Pilot Stormwater Monitoring Program
San Juan County, Washington

Stillwater Sciences

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November 18, 2013

San Juan County Stormwater Committee

Photo/Tom C. Jones

Stillwater Sciences

Project Purpose

Implement a pilot-level stormwater monitoring effort to evaluate stormwater effects in targeted watersheds and urban growth areas (UGAs) in San Juan County, consistent with Washington State Department of Ecology quality assurance guidelines.




Project Goals

- To identify where and to what degree stormwater is affecting water quality, sediment quality, and receiving water biotic health.
- To link stormwater quality to land use such that the County can make informed management decisions.
- To adaptively manage emerging stormwater issues, consistent with regional stormwater monitoring through Puget Sound Partnership.

Project Objectives

- Conduct a three-year pilot-level assessment of stormwater quality in the following six focus areas:

San Juan Island	Lopez Island	Orcas Island
False Bay	Lopez Village	Eastsound Village
Garrison Bay	Mud Bay	
Westcott Bay		




Project Objectives

- Measure water quality across 4 storm events and 1 dry-weather event/year for core set of constituents in key streams/conveyance structures

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- Measure water quality across 4 storm events and 1 dry-weather event/year for core set of constituents in key streams/conveyance structures
- Measure additional constituents in stormwater, sediment, and/or receiving waters for selected areas to address hypotheses

Hypotheses

1. Stormwater from the Lopez Village UGA carries relatively high concentrations of metals, TPHs, pesticides/herbicides, and surfactants (anionic) into Weeks Wetland, resulting in elevated toxicity of the stormwater and wetland sediments.

2. Fisherman Bay, a shallow, poorly flushed waterbody that receives runoff from Lopez Village UGA and multiple drainage culverts located along its perimeter, exhibits poor water quality and sediment quality during both storm/high-flow and low-flow conditions.

Hypotheses

3. For the six focus areas included in the pilot plan, levels of nutrients, metals, TPHs, herbicides/pesticides, surfactants (anionic), and toxicity of nearshore sediments are correlated to levels of these constituents in stormwater discharges to the associated waterbodies.

4. Focus areas possessing UGAs and/or Activity Centers (Lopez Village, East Sound, False Bay, Westcott Bay) exhibit higher levels of stormwater constituents, receiving water sediment contaminants, and toxicity as compared to focus areas that do not (Garrison Bay, Mud Bay).

Project Schedule

1. Review existing information, sampling network design	2009–2010
2. Draft monitoring plan development, coordination with Stormwater Committee	2010–2013
3. Site reconnaissance, equipment acquisition, laboratory coordination, monitor training	2011–2012
4. Year 1 data collection	2012–2013
5. Year 2 data collection, Year 1 data analysis	2013

