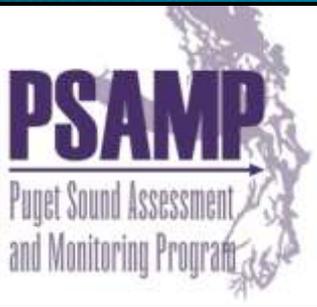


Nearshore Sediment Monitoring Analysis: 1997–2009 PSAMP/UWI Ambient Monitoring Data

Washington State Department of Ecology
Environmental Assessment Program
Marine Sediment Monitoring Team

Maggie Dutch, Sandra Weakland
Valerie Partridge, Kathy Welch, Ed Long



Background

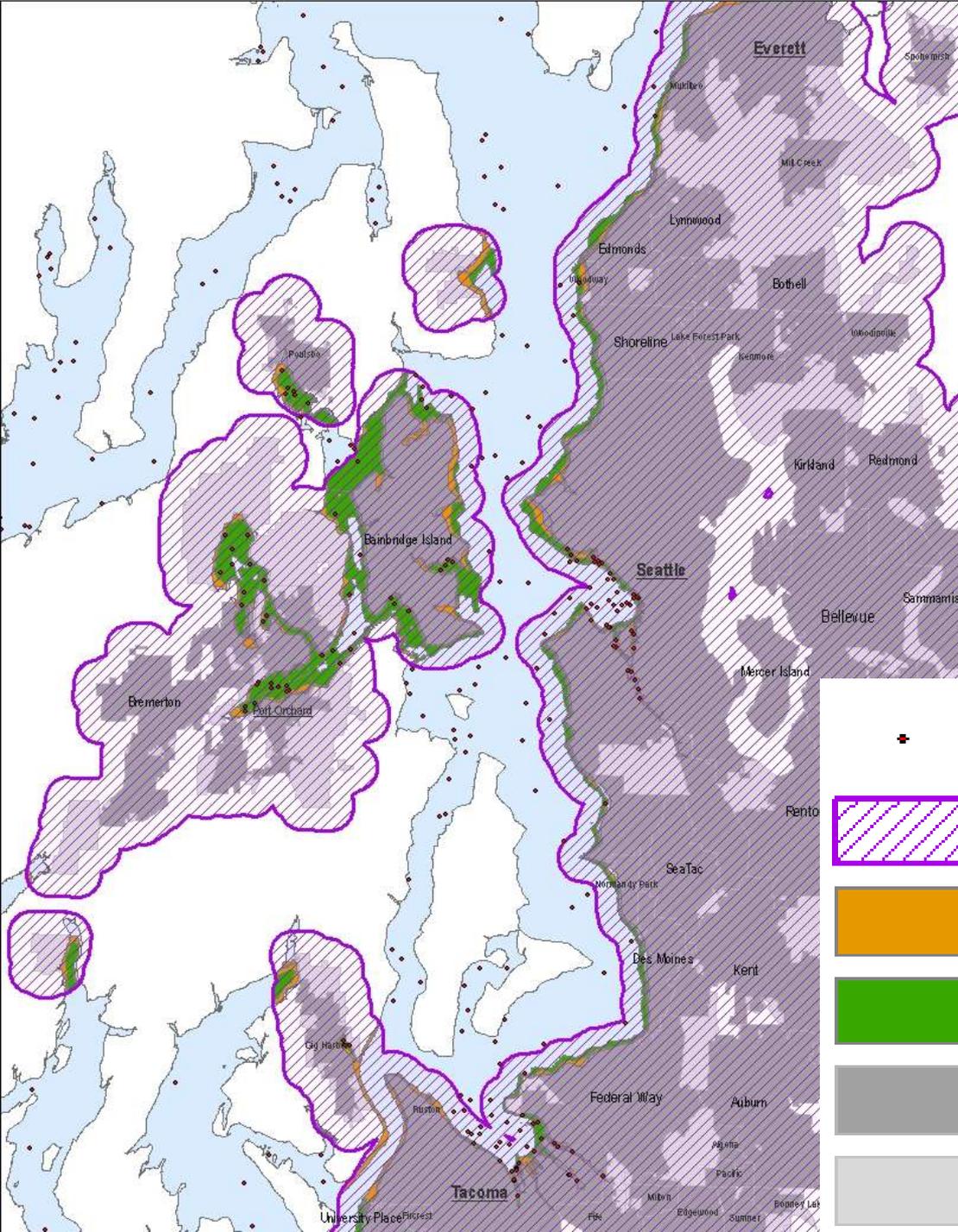
- Design a probabilistic nearshore sediment monitoring program similar to PSAMP
- **PSAMP** sampling frame – $\geq 2\text{m}$ (~ 1 fathom) MLLW
- **Nearshore** defined as 0 – 30m MLLW
- **New nearshore program** to sample sediments from 0 – 2m MLLW

Objectives

- **Characterize nearshore sediment quality (chemical contaminants, other parameters) in and outside of Urban Growth Areas (UGAs)**
- **Track changes in sediment quality over time in UGA and nonUGA**

Sampling Frame Development

- GIS ARCVIEW layers:
 - ✓ PSAMP Sampling Frame – $\geq 2\text{m}$ (1 fathom) MLLW
 - ✓ Urban/Harbor vs. Passage/Rural/Basin (PSAMP)
 - ✓ UGA land
 - ✓ UGA vs. nonUGA – 1500m buffer (easy)
 - 0 – 2m and 2 – 30m MLLW (in progress)
 - perpendicular lines from UGA through 2m, 30m boundaries (time, \$\$ commitment)



Inside/outside 1500m UGA buffer: Central Puget Sound (2-30m MLLW)

• 1997-2009 PSAMP Stations



City UGA_Buffer_1500m



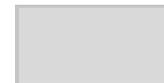
0-1f



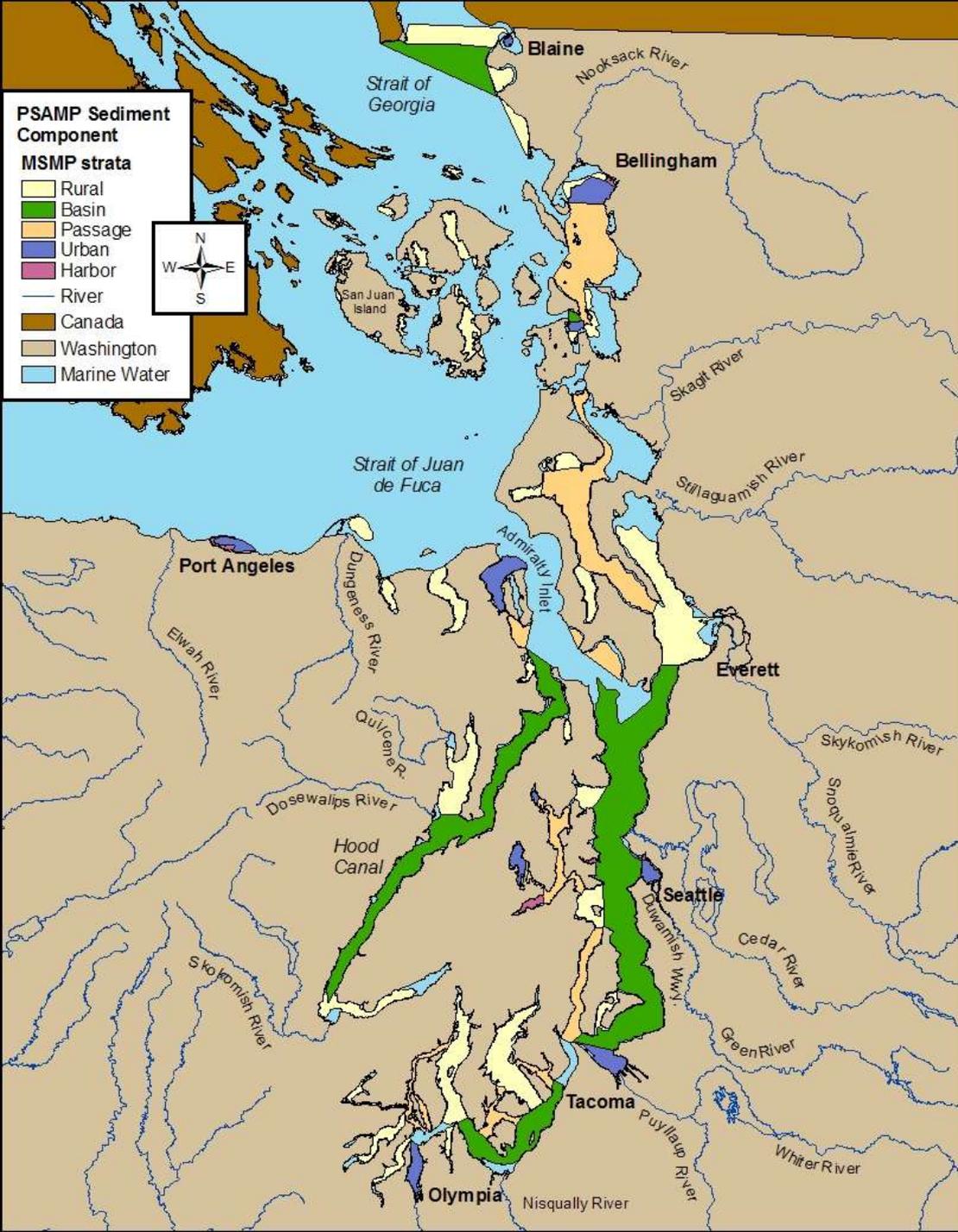
1-30m



City (incorp)



