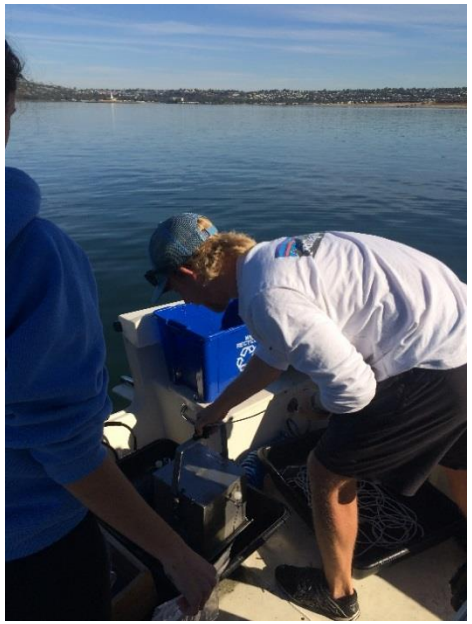
Experiential Learning and Interdisciplinary Research in Mission Bay





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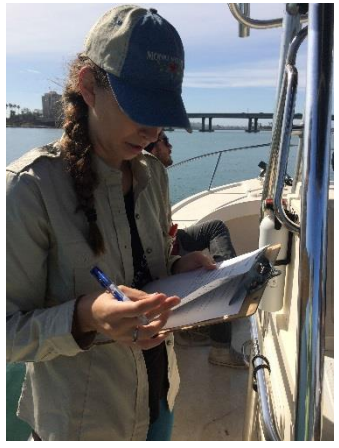
University of San Diego

Research Applications in Environmental and Ocean Sciences

- Upper division course in the Department of Environmental and Ocean Sciences. Required for all majors. Began in the Fall of 2015.
    - research training:
        - data collection
        - learning field sampling methods and analytical techniques
        - synthesizing multidisciplinary data sets
        - putting findings into context of the broader literature
        - scientific communication
    - **interdisciplinary**, hypothesis-based, hands-on research project examining the **spatial and temporal variability of biological, chemical, geological and physical factors** within **Mission Bay** and the surrounding watershed



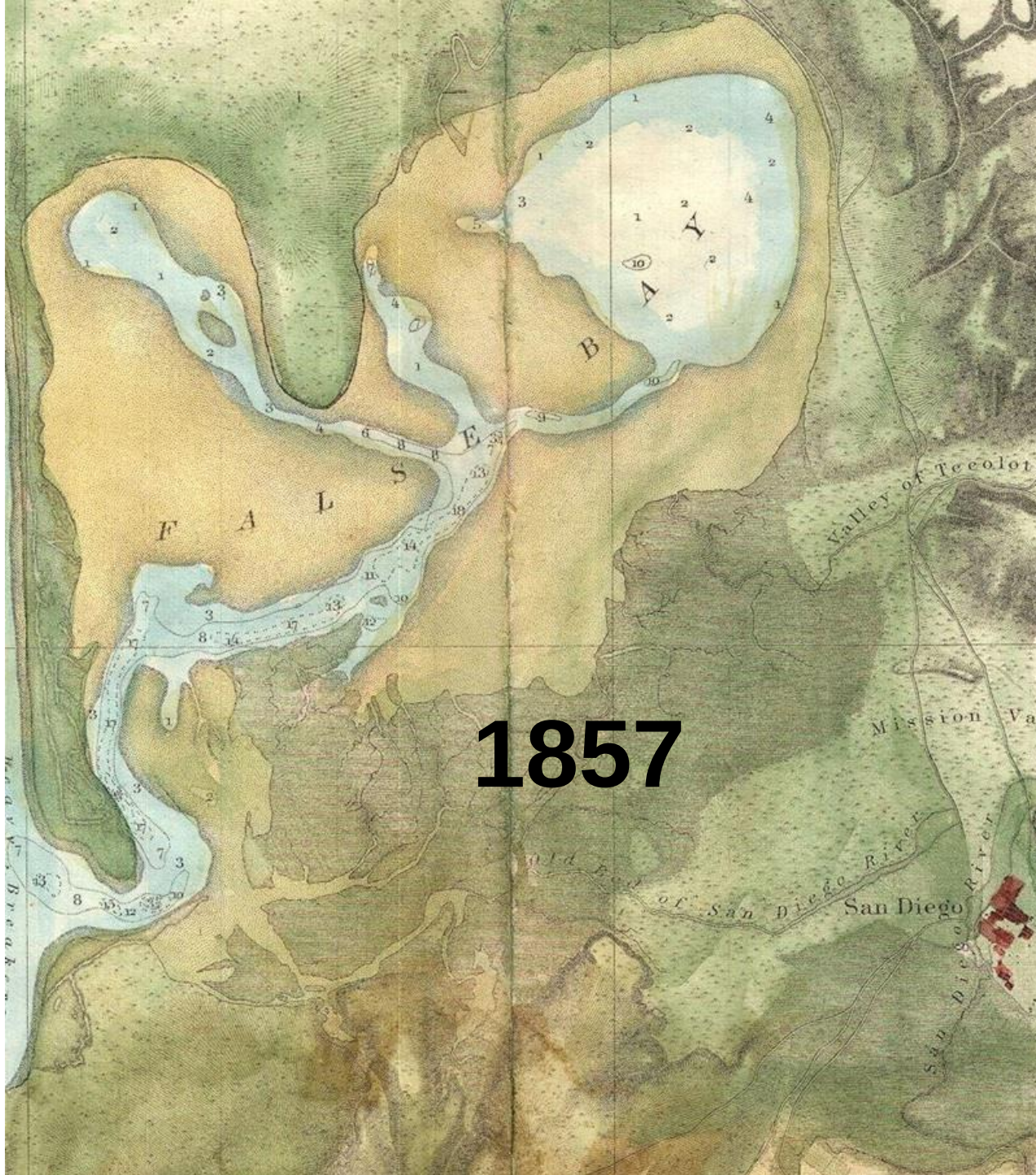
Why Mission Bay?

- urbanized, heavily modified estuary (can place into context of anthropogenic influences, ReWILD, which appeals to students from environmental impacts perspective)
- logistically easy to access from USD
- less research effort than other coastal lagoons (SD Bay)
- implications for human health and how bay is used recreationally

- **archive data to contribute to long-term Mission Bay database which supports additional faculty and student research projects**
- possibility for developing collaborations across institutions and agencies

Mission Bay History

- Originally known as False Bay
- 1888 — Rose Hartwick Thorpe writes poem referring to False Bay as Mission Bay; name officially changed in 1915 by action of U.S. Geographic Board
- Significant modifications made through the late 1940s



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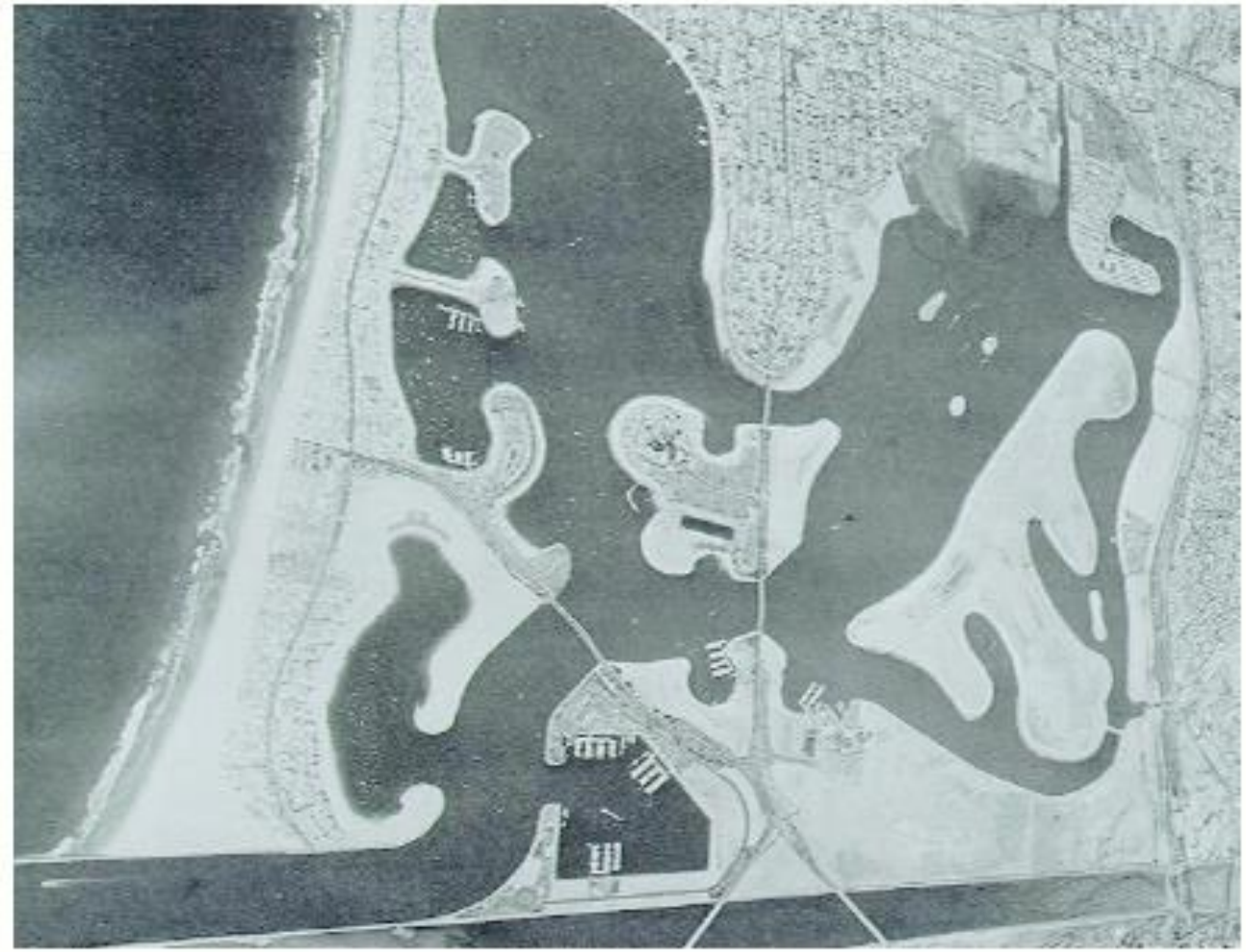
1926: Mission Beach

