# The ENVVEST Experience:


## Relating Water Quality to Upstream Land Use/Cover and Storm Intensity in Sinclair and Dyes Inlets

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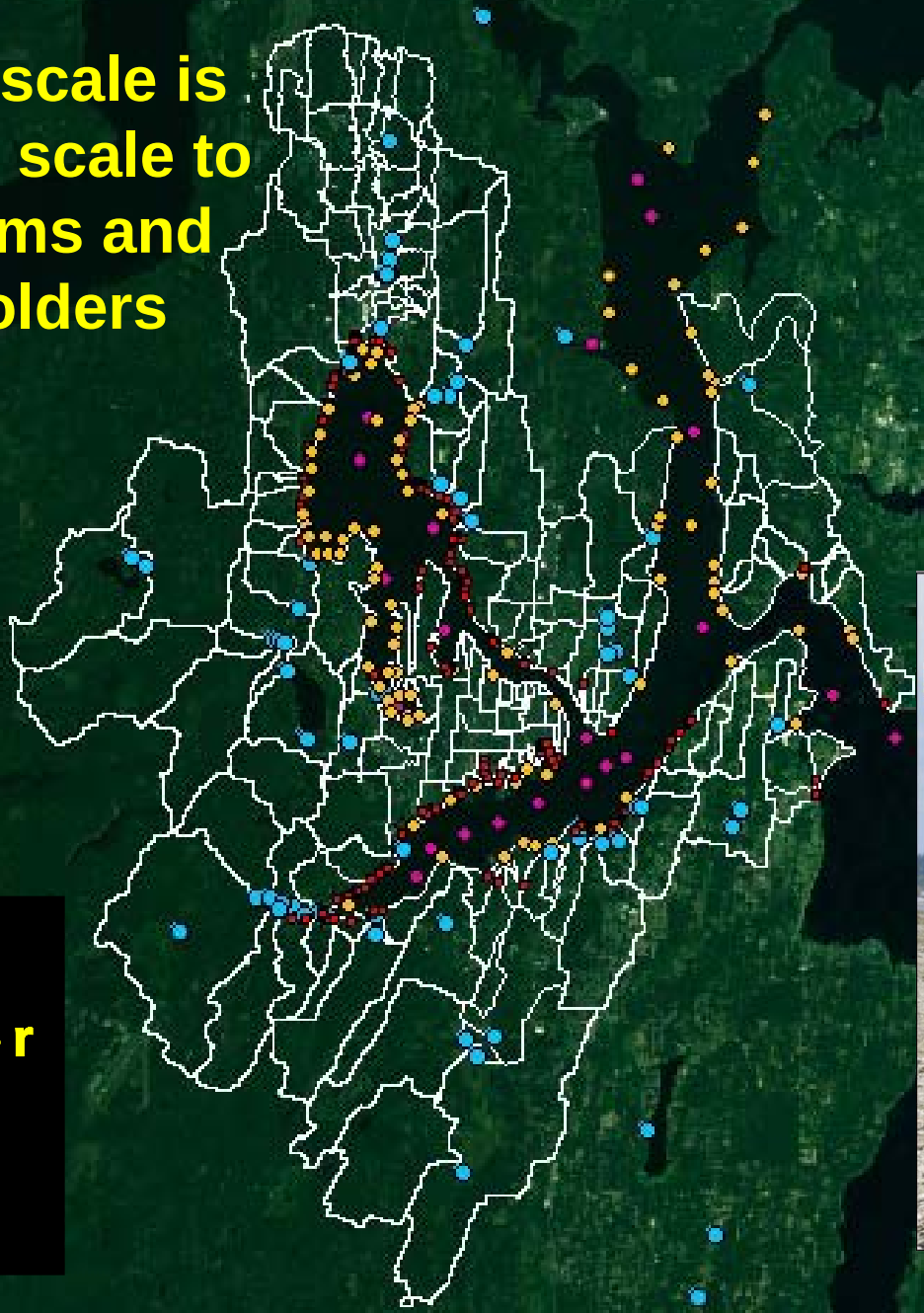
# Outline of Talk

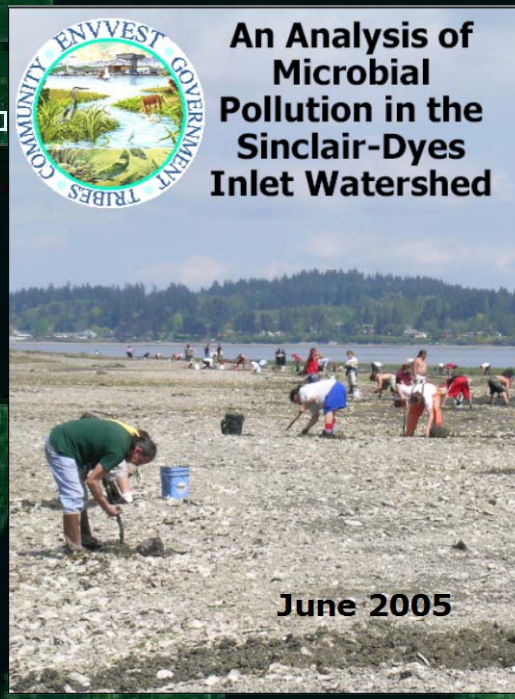
- How is your work or findings relevant to designing the regional monitoring strategy -- what lessons can you share?
- What are some key principals for success?
- Pitfalls to avoid??
- What are appropriate scales to work at and how can we best transfer study findings from one location to another?

# Predicting FC Loads from Watershed

**The watershed scale is the appropriate scale to address problems and engage stakeholders**



- Stream
- Stormwater
- Nearshore
- Marine

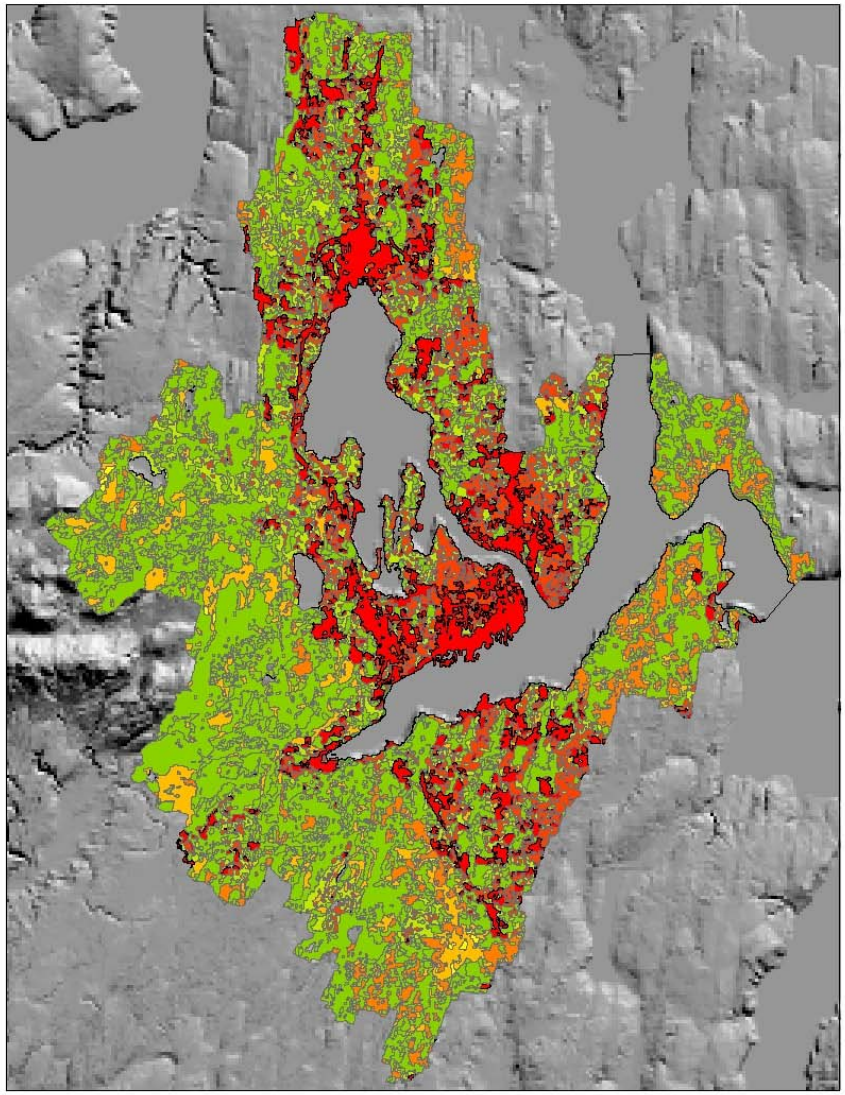


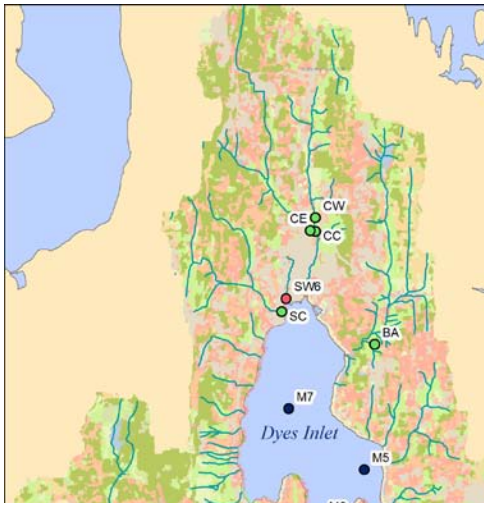
# Cooperative Storm Event Monitoring

**Cooperating with Cities and Kitsap County to:**

- **Sample representative storm events**
- **Collect data on hydrology and water quality parameters**
- **Relate landuse to environmental quality**
- **Quantify loading from the watershed into the receiving waters of the Inlet**
- **Support TMDLs**

**Sampled:** n = 16:68 Streams and 18:87 Stormwater Outfalls ranging from 2 to 9,634 acres





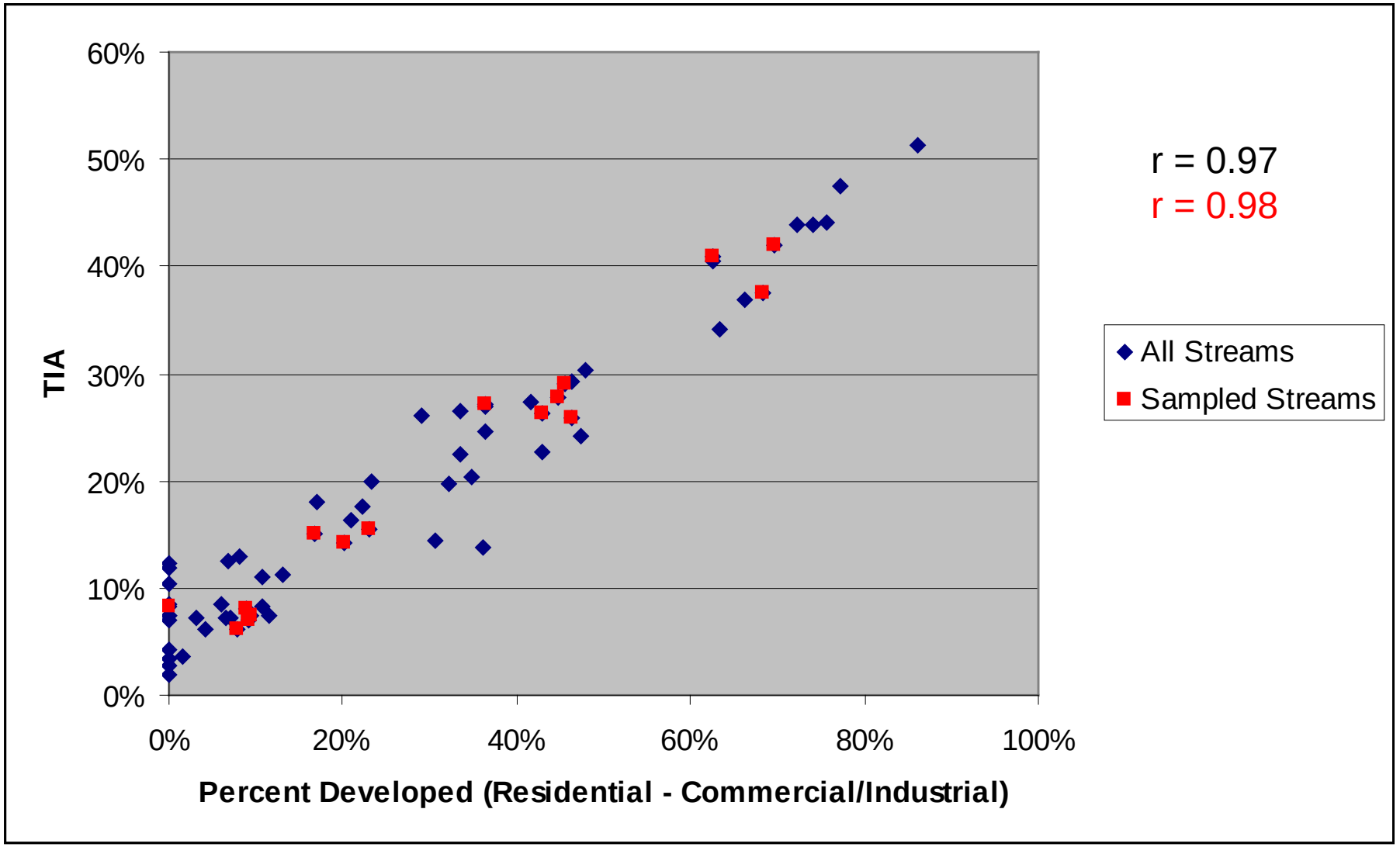

Increasing Development

Total Impervious Area (TIA)