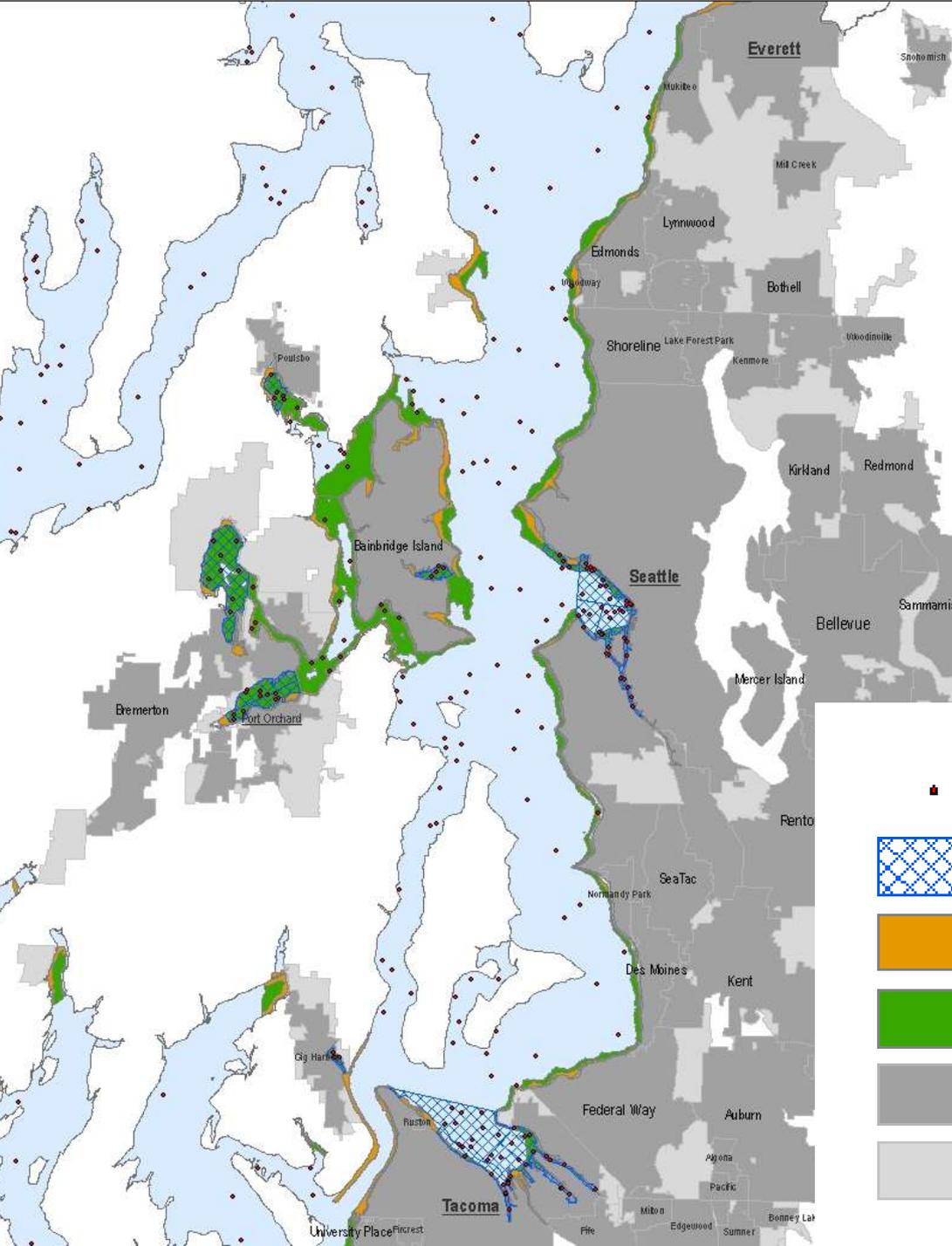
UGA (unincorp)



5 PSAMP Strata:

-  Urban
-  Harbor
-  Rural
-  Passage
-  Basin

Urban/Harbor VS Passage/Rural/Basin Central Puget Sound (2-30m MLLW)



- 1997-2009 PSAMP Stations
- ▨ PSAMP Urban and Harbor Strata
- 0-1f
- 1f-30m
- City (incorp)
- UGA (unincorp)

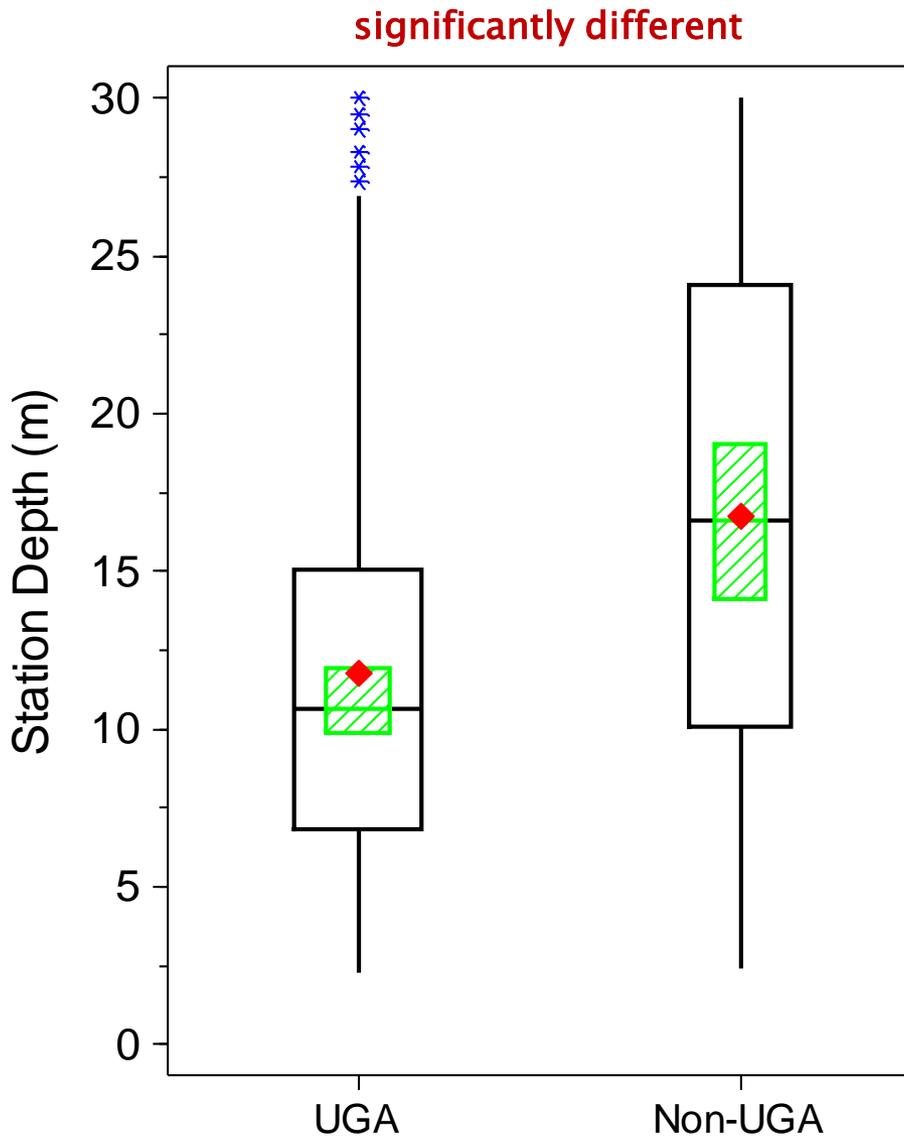
Preliminary Data Analyses

- **existing** PSAMP sediment data (n=441 sta)
- **2 – 30m MLLW**
 - Inside/outside 1500m UGA buffer
 - Urban/Harbor vs. Passage/Rural/Basin strata
- **Box Plots** (summary stats, data distribution)
- **Kruskal–Wallis** (nonparametric, between–groups comparisons)

Parameters

- **Physical** – Depth, % Fines, TOC
- **Chemical** – mSQSq – all chem, metals, PAHs, no. of contaminant concentrations exceeding criteria for each station
- **Sediment Chemistry Index (SCI)**
- **Sediment Quality Triad Index (SQTI)**
- Toxicity
- Benthic Invertebrates