1937 Mission Bay 1945

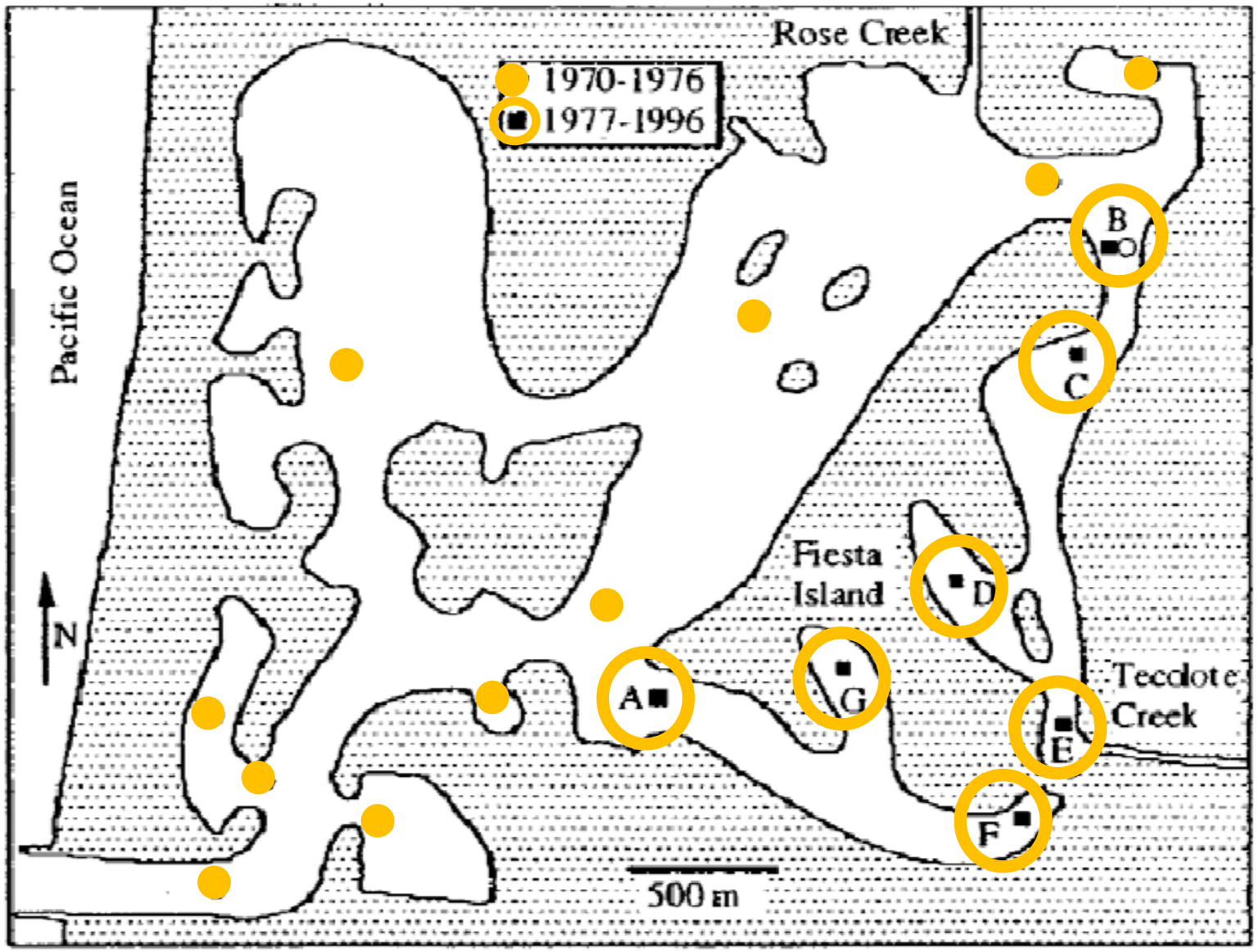


Mission Bay

- 1961 survey published in CA Fish and Game noted depleted mollusks, crab and shrimp populations

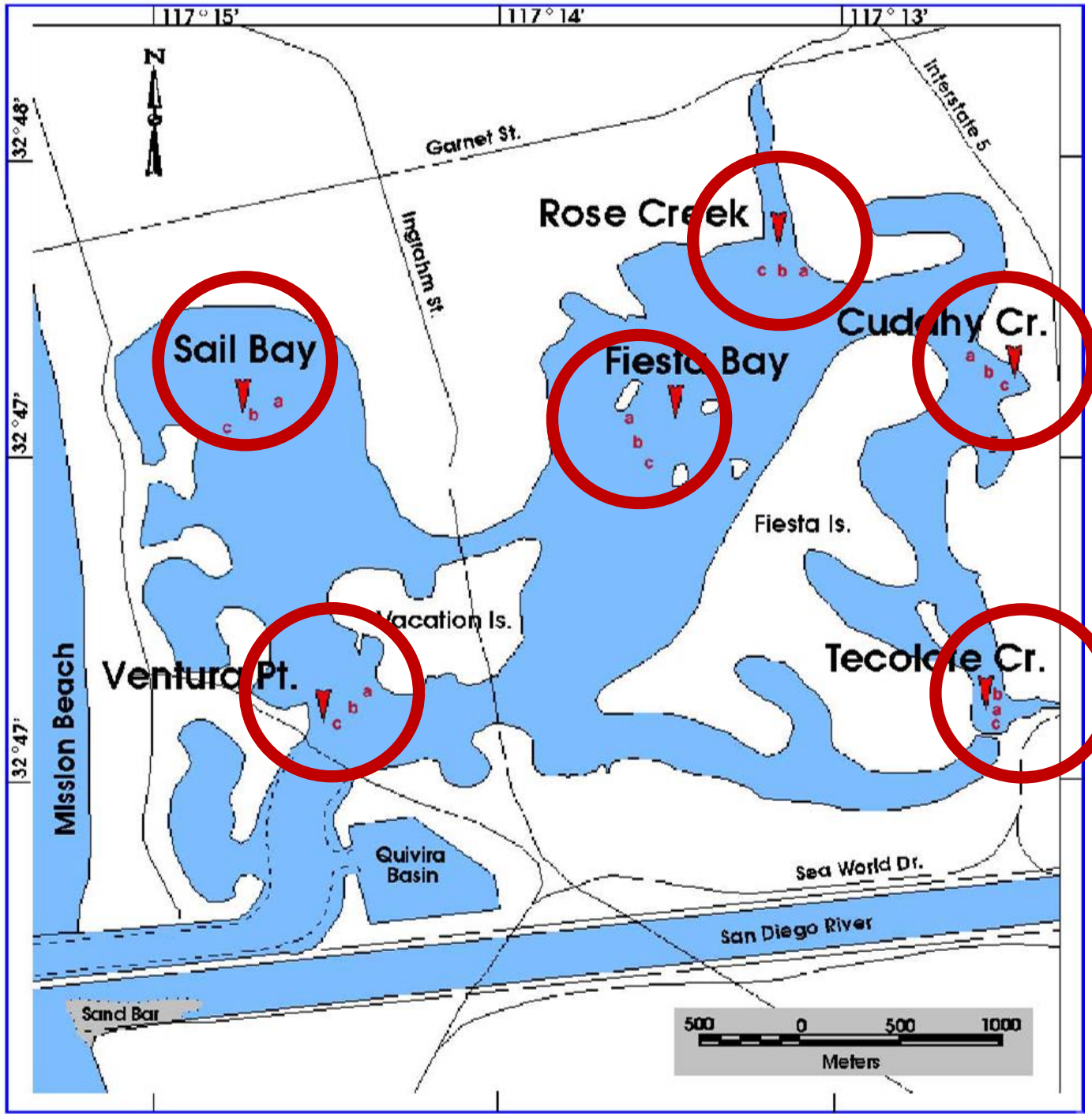
Dexter (1983)
Dexter & Crooks (2000)

- long-term spatial and temporal trends in subtidal benthic communities
- Biological:
  - 0.1m^2 Hayward orange peel grab (5 liters)
  - 15-20 cm depth
  - replicate grabs within 3-6m radius of station
  - organic content
  - grain size
  - 750µm mesh sieve (benthic infauna)
- Hydrographic:
  - surface & bottom temp and salinity
  - DO
  - water transparency



Kaufmann et al. (2001-2005)

- hydrographic parameters, nutrients and plankton
- sediment samples collected by Ekman grab
  - water content (weight), organic content (LOI) and grain size (LPS)
  - meiofauna
  - total organic carbon (TOC)
  - trace metals: cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn)



University of San Diego
Mission Bay Research Project

- **Main Research Question:**
  - **What are the biological, chemical, geological, and physical factors that influence the benthic environment at Mission Bay?**
    - **How do these factors vary spatially and temporally?**
  - **Additional focus this semester:**
    - **How have the populations of *Arcuatula senhousia* changed over time?**

  - **Longer term focus:**
    - **Compile all data and look at longer temporal trends**
    - **Ultimately publish primary literature articles synthesizing our data**
    - **ReWILD**

Course approach

-grid Mission Bay
(0.25 X 0.25 nautical miles)

-assign each grid a letter-number code

Fall 2015

- Sampled 50 Mission Bay stations to get high spatial resolution background data
- Shore-based sampling in Rose Creek, Cudahy Creek and Tecolote Creek
- October 27- November 5

Current Sampling Stations

-15 Boat Stations
-15 Shore Stations

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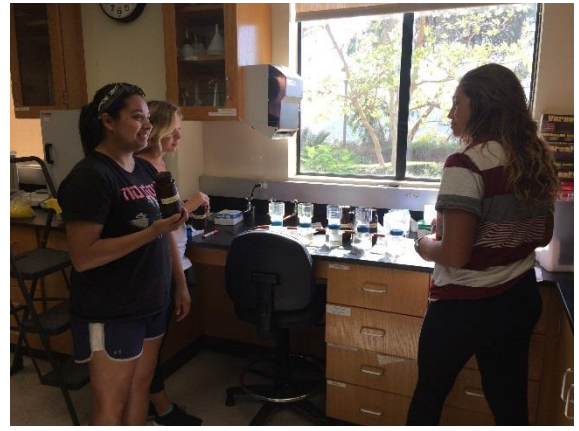
-15 Shore Stations

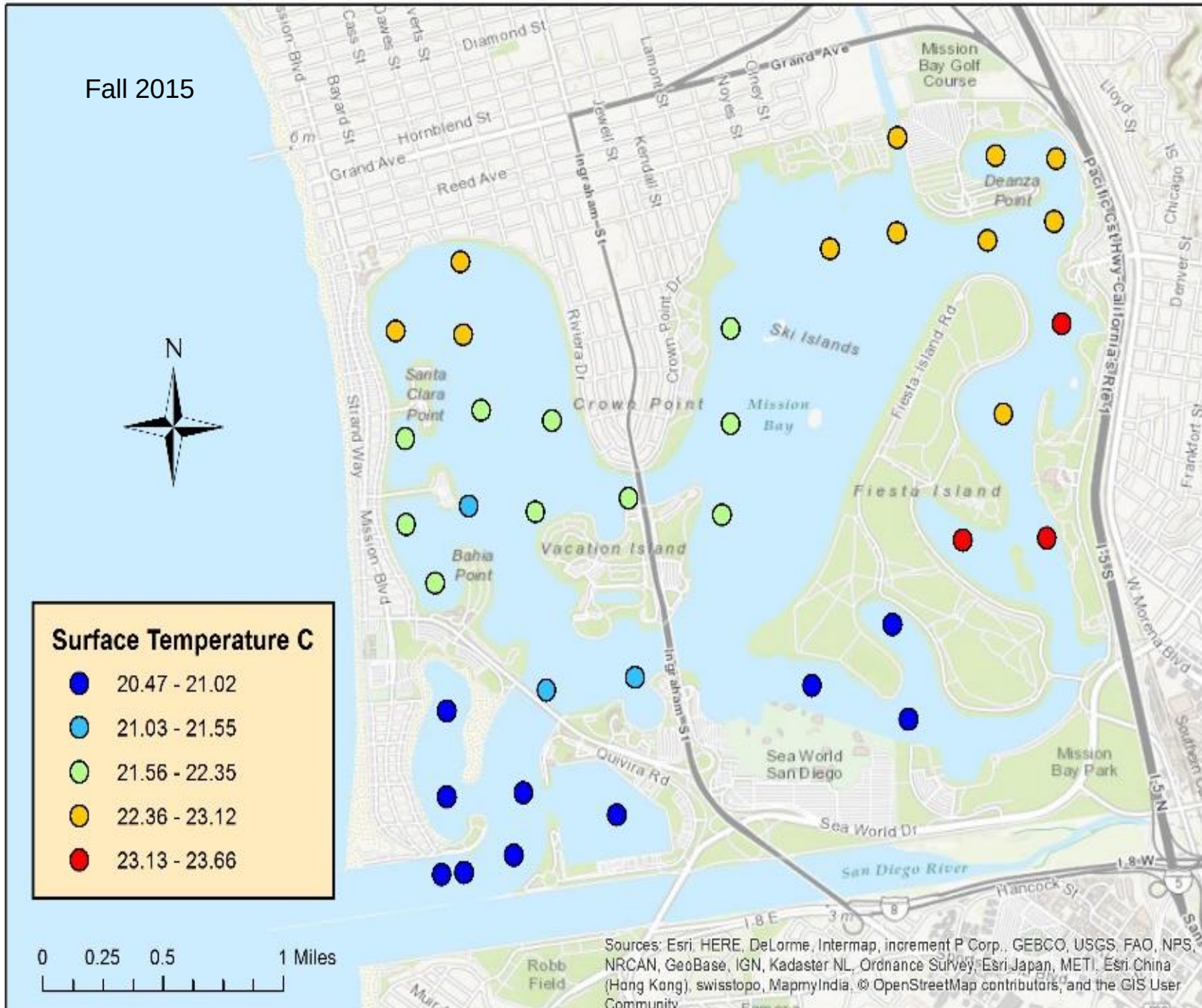
Sampling Approach

- At each station:
  - CTD cast (depth, salinity, temperature profile)
  - Ekman grab sample
    - Sediment collected for LOI, LPS, XRF, and pore water weight
    - 5-ml core (in triplicate) for meiofauna
    - 1-2 liters of sediment sieved (500 µm sieve) for macrofauna
  - 500 ml water sample from surface in dark bottle: chlorophyll and phosphate
  - YSI: DO, turbidity, temperature, pH at surface
  - Portable weather station
  - Surface Plankton Tow (boat sites only)

