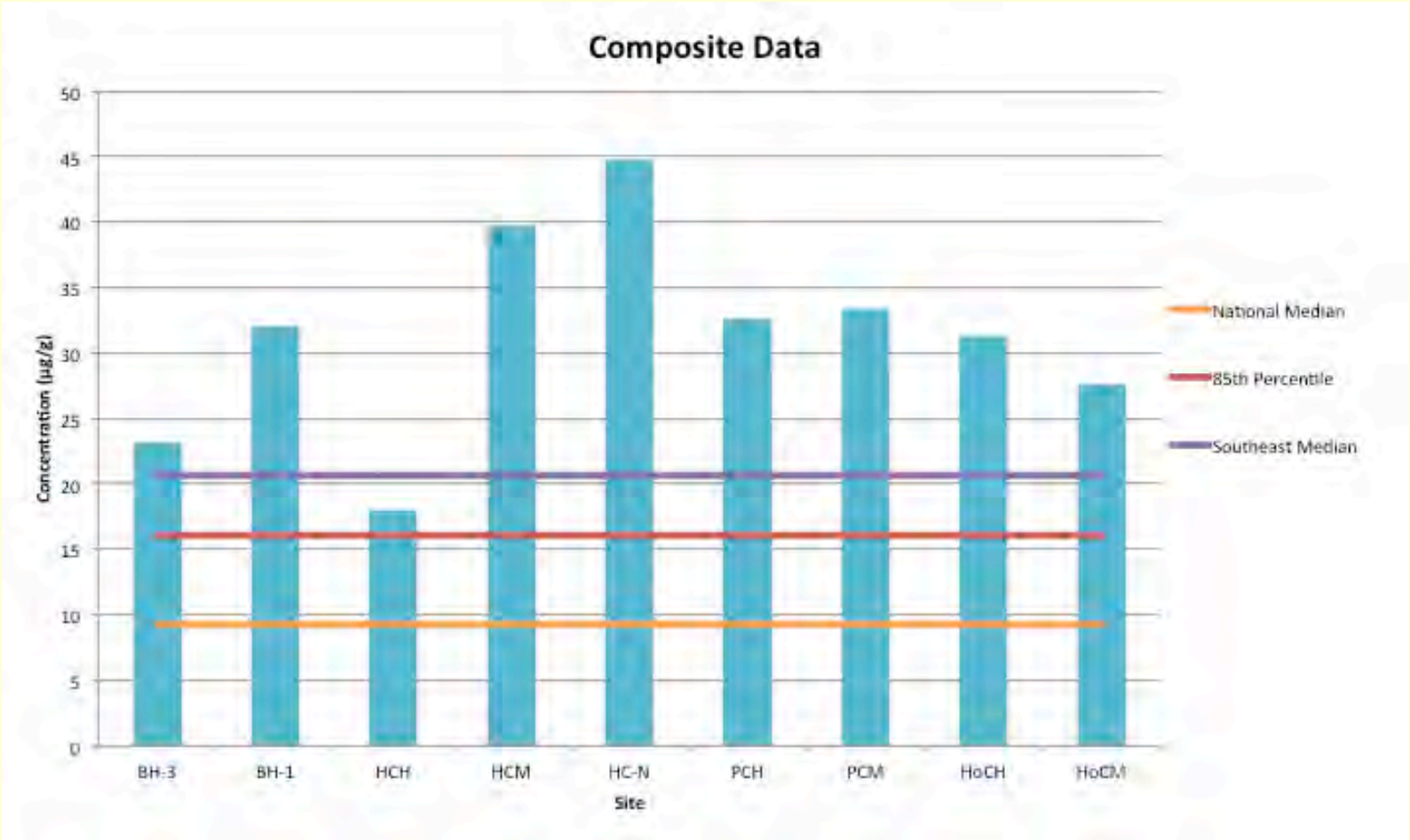
Southeastern U.S. median concentration from Valette-Silver et al. (1999)