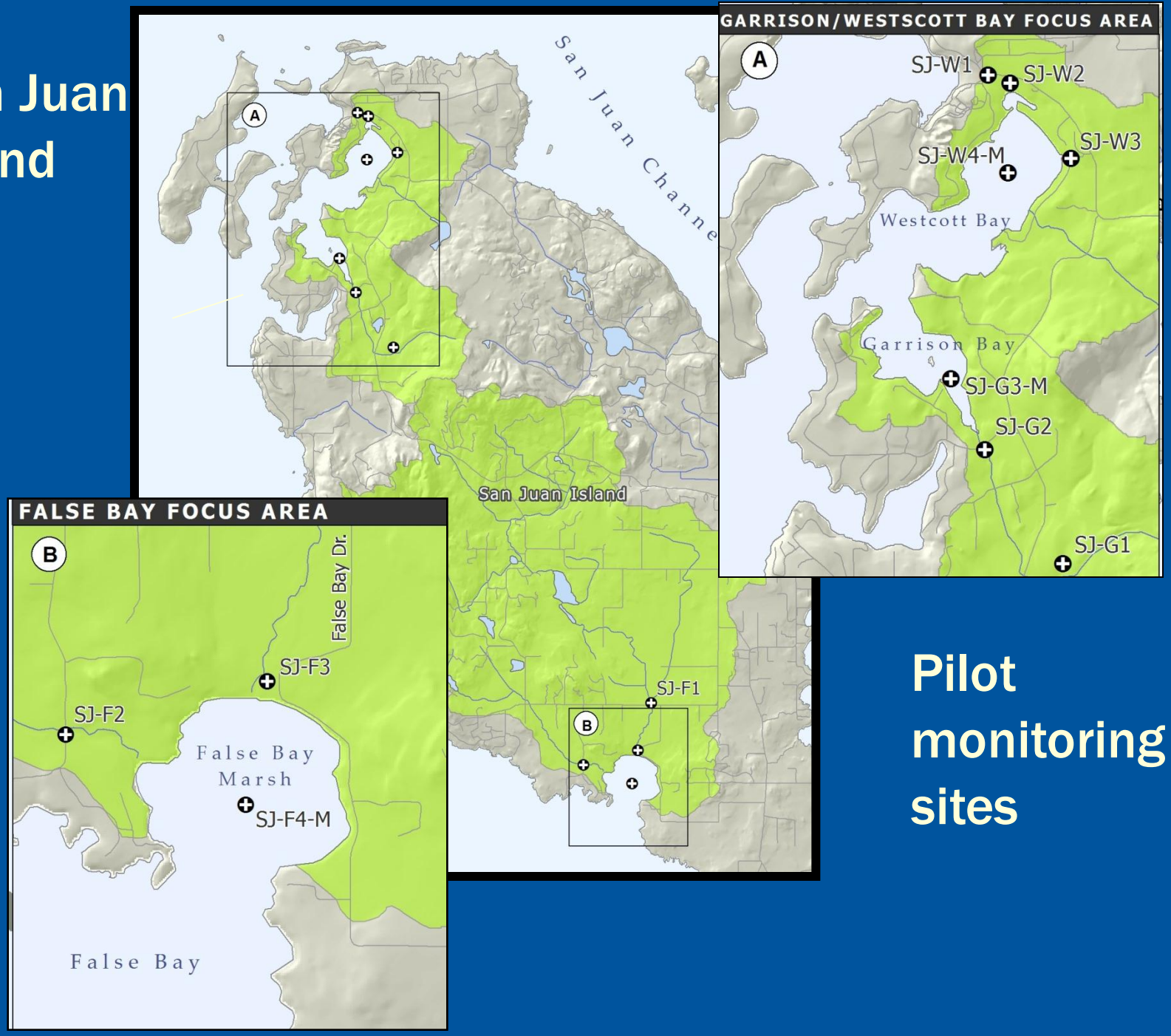
Sampling Network

Pilot Site Selection Criteria:

- Freshwater sites
  - Located at downstream portion of focus area
  - Representative of predominant land use
  - At transitions between land use types
  - At existing culverts or downstream of storm systems
- Receiving water sites
  - Located sufficiently proximal to discharges
  - Representative of nearshore environment

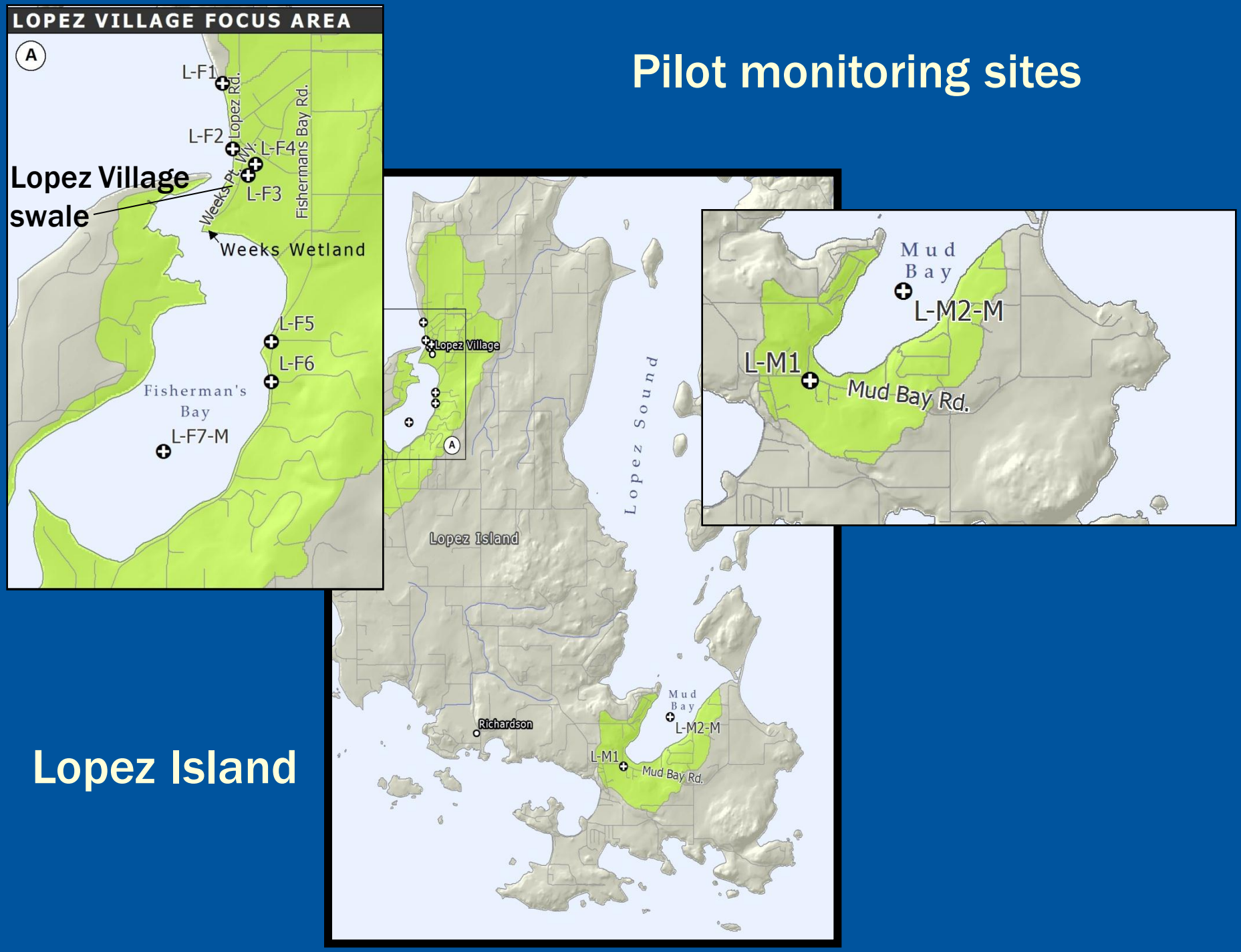
- All sites
  - Accessible
  - Able to accommodate sampling equipment
  - Coincident with ongoing monitoring