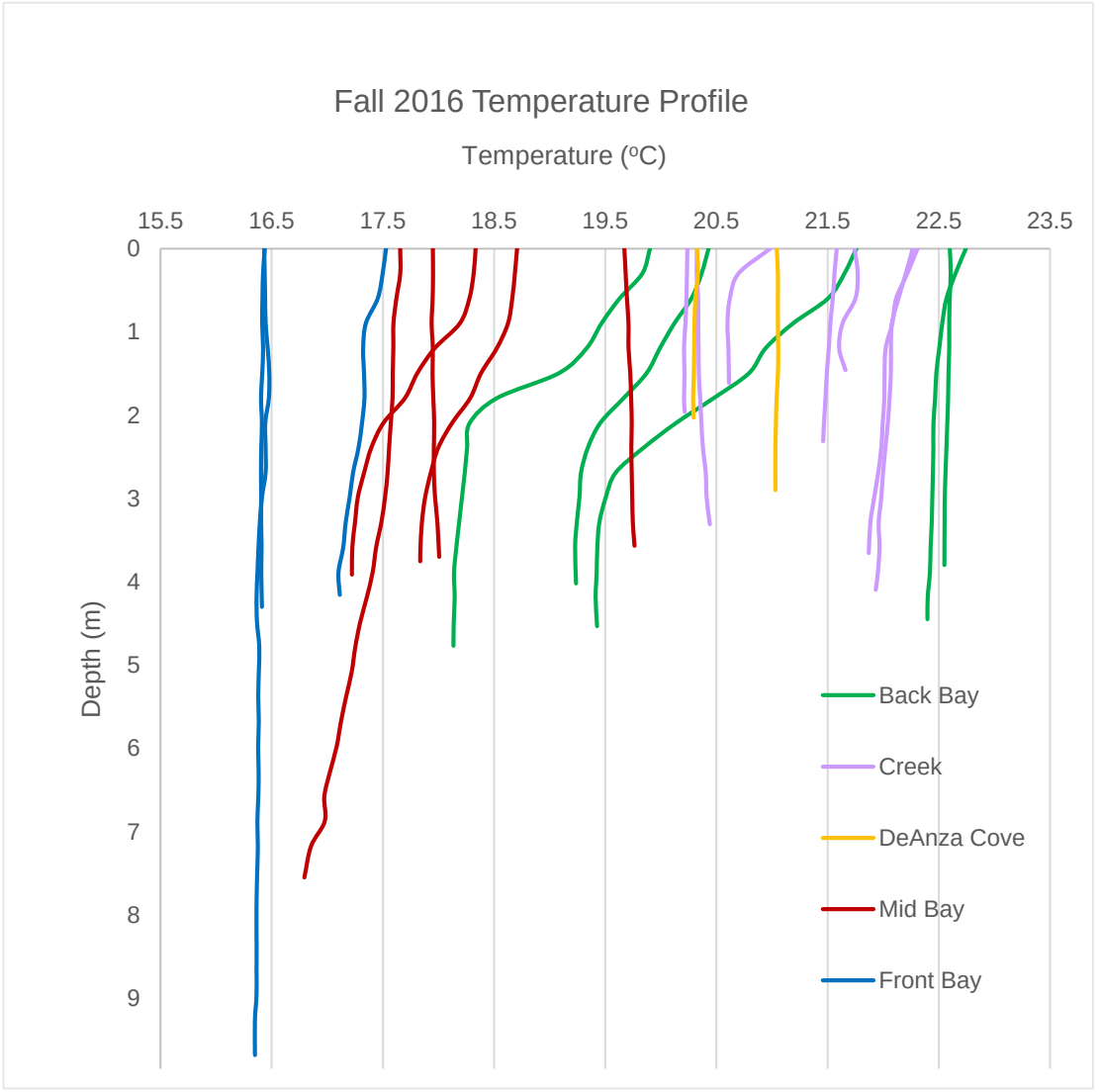


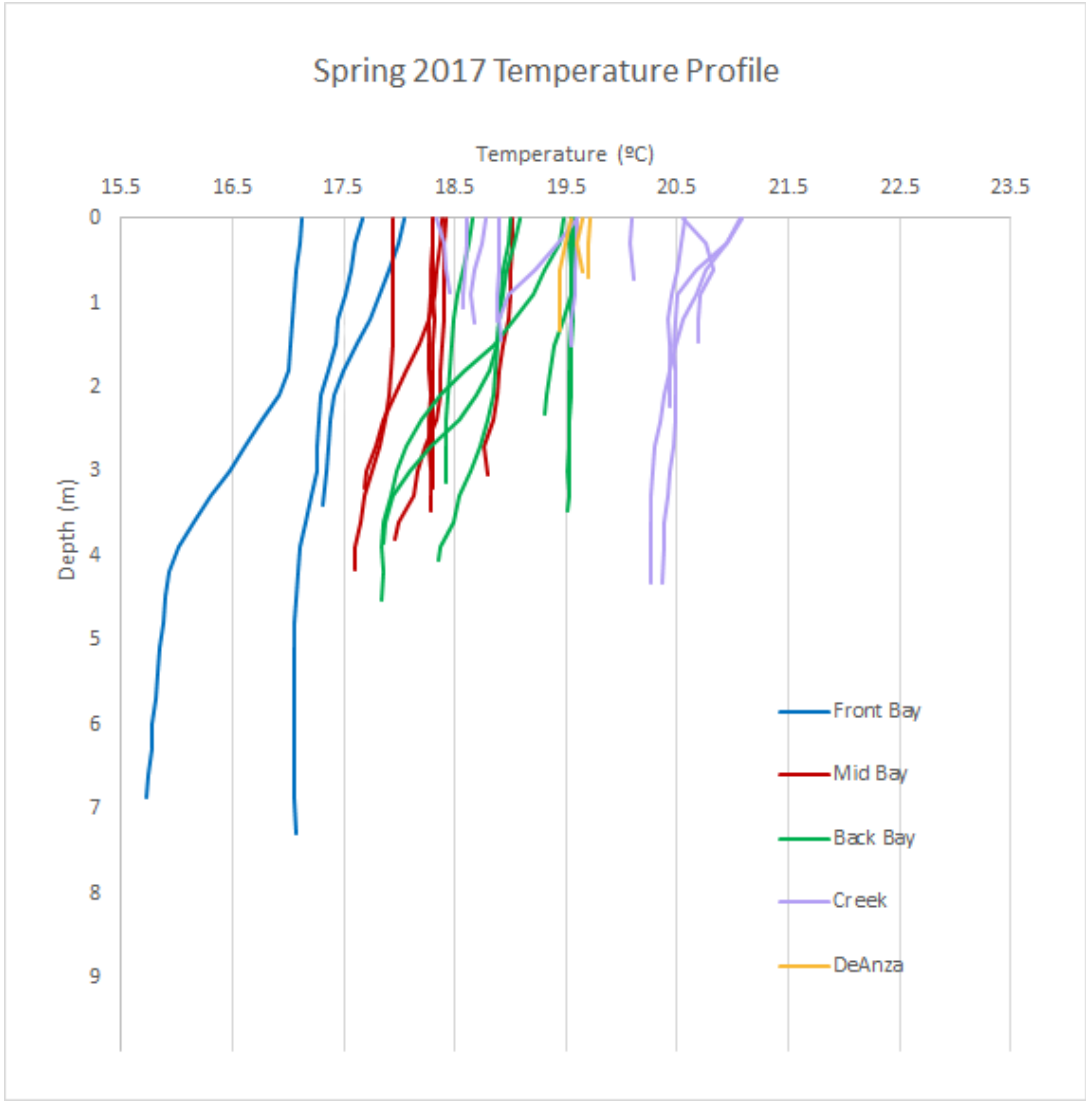
Results: surface temperature

- Cooler near the front bay, warmer in shallower embayments and back bay

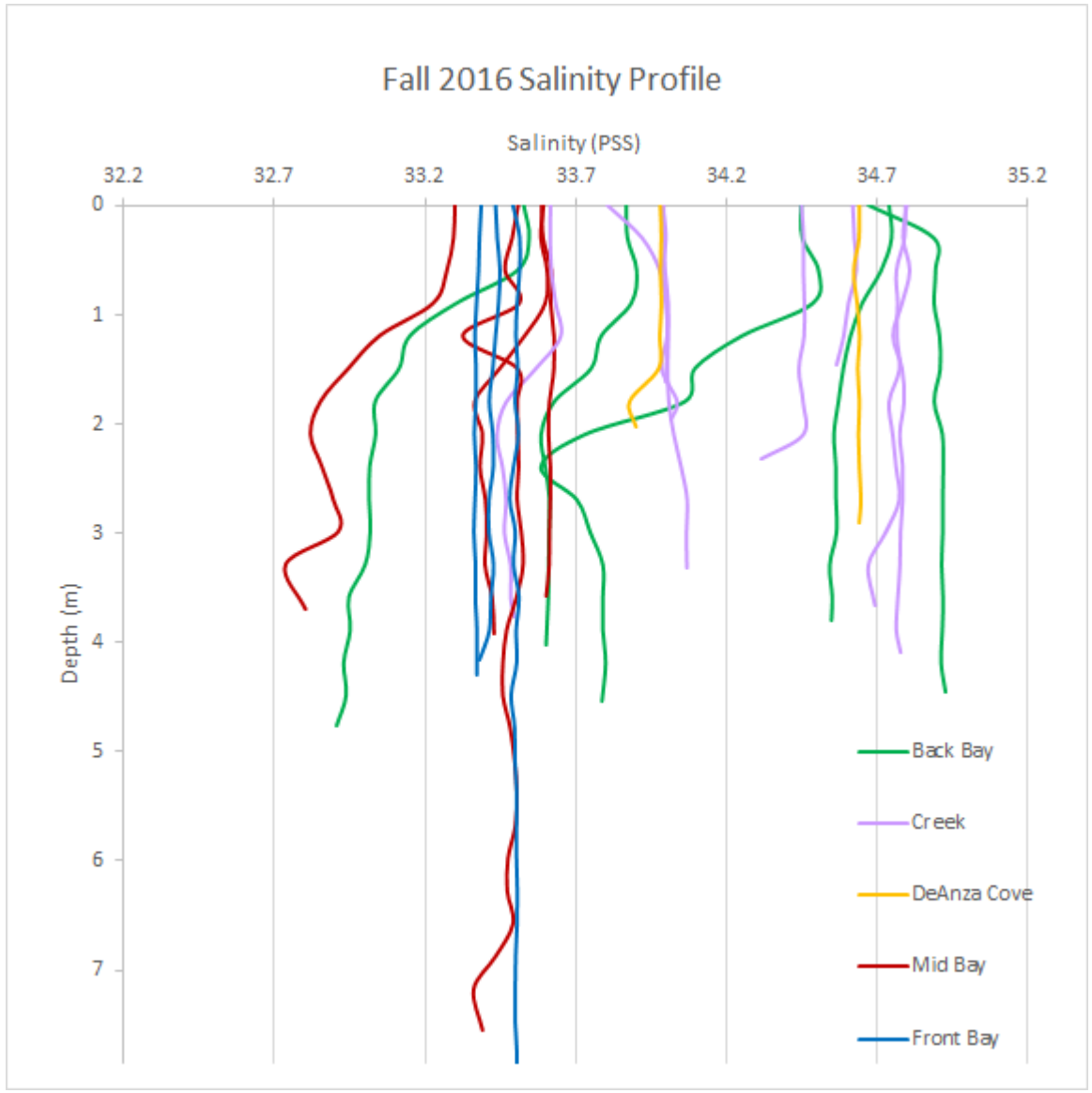


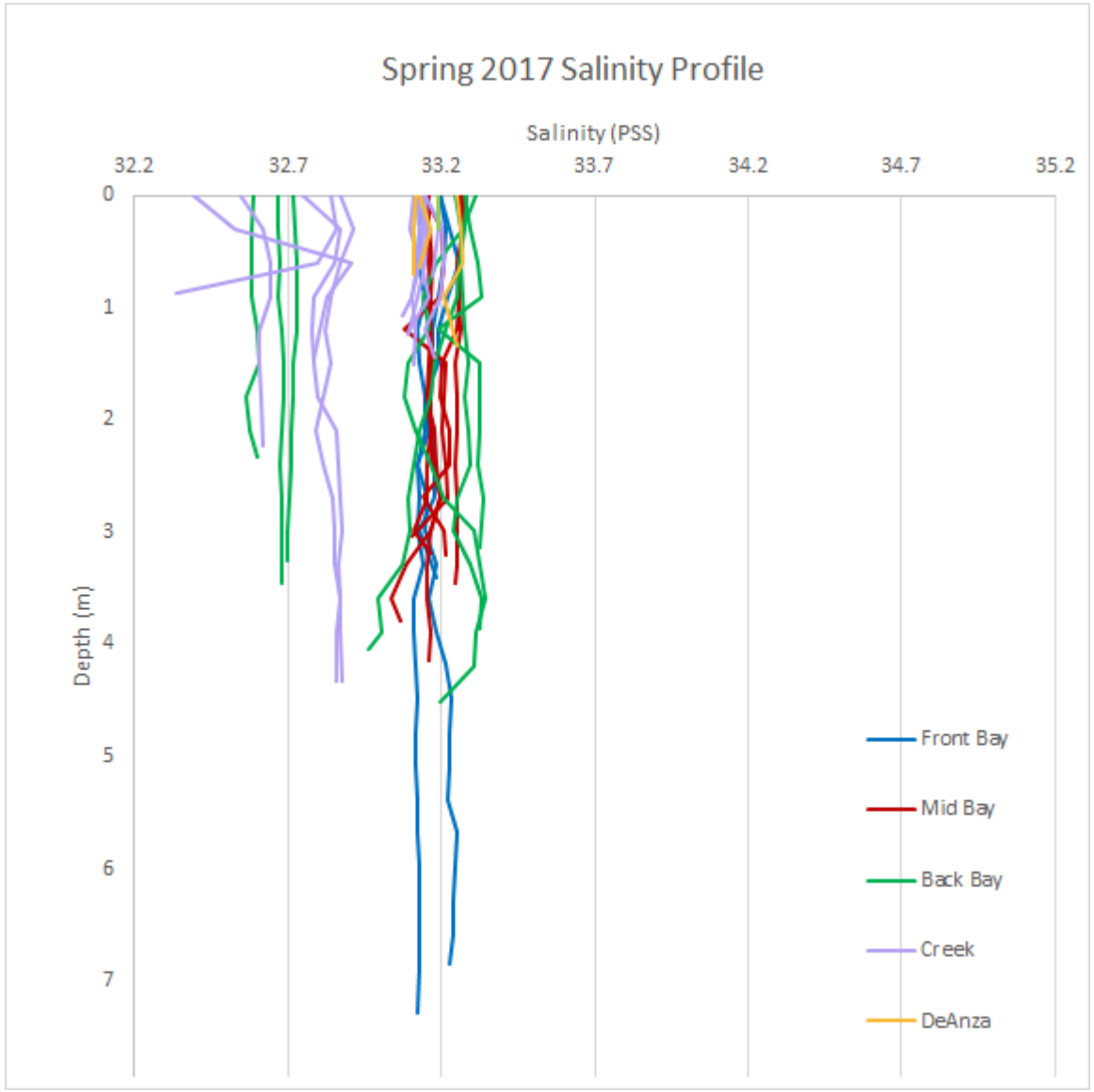
Temperature





Salinity





- average surface salinity 33.4 (±0.3)

Concentrations of phosphate in seawater (mg/L) – Fall 2015

Legend

Phosphate Concentration (mg/L):

- 0-0.01
- >0.01-0.02
- >0.02-0.03