- Higher at mouths
- At or above 85th perc. and SE medians

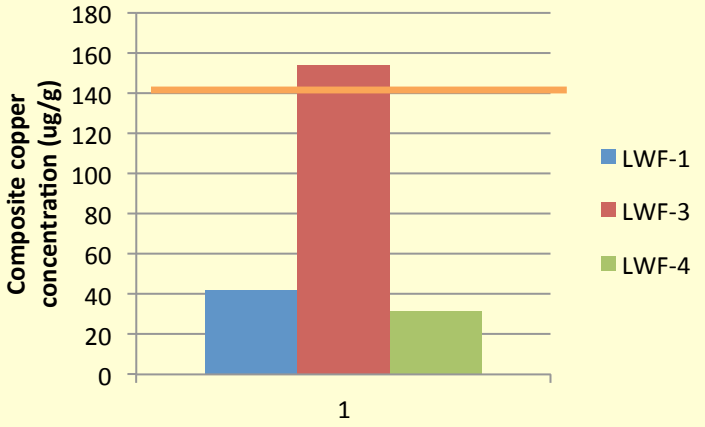
Arsenic in oyster tissues

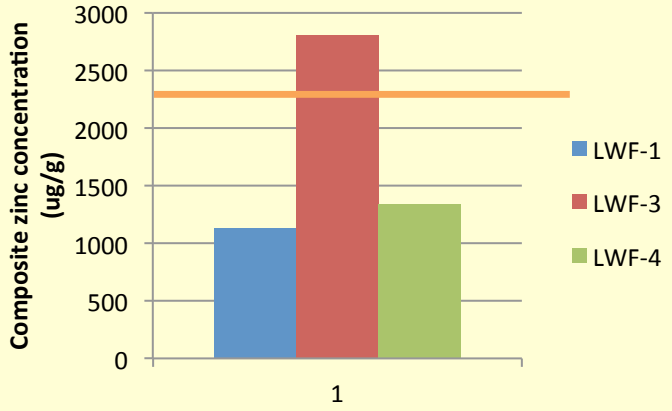
(Bald Head Island and Hewlett's, Pages, Howe creeks)



- Often greater at mouths
- At or above 85th perc. and SE median
- Bedrock/historical pesticide use in Cape Fear?

Lockwood Folly estuary
Brunswick County

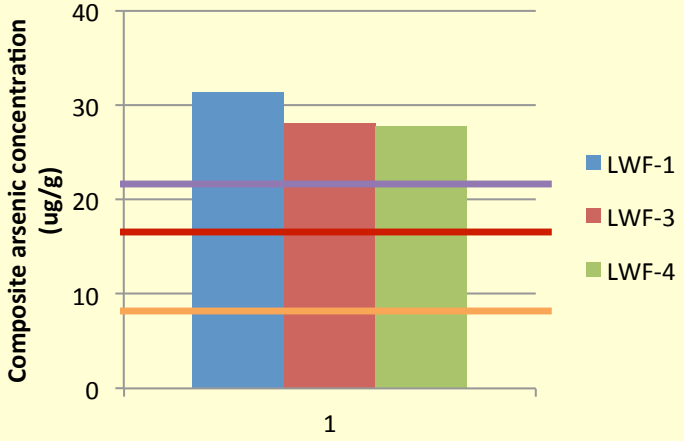




National median

National 85th perc.