San Juan Island



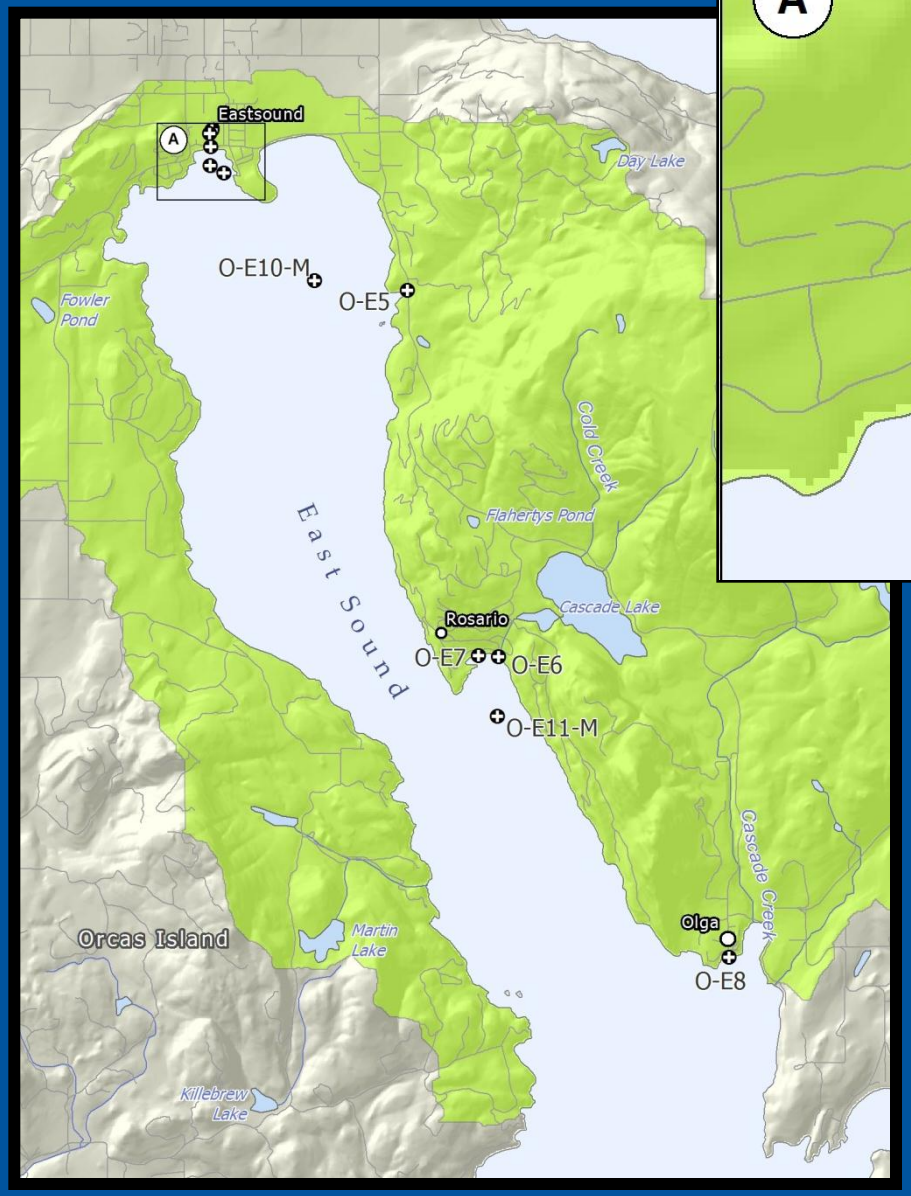
Pilot monitoring sites

Pilot monitoring sites



Lopez Island

Orcas Island



Pilot monitoring sites

Sampling Frequency & Event Size

Sampling Frequency

- First fall flush: one event in August-October
- Storm flow: up to four events in November-May
- Dry-weather flow: one event June-August

Target Storm Events

- Storm rainfall depth: minimum of 0.2 inches in a 24-hour period
- Antecedent conditions: period of at least 24 hours preceding the event with less than 0.05 inches of precipitation




Year 1+ Sampling Frequency

Year 1 (2012–2013)

- Fall – 11/12/12
- Winter – 1/23/13
- Spring – 4/05/13

Year 2 (2013–2014)

- Fall first flush – 9/16/13




Year 1+ Sampling Event Size

Island	Focus Area	Weather Station	Year 1						Year 2	
			11/12/12		1/23/13		4/5/13		9/16/13	
			Ant. Dry Period (hours)	Total Precip. (in)	Ant. Dry Period (hours)	Total Precip. (in)	Ant. Dry Period (hours)	Total Precip. (in)	Ant. Dry Period (hours)	Total Precip. (in)
San Juan	Garrison	MNSJW1	> 24*	0.48	168	0.07	288	1.52	> 48	0.28
	Westcott Bay	KWAFRIDA3	> 24*	0.48	192	0.54	312	0.59	> 48	0.19
	False Bay	MKFHR	96	0.14	288	0.02	24	0.03	> 48	0.24
Lopez	Mud Bay	MD5375	72	0.02	24	0.17	72	2.28	> 48	0.36
	Lopez Villiage	KWALOPEZ1	96	0.54	24	0.24	312	0.84	> 48	0.39
Orcas	Eastsound	KWAEASTS8	24	0.38	48	0.99	264	0.86	> 48	0.22