Station Depth



mean



75th %-ile



median



25th %-ile

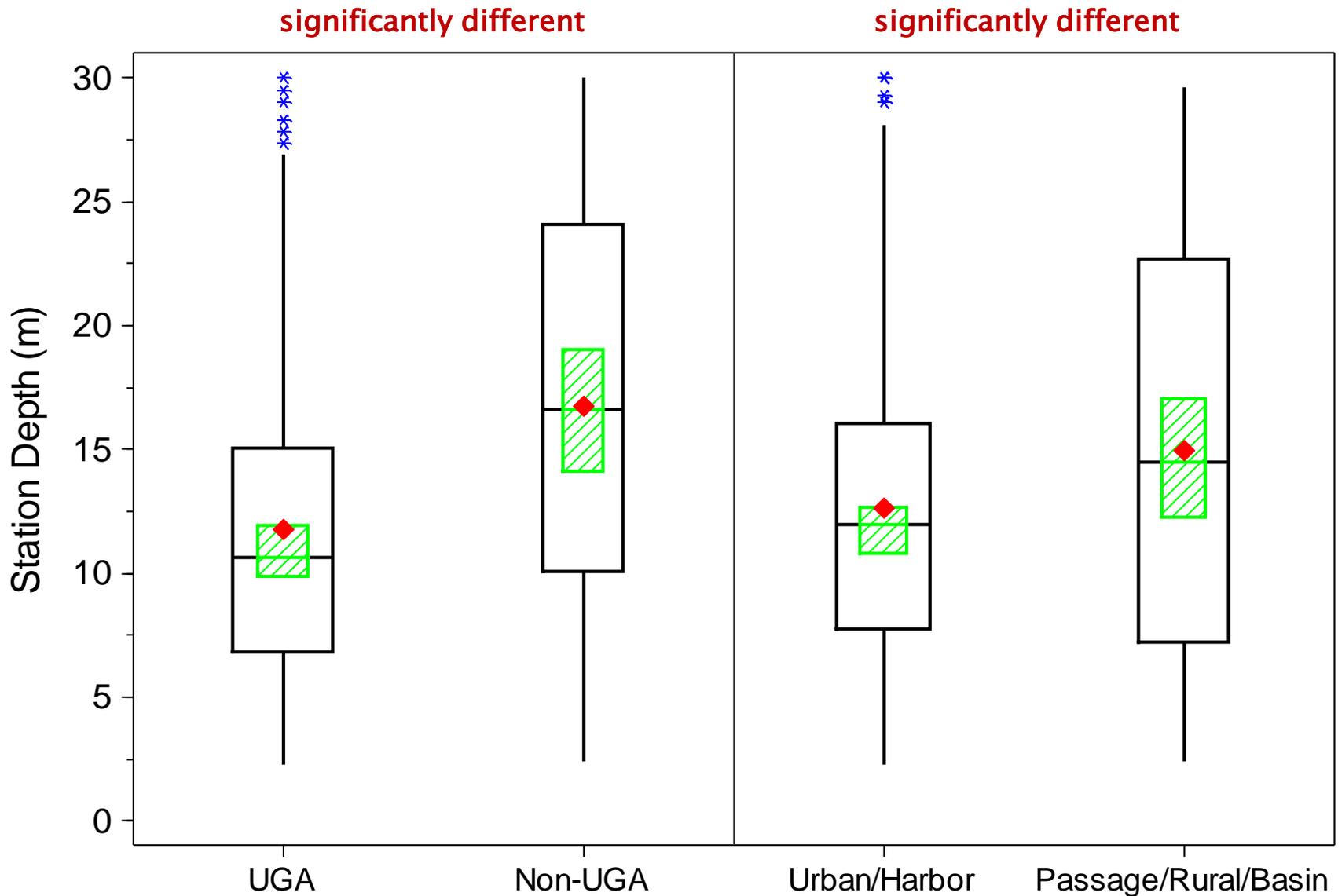


95% CI
for median

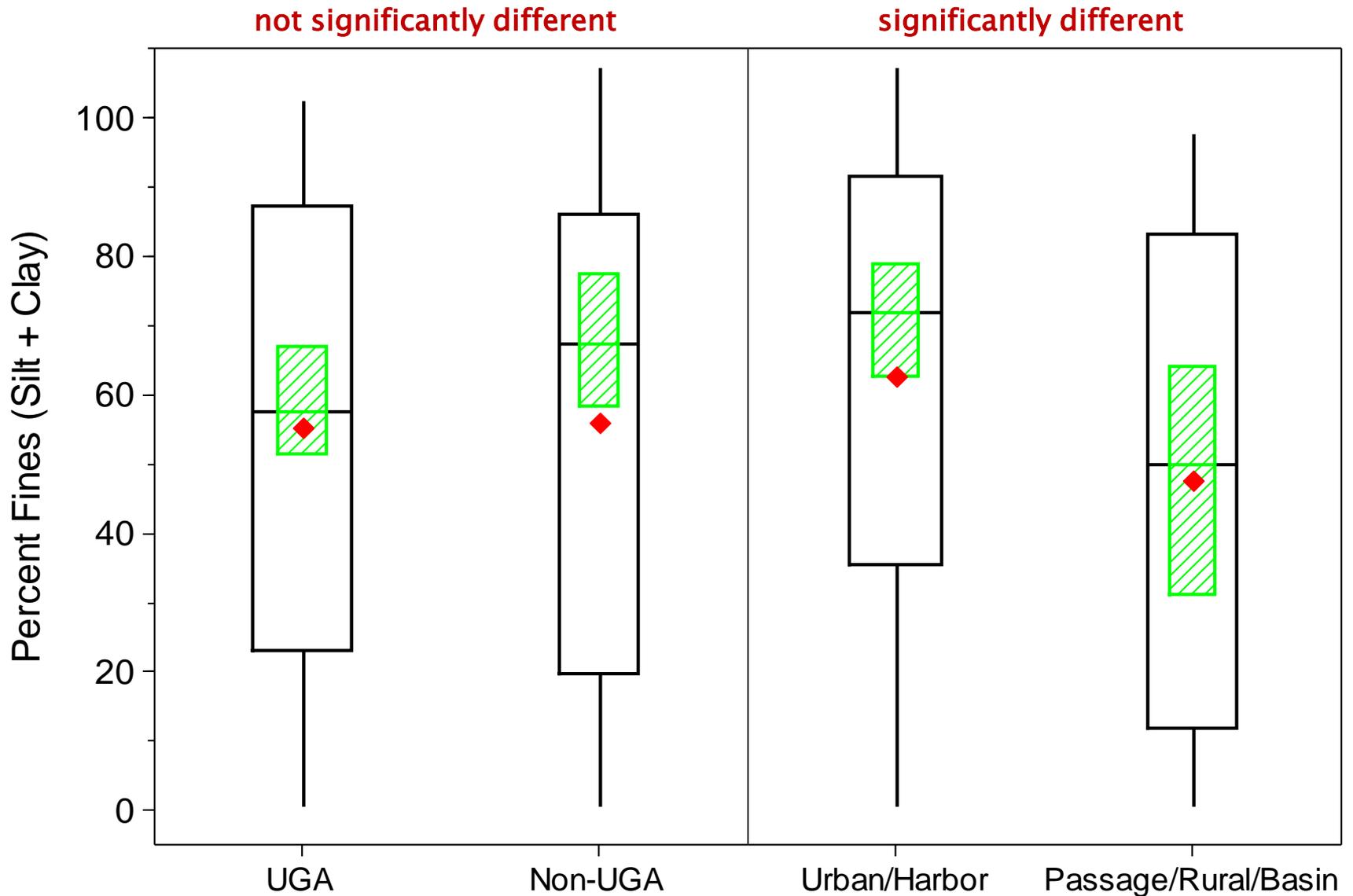


outlier

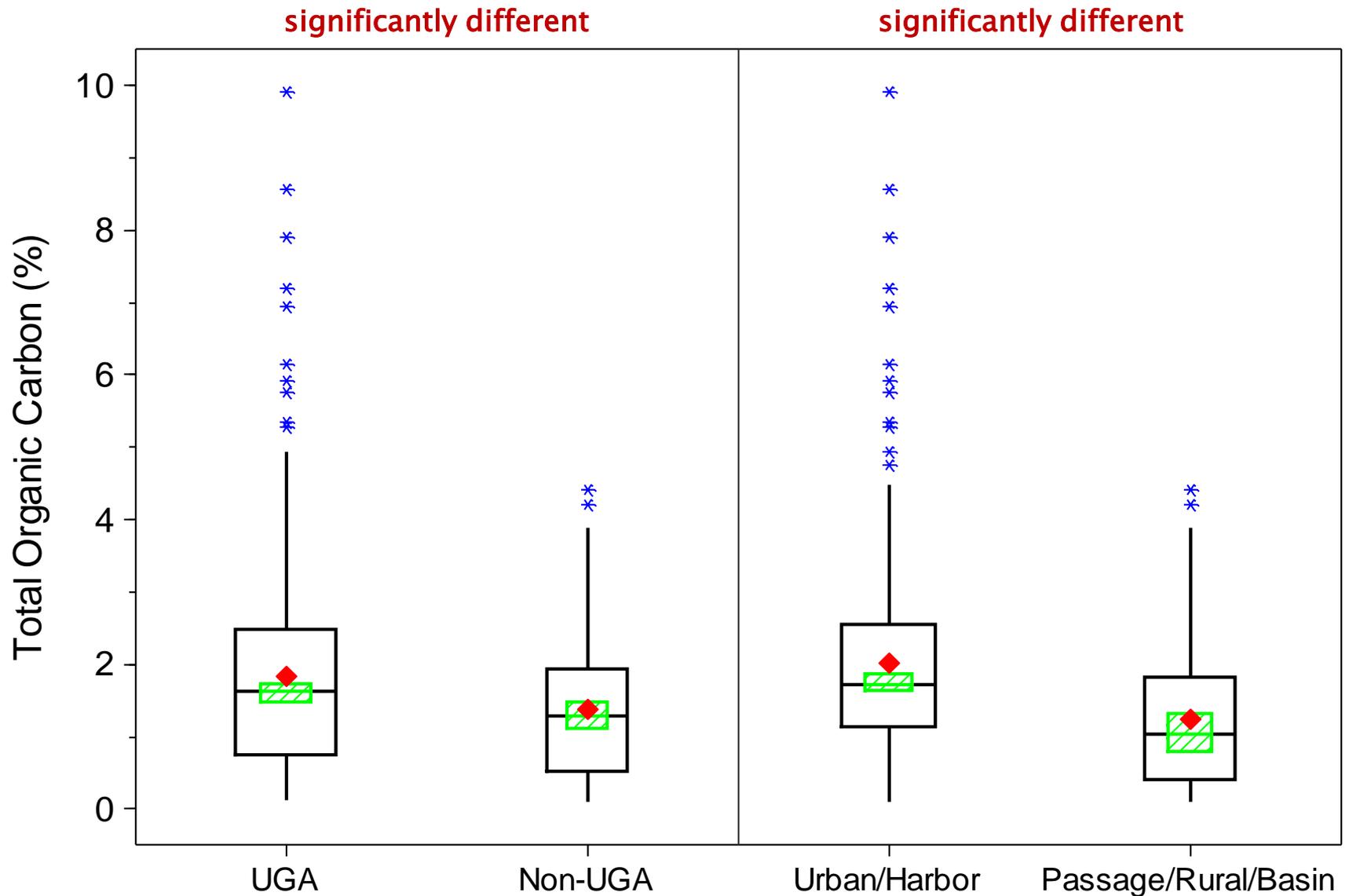
Station Depth



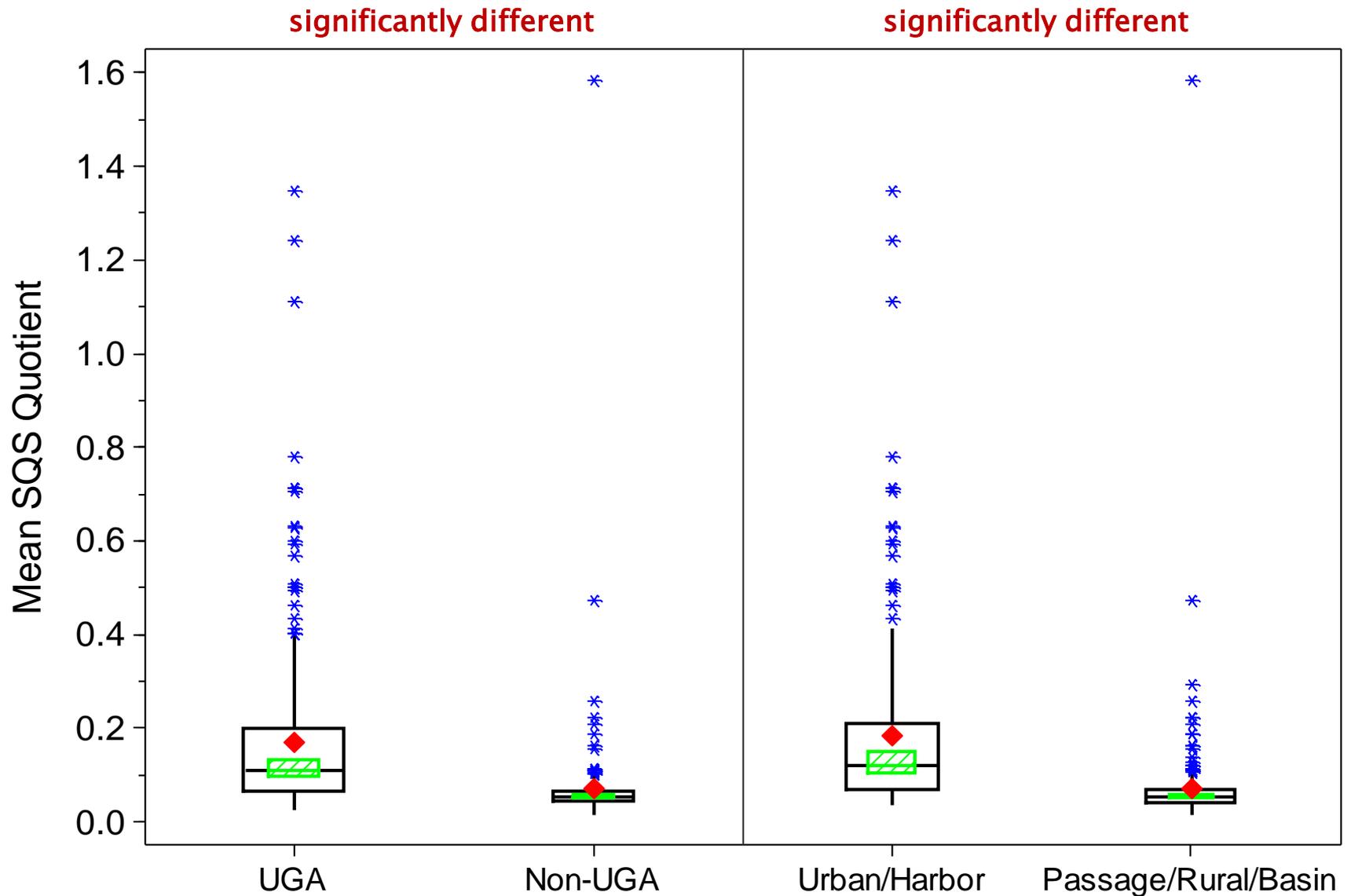
Percent Fines (Silt+Clay)