# Stream Monitoring

# Sampled Streams in Relation to All Streams

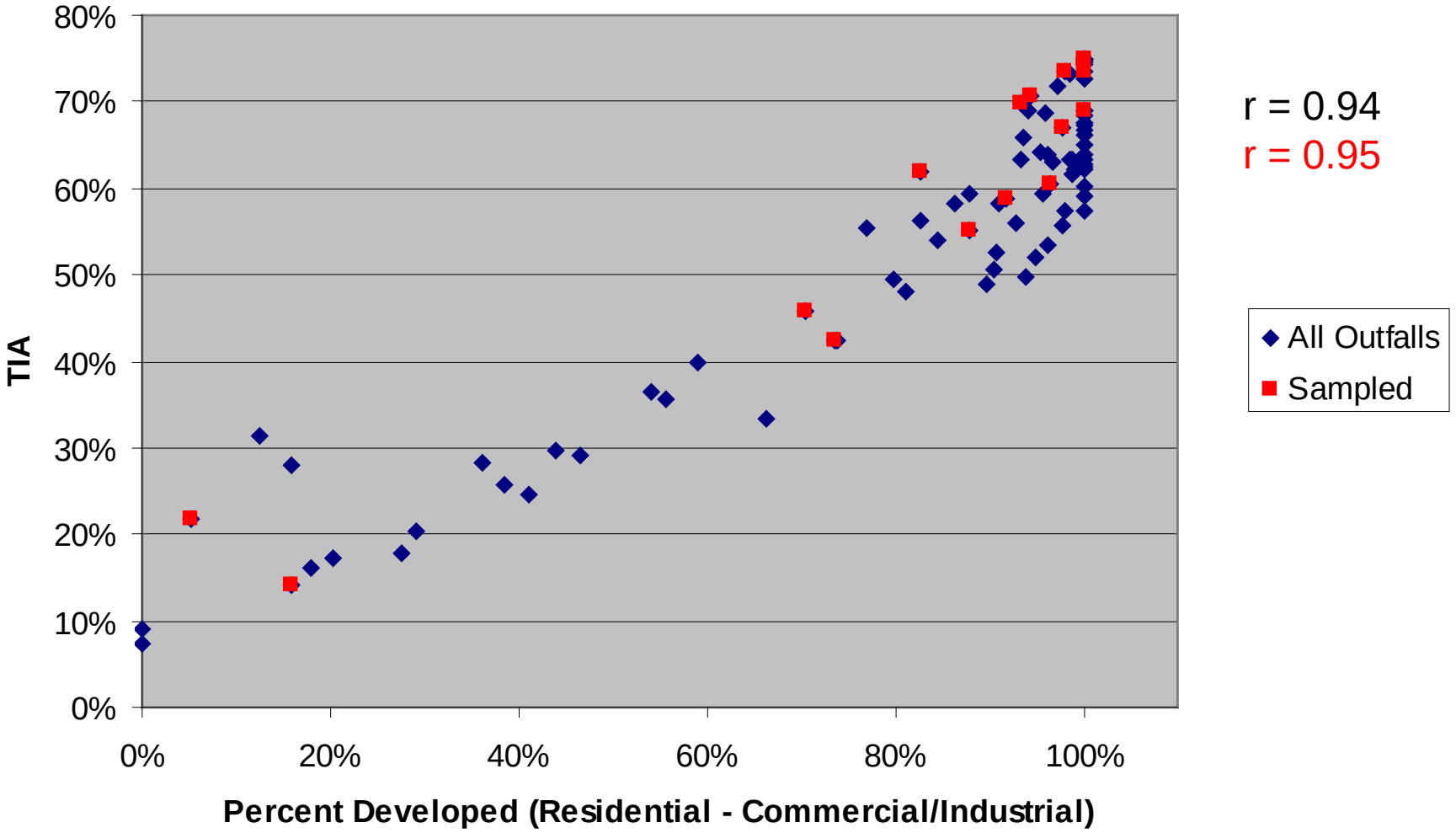
n = 16:68 Units



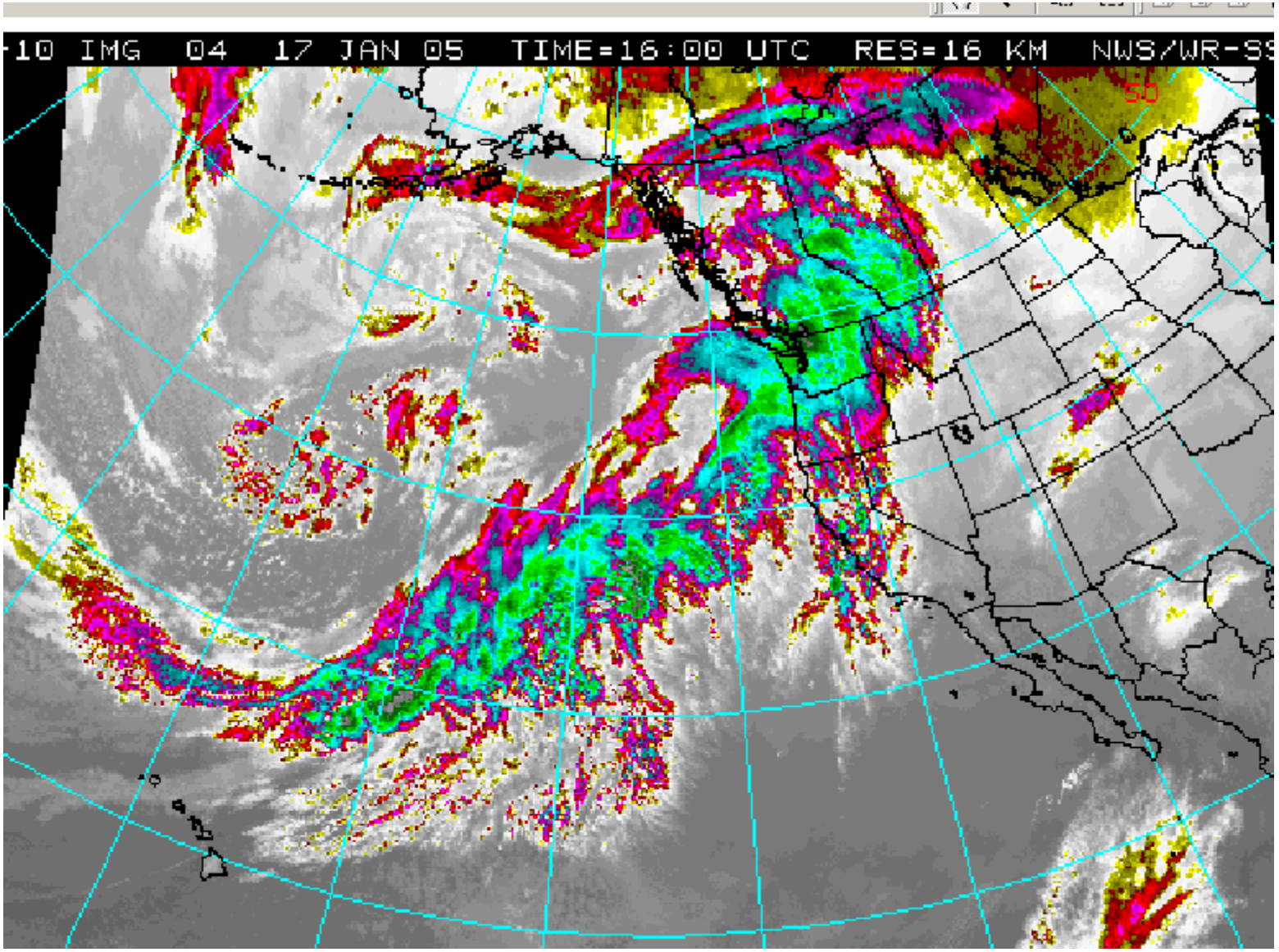
# Storm Water Flow Monitoring

# Storm Water Flow Monitoring Cont.

# Sampled Stormwater Outfalls in Relation to All Outfalls



# Storm Event Sampling



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# Puget Sound Naval Shipyard Project ENVVEST Fecal Coliform TMDL Study

## Sampling and Logistics Plan

Updated 10 JAN 2003

SAMPLING is **A GO** for JAN 13-17, 2003; – Check the Schedule

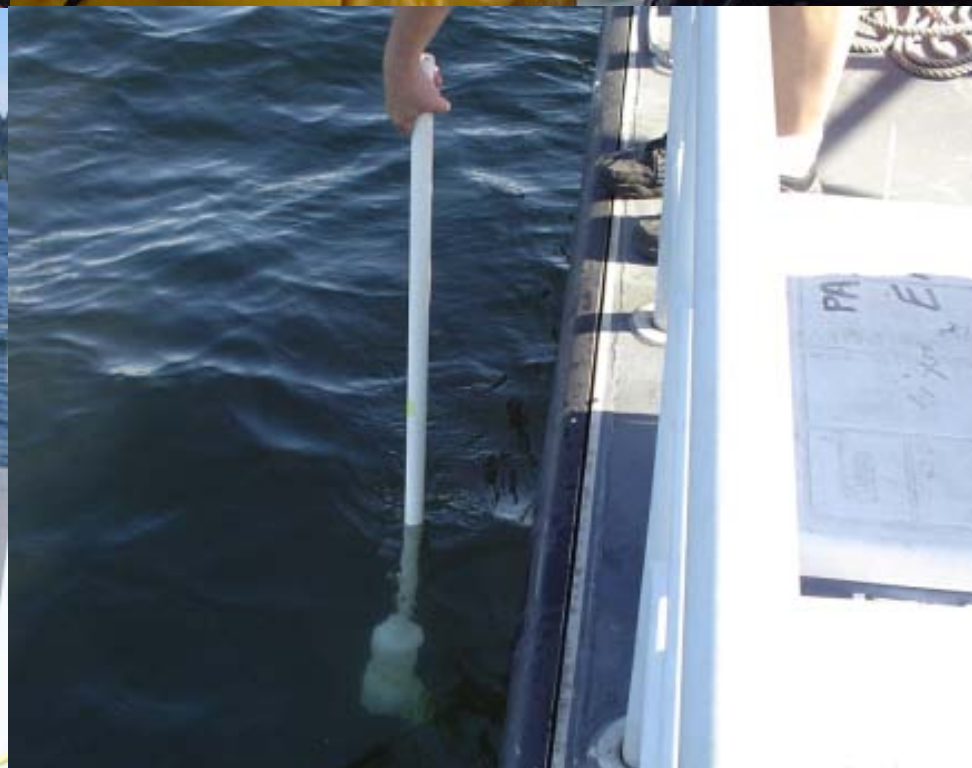
Look at some preliminary data from fecal coliform sampling https://swdata.spawar.navy.mil/envvest/DATA/

Review Chain of Custody Information https://swdata.spawar.navy.mil/envvest/DATA/FC_TMDL_Study/Chain_of_Custo

Check Current Weather Forecast

National Weather Service - Seattle

UW Department of Atmospheric Sciences



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# Sampling Team Standings (Samples collected between Nov 2002 and Mar 2003)

| | events[1] | stations | samples | field dups |
|---|---|---|---|---|
| Kitsap SSWM | 18 | 11 | 197 | 35 |
| South Streams | 17 | 9 | 153 | 17 |
| POKC | 17 | 7 | 103 | 14 |
| North Streams | 14 | 14 | 194 | 37 |
| PSNS | 14 | 13 | 121 | 11 |
| Bremerton | 13 | 8 | 86 | 12 |
| TEC Storm Event | 12 | 11 | 128 | 14 |
| PSNS NS/Marine | 4 | 26 | 104 | 11 |
| Bainbrigde Island | 4 | 6 | 23 | 3 |
| BKCHD NS/Marine | 1 | 25 | 25 | 3 |
| [1] Days samples collected | | Subtotal | 1134 | 157 |
| | | | Total Samples | 1291 |

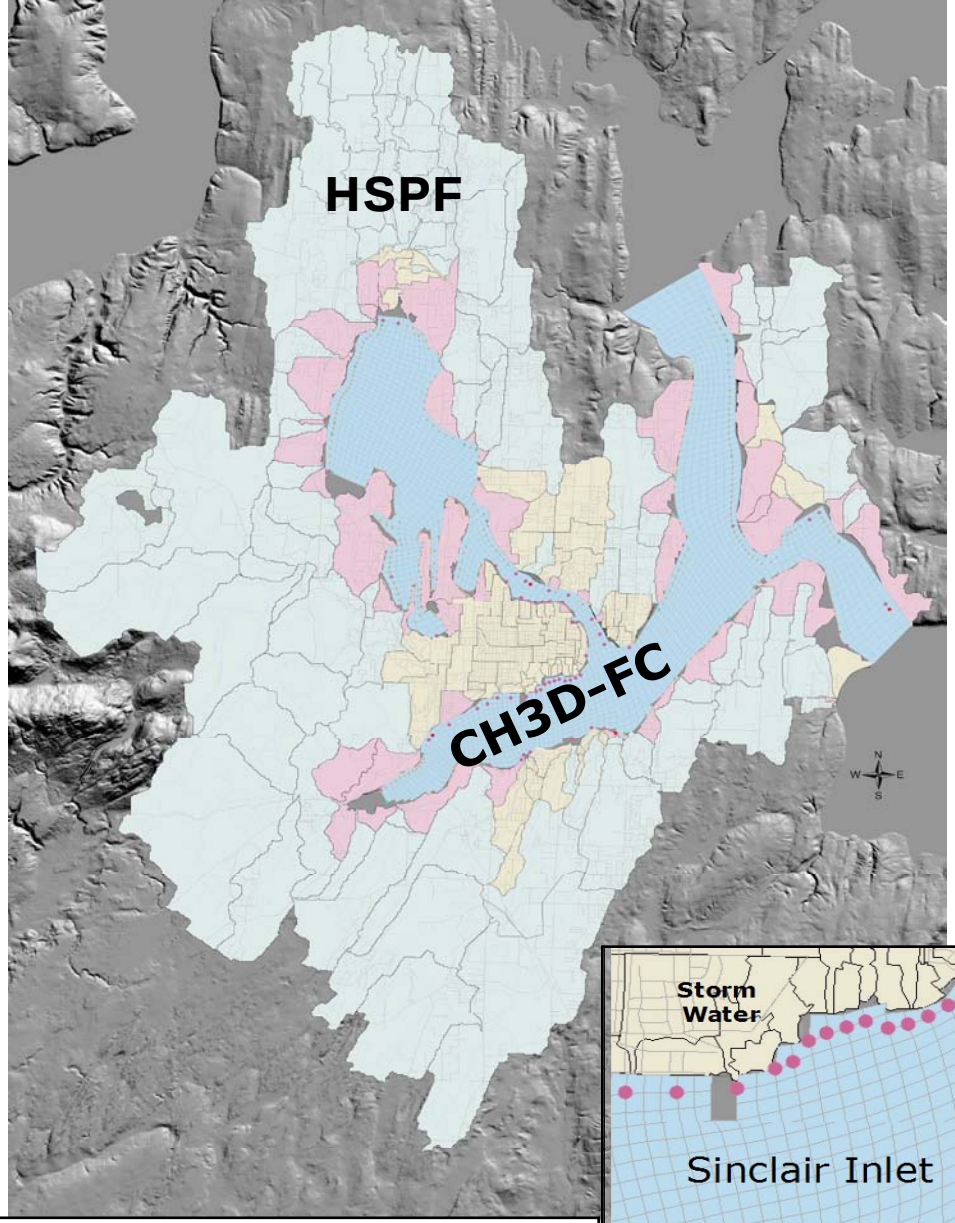
Feedback on analytical support provided by MEL

