

Optimizing Stormwater Sampling using Watershed Model Output

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Stormwater sampling

- Stormwater contains elevated levels of pollutants
- Need to estimate pollutant levels
 - Comply with stormwater permits
 - Develop accurate models of runoff dynamics
- Calculate pollutant loads from Event Mean Concentrations (EMCs)

EMC accuracy is important



How good are our estimates?

- What is the bias associated with different sampling strategies?
- How accurate are different sampling strategies?
- How do the sampling strategies perform across storm sizes?
- How does accuracy vary with respect to cost?



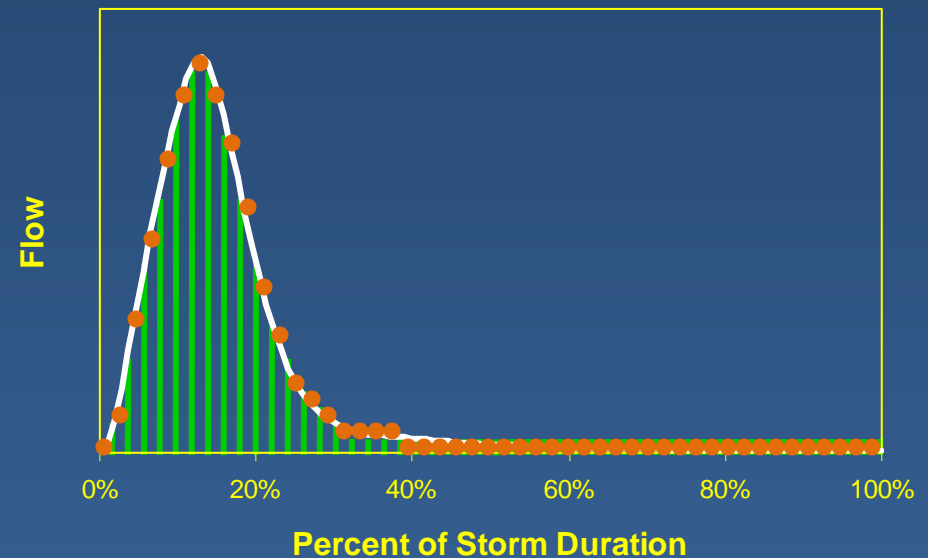
Approach

- Use dynamic model to simulate runoff
 - Simulate a decade of storms
 - 167 sampleable storms
 - Flow, **TSS**, total copper, fecal coliform
- Virtually sample model hydrograph and pollutograph
 - Know “true” EMC
 - Estimate EMC with different samplings



True storm EMC

- Calculate model load at each time step
- Sum all to get “true” storm load



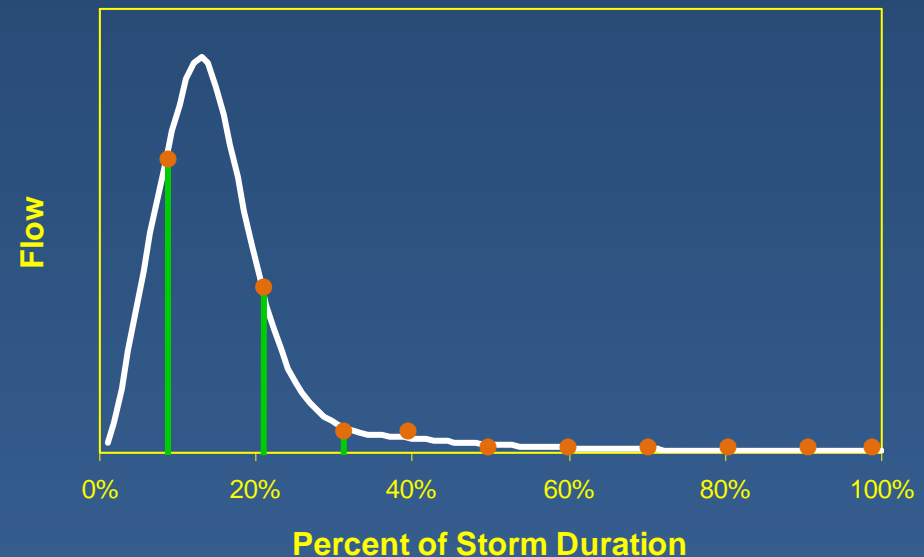
Sampling strategies

- Time-weighted composite
- Flow-weighted composite
- Pollutograph
- Microsampling
 - Flow weighted
 - Time weighted