- >0.03-0.04
- >0.04

Rainfall and phosphate Spring 2016

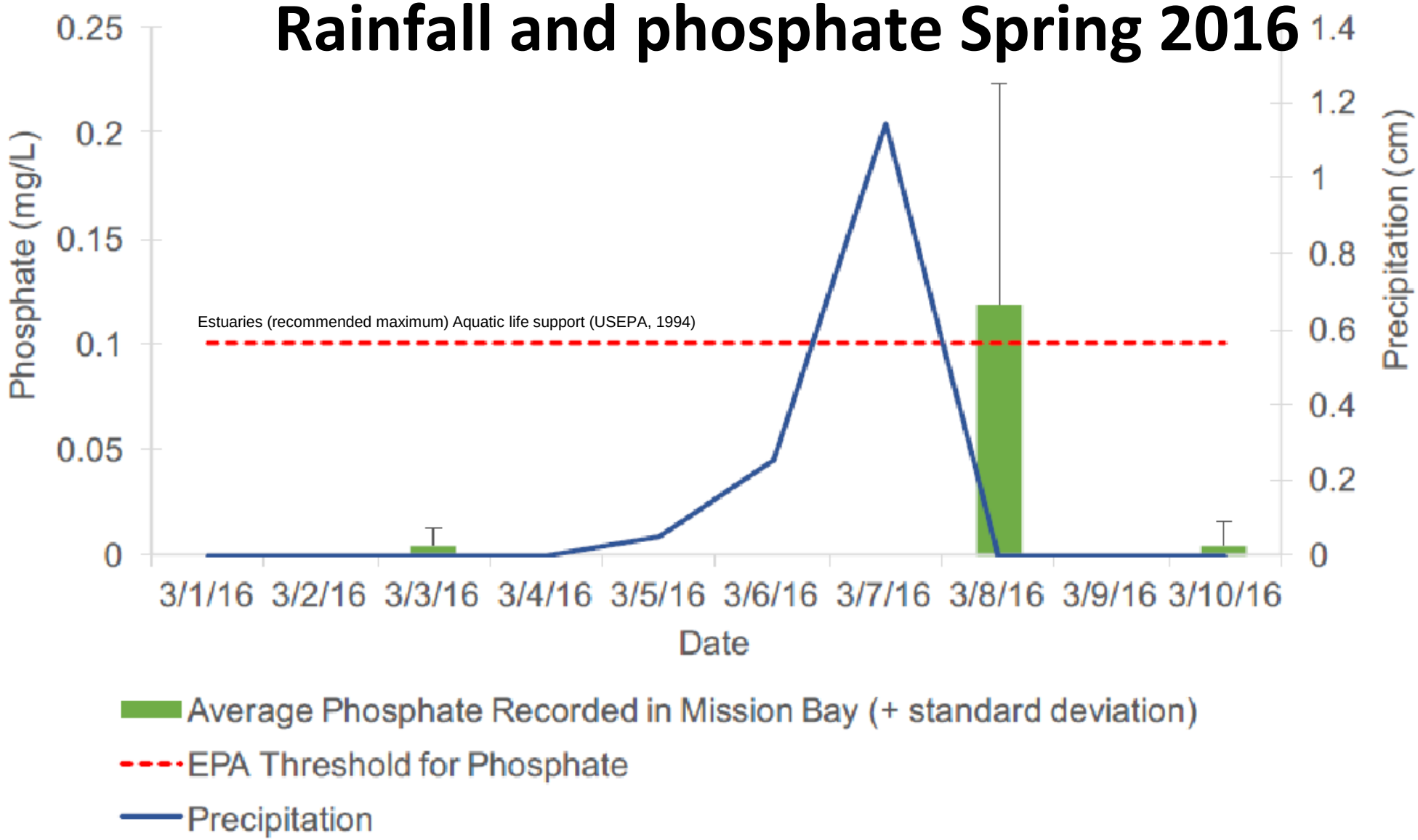
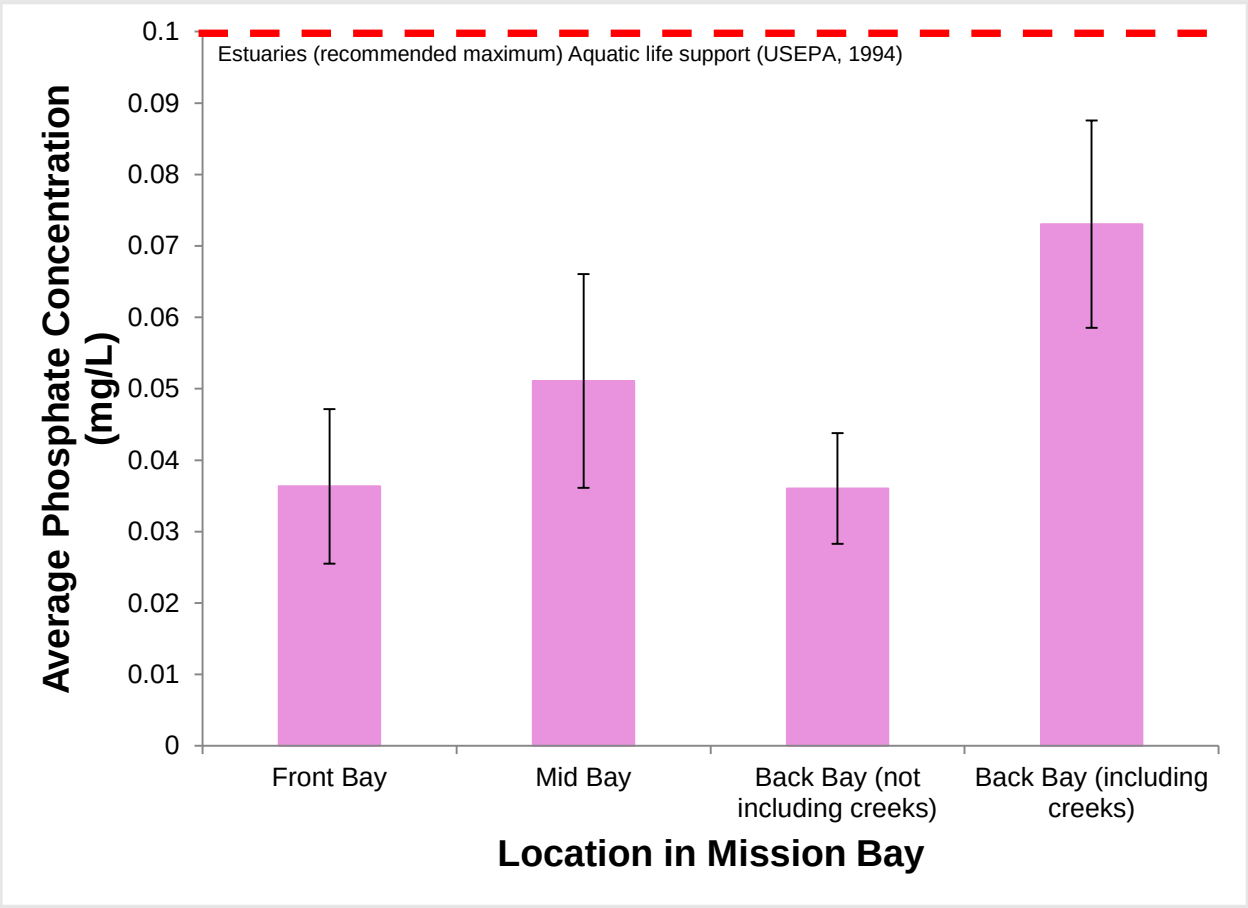


Figure 10: Average concentration of phosphate recorded in Mission Bay on different dates in relation to precipitation events during the same time period. The same number of stations (6) were sampled on each of the three dates (March 3, 8 and 10). Precipitation data was obtained from the Climate Data Record Program (NOAA.gov).