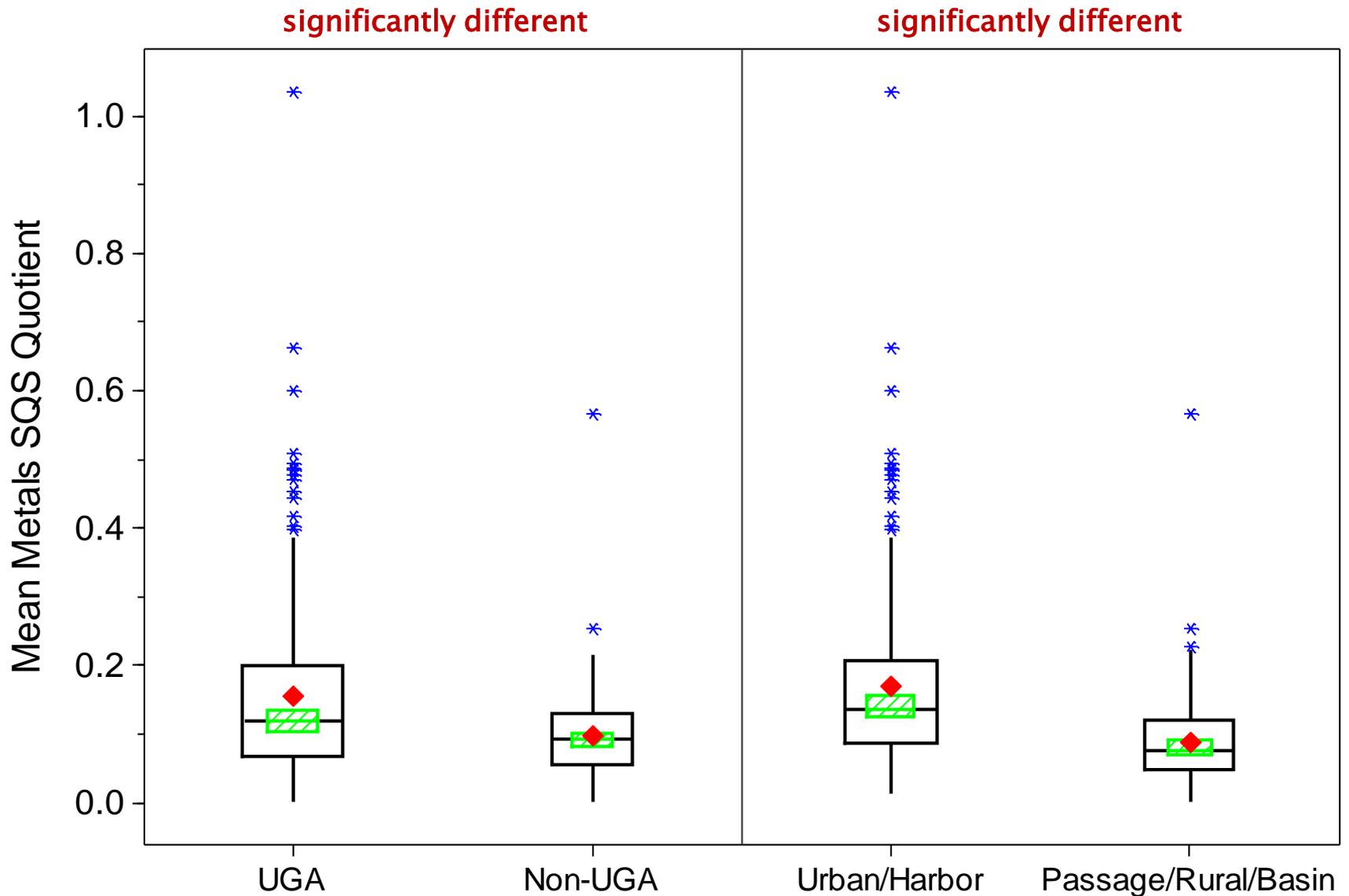
Total Organic Carbon (%)



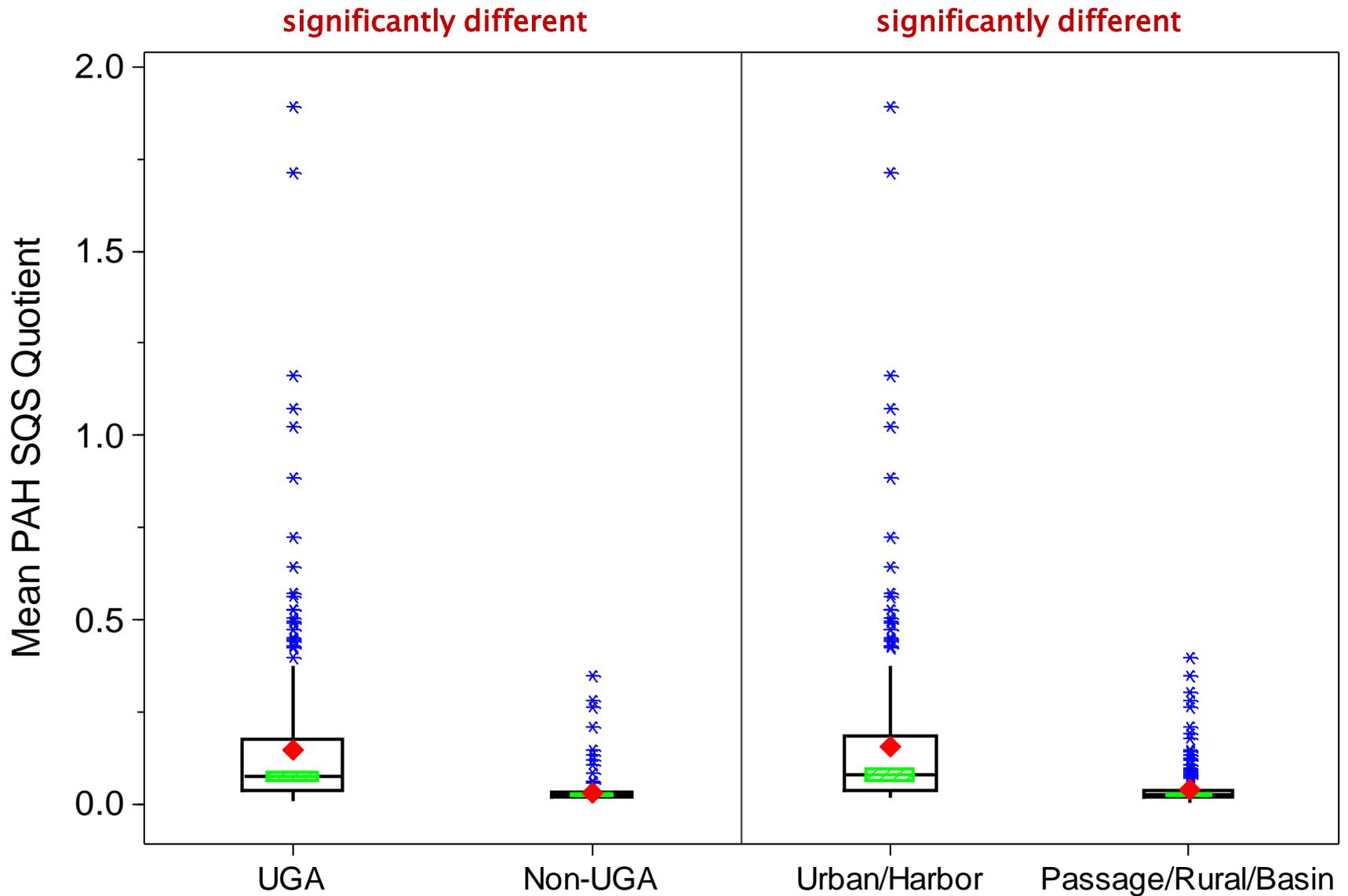
mSQSq (39 chemicals)



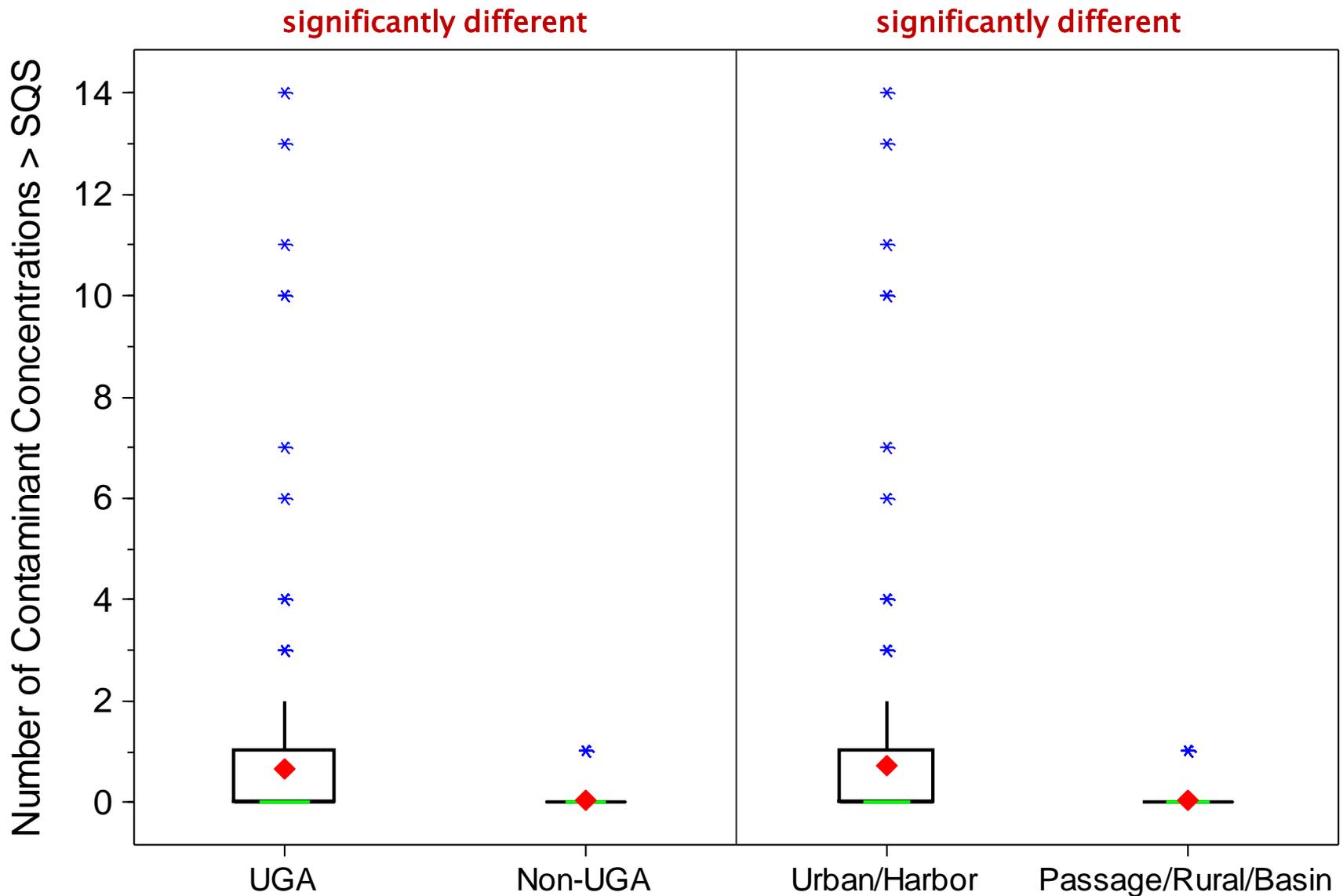
mSQSq (metals)