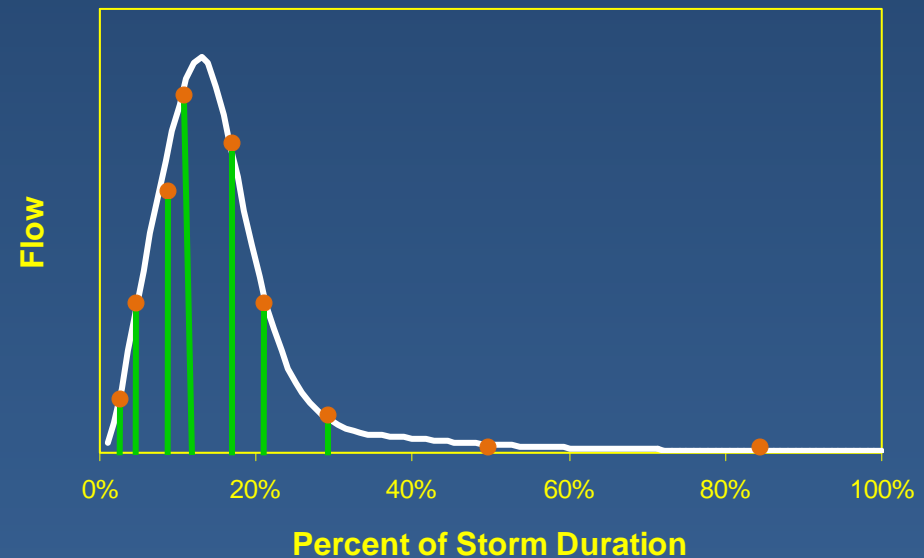
Time-weighted composite

- Take aliquots at a set time pacing
 - Often with an autosampler
 - 48 aliquots
- All aliquots into a common sample
 - Analyze one sample for a storm EMC



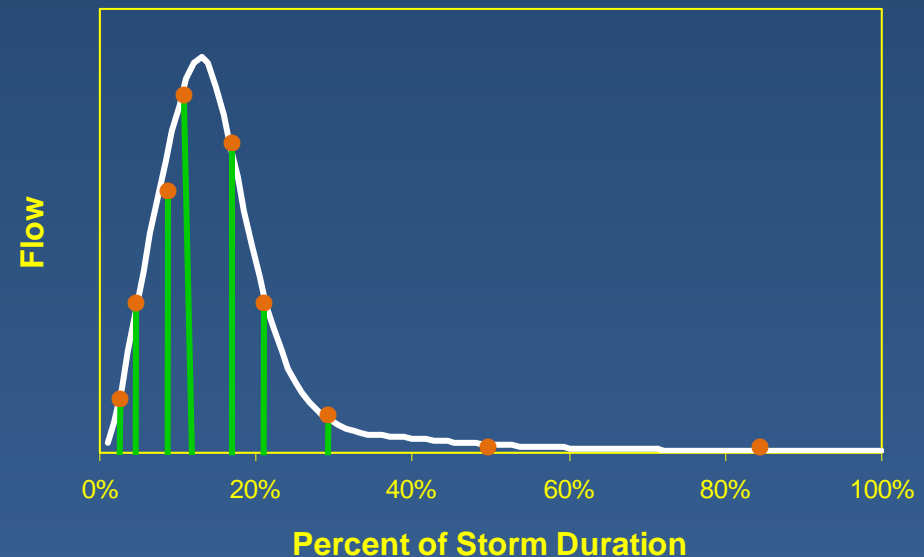
Flow-weighted composite

- Take aliquots at a set flow pacing
 - Autosampled every χ ft³
 - 48 aliquots
- All aliquots into a common sample
 - Analyze one sample for a storm EMC