Meets target storm requirements

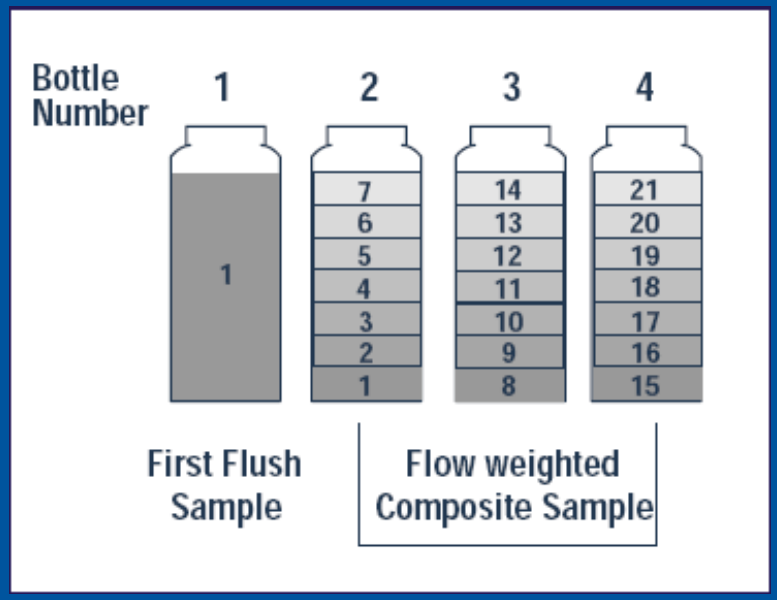
Year 1 - Monitoring Constituents

- Water Quality
  - *In situ* (temp, pH, DO, turbidity, conductivity)
  - Bacteria (Total coliform, *E. coli*)
  - Nutrients (NO_3+NO_2, NH_4, TKN, TN, TP)
  - Metals (Tot and Diss) (As, Cd, Cu, Pb, Zn)
  - Total petroleum hydrocarbons (TPH)
  - Pesticides/herbicides (permethrin, MGK-264, glyphosate)
  - Anionic surfactants




Sampling Methods

- *In situ* and grab samples – Year 1–3
- Continuous samples – Year 2–3
  - Eastsound: Eastsound Village stormwater outlet to East Sound along Main Street (Site O-E1)
  - Automated sampler
  - Flow-weighted composite samples
  - Flow sensor & rain gage



Year 1 - Preliminary QA/QC Review

Accuracy

Agreement between observed and reference values

- Matrix spike and duplicate analyses meet laboratory QA requirements
- *In situ* meter calibration with known standards

Year 1 - Preliminary QA/QC Review

Precision

Variability in replicate measurements

- 2-3 duplicate tests analyzed per event
- Year 1
  - 211 duplicate tests
  - 81 detects
  - Of these, 75% have RPD 0–10%

Year 1 - Preliminary QA/QC Review

Bias

Persistent deviation from true value

- Matrix spike and duplicate analyses meet laboratory QA requirements
- *In situ* meter calibration with known standards

Year 1 - Preliminary QA/QC Review

Sensitivity

Method detection limit (MDL) and practical quantitation limit (PQL)

- 80 tests
  - 20% tests – MDL actual > MDL expected
  - 8% tests – MDL actual 1.1 – 1.6x > MDL expected

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  - Example – MGK-264
    - MDL actual = 0.08 ug/L
    - MDL expected = 0.03 ug/L

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  - Example – MGK-264
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  - 100% PQLs < regulatory threshold

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Representativeness

Do data represent true environmental condition?

- Sampling sites, frequency, methods

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Completeness

Amount of data that is valid compared with the amount of data collected

- *In situ* = 75-100%
- Analytical = 98%

Year 1 - Preliminary QA/QC Review

Representativeness

Do data represent true environmental condition?

- Sampling sites, frequency, methods

Completeness

Amount of data that is valid compared with the amount of data collected

- *In situ* = 75-100%
- Analytical = 99.8%

Comparability

Can data be evaluated in relation to other stormwater data?

- Sample methods, measurement, analytical methods, reporting are consistent

Year 1 – Preliminary *In situ* Data

Freshwater – Aquatic Life – Salmonid, spawning, rearing and migration.

- Water temperature: 4–20 ºC
- Dissolved oxygen: 7.2–12.4 mg/L (57–98% sat)
- pH: 7–8 pH units
- Specific conductivity: 0.03–0.5 mS/cm
- Turbidity: 1.5–185 NTU

- Anionic surfactants: 0.1–1.5 ug/L

Year 1 - Preliminary Bacteria

Freshwater – Primary contact recreation – Fecal coliform <100 CFU/100 mL (geometric mean), with <10 % of all samples (or any single sample when <10 sample points exist) >200 CFU/100 mL