Average phosphate values (mg/L)

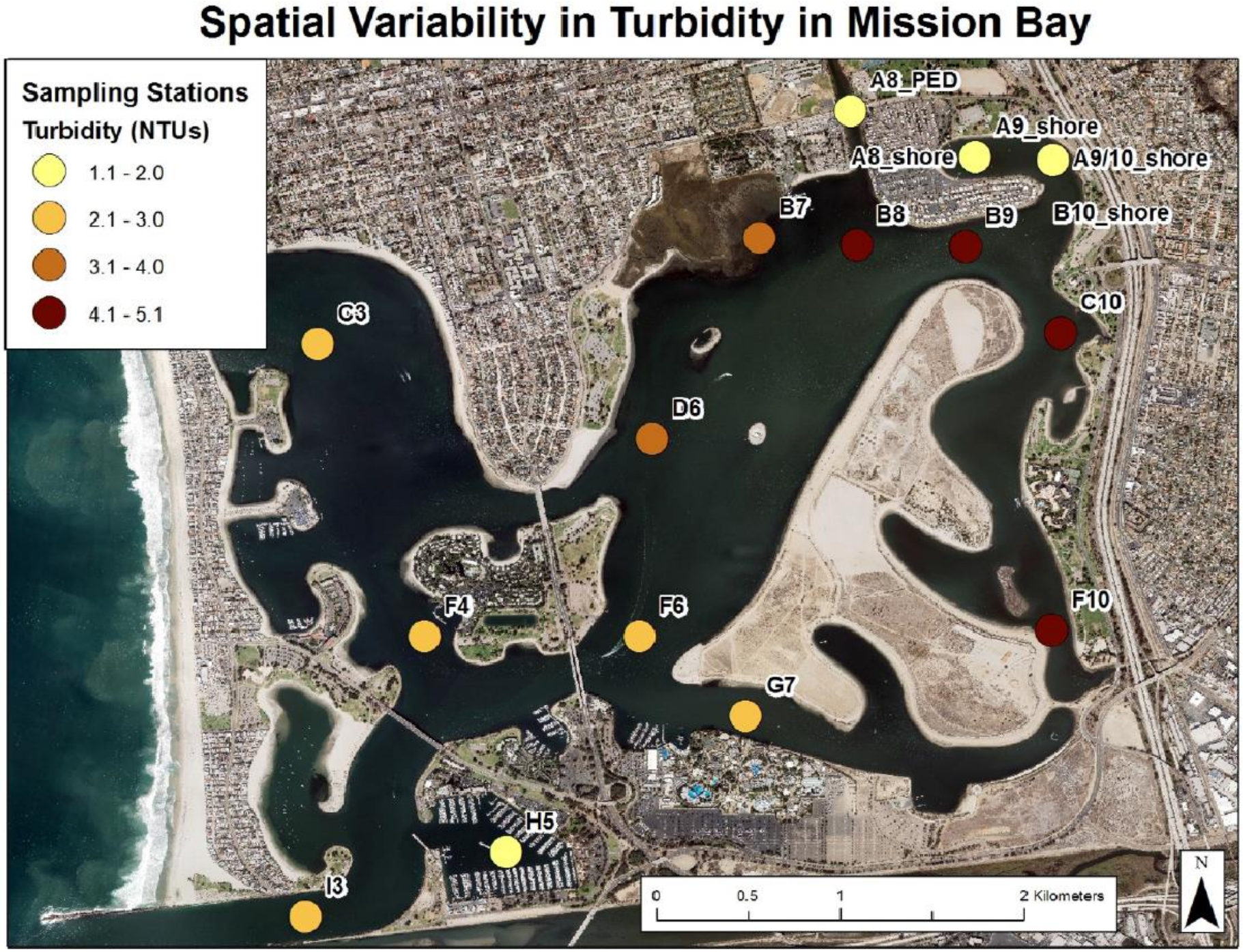


- Front Bay: 0.0363 mg/L
- Mid Bay: 0.0511 mg/L
- Back Bay (not including creeks): 0.0360 mg/L
- Back Bay (including creeks): 0.0730 mg/L

Results: turbidity Spring 2016

- lowest near front of bay and (DeAnza Cove and Rose Creek were shore-based and shallow)

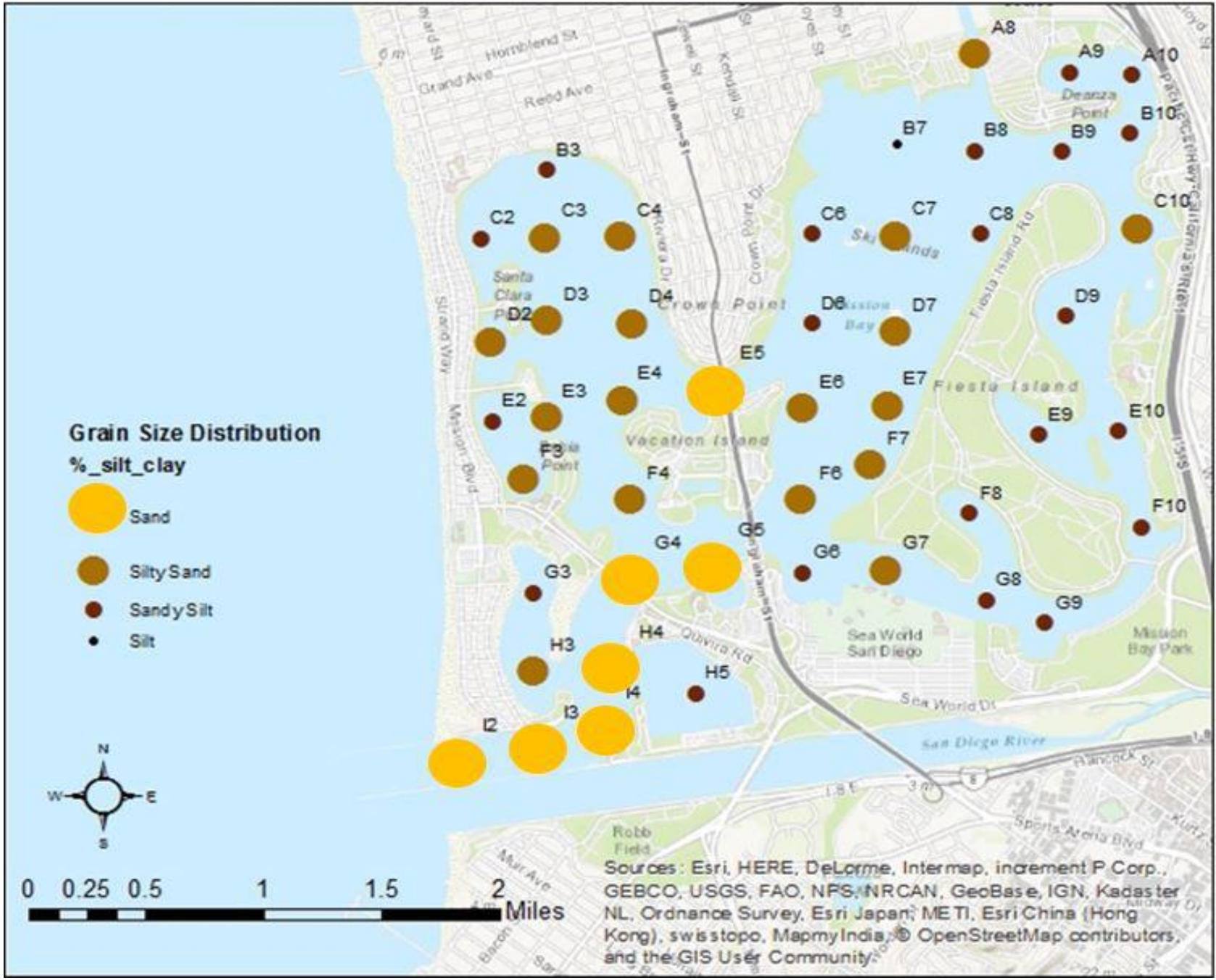
- highest in back bay



Results: grain size Fall 2015

- highly variable; generally: sediments in back bay were fine, compared to those in the front bay

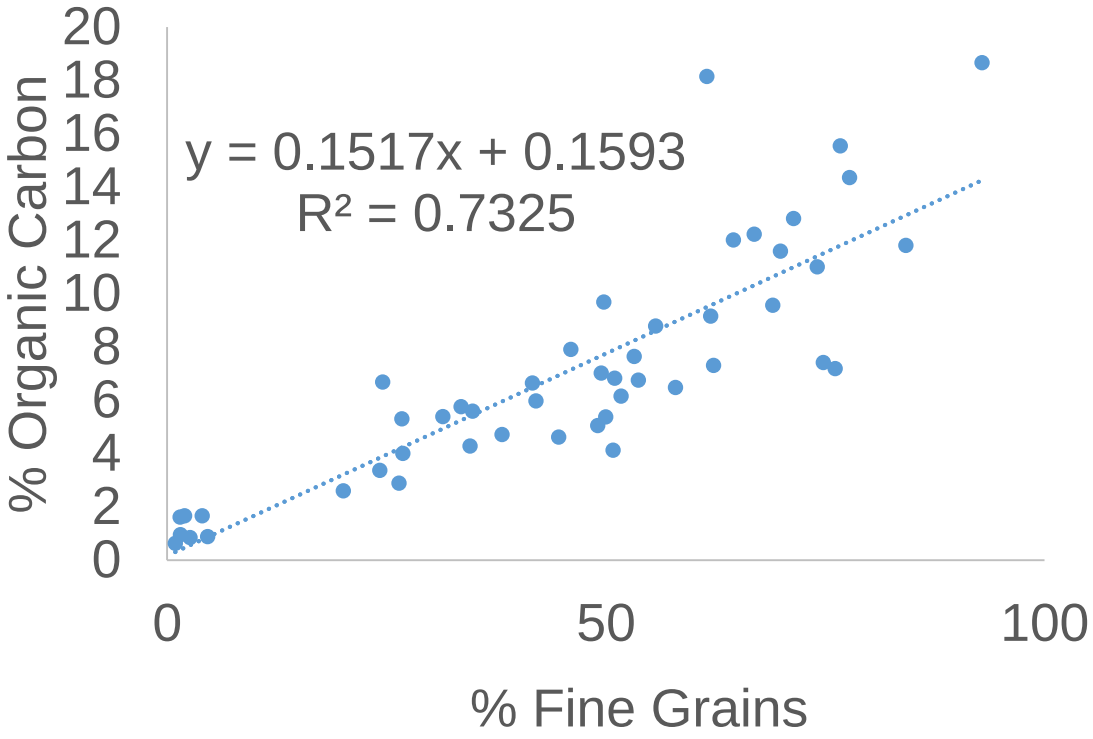
- coarsest sediments collected near front of Bay