Pollutograph

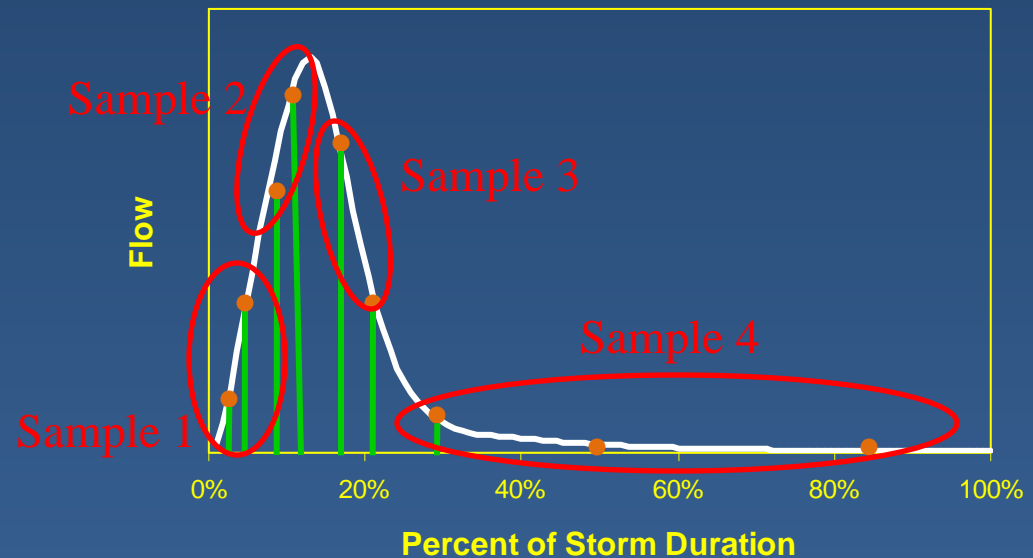
- Sample at targeted storm volumes
 - Evenly-, front- and back-weighted
- Analyze all samples
 - Use flow data and individual sample data to calculate EMC



$$EMC = \frac{\sum V_i C_i}{\sum V}$$

Microsampling

- Take a sample at a set flow or time pacing
 - Target storm sizes
 - 0.25" 0.55" 1.1" 2.4"
 - Time pacings
 - 10 aliquots/sample
- Analyze all samples
 - Use flow data and individual sample data to calculate EMC



$$EMC = \frac{\sum V_i C_i}{\sum V}$$

Sampling strategies

- Flow-weighted compositing
 - 50,000 100,000 200,000 300,000 500,000 1,000,000 ft³
- Time-weighted compositing
 - 5 10 15 20 30 60 min
- Pollutograph sampling
 - Front, evenly and back weighted
 - Entire storm and limited to 24 hours
 - 4 and 10 samples
- Microsampling
 - Front, evenly and back flow-weighted
 - Increasing time paced
 - 2, 4, or 8 samples