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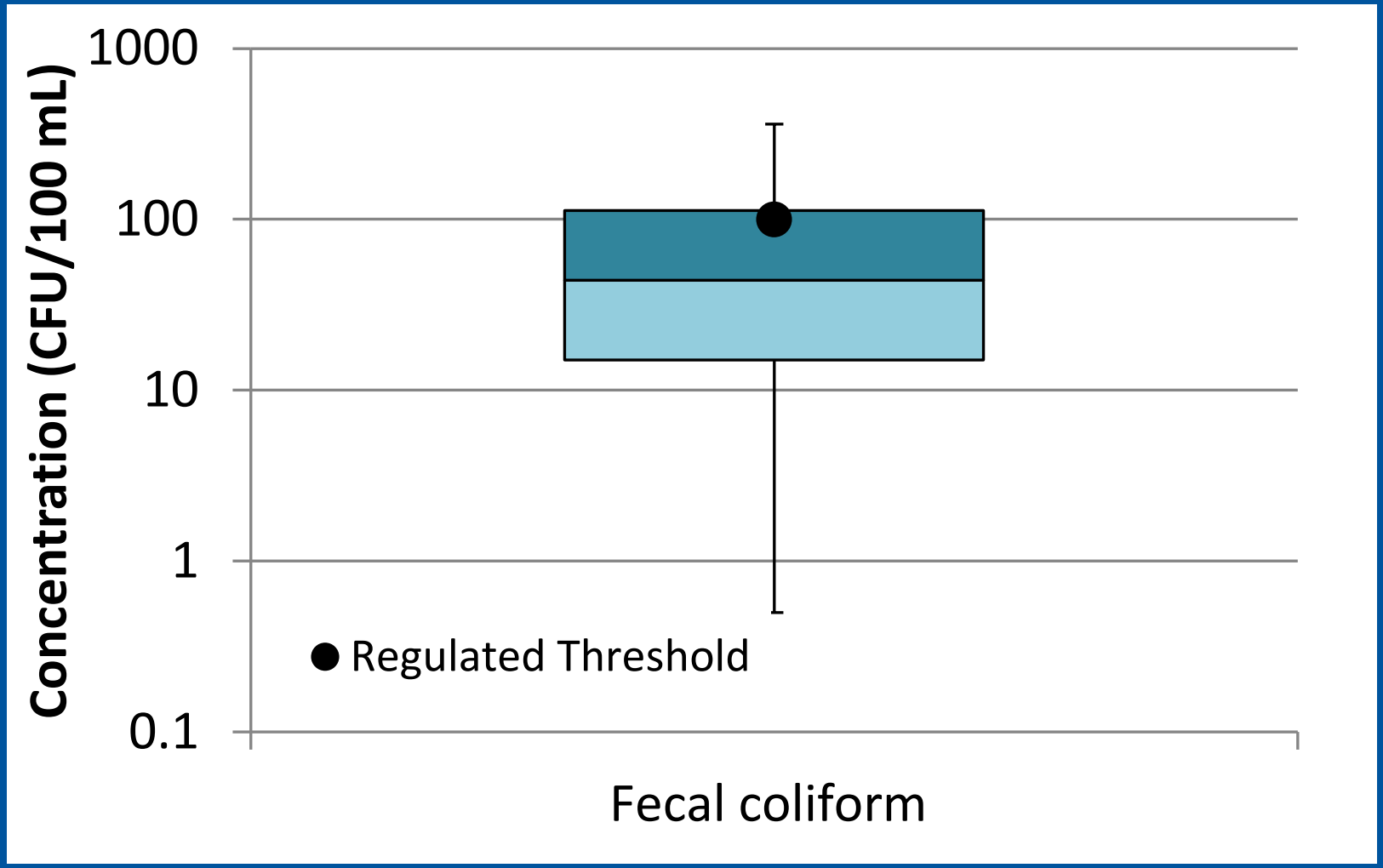
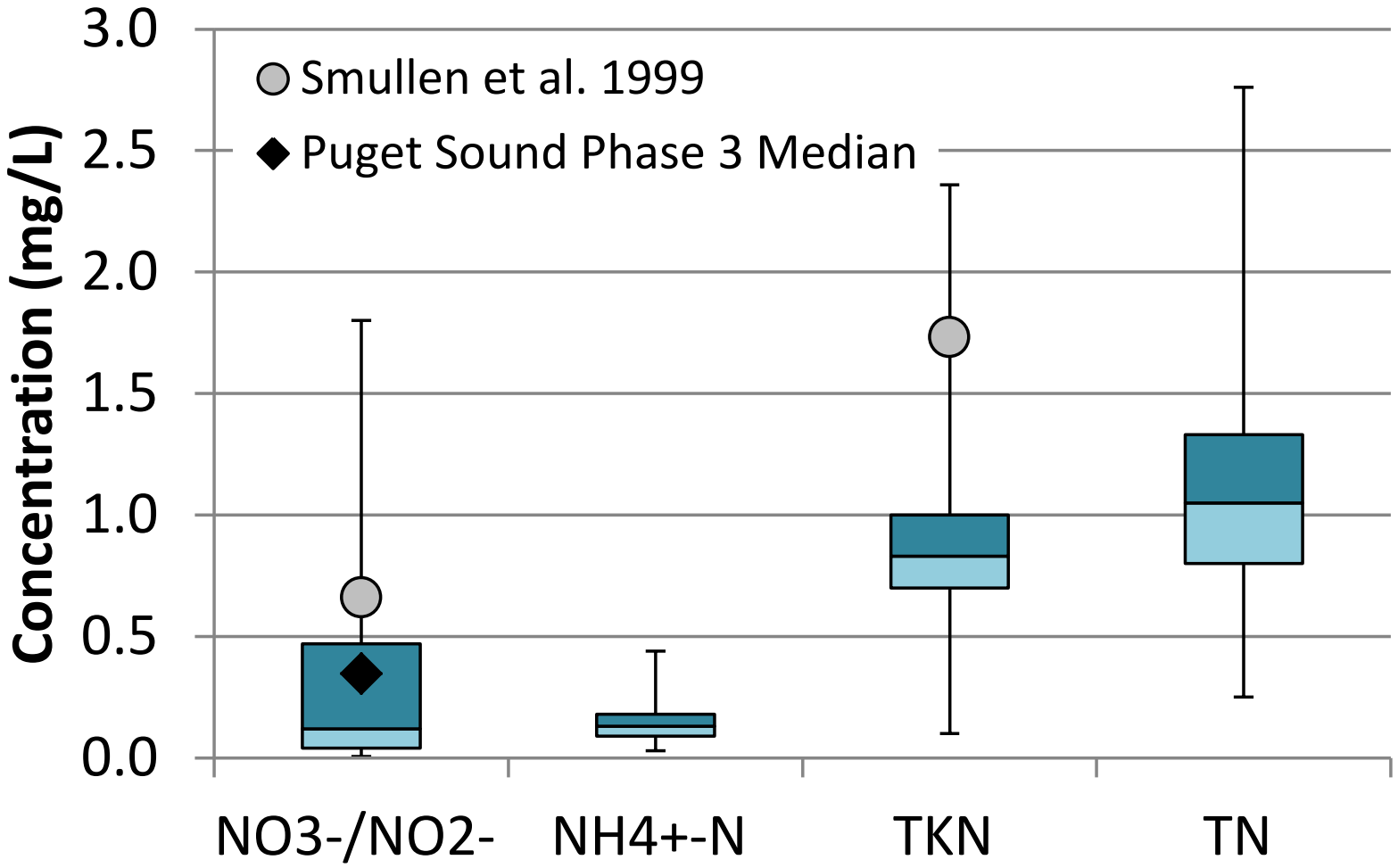
- 8 out of 34 samples (24%) > 200 CFU/100 mL