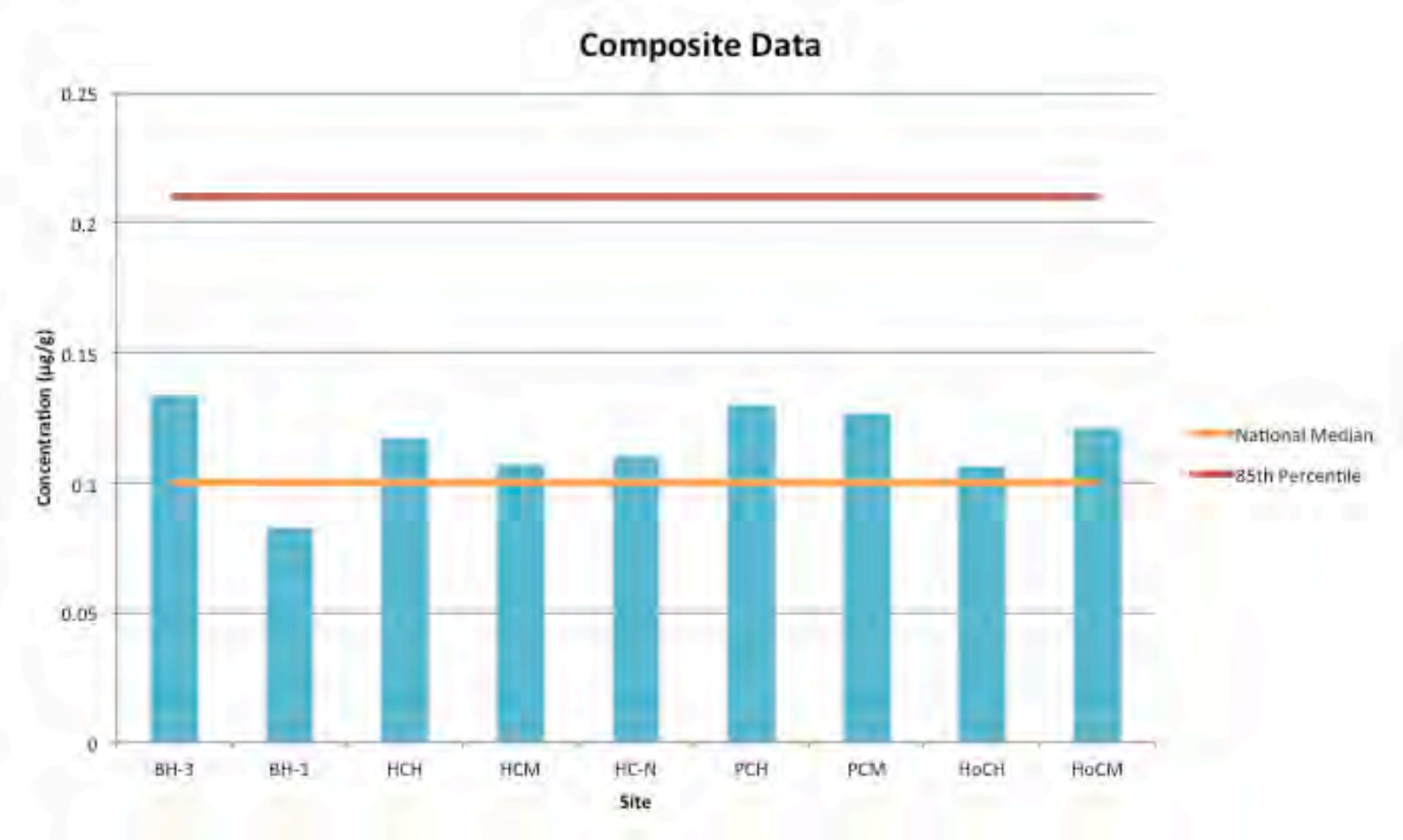
SE median



- Similar arsenic as CF system
- High copper and zinc at site 3—nearest boating activities
- Very muddy