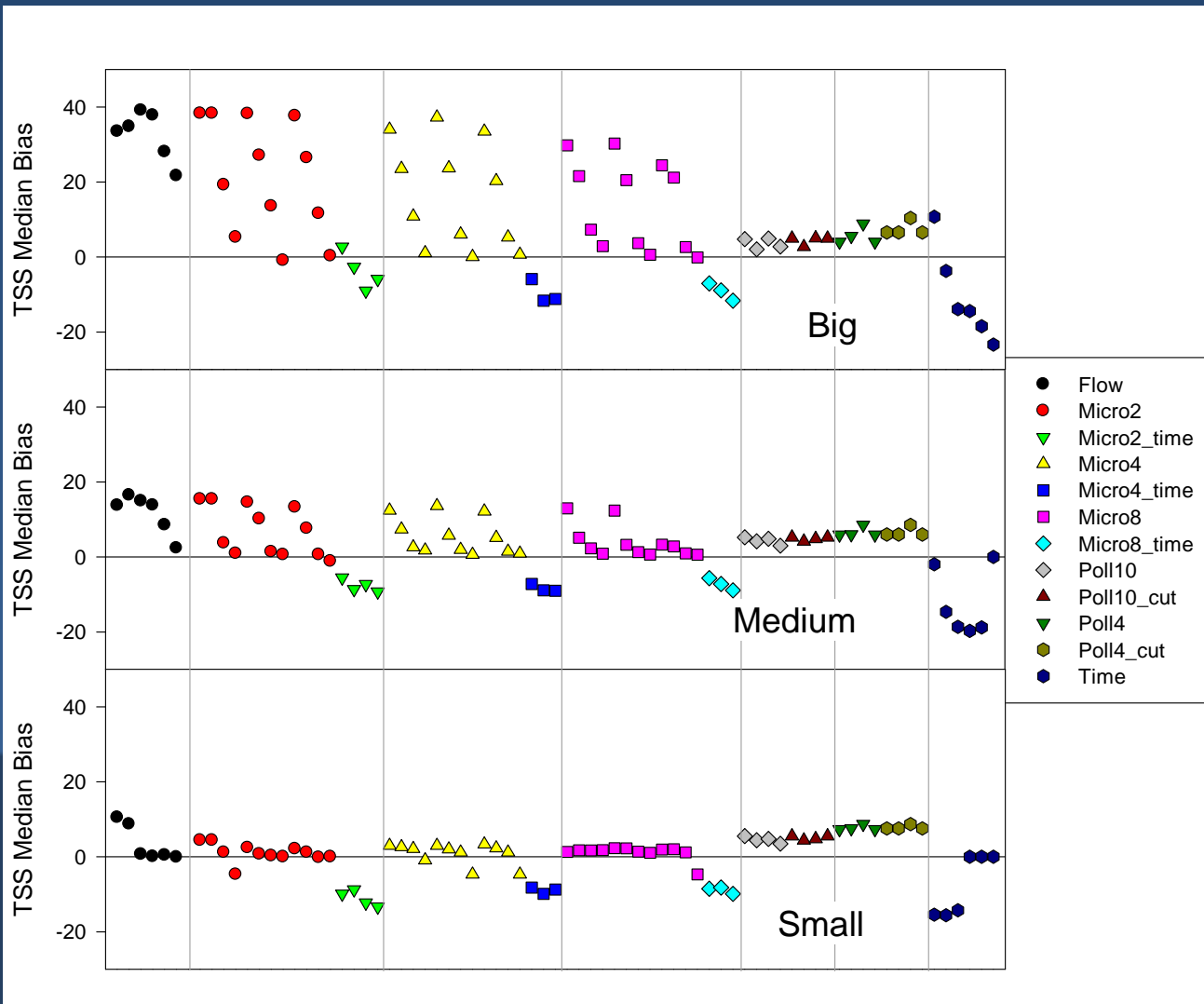


Analysis