Year 1 - Preliminary Bacteria



Year 1 - Preliminary Nutrients



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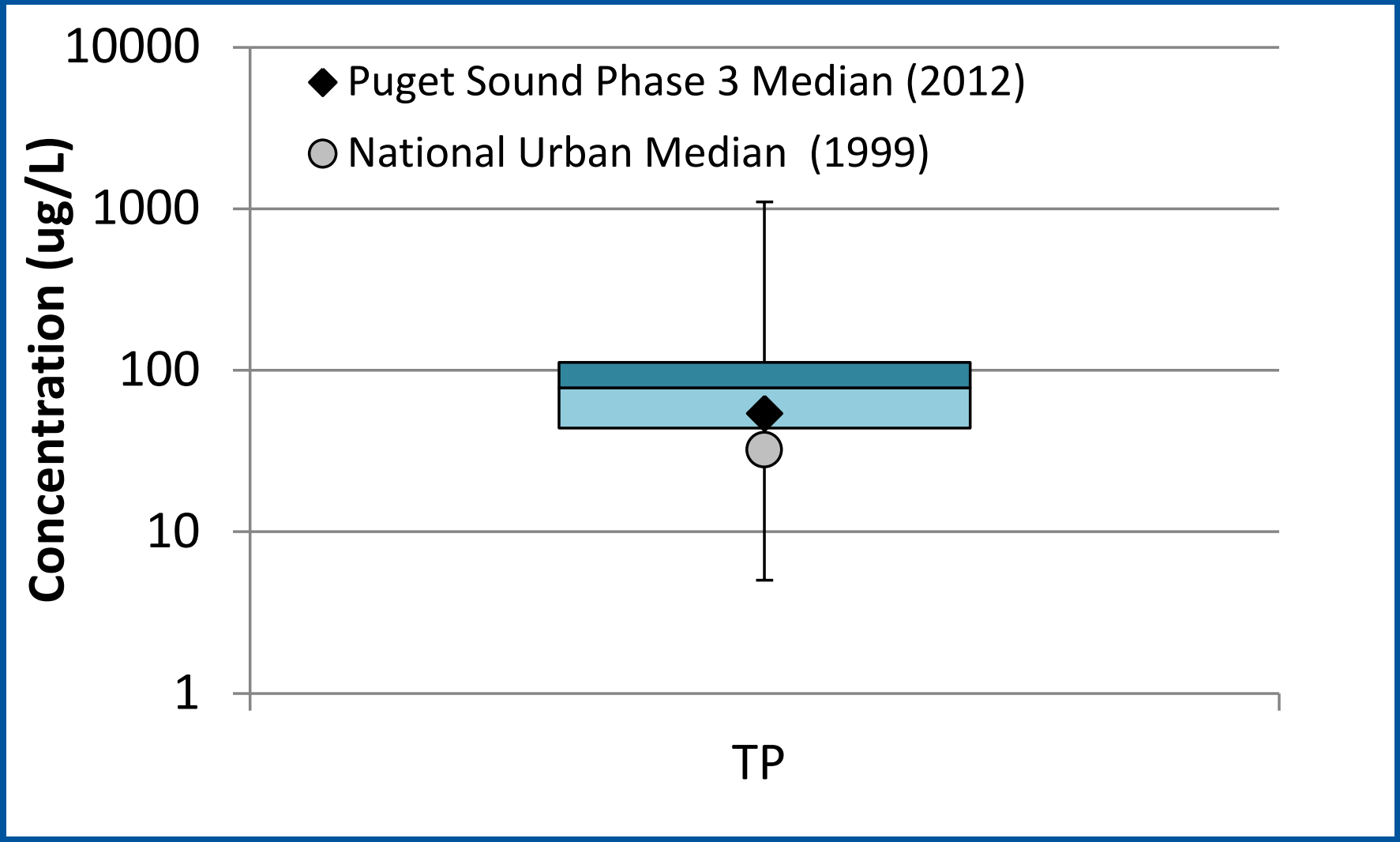
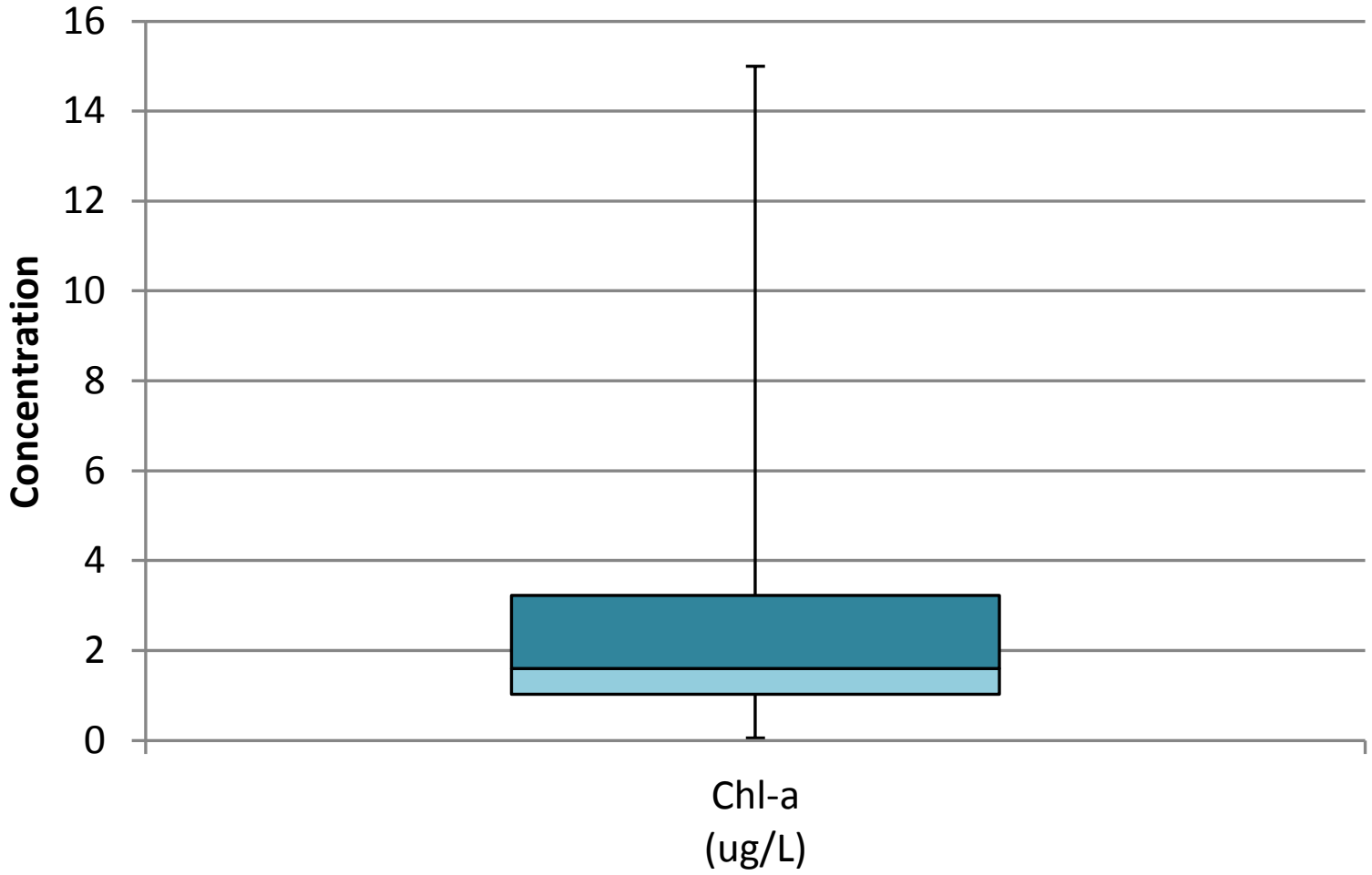