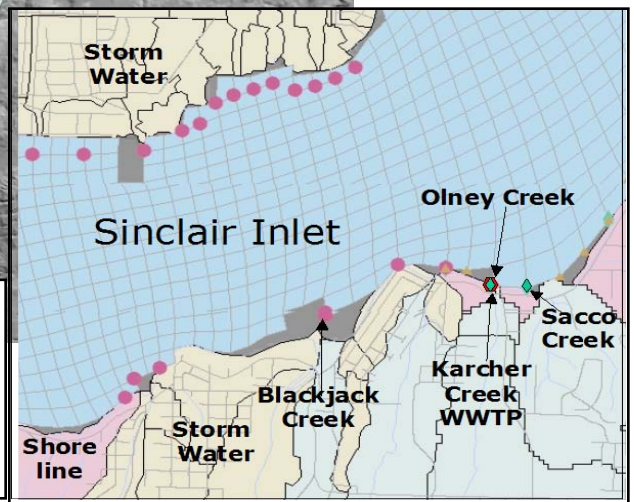
Link to In-Stream Storm Sampling Page

# Integrated Modeling

The integrated watershed (HSPF) and receiving water (CH3D-FC) models all inputs.

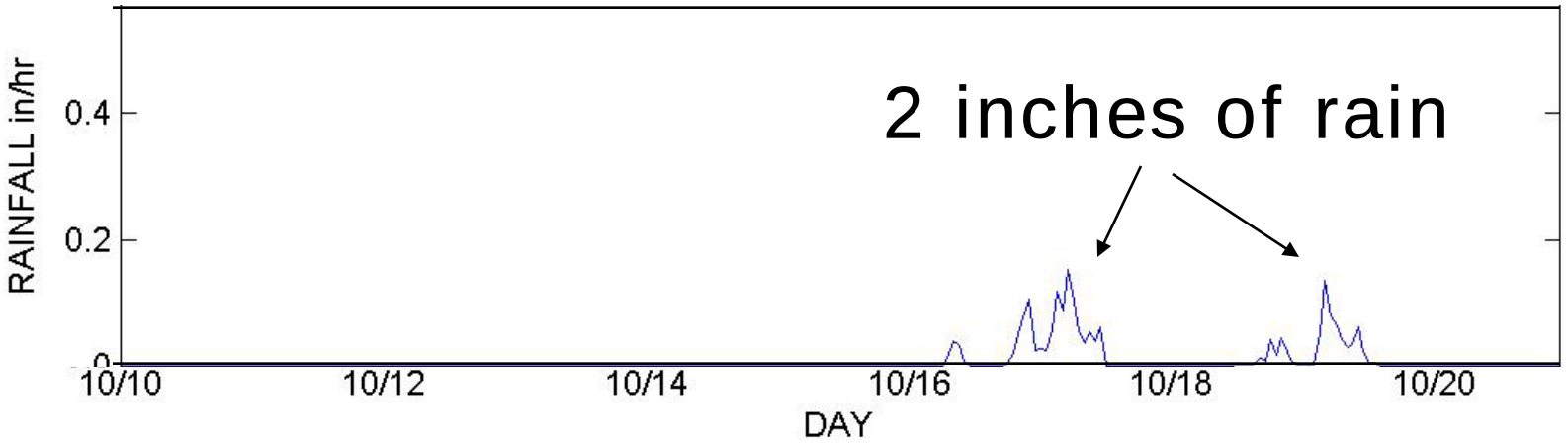
**Current Configuration:**
**39 Streams**
**50 Stormwater Outfalls**
**44 Shoreline Drainages**
**4 Treatment Plants**
**---**
**137 Separate Inputs**



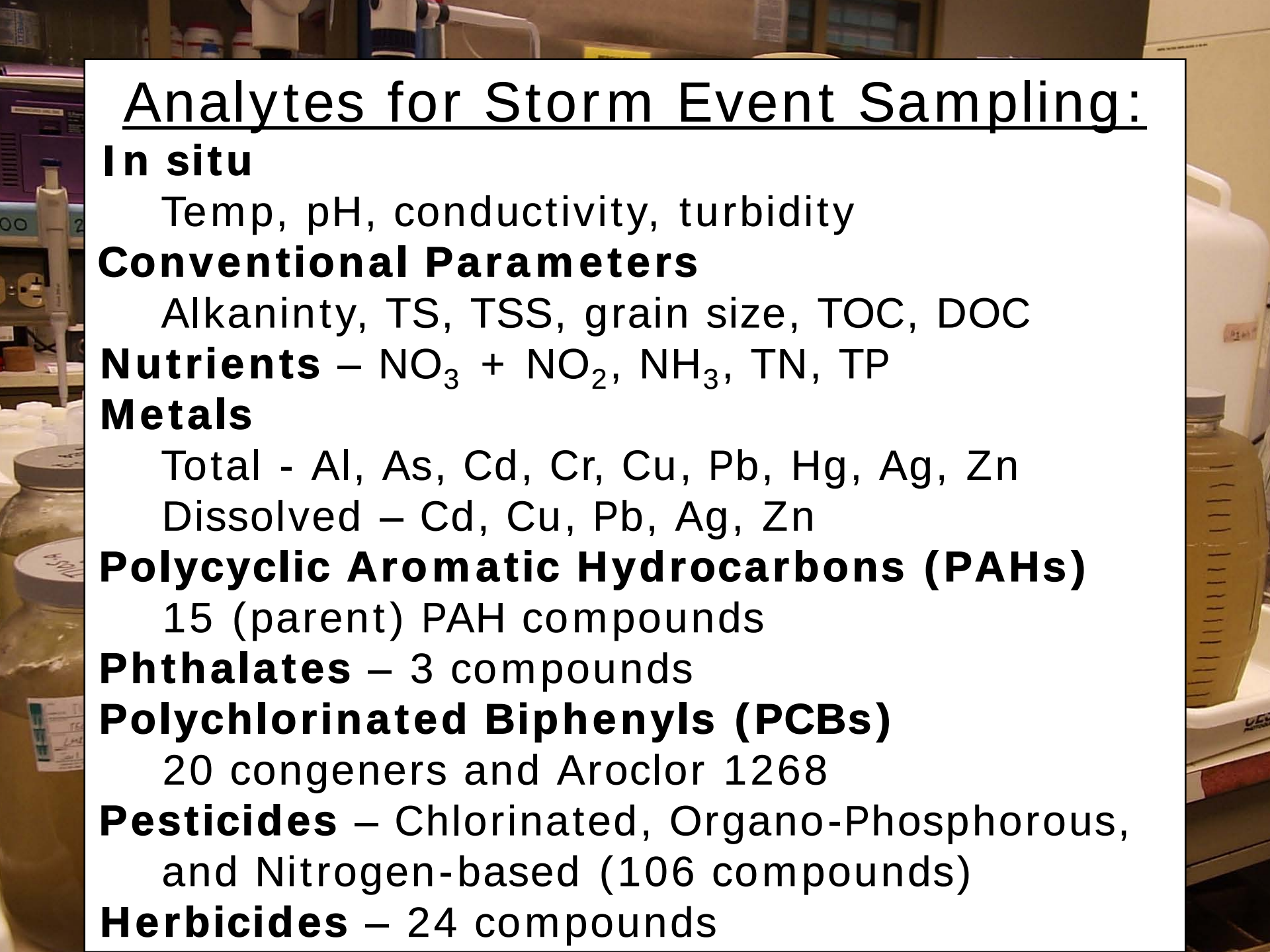




Inputs
- Stream
- Storm water
- Shoreline runoff
- Wastewater Treatment Plant (WWTP)

# Example Model Simulation




**October 2004 Storm Event**



# Analytes for Storm Event Sampling:

**In situ**

Temp, pH, conductivity, turbidity

**Conventional Parameters**

Alkaninty, TS, TSS, grain size, TOC, DOC

**Nutrients** – $NO_3$ + $NO_2$, $NH_3$, TN, TP

**Metals**

Total - Al, As, Cd, Cr, Cu, Pb, Hg, Ag, Zn

Dissolved – Cd, Cu, Pb, Ag, Zn

**Polycyclic Aromatic Hydrocarbons (PAHs)**

15 (parent) PAH compounds

**Phthalates** – 3 compounds

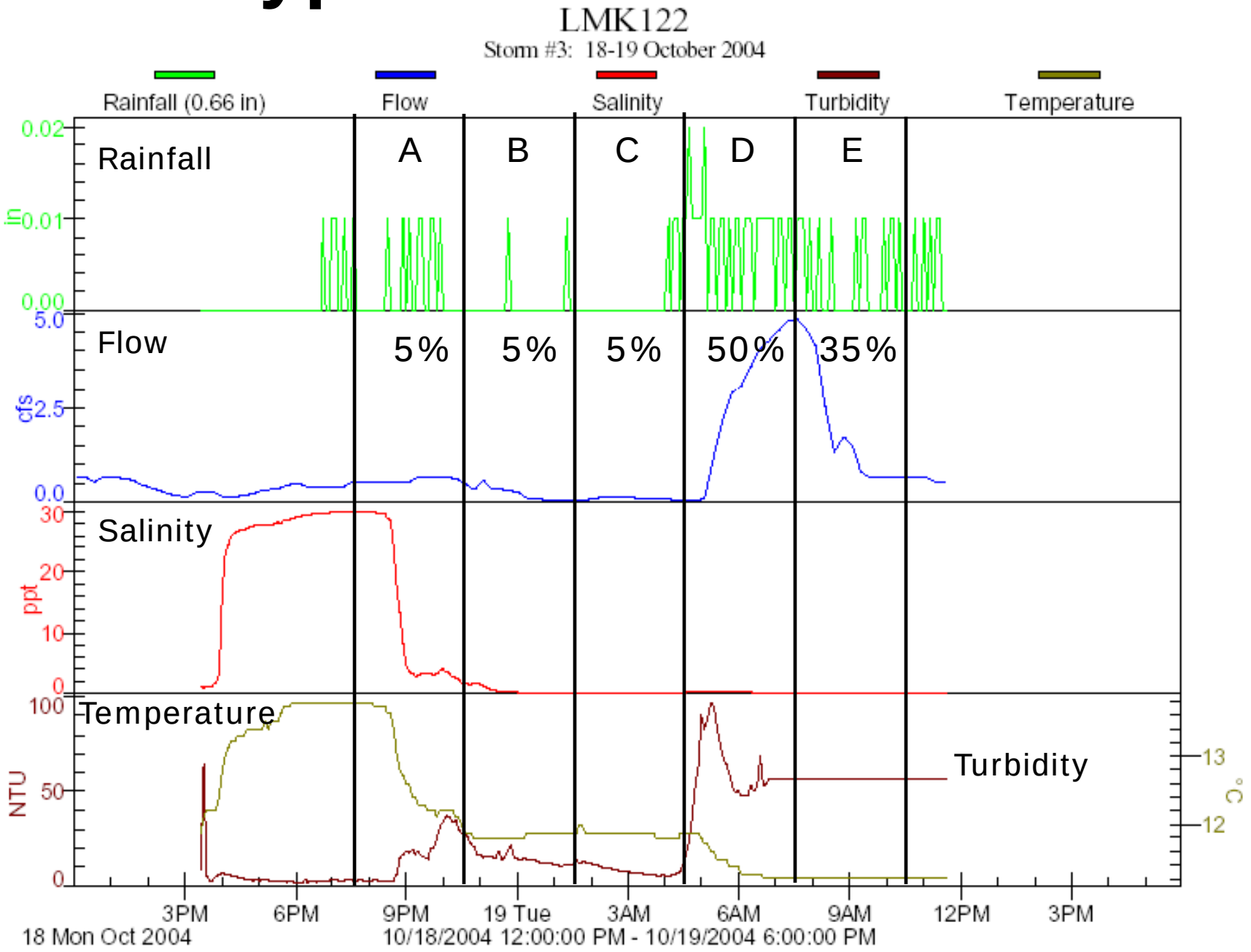
**Polychlorinated Biphenyls (PCBs)**

20 congeners and Aroclor 1268

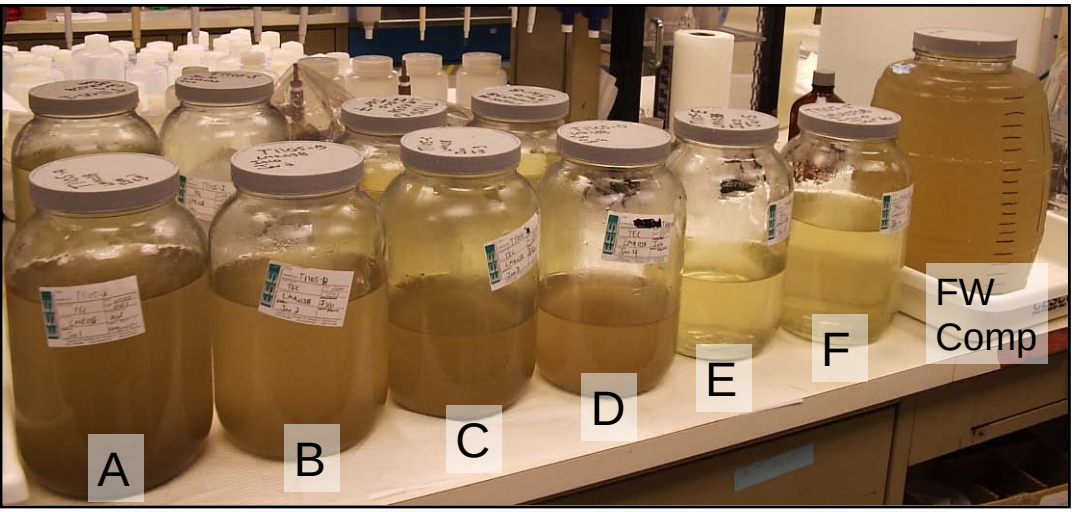
**Pesticides** – Chlorinated, Organo-Phosphorous, and Nitrogen-based (106 compounds)