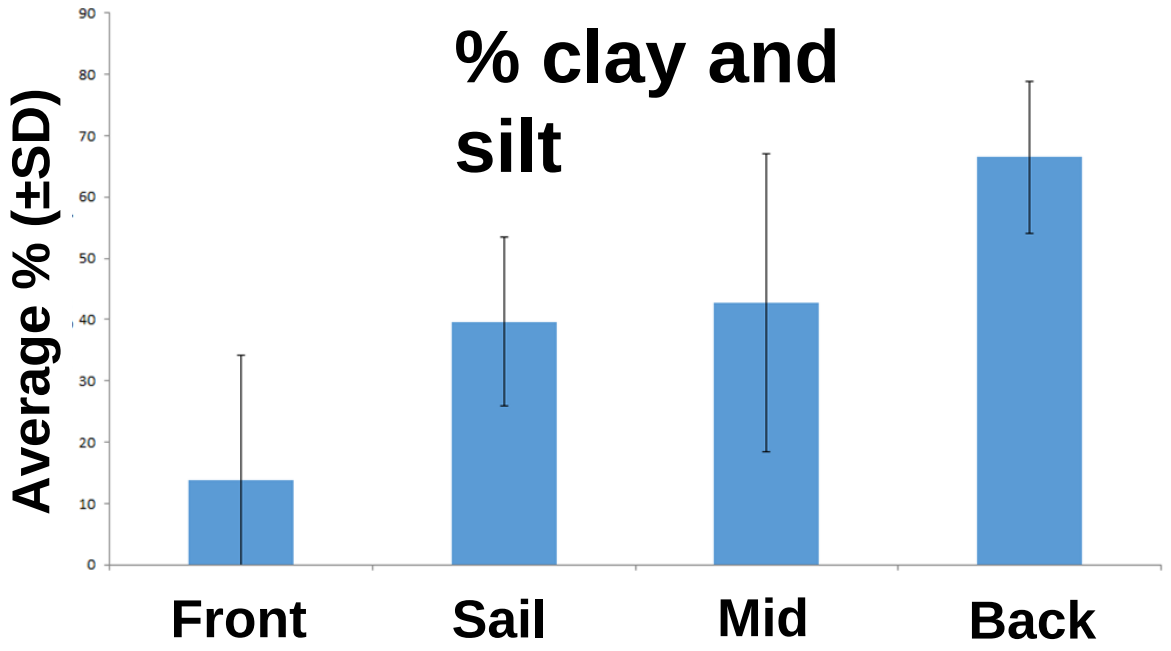


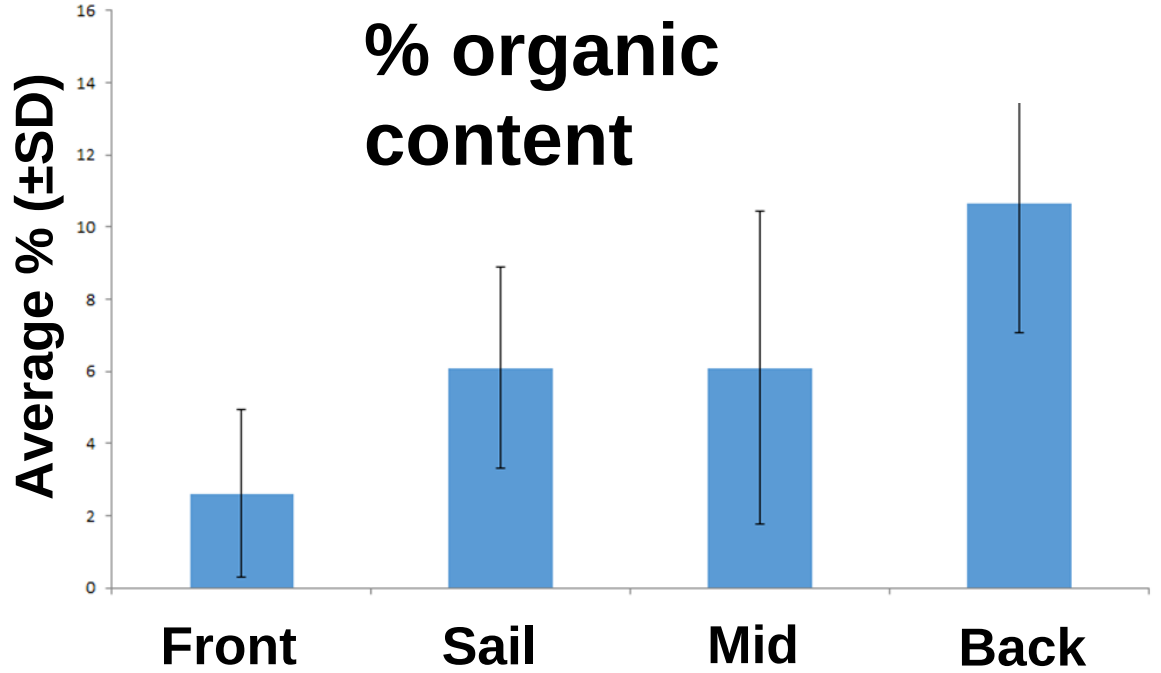
S. Dunlap

Results: grain size and TOC - Fall 2016

- greater percentage of finer sediments towards back-bay sites
- corresponds to increase in % TOC



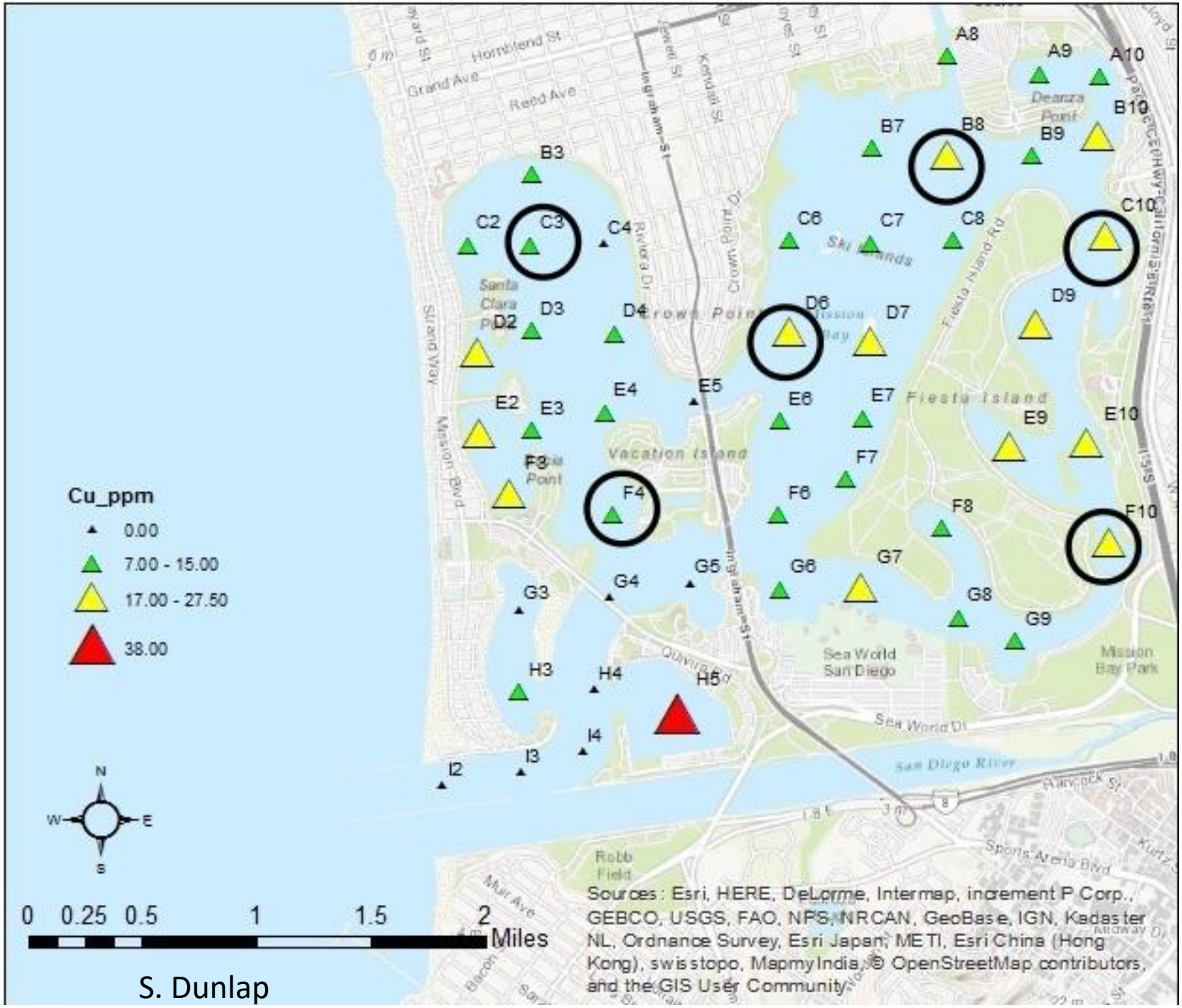




Results: Metals Copper Fall 2015

- Cu (XRF)
  - lowest near front of bay
  - highest Quivera basin
  - elevated in embayments

- Subset of data corresponding to Kaufmann et al. sites analyzed by EnviroMatrix



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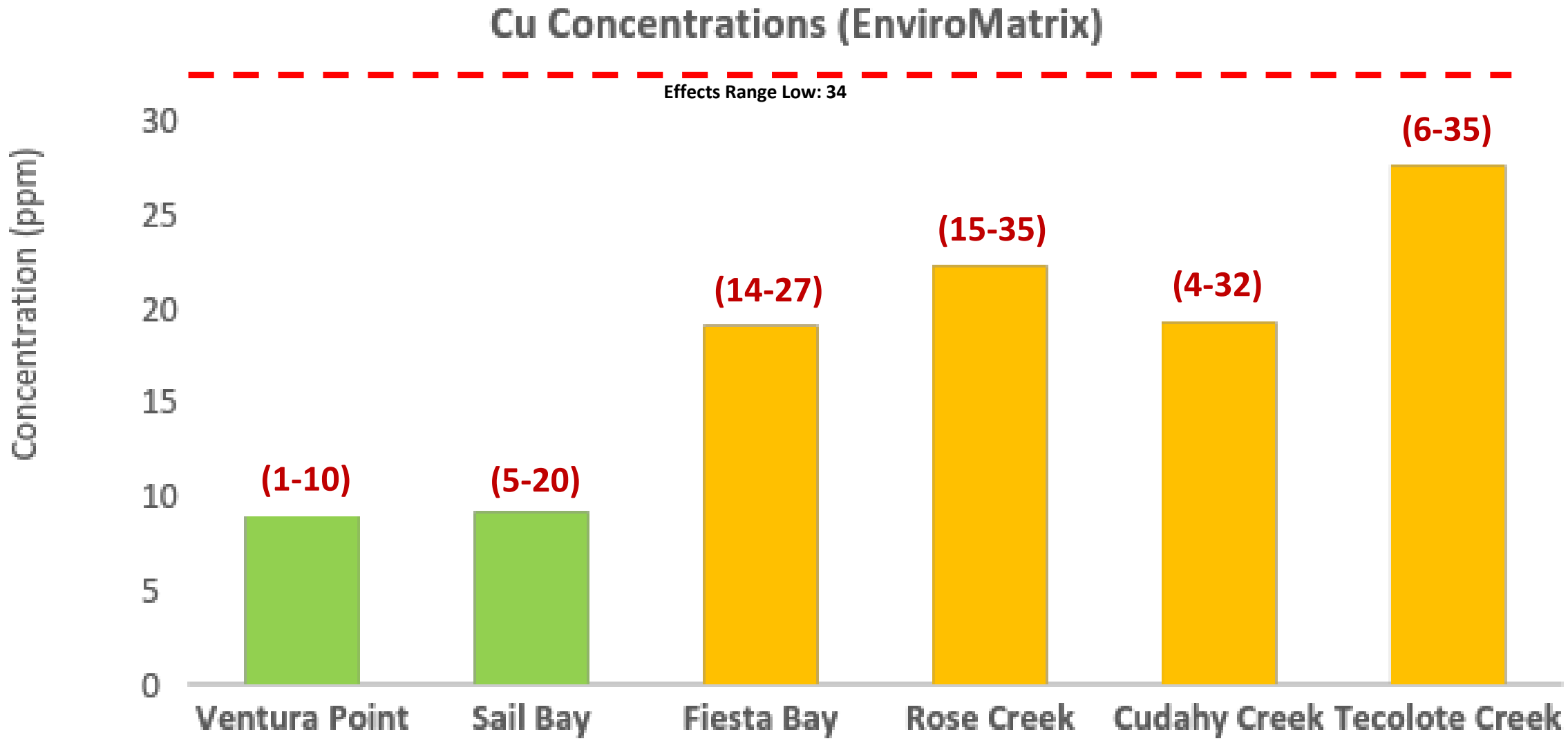
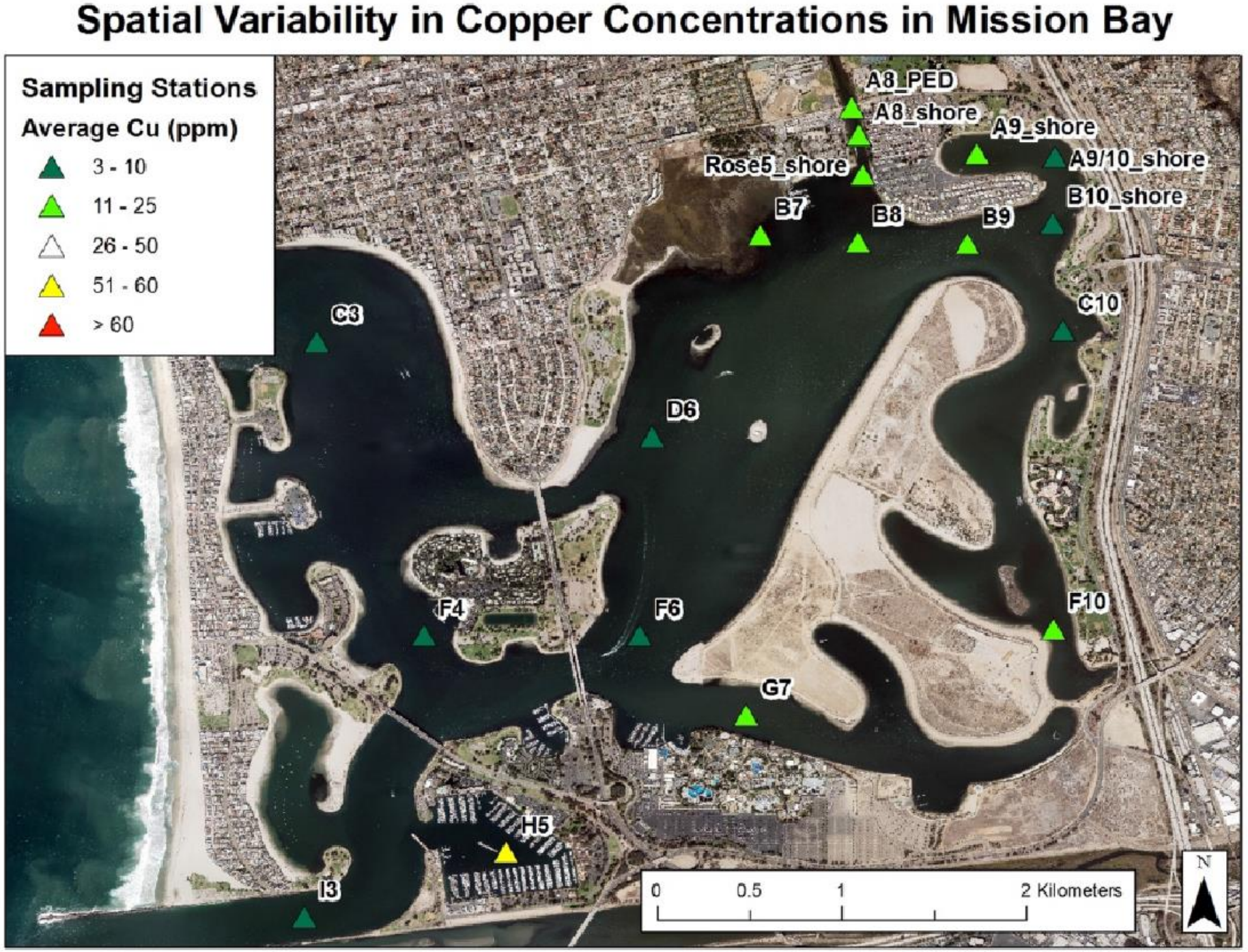