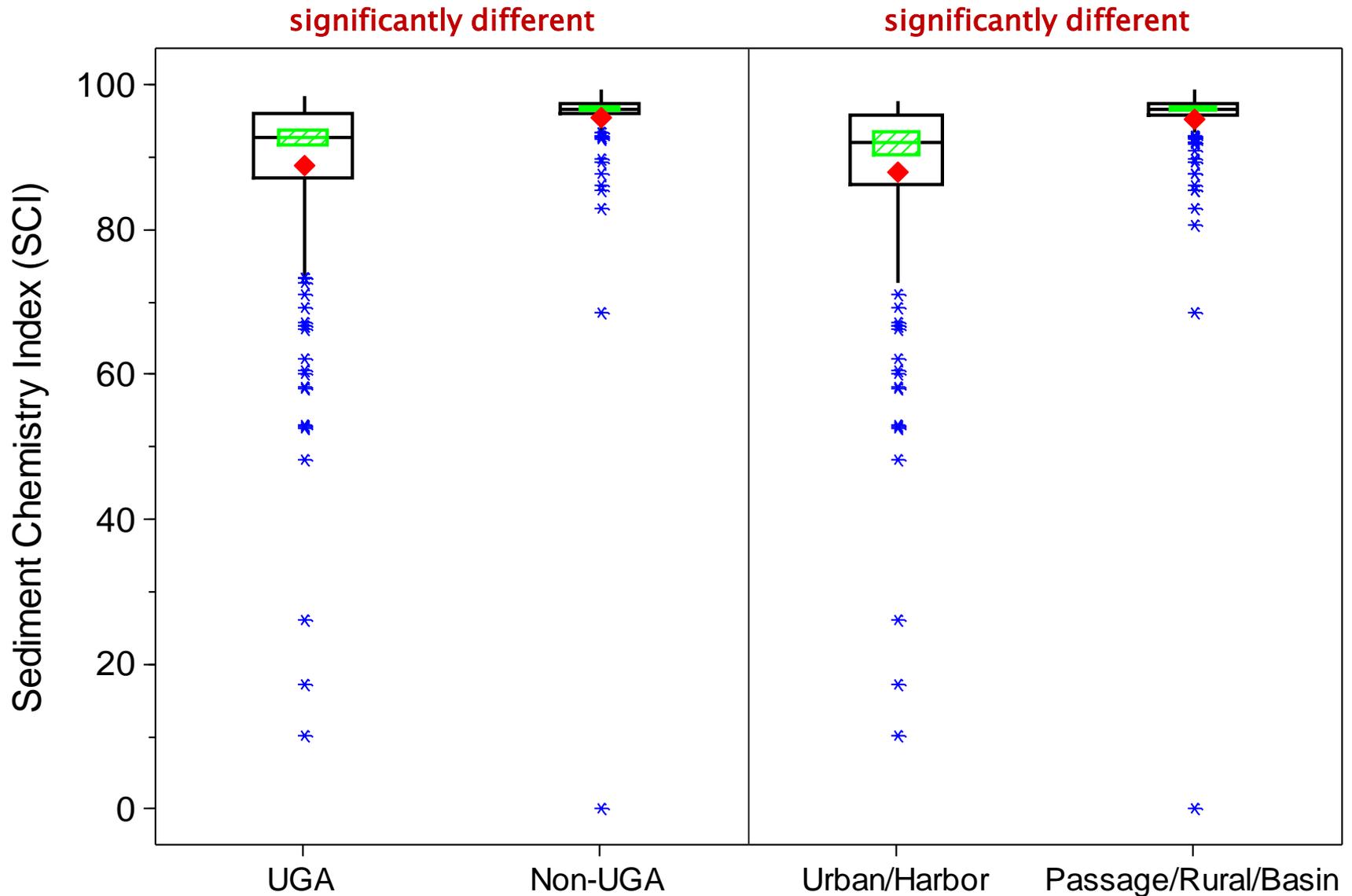
mSQSq (PAHs)



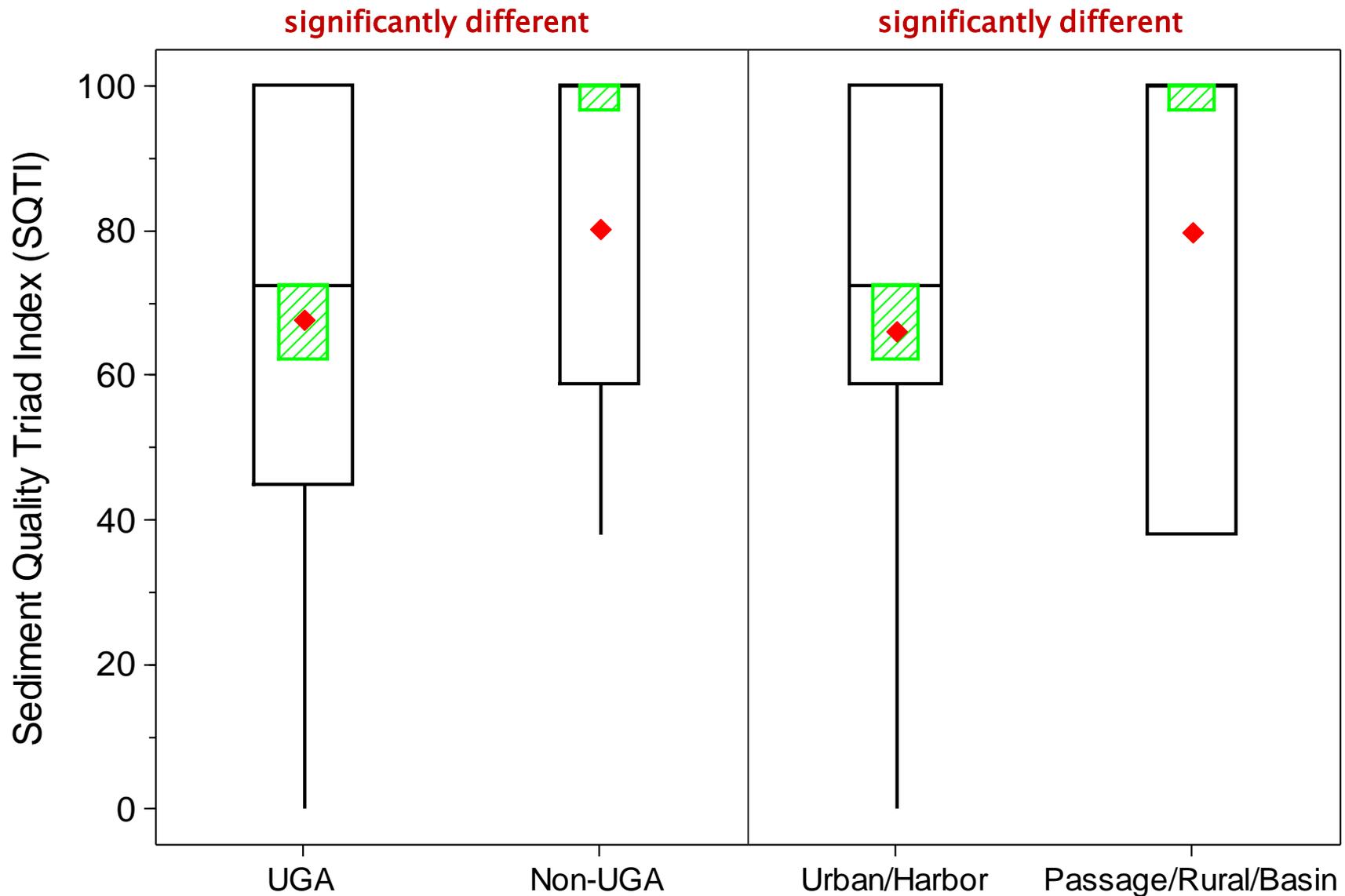
No. Contaminant Conc. > SQS



Sediment Chemistry Index

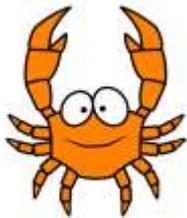


Sediment Quality Triad Index



Conclusions

- Physical/chemical variables **significantly different** between most UGA vs. nonUGA, U/H vs. P/R/B in 2–30m MLLW frame
- Similarities due to higher contaminant concentrations in **UGA–U/H overlap stations**
- 0 – 2m MLLW sampling frame **ecologically important/sensitive**, not quantitatively sampled



Recommendations

Adopt probabilistic design for 0–2m MLLW to:

- **characterize** sed qual (including **chemistry, toxicity, benthic invertebrates**) and **generate baseline data** for UGA, nonUGA
- **track** sediment quality **changes** over time
- **track Dashboard Indicators** (SCI, SQTI) over time



Additional Information

Primary Questions

- Do nearshore SQT measures (chem/tox/benthos) meet WA Sediment Management Standards and PSP Marine Sediment Quality Dashboard Indicator Targets?
- Does nearshore sediment quality differ between UGA/nonUGA sampling frames?
- Is nearshore sediment quality improving or deteriorating in UGA/nonUGA sampling frames over time?