**Herbicides** – 24 compounds

# Typical Storm Event



# Compositing and Analysis




**Storm Event Mean Composites (EMCs):**

**Storm Drains = Flow Weighted**

**Streams = Equal Weighted**

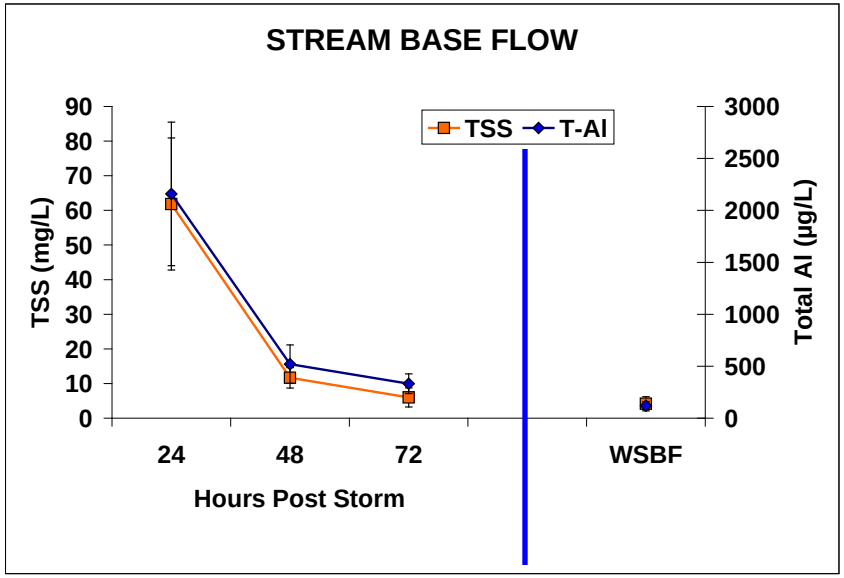
**Grabs = Average of Grabs**

# Types of Samples

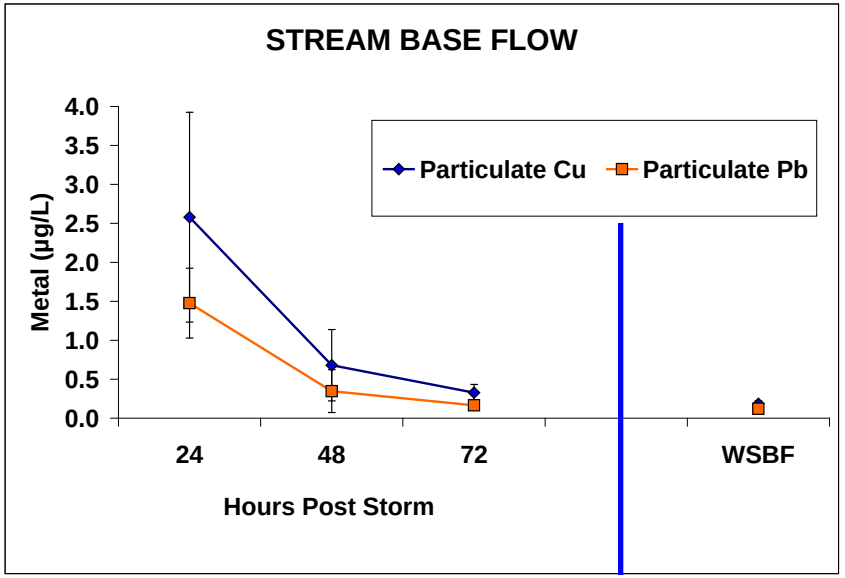
- Dry Season Base Flow (DSBF)
- Wet Season Base Flow (WSBF)
- Small Storms (rain < 0.5 in.)
- Medium Storms (0.5 ≤ rain < 1 in.)
- Medium Large Storms (1 ≤ rain < 2 in.)
- Large Storms ≥ 2 in.

# Wet Season Base Flow (WSBF)

- 6 Streams sampled following large storm.
- Baseflow defined as >72 hours following storm.

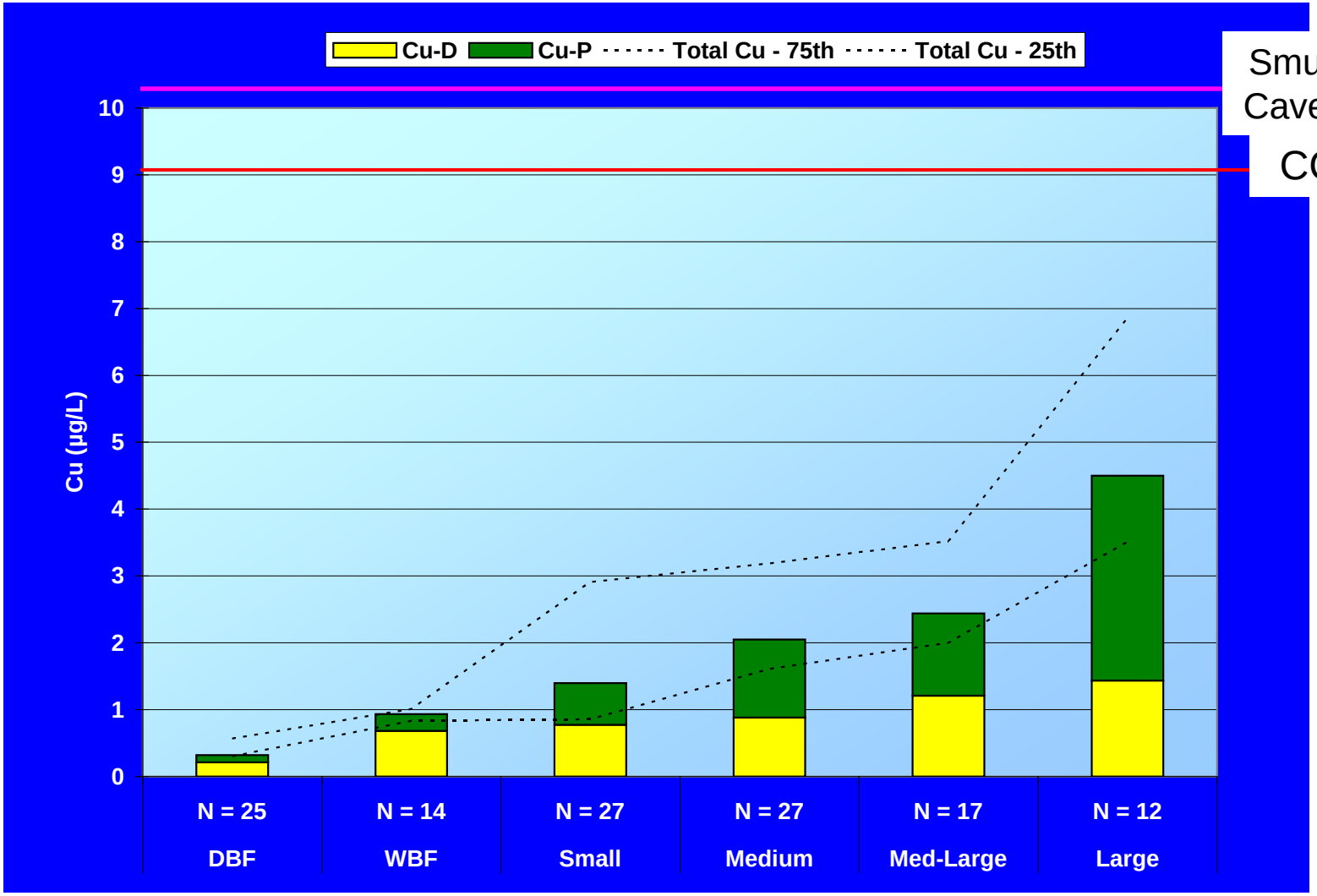



Total Suspended Solids (TSS) and Aluminum (Al)




Metals Copper (Cu) and Lead (Pb)