Kaufmann et al. data from 2001-2002 (ranges shown)

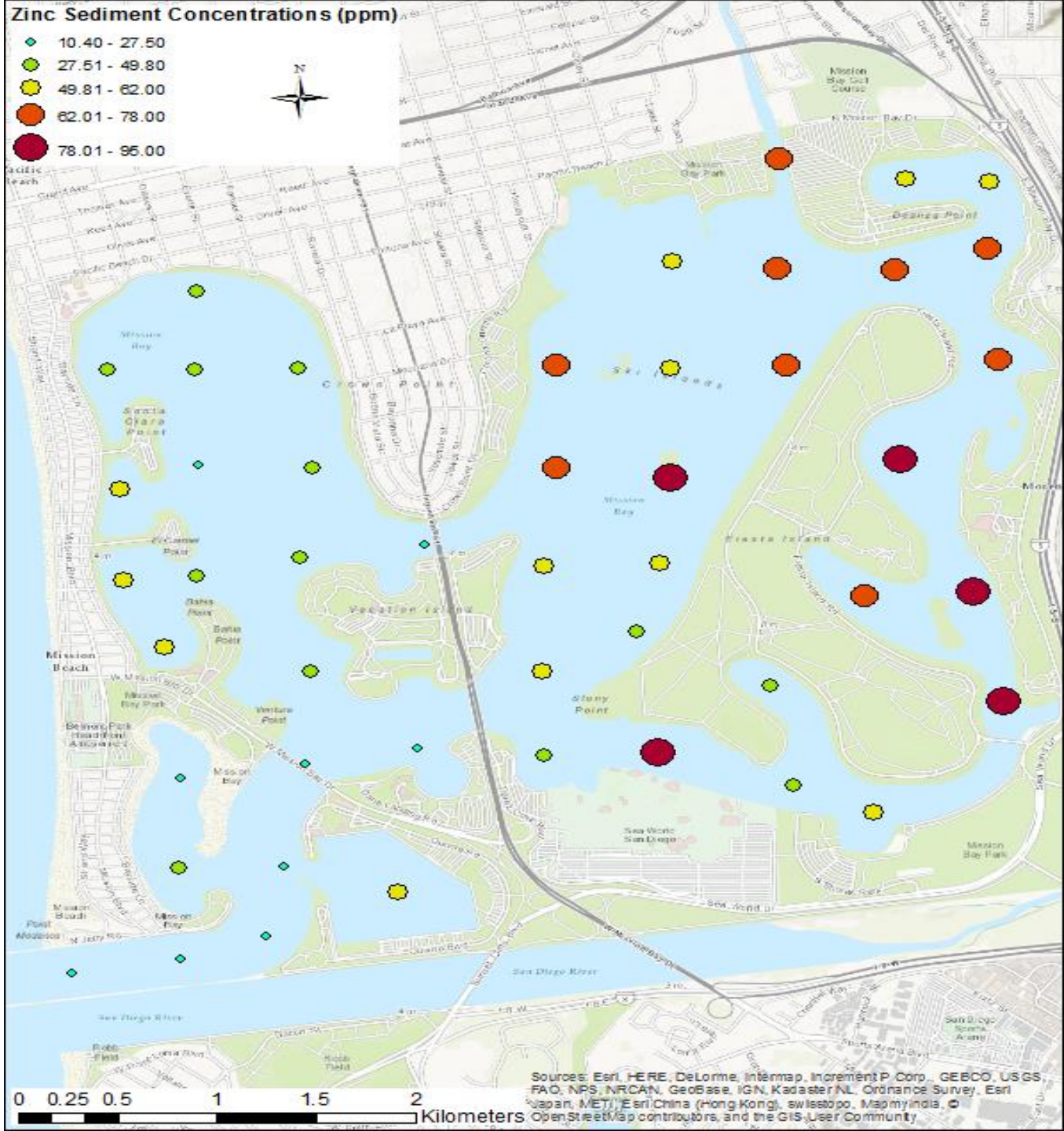
Metals: Copper Spring 2016

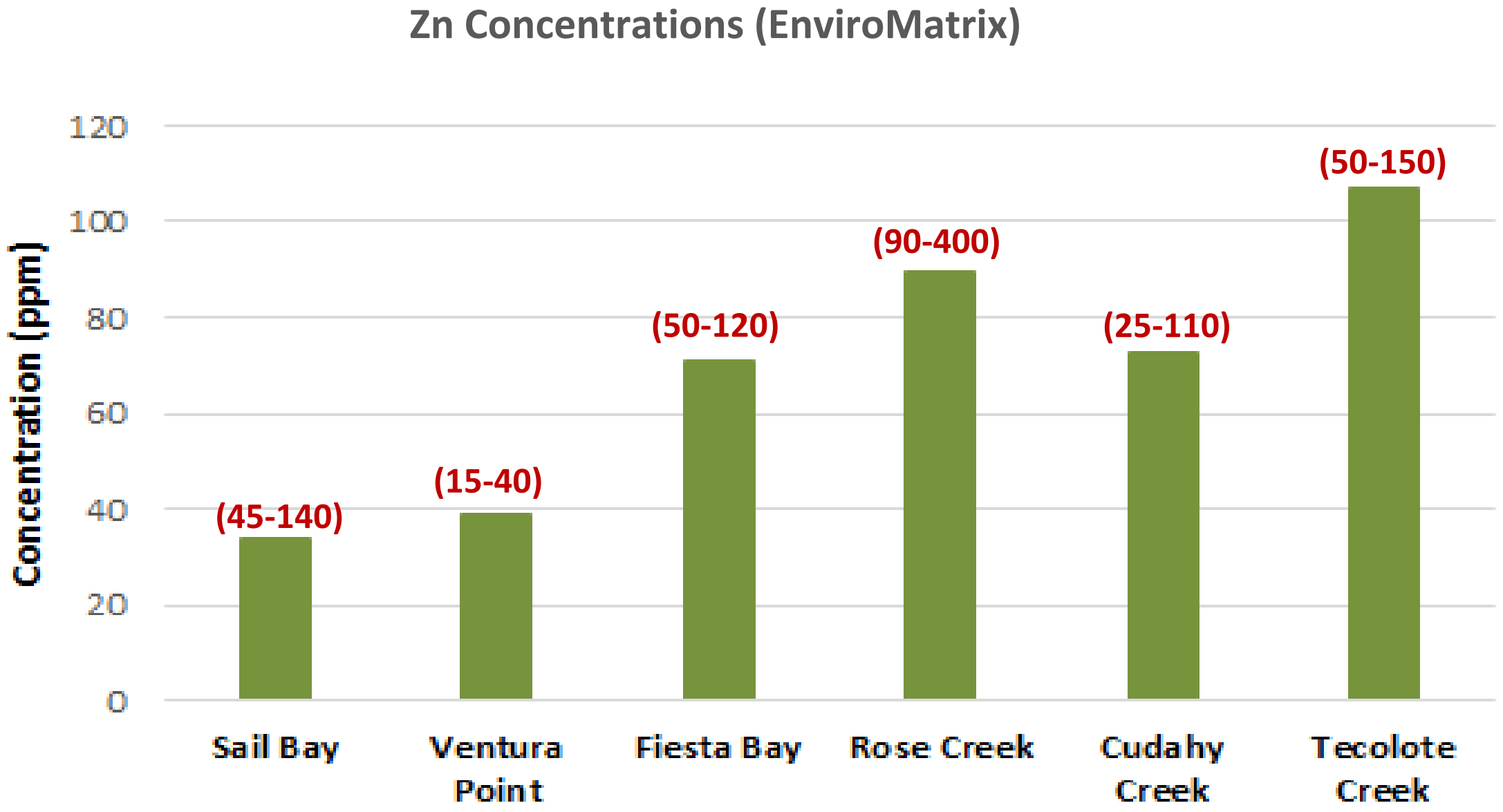
- Cu more elevated in Quivera Basin than in the fall of 2015



Results: Metals
Zinc
Fall 2015

- Zn (XRF)
  - lowest near front of bay
  - highest in mid- to back- bay

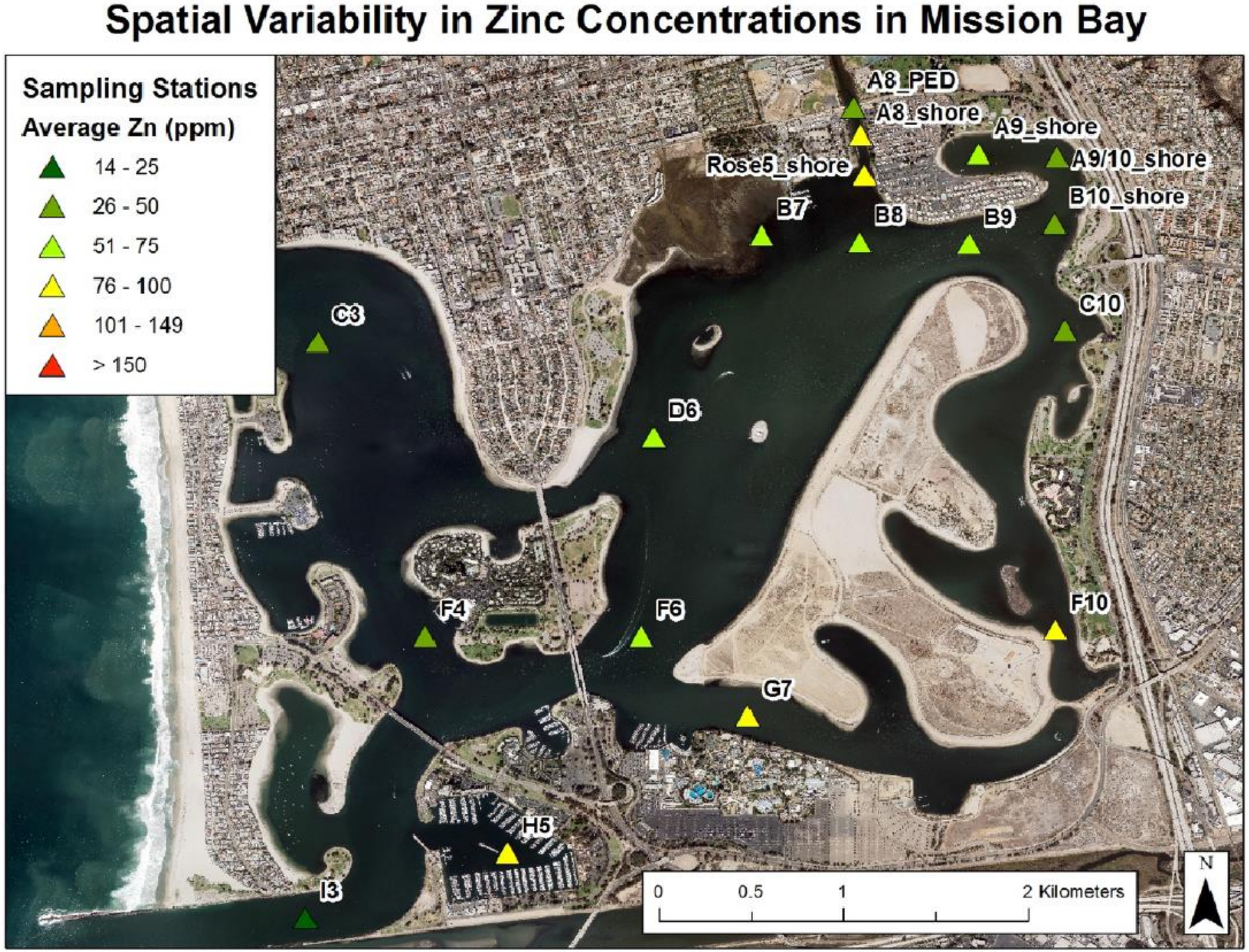




Kaufmann et al. data from 2001-2002 (ranges shown)