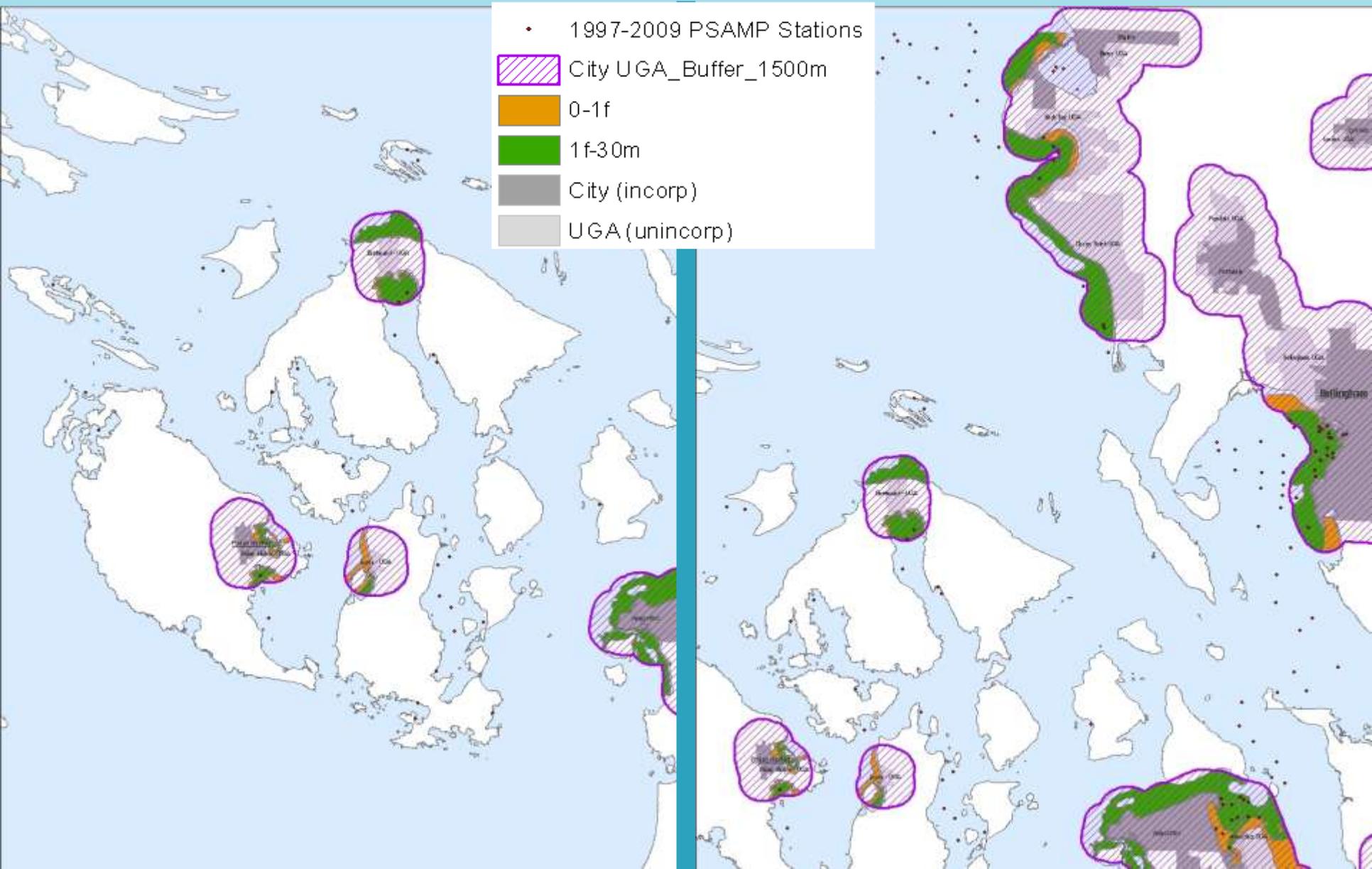
Further Questions

- What can spatial patterns and gradients in nearshore sediment quality tell us about possible stormwater sources?
- How does sediment quality in the nearshore compare with the PSAMP sediment values for regions, strata, and Puget Sound-wide?
- Are nearshore sediment conditions significantly different from offshore?

Next Steps

- 0m–2m and 2m–30m MLLW (finish matching 1f boundary to PSAMP 1f for full coverage)
- UGA – draw perpendicular lines using UGA, topo, WRIA layers, tribe/military info, BPJ (time and \$\$ commitment)
- Finish preliminary stats (cluster analyses, MDS, box plots, t-tests)
- PSAMP QAPP addendum

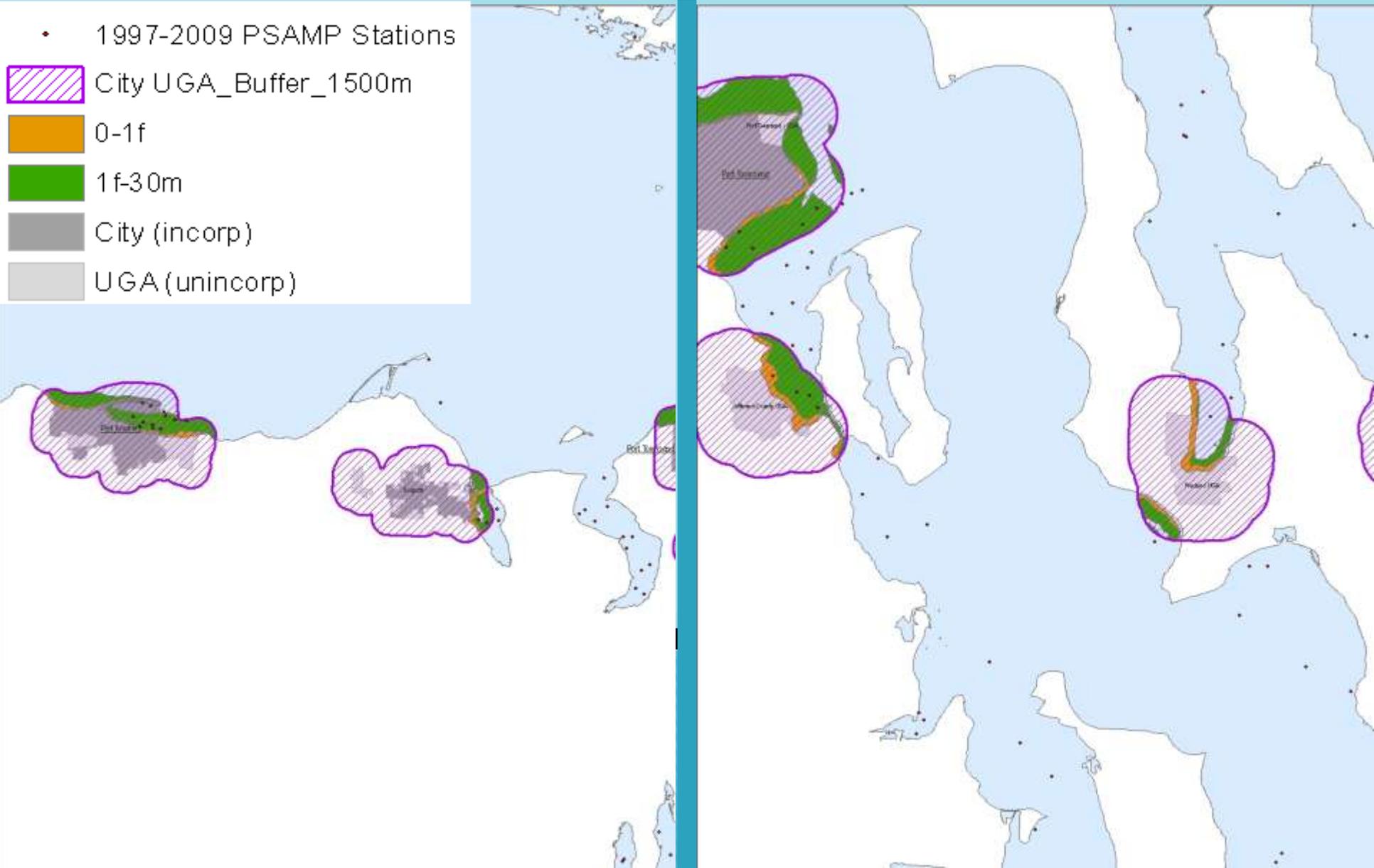
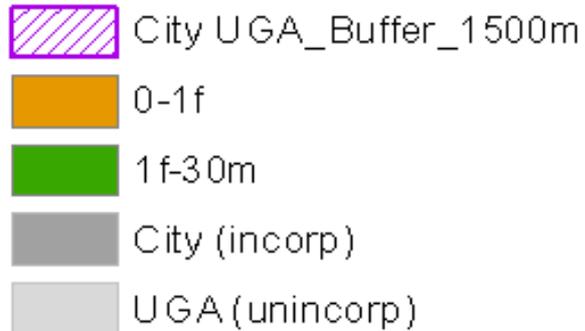
Inside/outside 1500m UGA buffer San Juan Islands, Strait of Georgia