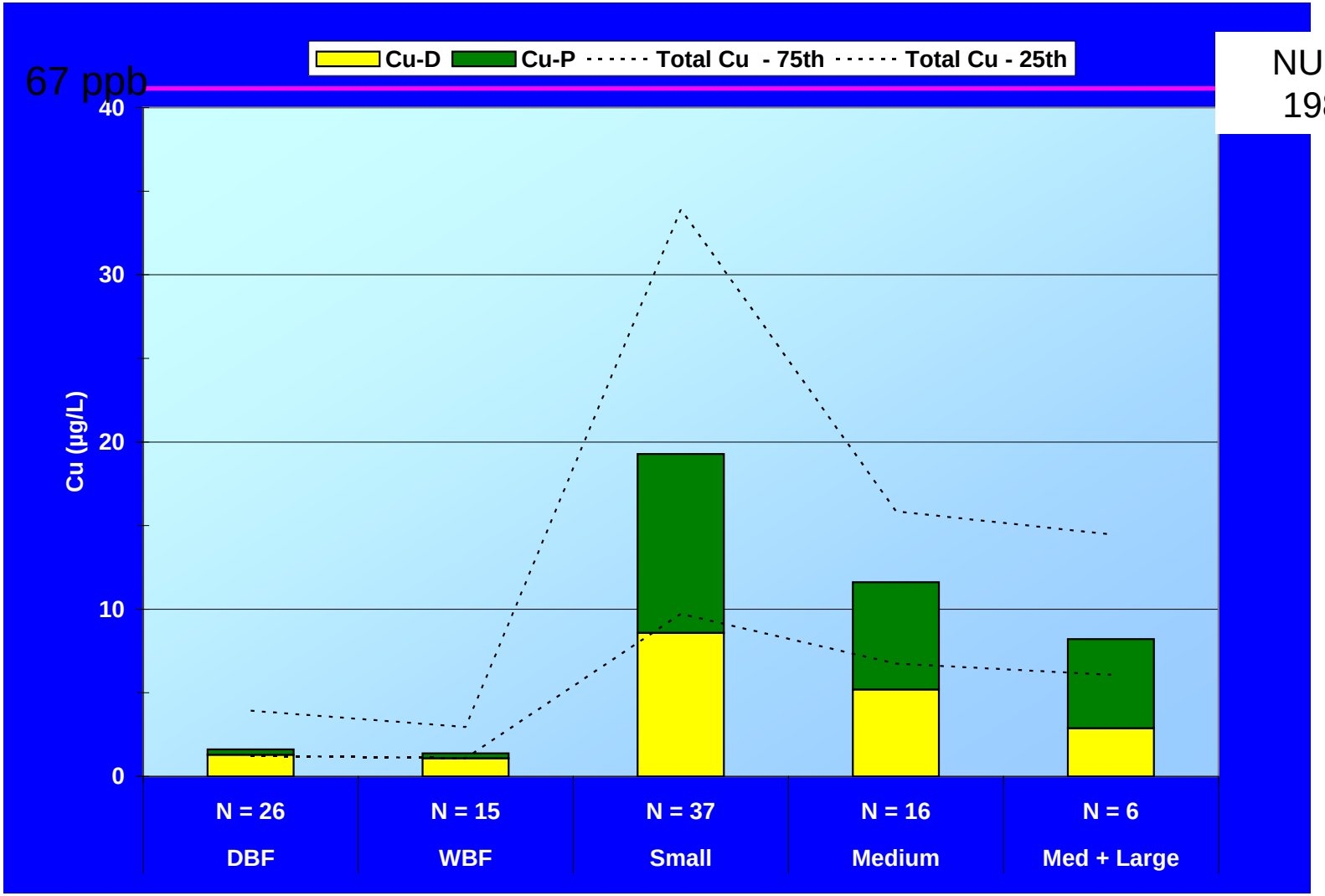
# Median EMCs for Cu in Streams




Smullen & Cave 1998

CCC

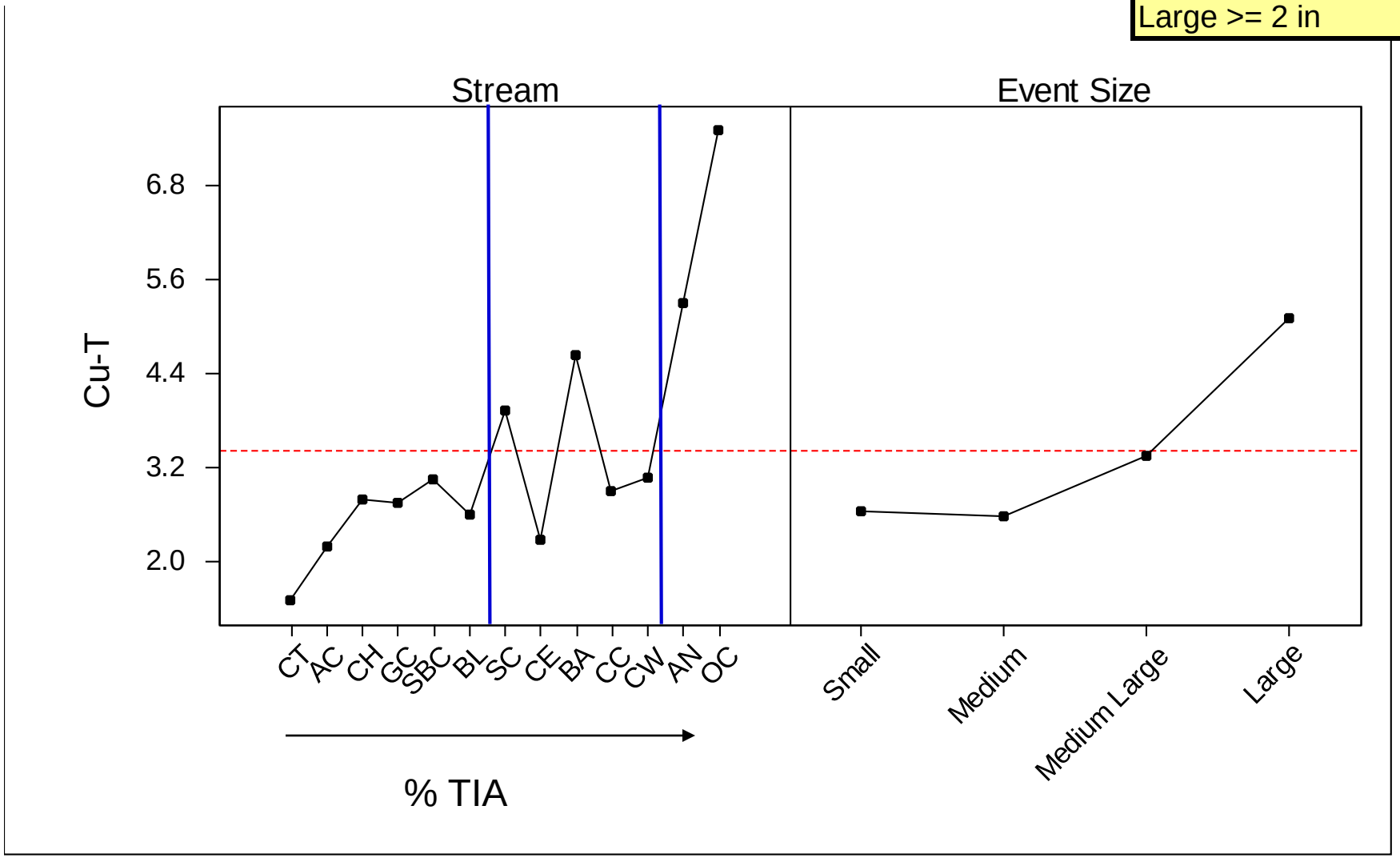
# Median EMCs for Cu in Outfalls



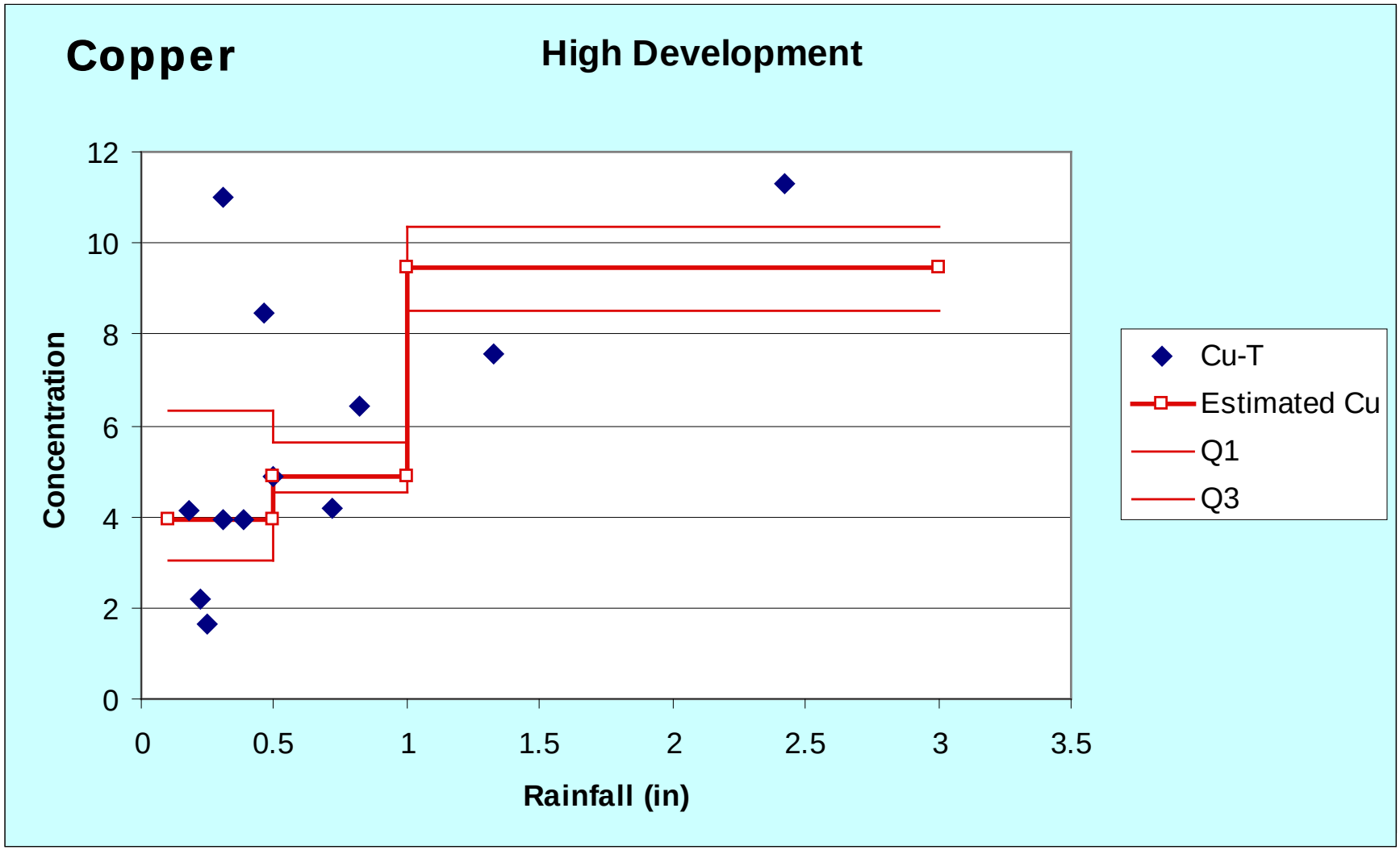
# Relationship Between EMC and Storm Characteristics

**Event Size**
Small < 0.5 in
Medium < 1 in
Medium Large < 2 in
Large >= 2 in

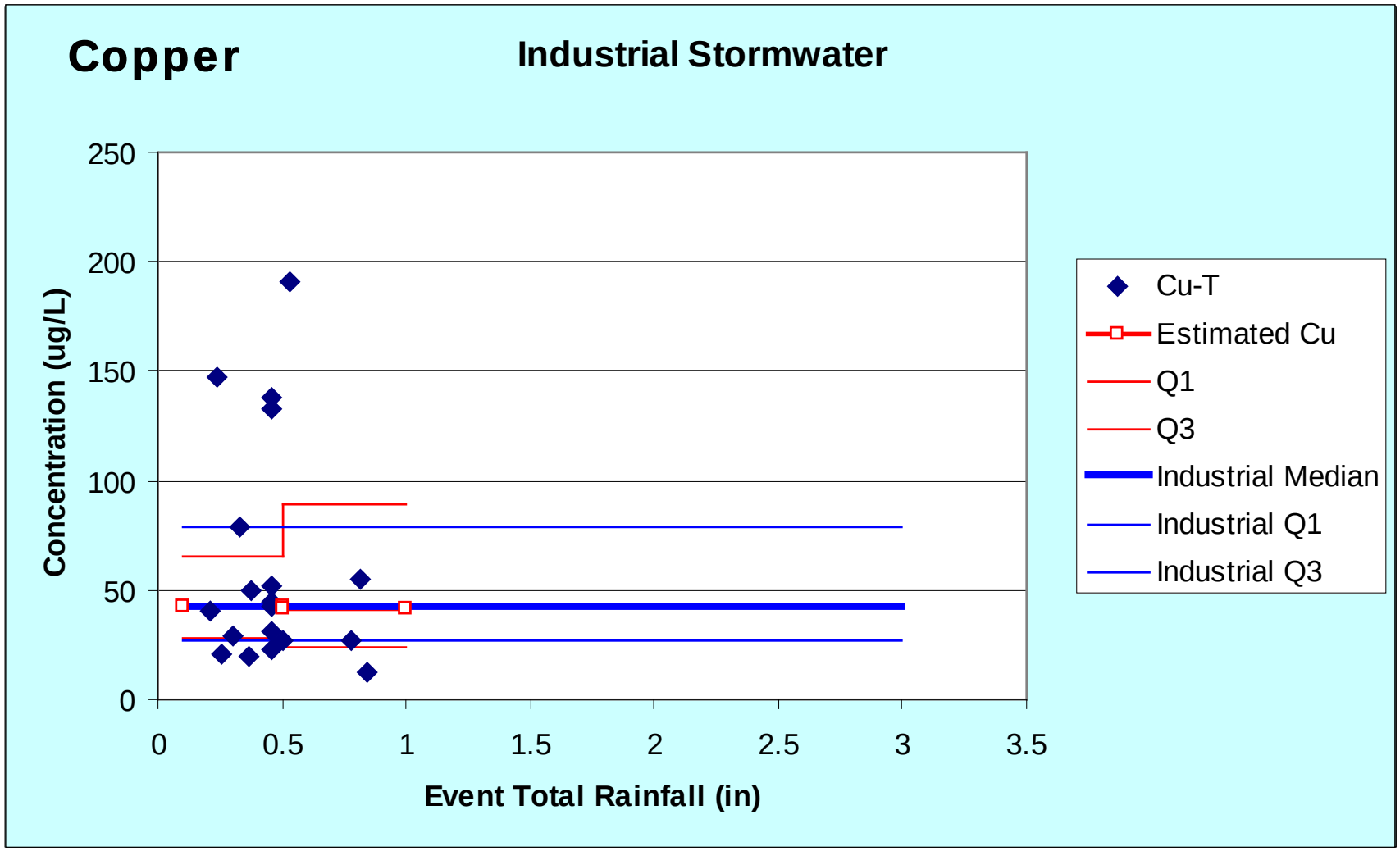
For all storm samples, n = 64 to 85



# Loading Function for Copper



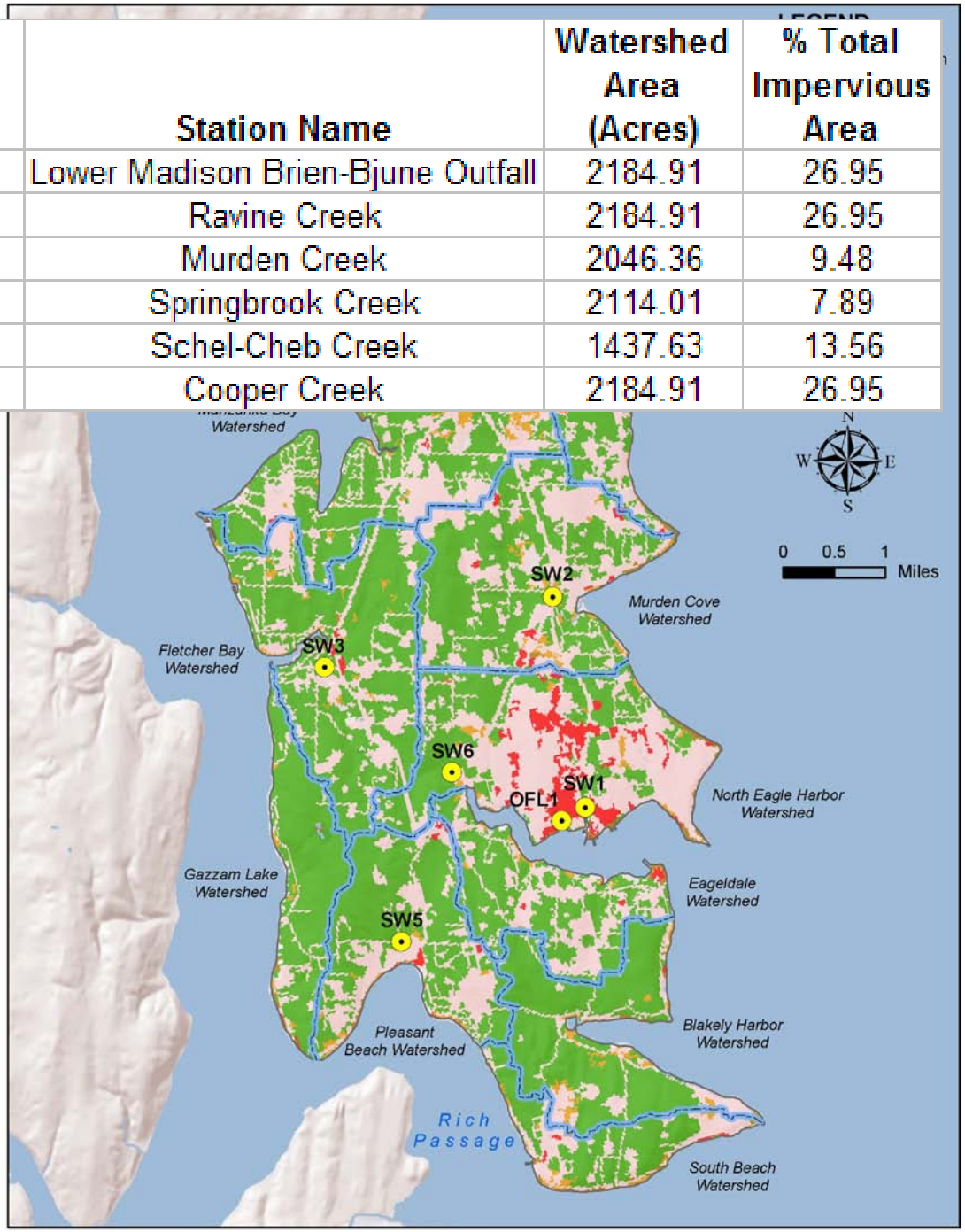
# Loading Analysis for Urban Stormwater



| Classification | Watershed | Station ID | Station Name | Watershed Area (Acres) | % Total Impervious Area |
|---|---|---|---|---|---|
| Moderate | North Eagle Harbor | OFL1 | Lower Madison Brien-Bjune Outfall | 2184.91 | 26.95 |
| Low | North Eagle Harbor | SW1 | Ravine Creek | 2184.91 | 26.95 |
| Low | Murden Cove | SW2 | Murden Creek | 2046.36 | 9.48 |
| Low | Fletcher Bay | SW3 | Springbrook Creek | 2114.01 | 7.89 |
| Low | Pleasant Beach | SW5 | Schel-Cheb Creek | 1437.63 | 13.56 |
| Moderate | North Eagle Harbor | SW6 | Cooper Creek | 2184.91 | 26.95 |