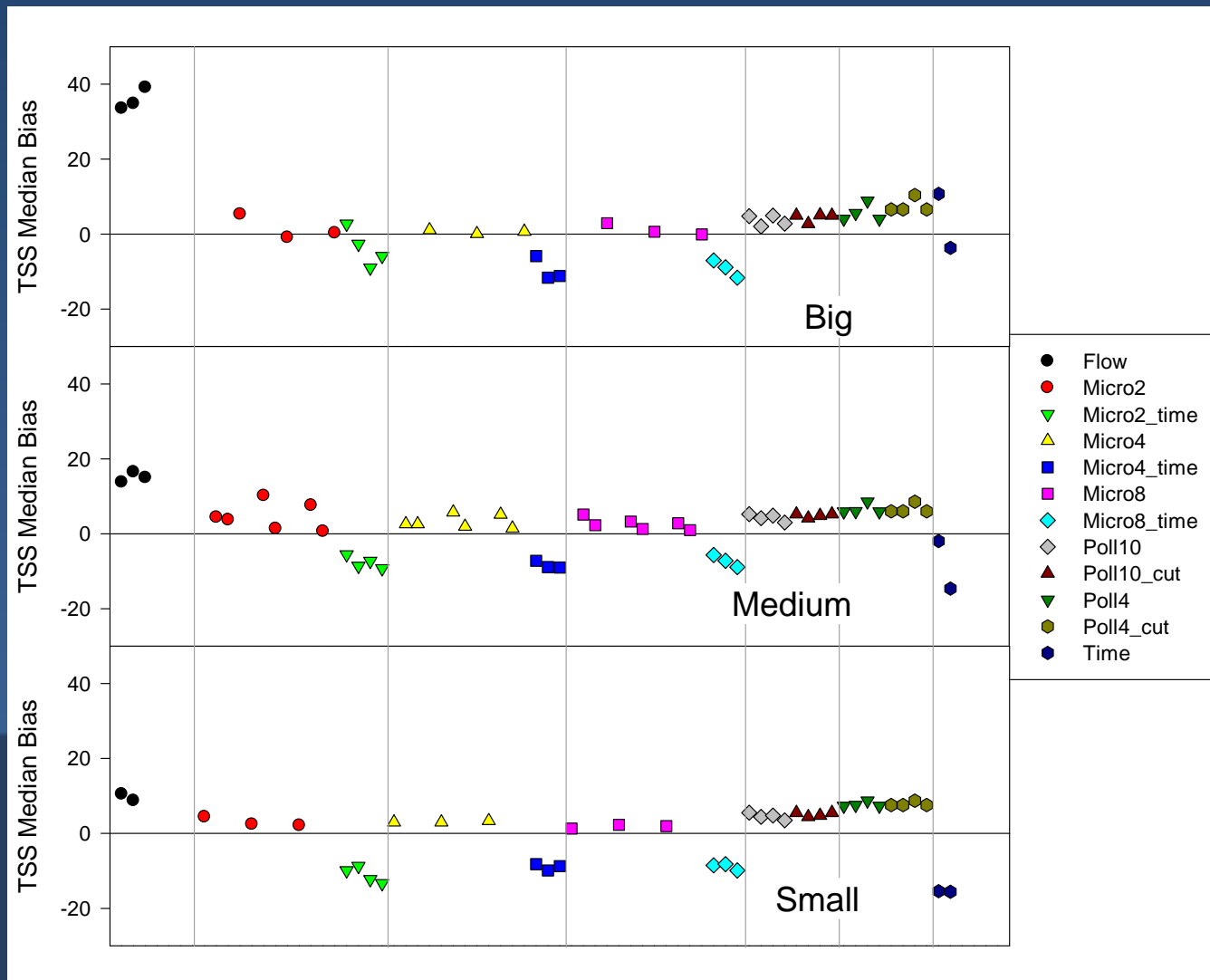
- Bias
- Accuracy
- Cost vs. bias and accuracy