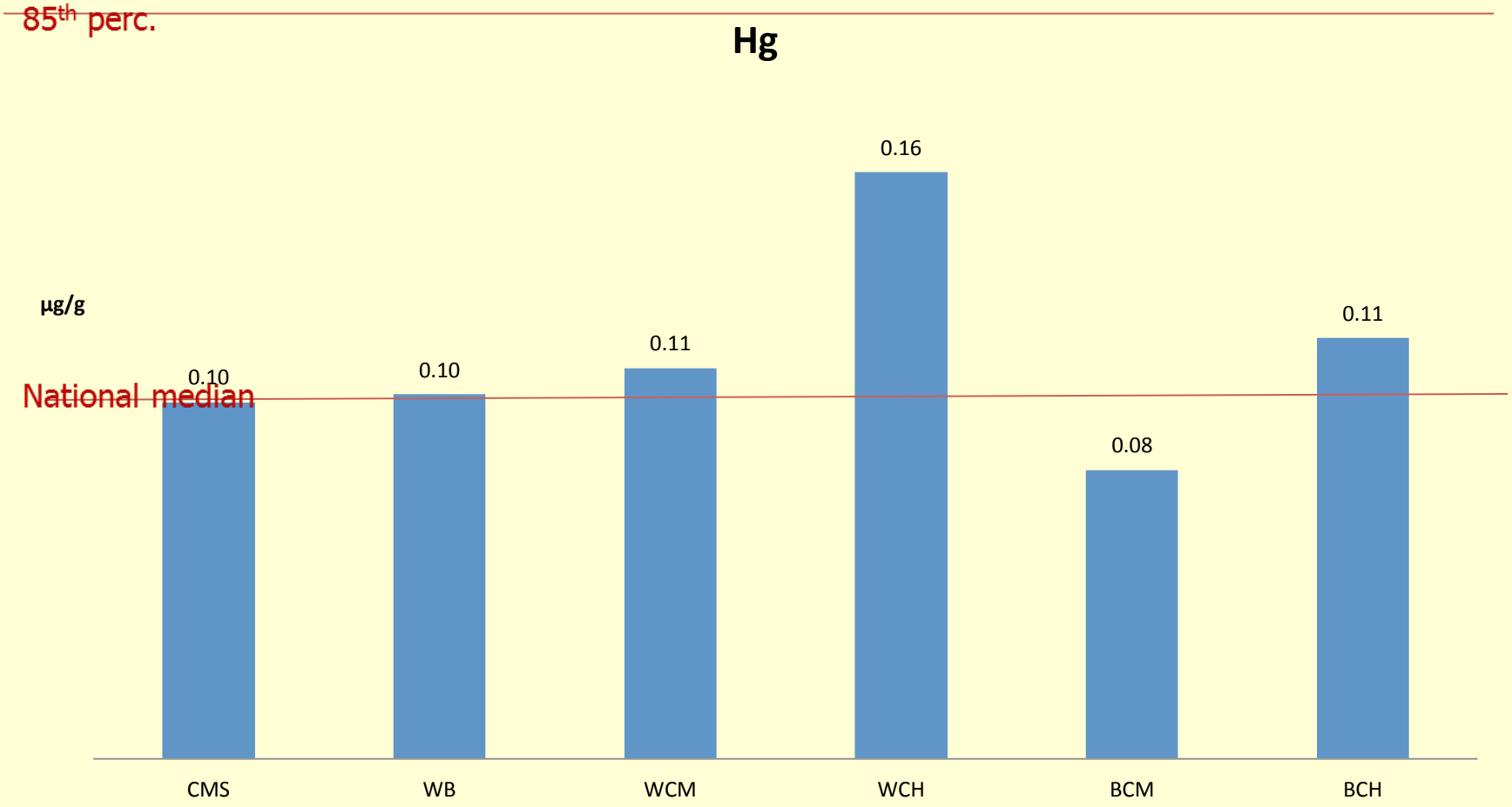
Mercury in oyster tissues

(Bald Head Island and Hewlett's, Pages, Howe creeks)



- "Typical levels • Close to national median • Higher in muddier sediments

Mercury in oyster tissues
(AIW, Wrightsville Beach, and Whiskey and Bradley creeks)

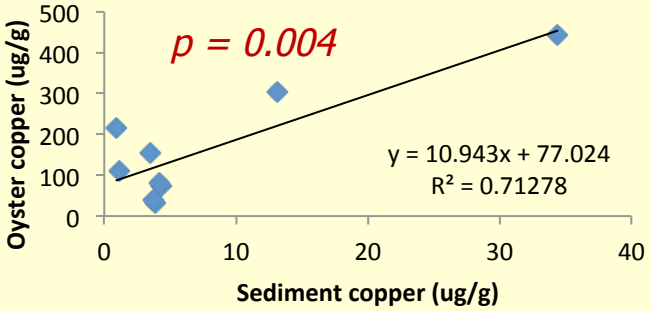


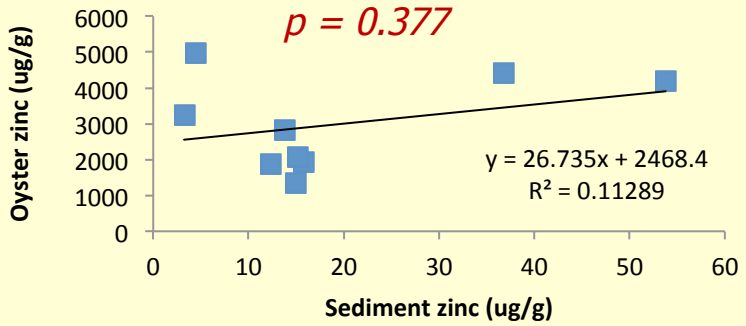
• "Typical levels • Close to national median • Higher in muddier sediments

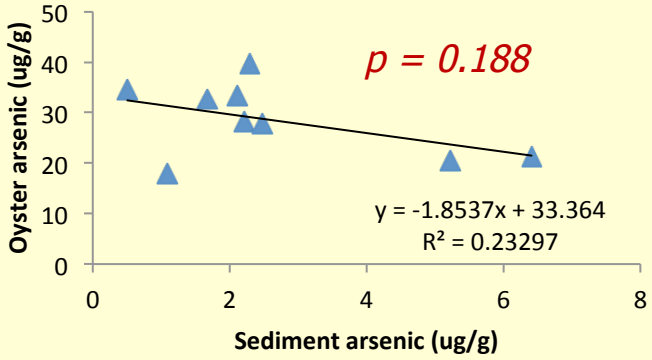
Mercury bioaccumulation

- Assuming the concentrations of total mercury in the water column are 10-20 pM (Schneider, 2009)
- Average mercury concentration in the collected oysters is 0.10 μg/g,
- Bioaccumulation factor for total mercury is 50,000 to 100,000 in the sampled oysters

Is there a relationship between sediment and oyster metal content?