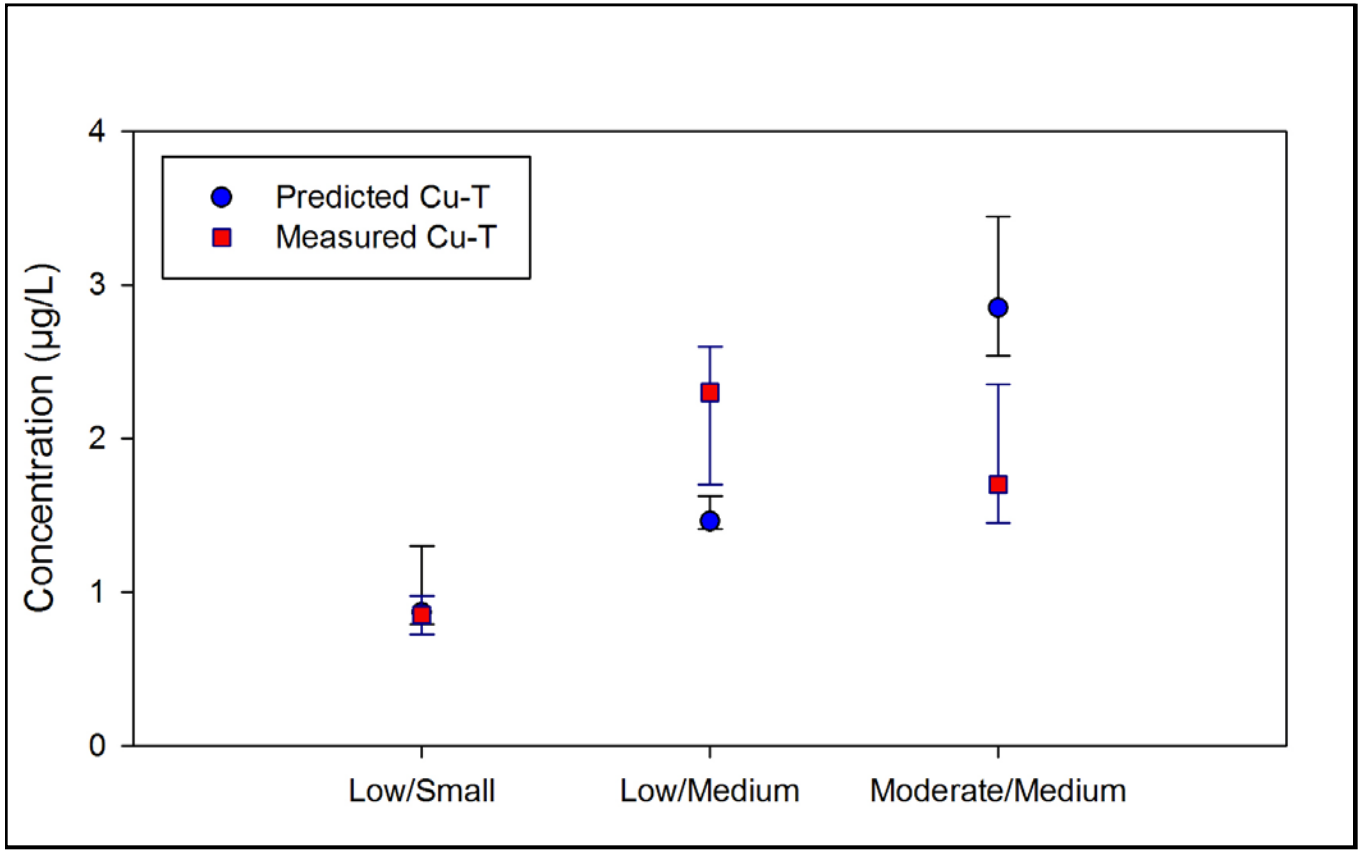
## 2008 Sampling:

- 1 Small Storm (0.13 inch.)
- 1 Med. Storm (0.51 inch.)



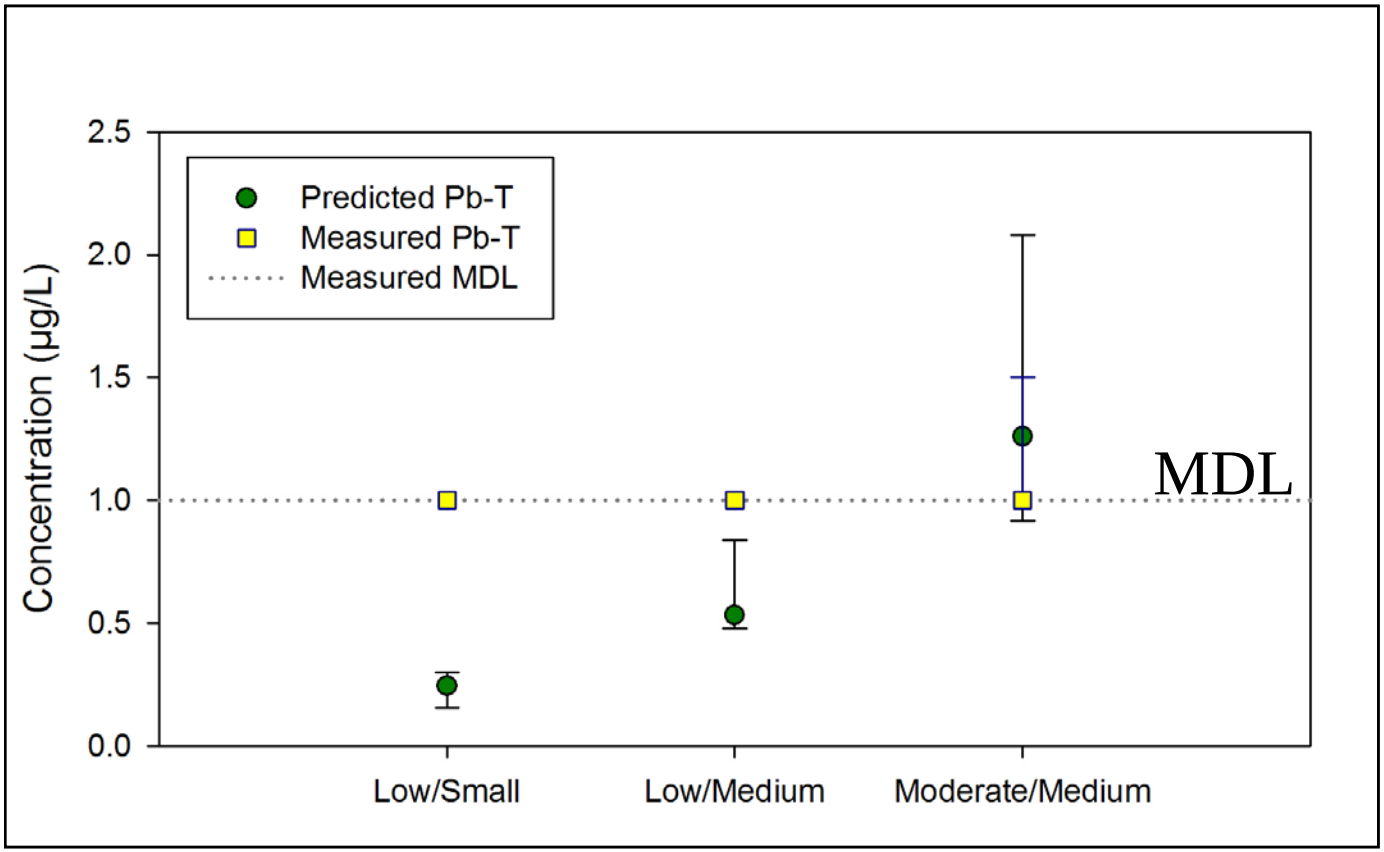

TAYLOR ASSOCIATES, INC.