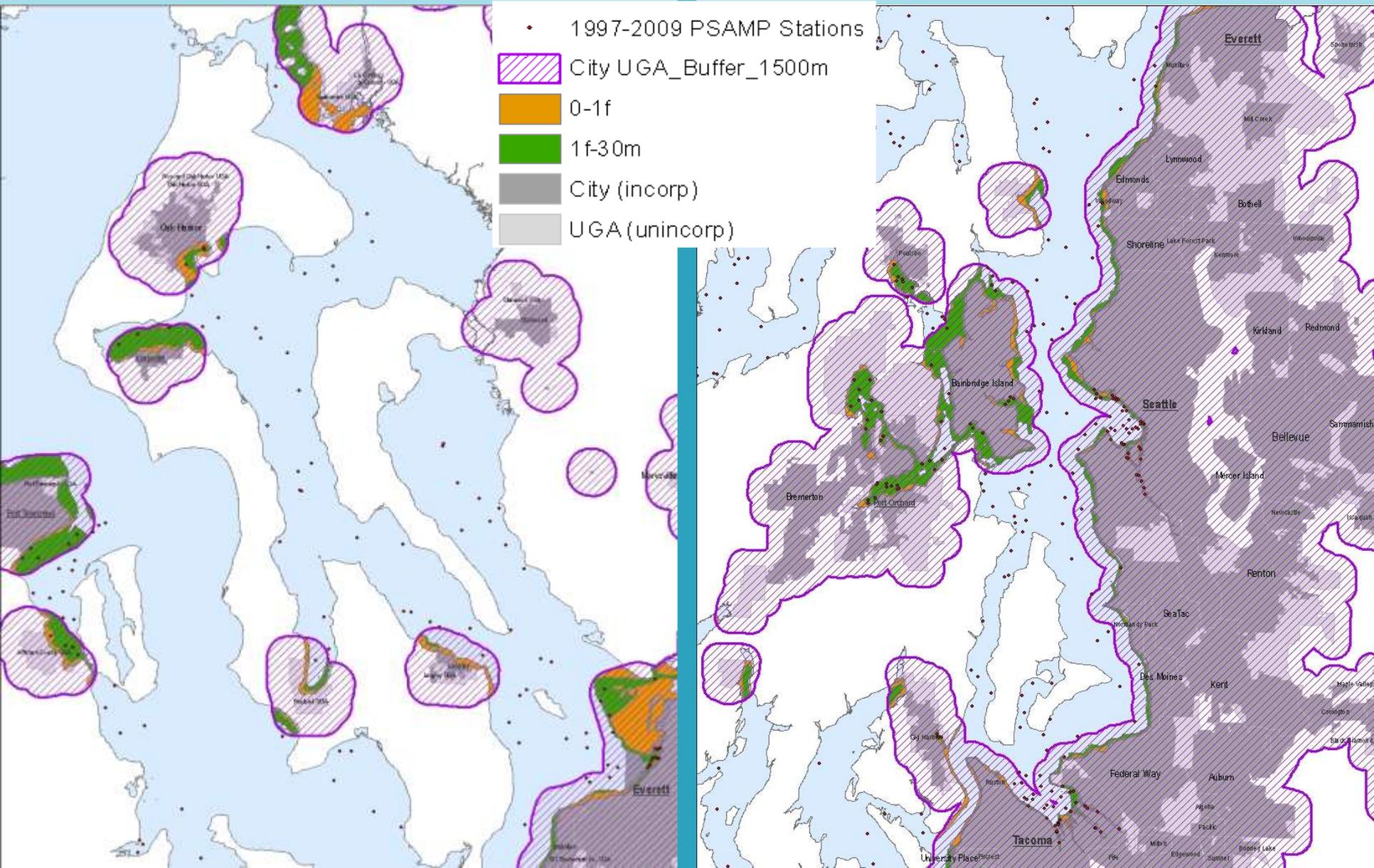
Inside/outside 1500m UGA buffer

Eastern Strait of Juan de Fuca, Admiralty Inlet

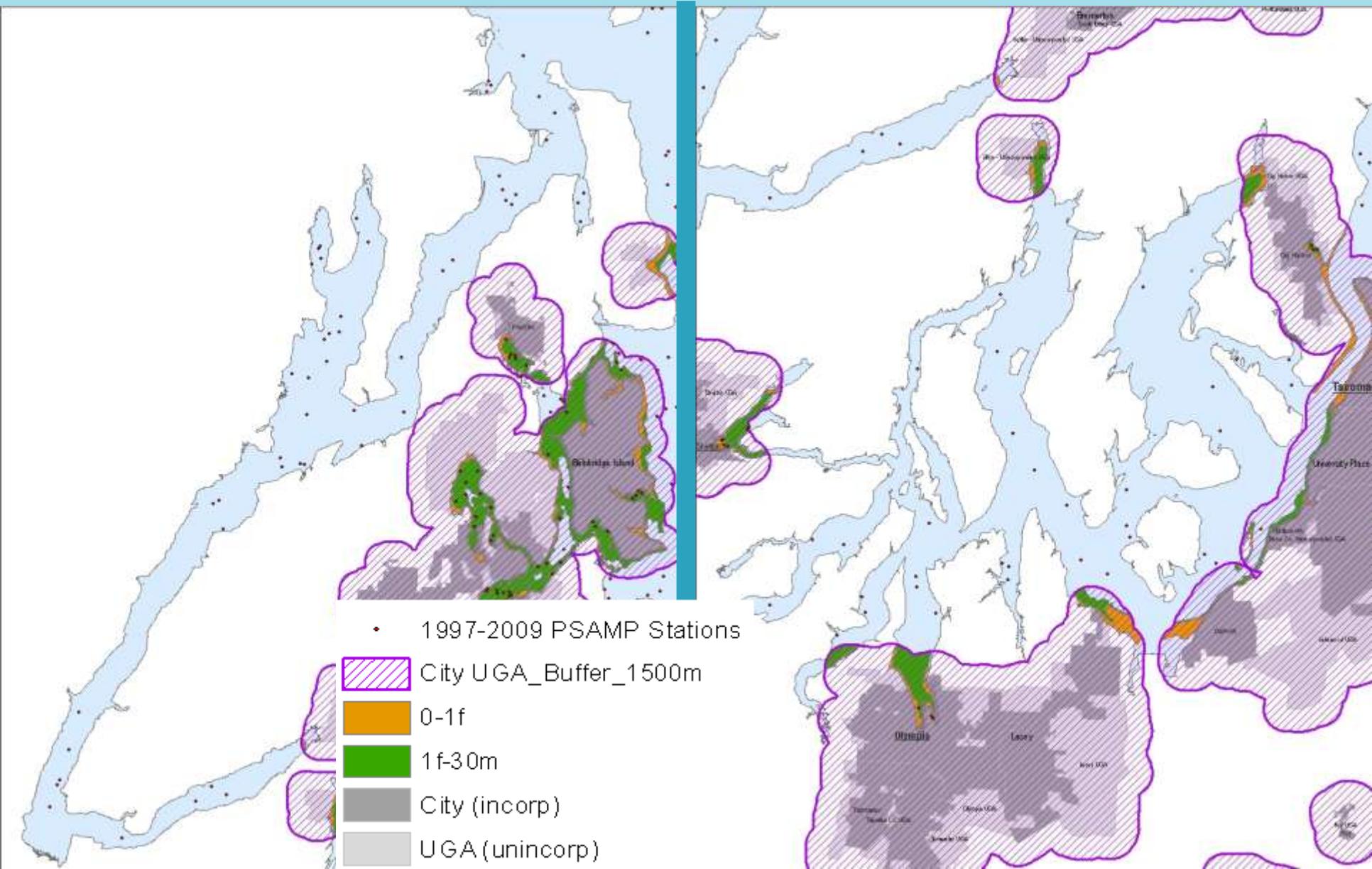
• 1997-2009 PSAMP Stations



Inside/outside 1500m UGA buffer Whidbey Basin, Central Puget Sound



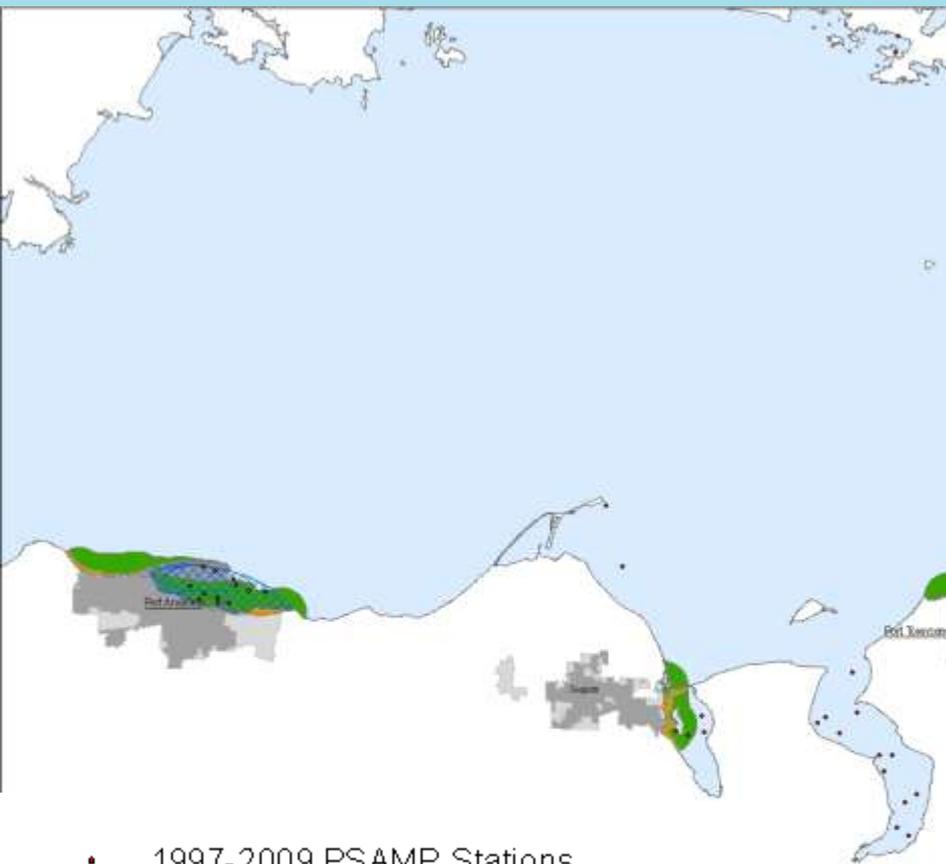
Inside/outside 1500m UGA buffer Hood Canal, South Puget Sound