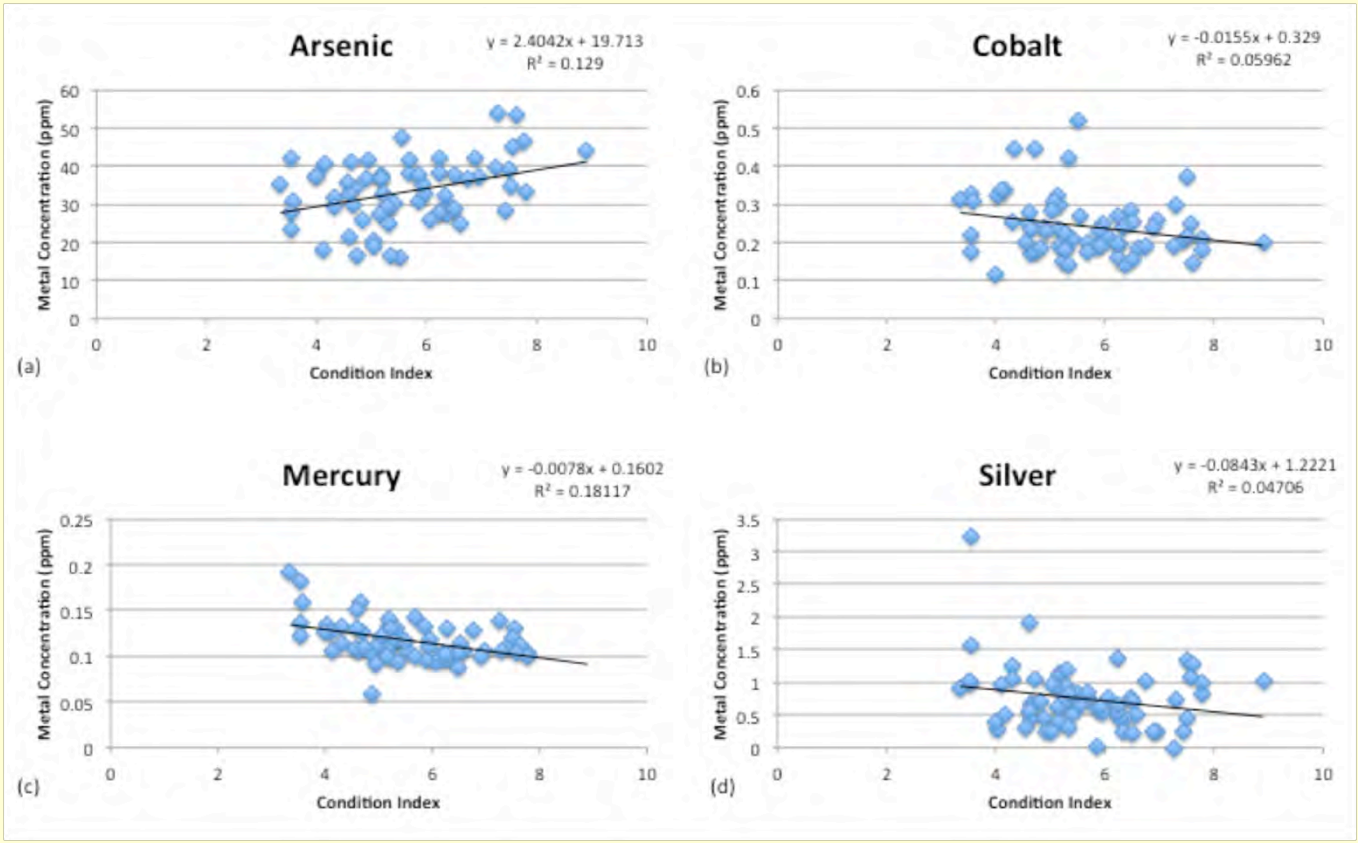






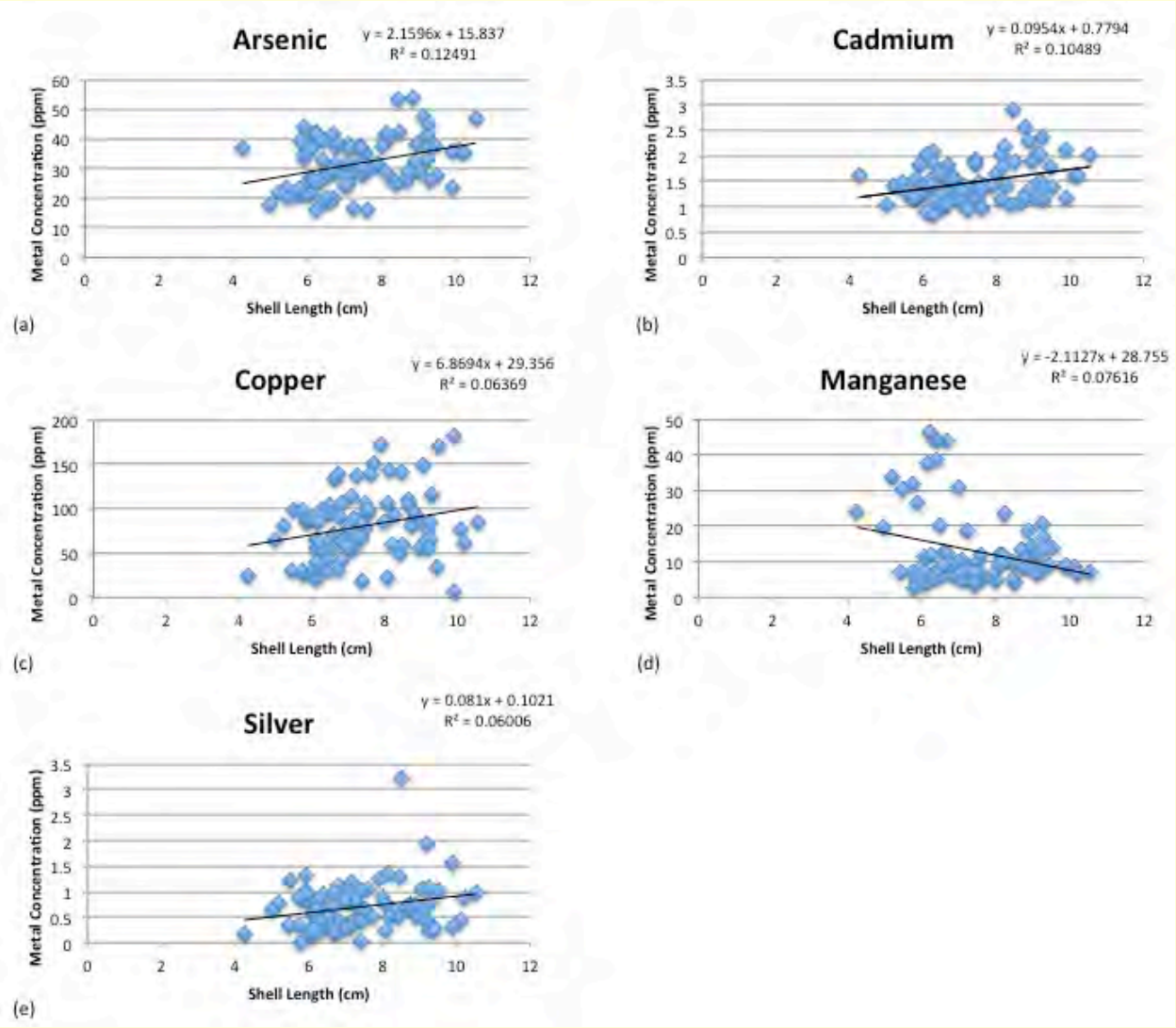
- Yes for copper, but driven by higher concentrations
- No for arsenic and zinc
- More data coming
- No relationship necessarily expected because of nature of filter feeders

Correlations with condition index



- Significant correlations with pictured metals ($p < 0.05$)
- Not signficant for other metals (copper, zinc)
- Arsenic—bioaccumulation?
- Mercury-negative correlation

Correlations with shell length



- Significant correlations ($p < 0.05$) for pictured metals
- Not significant for other metals (zinc, mercury)
- Evidence of bioaccumulation?

Conclusions

- Copper and zinc typically higher in tidal creek heads relative to mouths—accumulation in fine sediments, poor flushing
- Association of copper and zinc with antifouling paints, development, runoff
- Arsenic at or exceeding 85th percentile and/or Southeastern US median—naturally occurring or legacy of historical pesticide use?
- Mercury typical. Bioaccumulation by 50,000-100,000 fold in oysters