Year 1 - Preliminary Nutrients



Year 1 - Preliminary Metals

Freshwater – Aquatic Life – at or below natural background levels. Numeric criteria for dissolved metals.

- Arsenic
  - Total – all samples at or near PQL of 1 ug/L
  - Dissolved – all samples at or near PQL of 1 ug/L
    - Acute effects threshold = 360 ug/L
    - Chronic effects threshold = 190 ug/L




Year 1 - Preliminary Metals

Freshwater – Aquatic Life – at or below natural background levels. Numeric criteria for dissolved metals.

- Cadmium
  - Total – all samples below PQL of 0.25 – 1 ug/L
  - Dissolved – all samples below PQL of 0.25 – 0.5 ug/L
    - Hardness range 70 – 230 mg/L as $CaCO_3$
    - Acute effects threshold = 3 – 9 ug/L (4/5/13)
    - Chronic effects threshold = 1 – 2 ug/L (4/5/13)




Year 1 - Preliminary Metals

Freshwater – Aquatic Life – at or below natural background levels. Numeric criteria for dissolved metals.

- Copper
  - Total – samples range 2 – 70 ug/L
  - Dissolved – samples range 2 – 13 ug/L
    - Hardness range 70 – 230 mg/L as $CaCO_3$
    - Acute effects threshold = 12 – 38 ug/L (4/5/13)
    - Chronic effects threshold = 9 – 23 ug/L (4/5/13)




Year 1 - Preliminary Metals

Freshwater – Aquatic Life – at or below natural background levels. Numeric criteria for dissolved metals.

- Lead
  - Total – samples range 0.7 – 7 ug/L
  - Dissolved – all samples below PQL of 0.5 ug/L
    - Hardness range 70 – 230 mg/L as $CaCO_3$
    - Acute effects threshold = 45 – 160 ug/L (4/5/13)
    - Chronic effects threshold = 2 – 6 ug/L (4/5/13)




Year 1 - Preliminary Metals

Freshwater – Aquatic Life – at or below natural background levels. Numeric criteria for dissolved metals.

- Zinc
  - Total – samples range 2.5–110 ug/L
  - Dissolved – samples range 3 – 72 ug/L
    - Hardness range 70 – 230 mg/L as $CaCO_3$
    - Acute effects threshold = 86 – 235 ug/L (4/5/13)
    - Chronic effects threshold = 79 – 214 ug/L (4/5/13)




Year 1 - Preliminary TPHs, Herbicides/Pesticides

Freshwater – Aquatic Life – at or below natural background levels. No numeric criteria.