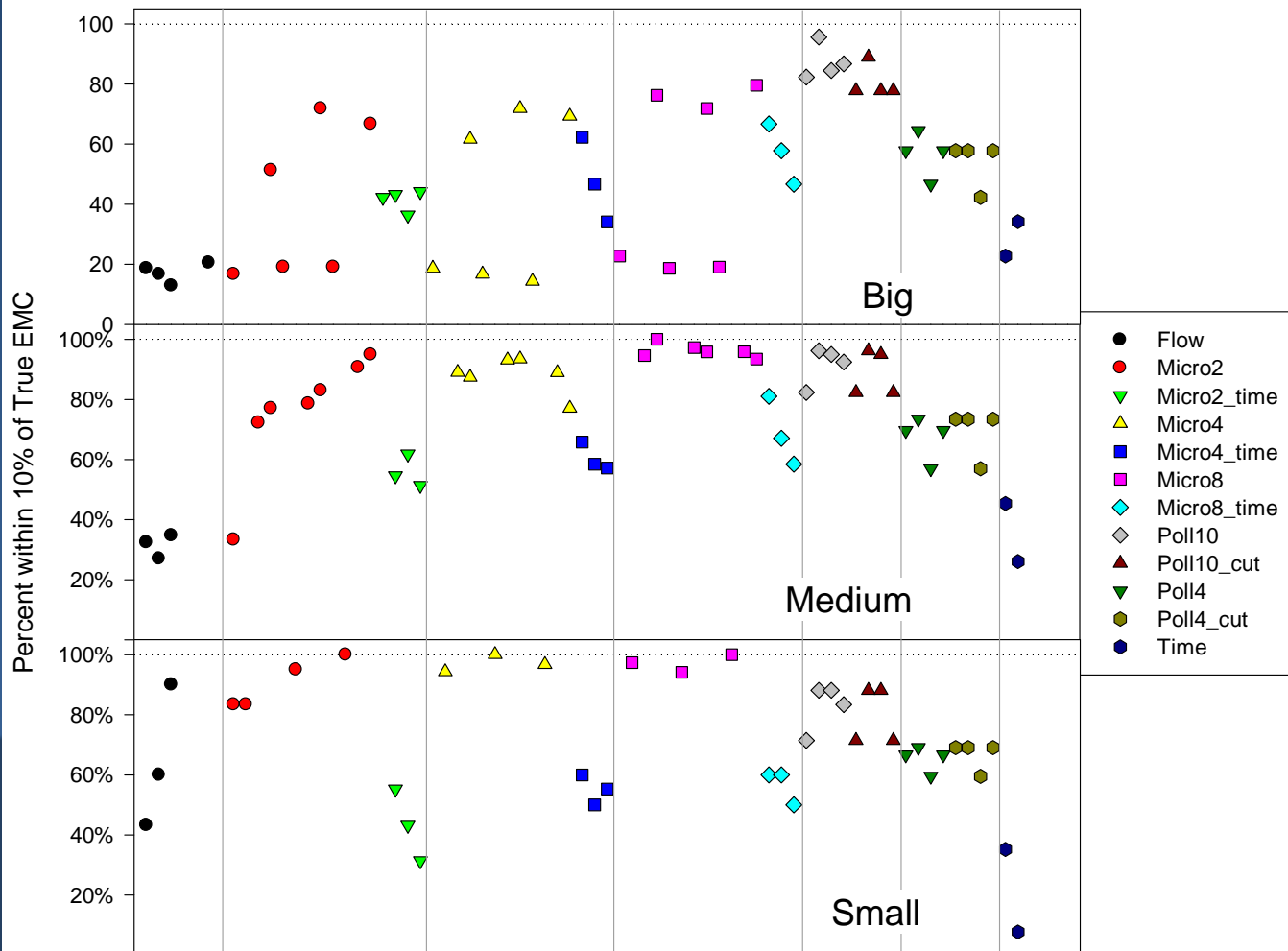
Bias of strategies



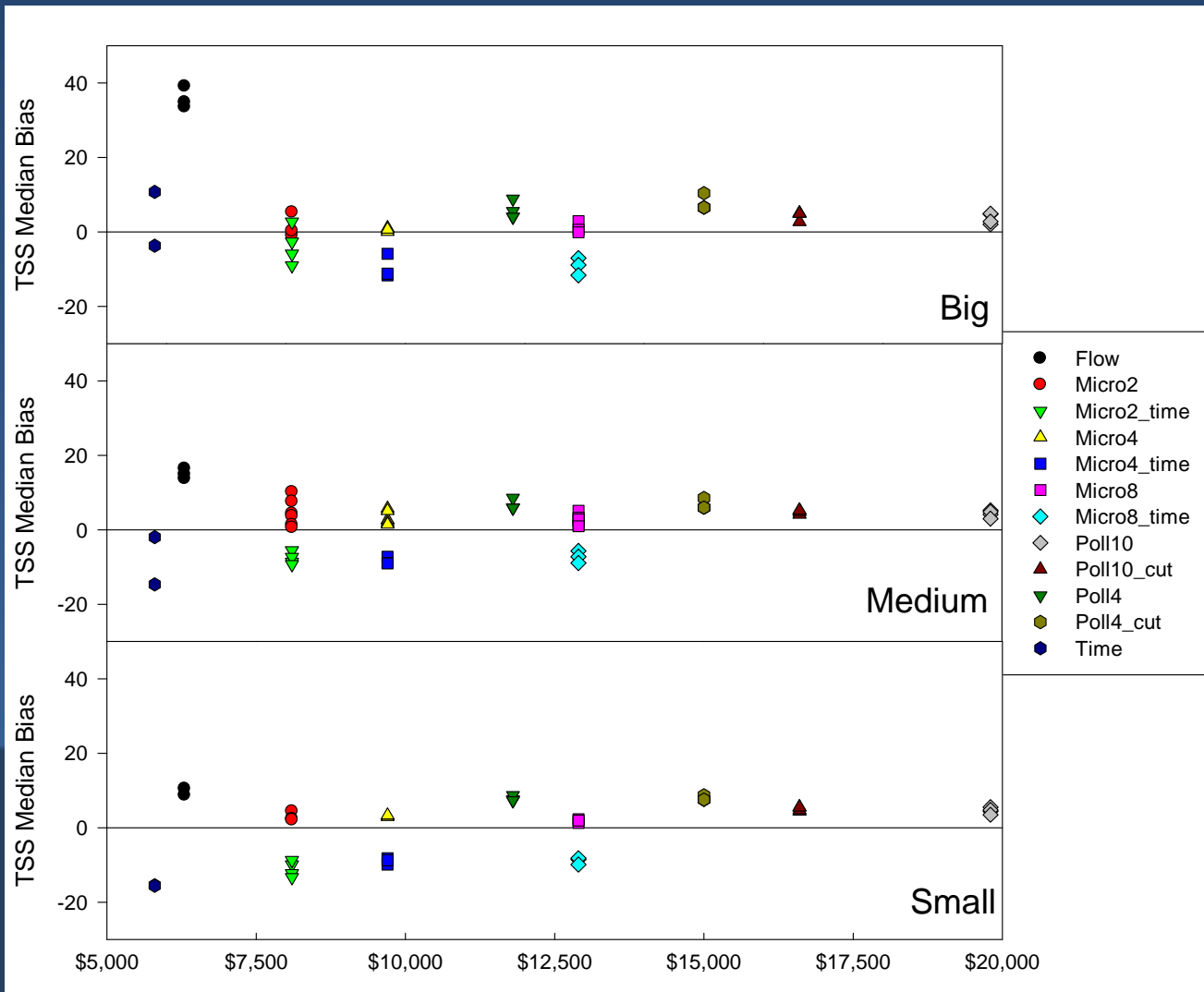
Bias of screened strategies



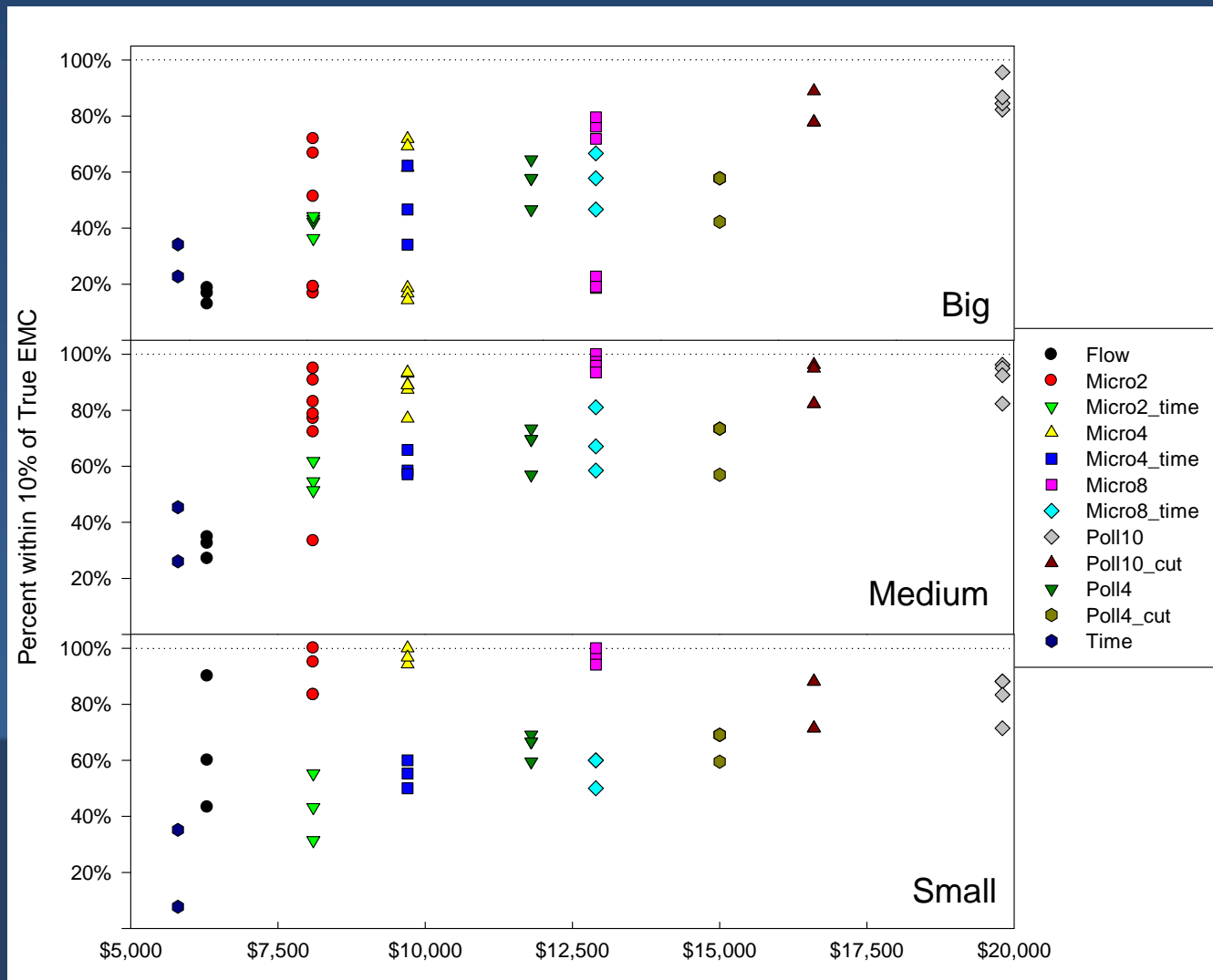
Accuracy



Bias and sampling cost



Accuracy and sampling cost



Summary

Method	Bias	Accuracy	Cost
Flow-weighted	+++	•	\$
Time-weighted	---	•	\$
Microsampling 2	+	•••	\$\$
Microsampling 2 time	--	••	\$\$
Microsampling 4	+	•••	\$\$\$