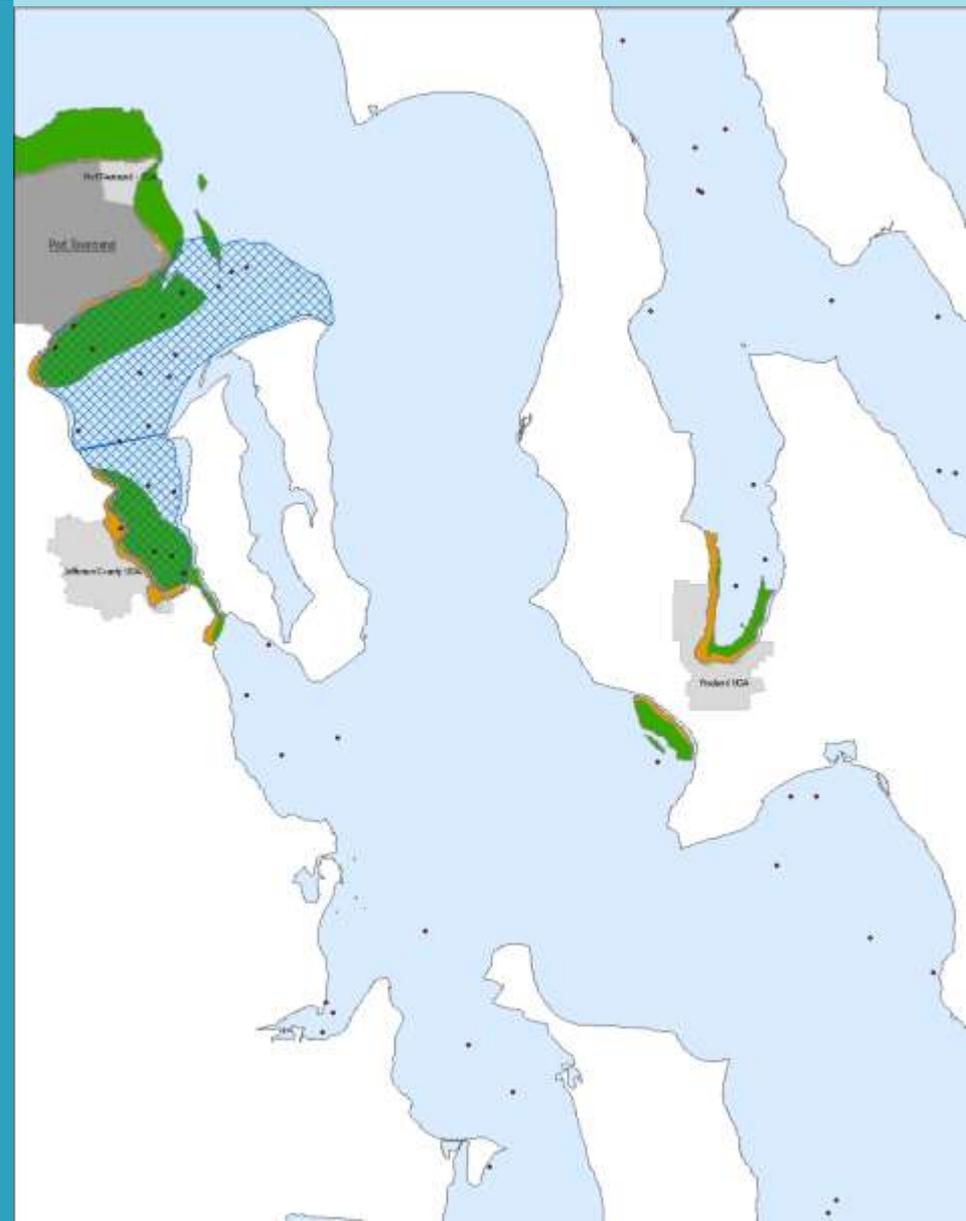
5 PSAMP Strata

Type	Natural features	Anthropogenic features
Harbor	<ul style="list-style-type: none"> • semi-enclosed embayments, terminal inlets - head of bay/estuary • shallow 	<ul style="list-style-type: none"> • maritime • adjacent to urban/industrial centers • high numbers of point/nonpoint discharge • frequently dredged • presence of docks, breakwaters, jetties
Urban	<ul style="list-style-type: none"> • semi-enclosed embayments, sometimes head of bay/estuary, includes outer harbors • shallow to mid-depth 	<ul style="list-style-type: none"> • adjacent to urban/industrial centers • lower numbers of point/nonpoint discharge • may or may not be dredged
Basin	<ul style="list-style-type: none"> • deep • associated with a sill 	<ul style="list-style-type: none"> • may/may not be adjacent to urban/ industrial centers • lowest numbers of point and/or nonpoint discharge
Passage	<ul style="list-style-type: none"> • bounded by two shorelines and open at both ends • deep • not associated with a sill 	<ul style="list-style-type: none"> • not adjacent to urban/industrial centers • lowest numbers of point and/or nonpoint discharge
Rural	<ul style="list-style-type: none"> • includes semi-enclosed embayment, terminal inlets, as well as larger inlets • shallow to deep 	<ul style="list-style-type: none"> • not adjacent to urban/industrial centers or maritime activity; adjacent land largely undeveloped • lightly populated • lowest numbers of point and/or nonpoint discharges • frequently used as reference locations

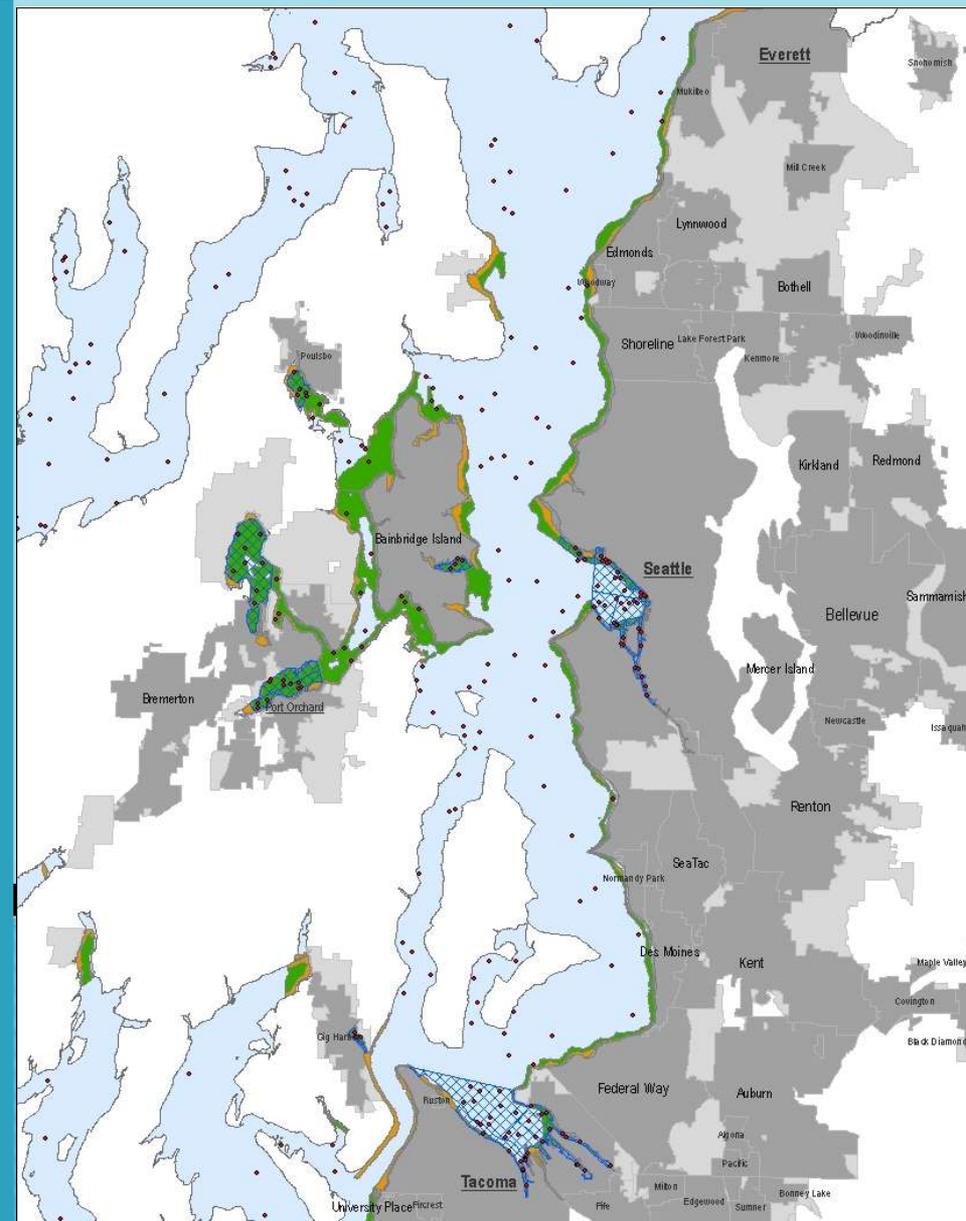
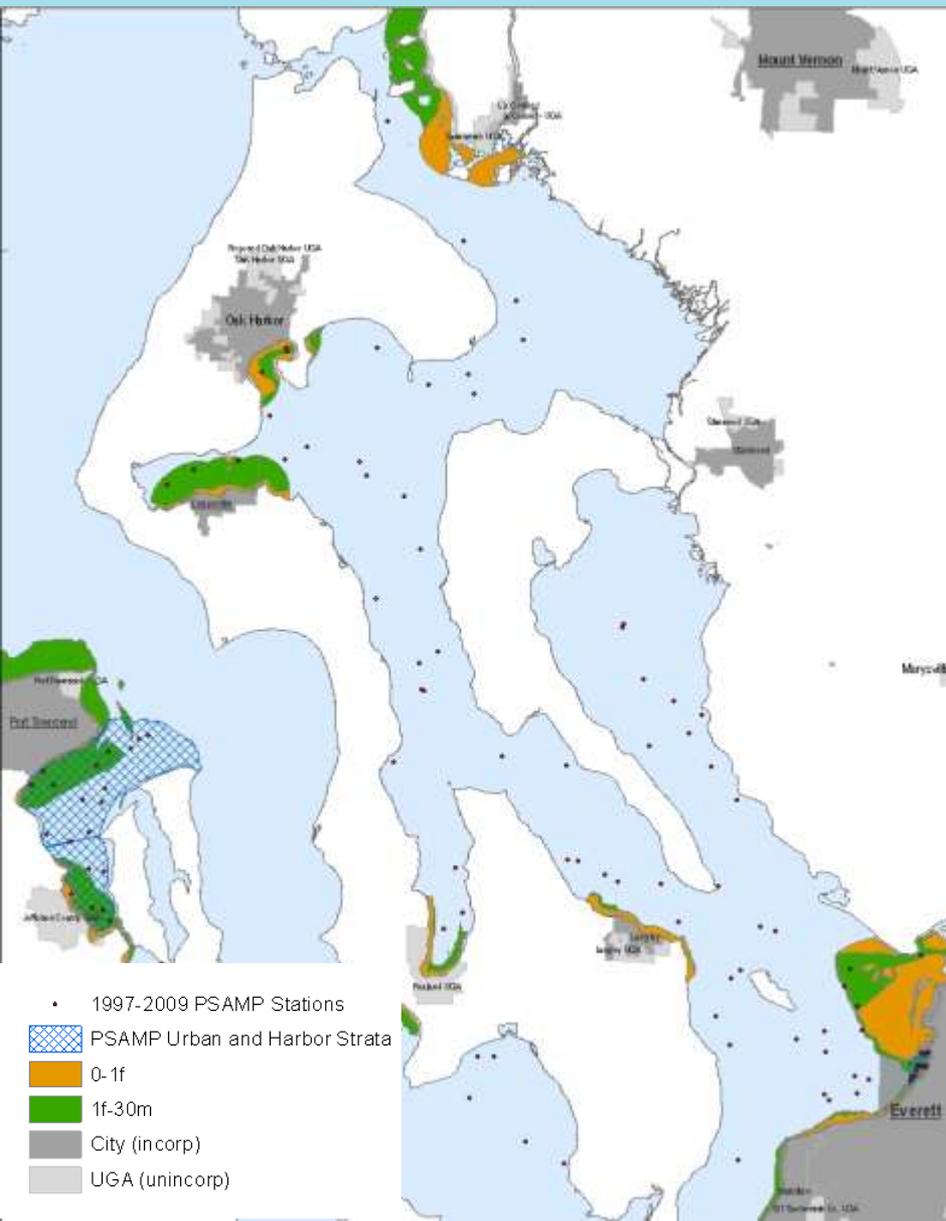
Urban/Harbor vs Rural/Passage/Basin Eastern Strait of Juan de Fuca, Admiralty Inlet



- 1997-2009 PSAMP Stations
- ▨ PSAMP Urban and Harbor Strata
- 0-1f
- 1f-30m
- City (incorp)
- UGA (unincorp)



Urban/Harbor vs Rural/Passage/Basin Whidbey Basin, Central Puget Sound



Urban/Harbor vs Rural/Passage/Basin Hood Canal, South Puget Sound

- 1997-2009 PSAMP Stations
- ▨ PSAMP Urban and Harbor Strata
- 0-1f
- 1f-30m
- City (incorp)
- UGA (unincorp)