- Benzene, toluene, ethylbenzene, total xylenes, gasoline (C_8–C_{12}) – all samples below PQL of 0.13 – 0.27 ug/L
- Permethrin (cis, trans), MGK-264 – all samples below PQL of 0.03 – 0.08 ug/L
- Glyphosate – all samples below PQL of 4 ug/L




Year 1 - Preliminary Conclusions

- *In situ*
  - Need to reduce QA/QC issues
  - Dissolved oxygen generally high, few exceptions
  - pH in range
  - Turbidity variable
  - Anionic surfactants similar to previous measurements
- Bacteria – multiple sites exceed 200 CFU/100 mL
- Nutrients are low to moderate
  - Need receiving water data




Year 1 - Preliminary Conclusions

- Algal productivity (chl-a) is low
  - Need receiving water data
- Metals are low
  - As below acute and chronic thresholds for dissolved fraction
  - Cd, Pb, Zn all below hardness-based acute and chronic thresholds for dissolved fraction
  - Cu may have some exceedances at the low end of hardness-based chronic threshold for dissolved fraction – more data needed to confirm
- TPHs & select herbicides/pesticides are low




Data Analysis & Adaptive Management

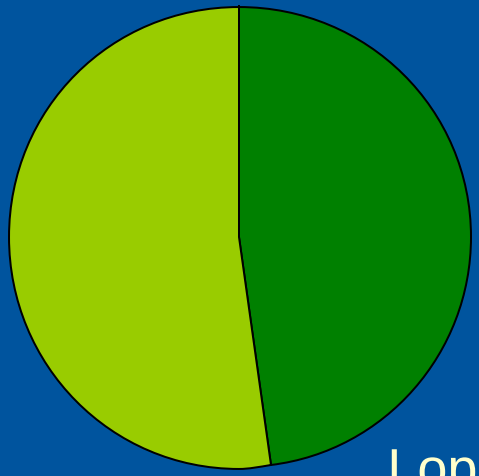
Next Steps

- Confirm all data has been received from laboratory
- Review QA/QC procedures with monitors to increase completeness on *in situ* samples
- Review sites that consistently have low/no water for target storm frequency – remove or replace sites
- Trend analyses for Year 1 data
- Consider whether source identification is possible given Year 1 data
- Get Eastsound autosampler up and running
- Implement sediment and receiving water sampling

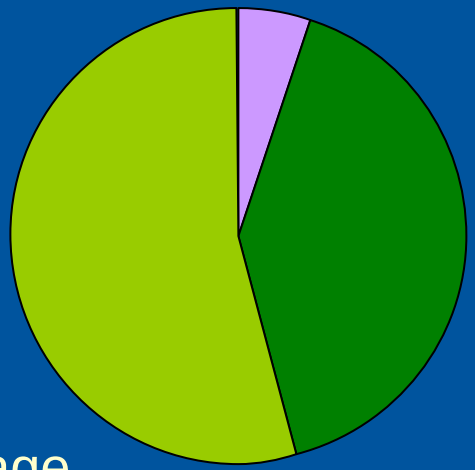

Questions?
All photos in presentation courtesy of Tom C. Jones.

Land Use by Focus Area

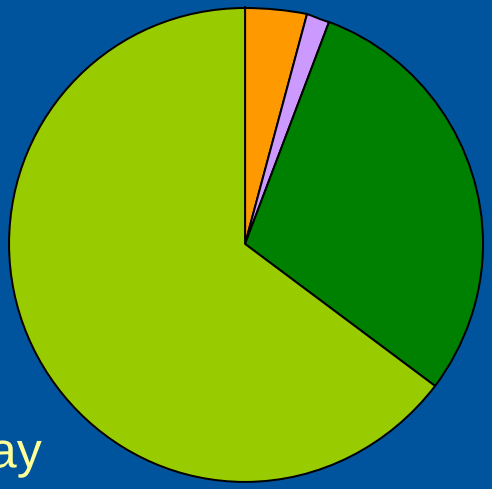
Garrison Bay



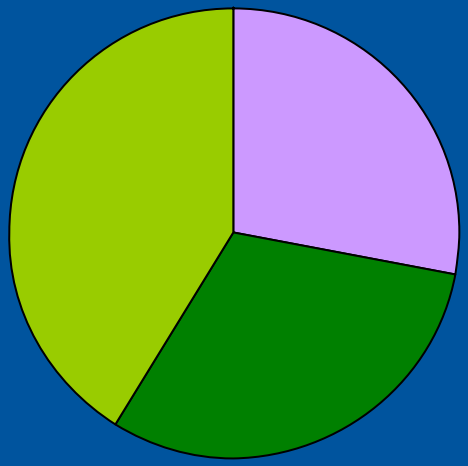
False Bay



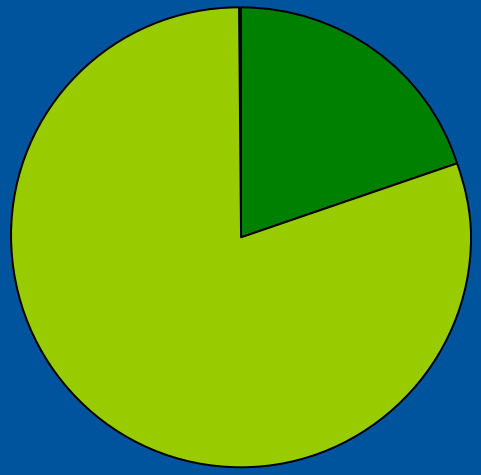
Eastsound



Lopez Village



Mud Bay



Road Density by Focus Area