# Total Copper in Streams



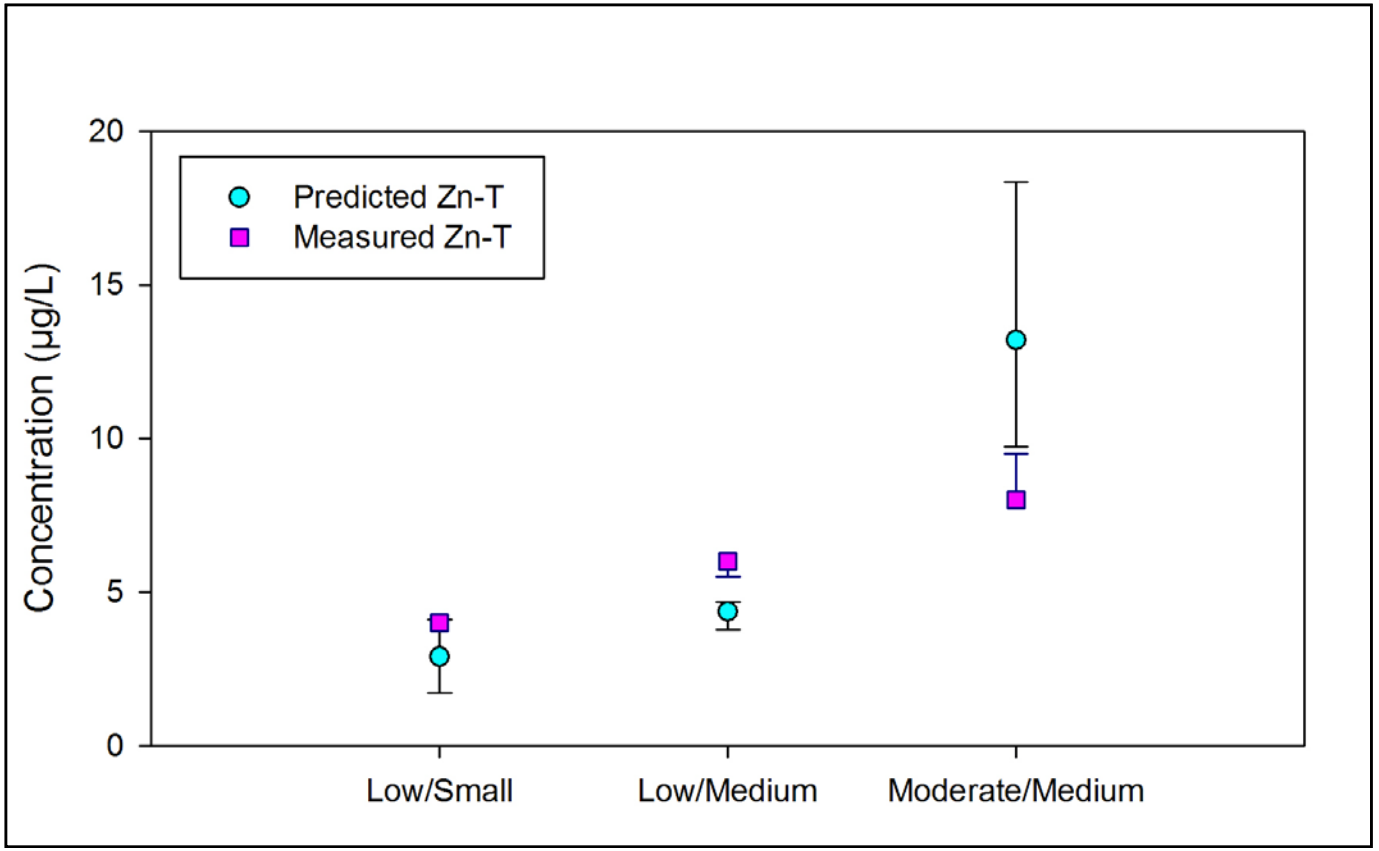

Level of Development and Storm Size

# Total Lead in Streams



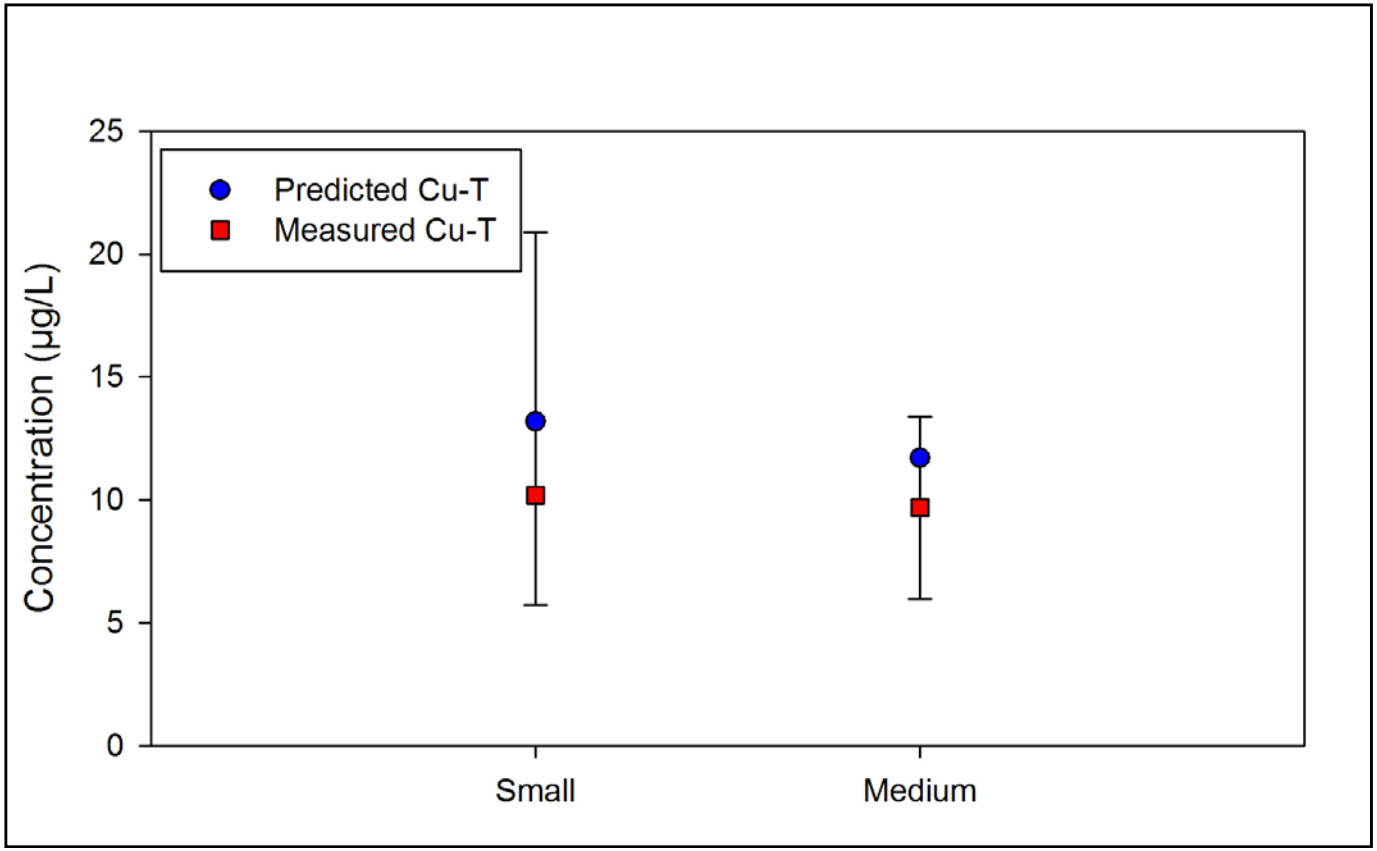

Level of Development and Storm Size

# Total Zinc in Streams



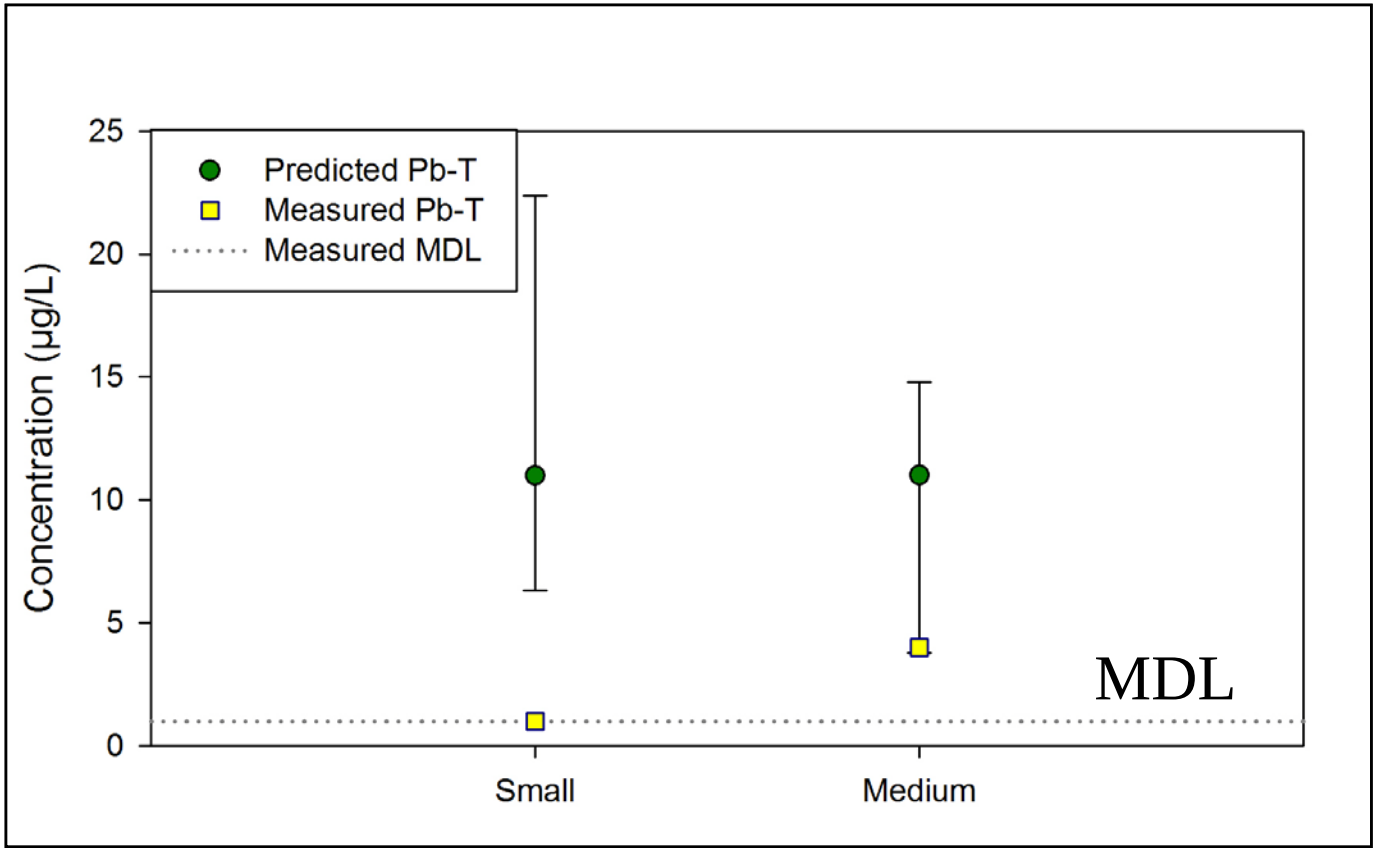

Level of Development and Storm Size

# Total Copper in the Outfall

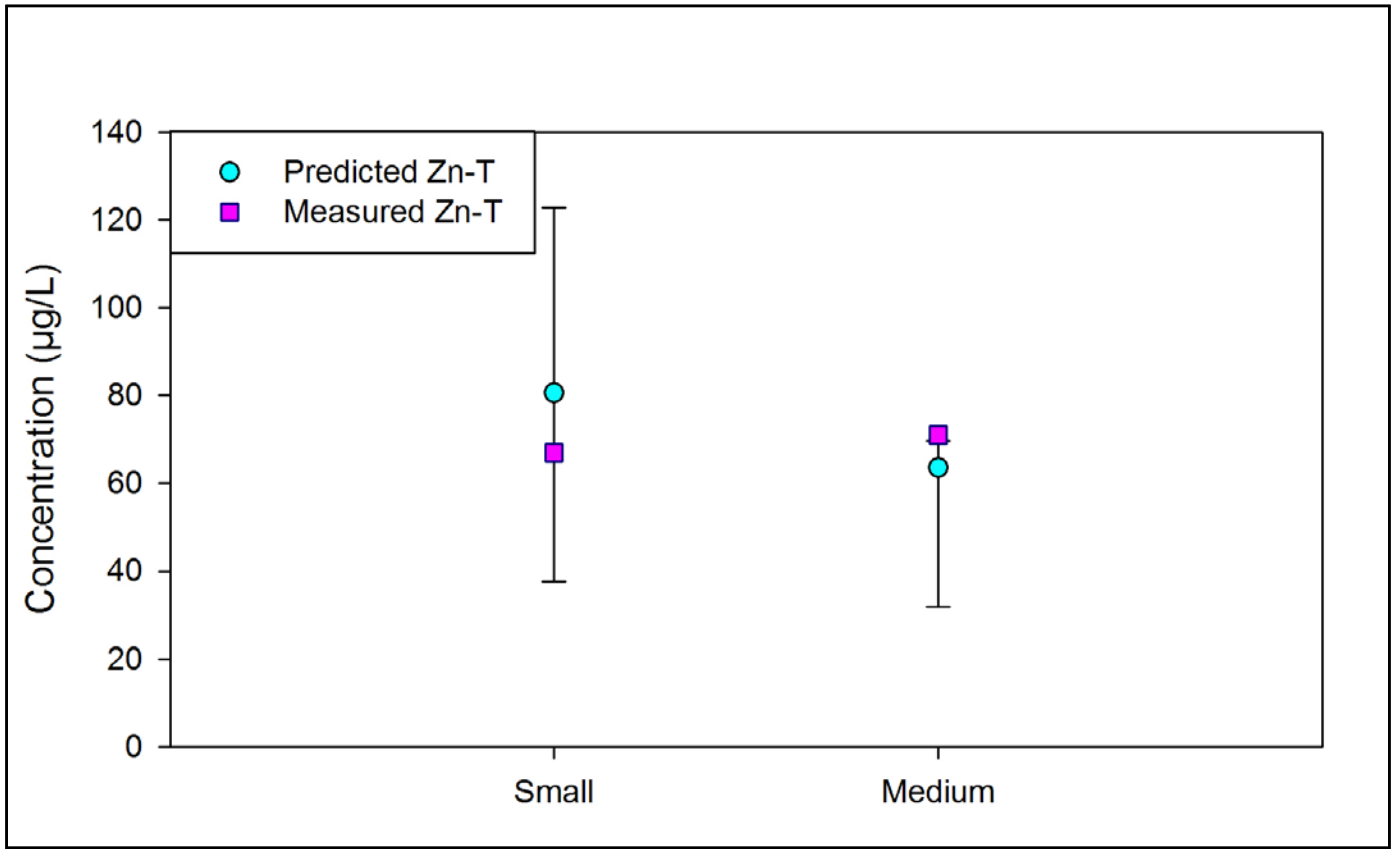



Storm Size

# Total Lead in the Outfall



# Total Zinc in the Outfall



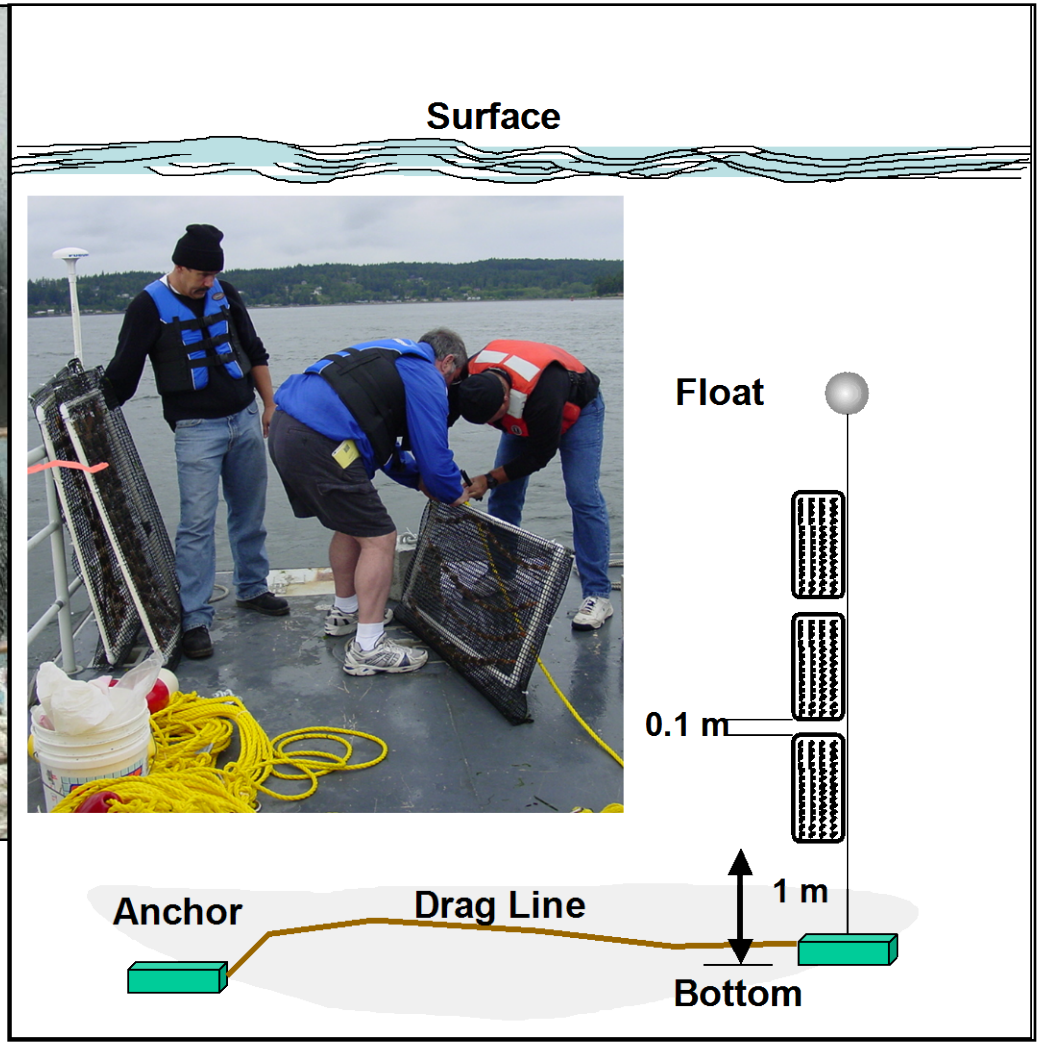

Storm Size

# Biota Sampling

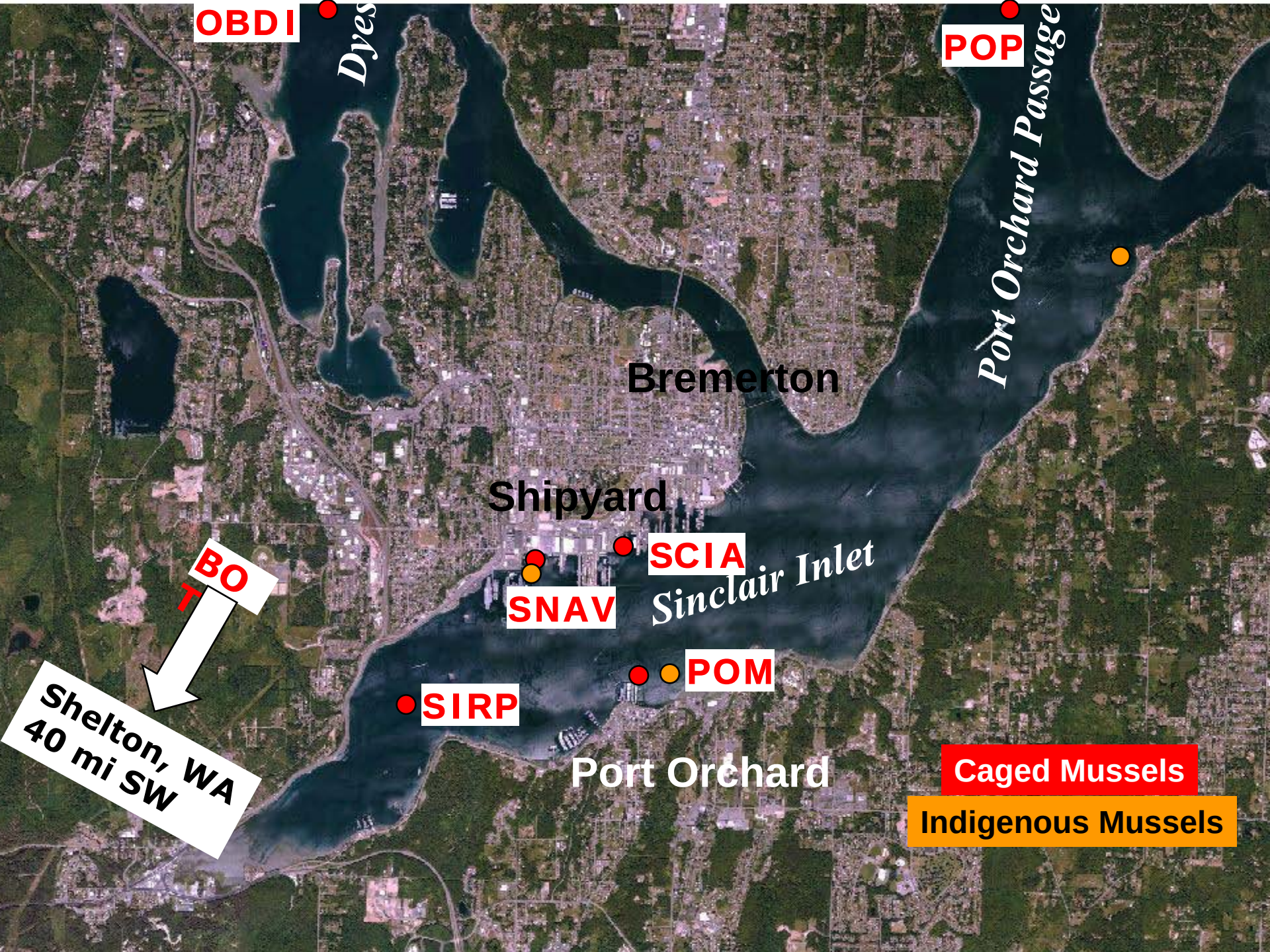
## Bottom Fish Sampling

Bottom fish trawl in Sinclair Inlet.

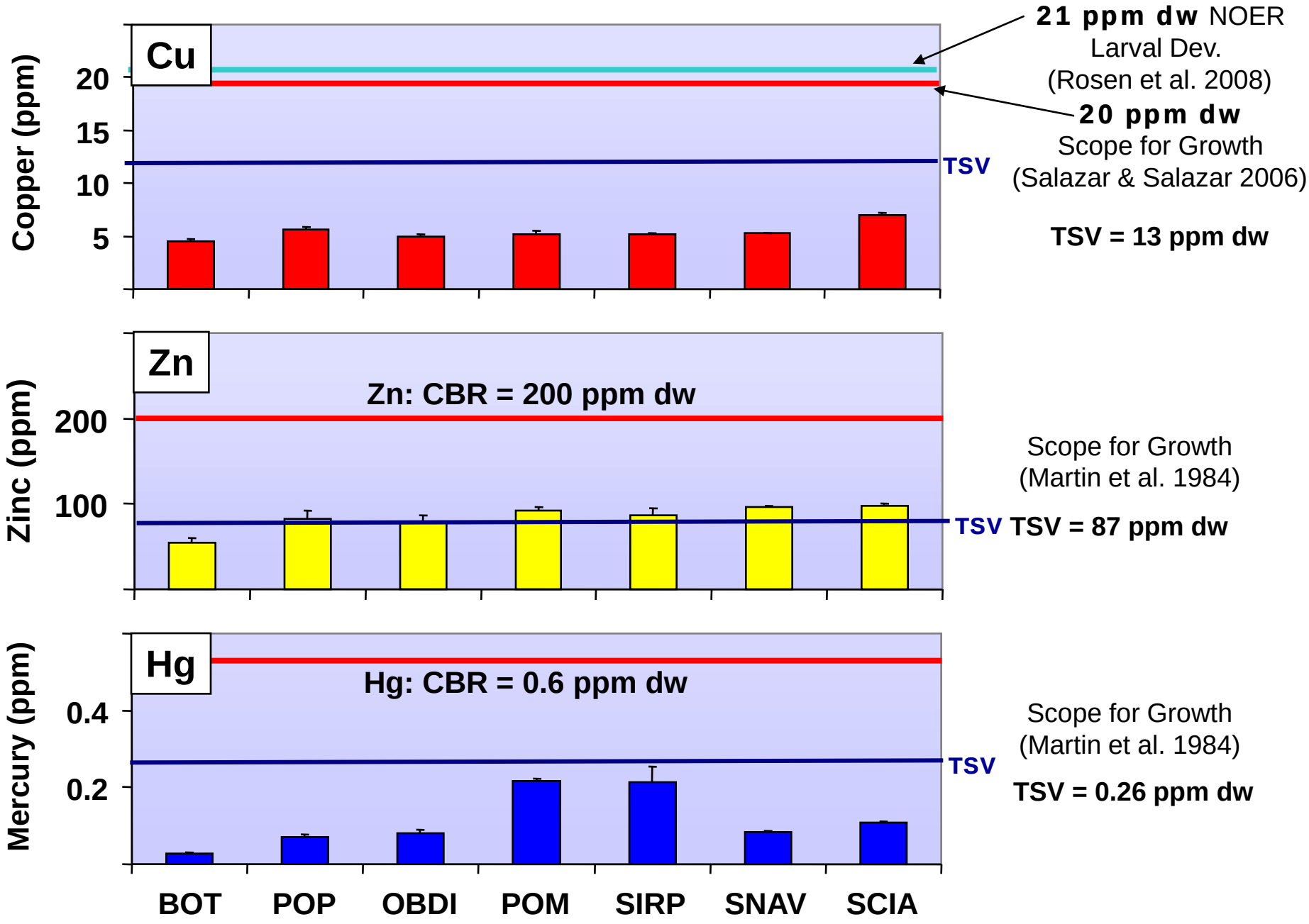
## Caged Mussel Study




Mussel cage configuration.


OBDI
Dyes
POP
Port Orchard Passage
Bremerton
Shipyard
SCIA
Sinclair Inlet
SNAV
BOT
POM
SIRP
Port Orchard
Shelton, WA
40 mi SW
Caged Mussels
Indigenous Mussels

# Deployed Mussel Tissue Residues (Dry Weight)



# Lessons Learned

# What are appropriate scales to work at and how can we best transfer study findings from one location to another?

- Watershed Scale
  - Basis for Partnering
- Sub-Watershed Basins are the Experimental Units
  - Provides for Replication Across the Region
