Clackamas County – Water Environment Services Benthic Macroinvertebrate and Geomorphic Monitoring

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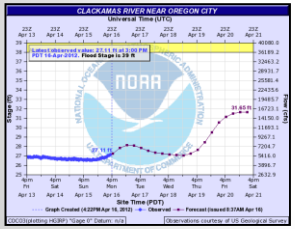
OVERVIEW

- Water Environment Services funds a long-term monitoring program to evaluate stream health in northern Clackamas County
- The desire to monitor stream health is based on observed impacts associated with hydromodification
- Hydromodification has been shown to have cumulative impacts on channel form and function and the ecological health of streams
- The comprehensive monitoring program began in 2009 although macroinvertebrates have been sampled since 2002

Urbanization	Hydromodification	Channel Geomorphology	Instream Physical Habitat	Biological Communities
• Impervious cover • Infiltration rates • Runoff	• Lower base flows • Higher peak flows	• Connectivity • Scour/Incision • Erosion • Deposition	• Habitat condition & complexity • Substrate • Embeddedness	• Periphyton • Macroinvertebrates • Fish



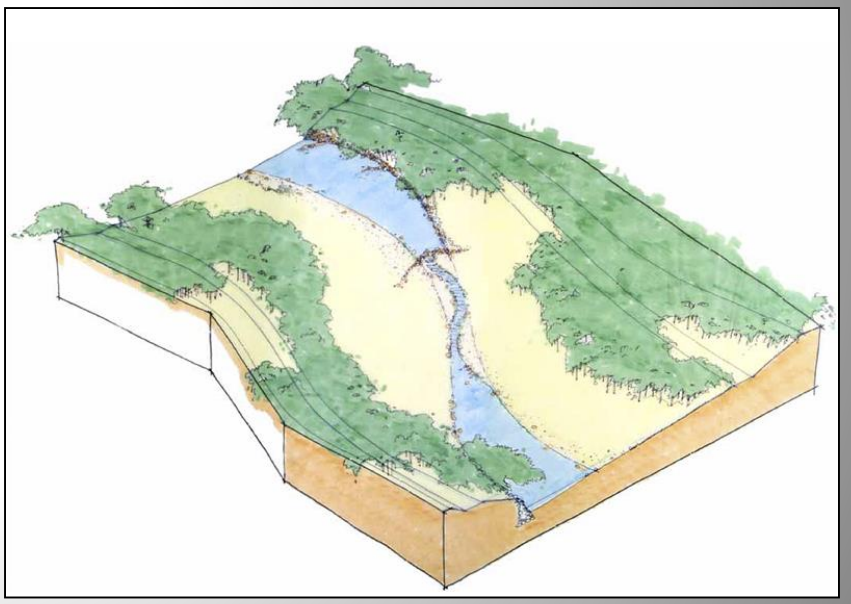
Water Chemistry

Riparian Conditions

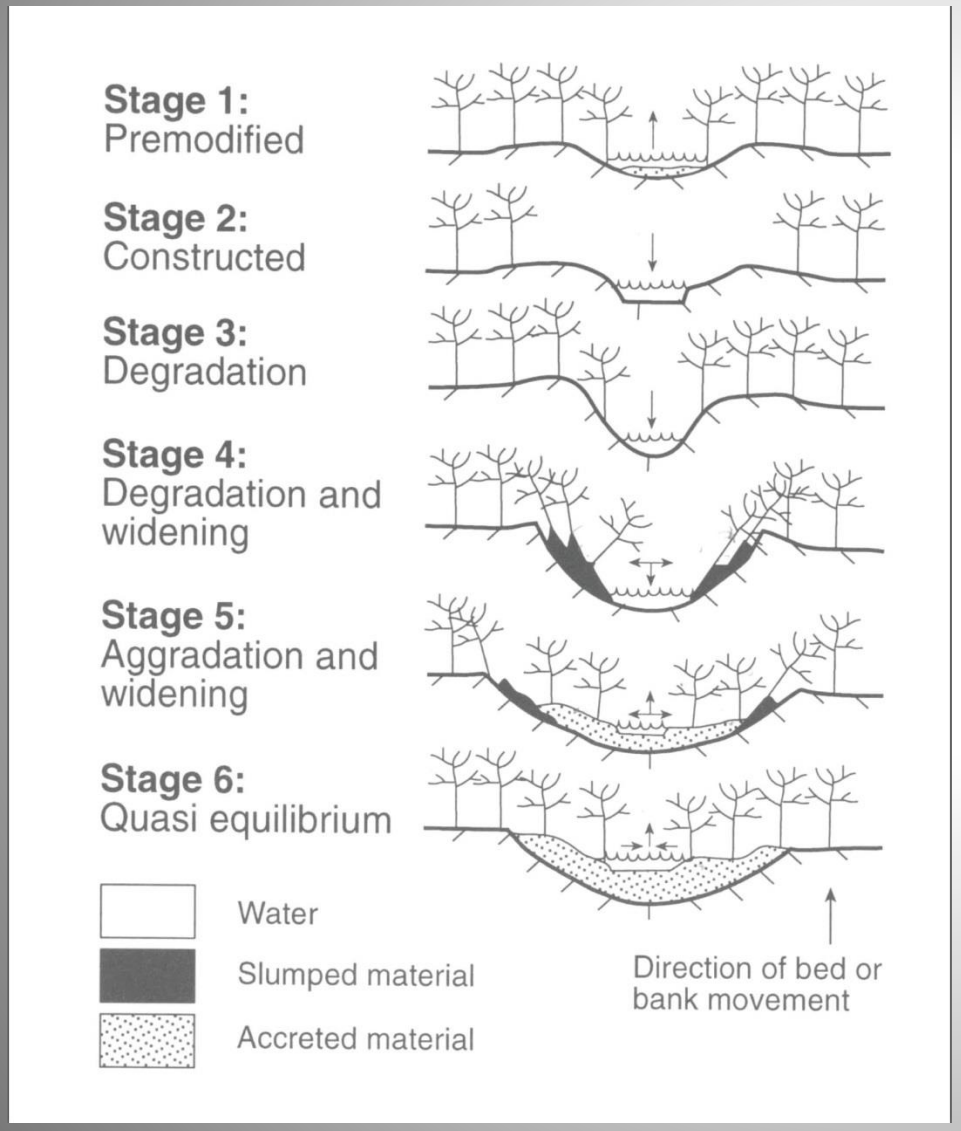
Used to evaluate the physical integrity of stream reaches.

Geomorphic changes can result in degradation of physical habitat conditions necessary to support healthy, diverse, native aquatic communities.

- Channel incision
- Disconnection from floodplain
- Erosion
- Fine sediment deposition



Channel Evolution Model (Simon and Hupp)