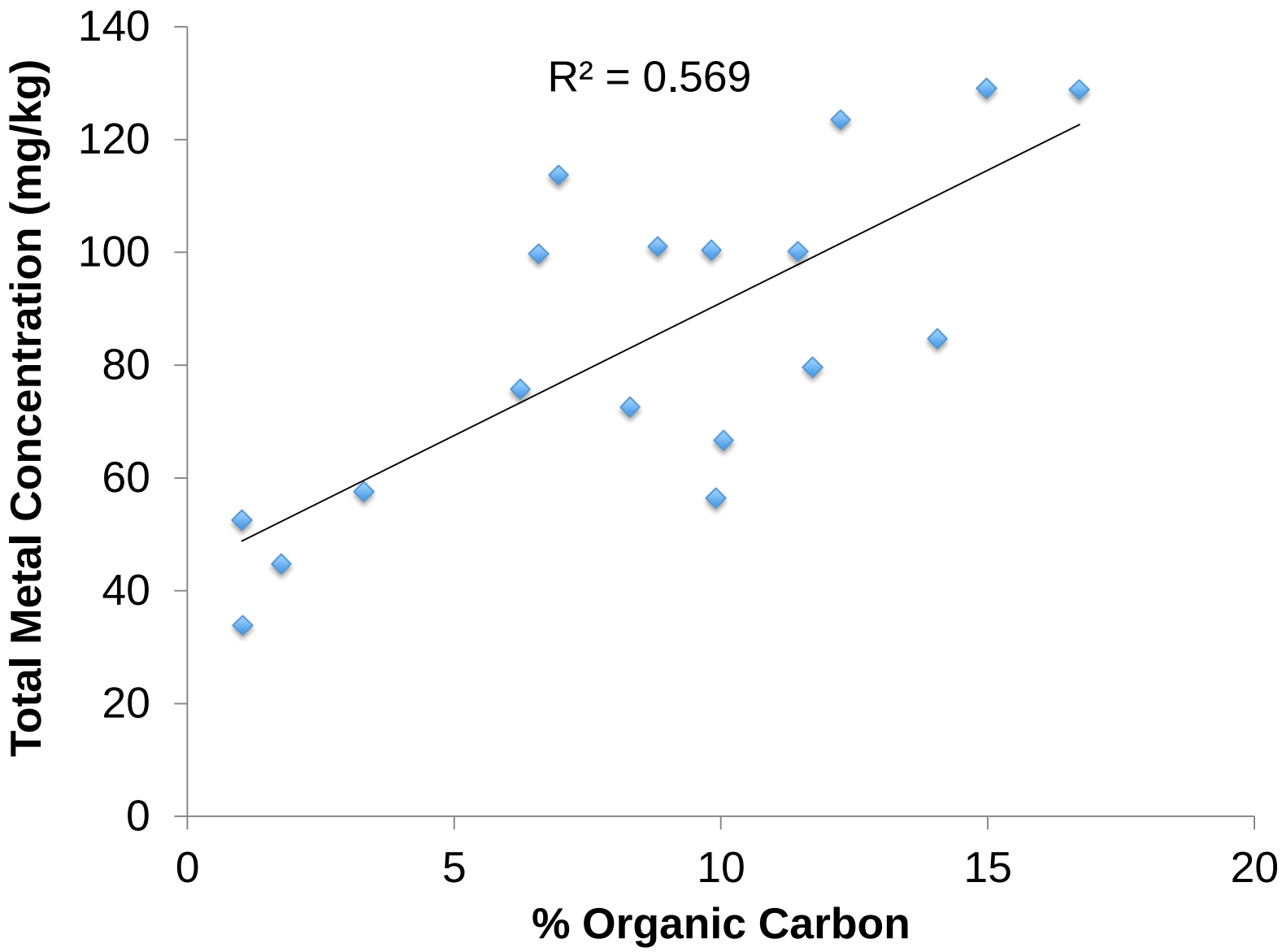
Metals: Zinc Spring 2016

- similar patterns as in fall 2015



Metals vs % organic carbon

- Increasing metals concentration with increasing % organic carbon
- Related to increased fine grained sediments



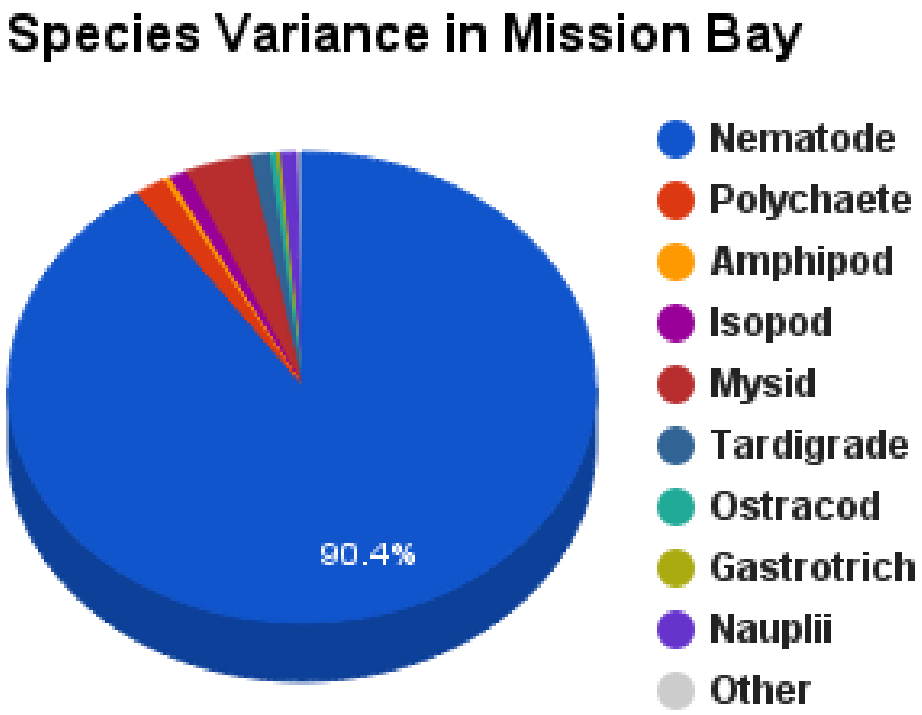
Results: meiofauna (ind. ml^{-1})

- 72% nematodes
- 7% harpacticoid copepods
- 5% amphipods
- 4% ostracods
- 3% polychaetes

- highest in back bay

Spatial Variability in Meiofauna Organisms in Mission Bay

Species Richness

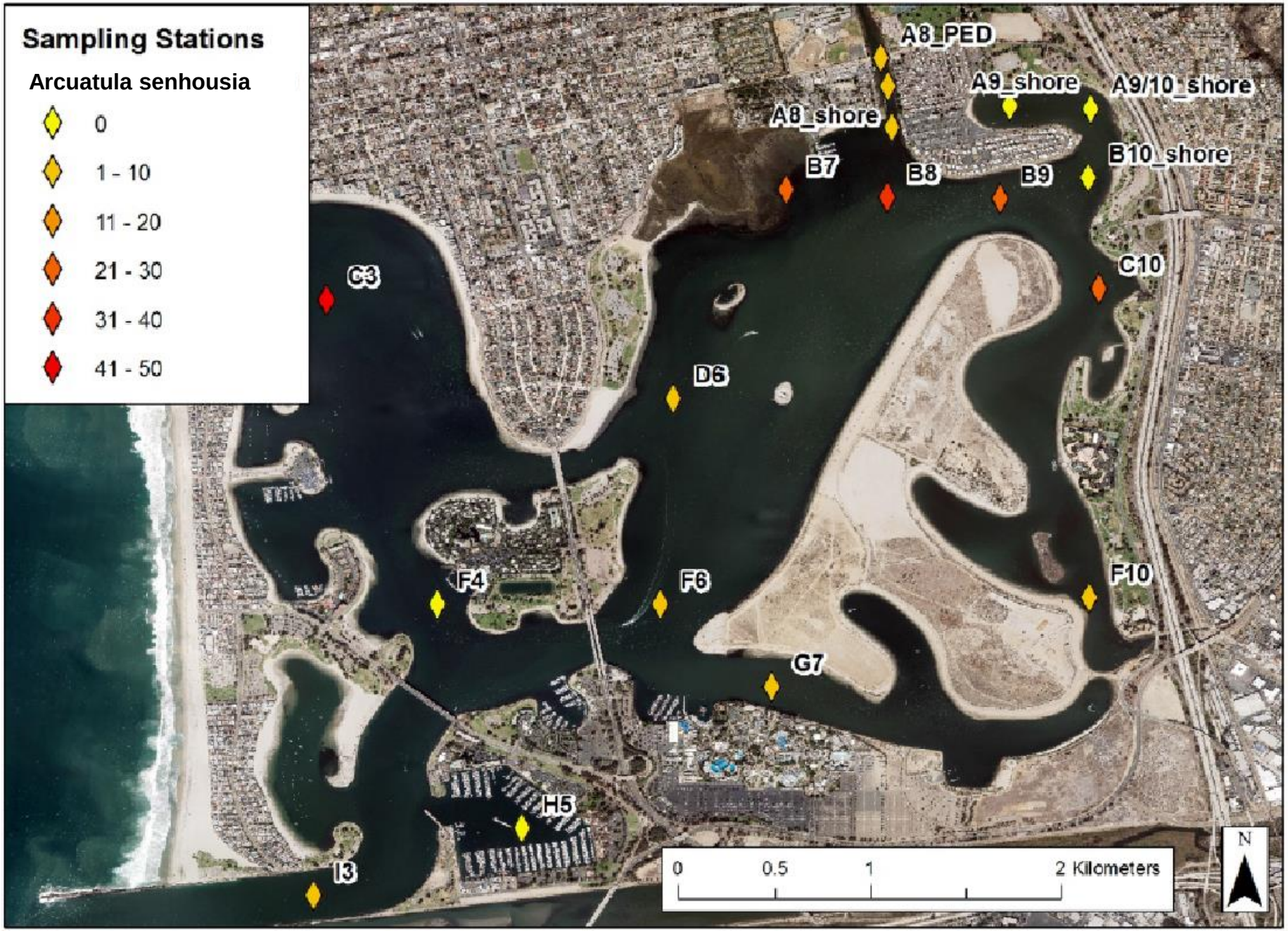


- Total species composition across Mission Bay
- Nematodes dominate
- Other large groups are Mysid (3.6%) and Polychaete (1.7%)

Summary of Results

- Water Quality
  - Phosphate levels were consistently below the EPA threshold of 0.1 mg/L (excluding storm events).
  - The average salinity in Mission Bay was 33.4 (±0.3). Generally the highest salinity values occurred in the back bay (excluding storm events).
  - Temperatures were consistently cooler in the front bay and warmer in the back bay and shallower embayments.
- Sediment
  - Generally, grain size decreased towards the back bay and metals and organic carbon concentrations increased. No metals were consistently detected above ERLs except copper at one station.
- Benthic biota
  - Nematodes dominated the meiofauna within Mission Bay. Their population generally increased towards the back bay and species richness decreased.

Spatial Distribution of *Arcuatula senhousia* in Mission Bay



Future Work

- Continue to collect data and extend the current time series
- Focused sampling in the area of storm drains
- Continued sampling in the ReWILD area
- Increased monitoring of the creeks in the back bay, especially during storm events

Questions?