Microsampling 4 time	--	••	\$\$\$
Microsampling 8	+	•••	\$\$\$\$
Microsampling 8 time	--	••	\$\$\$\$
Pollutograph 4	+	••••	\$\$\$\$\$\$
Pollutograph 4 cutoff	+	••••	\$\$\$\$\$
Pollutograph10	+	••••	\$\$\$\$\$\$
Pollutograph 10 cutoff	+	••••	\$\$\$\$\$

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Questions??

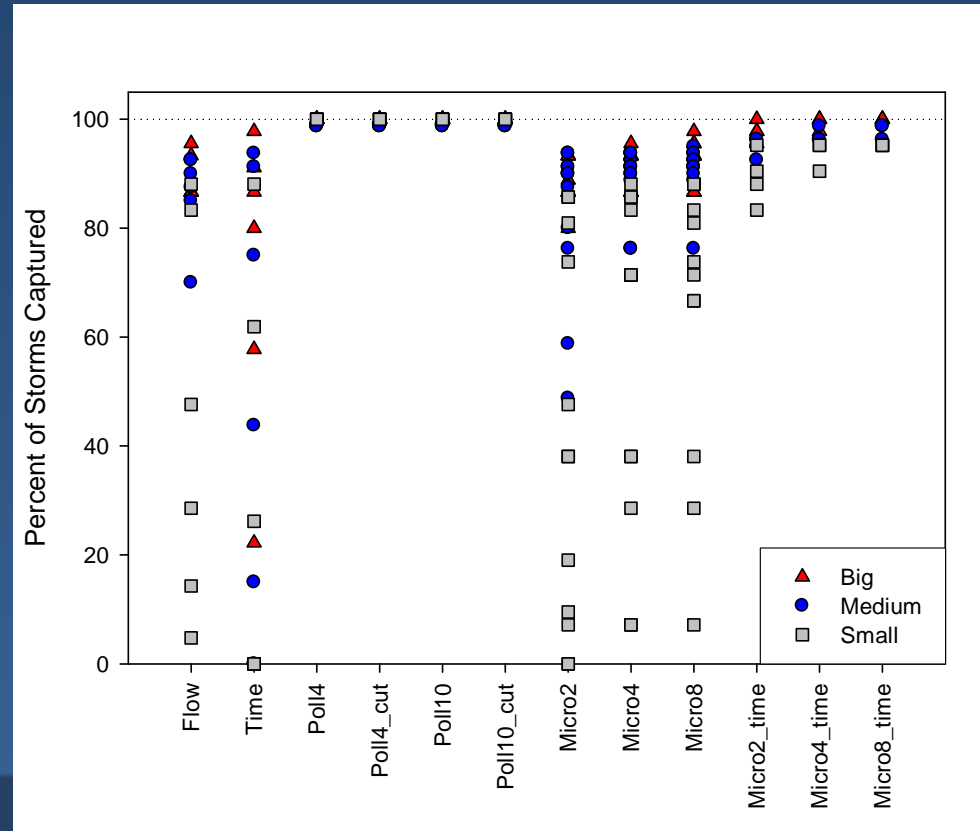
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Percent of storms captured

- Look at number of storms that were sampled



Conclusions

- Different sampling methods have different bias and accuracy
- Method bias and accuracy can be quantified
 - Flow and time weighted generally most inaccurate
 - Flow weighted microsampling better
 - Pollutograph sampling most accurate
- Costs generally go up with increased bias and accuracy
 - Trade off between cost and bias/accuracy