- Pool resources and data to get a better product.
- Much better chance for successful implementation.

# What are some key principals for success?

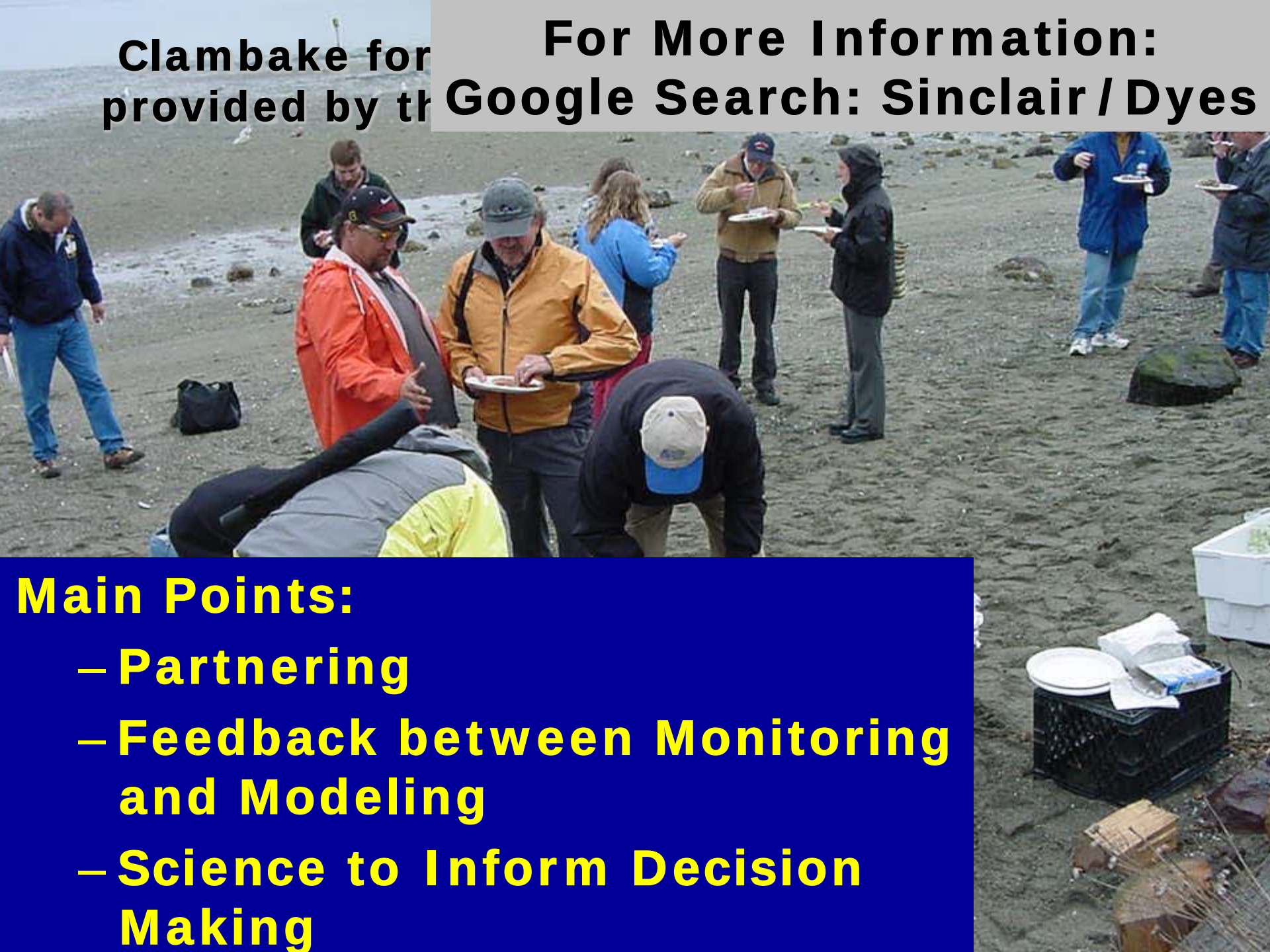
- Integration
  Modelers ↔ Monitors
  Terrestrial ↔ Nearshore ↔ Marine
- Clear goals and achievable objectives
- Rational decision making process
- Incorporate stakeholder interests
- Draw on the strengths and contributions of all partners
- Communicate early and often
- Allow all partners to benefit

# Pitfalls to avoid??

- Don’t be freaked out by cost!
  - Incremental Funding
- Don’t try to do too much
  - Focus on key objectives
- Don’t fight Mother Nature
  - Work with what you have
- Be Flexible
  - Plan, Adjust, Improvise

# Conclusions

- An empirically-based model of water quality as a function of LULC and the amount of rainfall within 24 hours
- Predicted loading concentrations were within a factor of 2
- Apply to other areas of Puget Sound.
  - A comparable LULC classification
  - Ambient level MDLs and appropriate collection methods
  - Additional data needed for high density urban and agricultural areas.




**Main Points:**

- Partnering
- Feedback between Monitoring and Modeling
- Science to Inform Decision Making