When selecting appropriate indicators for stream bioassessment, the objective is to choose an assemblage that:

- Is a reliable indicator of overall ecological condition
- Can be sampled and analyzed in a cost-effective manner,
- Is consistent with the current expertise available, and
- Can be readily interpreted and results conveyed to managers

- Provide an essential link between primary producers and vertebrates such as fish and amphibians
- Excellent indicators of ecological health
- Highly sensitive to changes in physical habitat (e.g.; depth/velocity regimes, substrate conditions, cover) and water chemistry (D.O., temp., etc.)
- Integrate the effects of multiple stressors
- Field, lab, and analysis protocols are well established and widely used

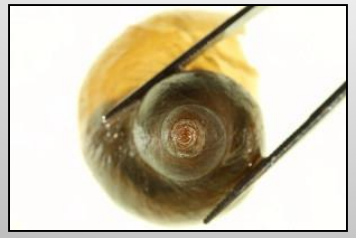
- Orders regarded as sensitive:
  - Mayflies (Ephemeroptera), Stoneflies (Plecoptera), Caddisflies (Trichoptera)

- Sediment sensitive organisms



- Tolerant organisms
- Sediment tolerant organisms






PURPOSE AND NEED

- Evaluating the effects of hydromod on stream channels requires a characterization of channel conditions over time throughout the watershed.
- Understanding the impacts to ecological systems is often best achieved by sampling macroinvertebrates.
- Can also be used to monitor the effectiveness of stormwater management practices and efforts to mitigate the impacts of hydromodification.
- Primary monitoring approach is assessment of TEMPORAL CHANGE and CUMULATIVE EFFECTS.

LIMITATIONS

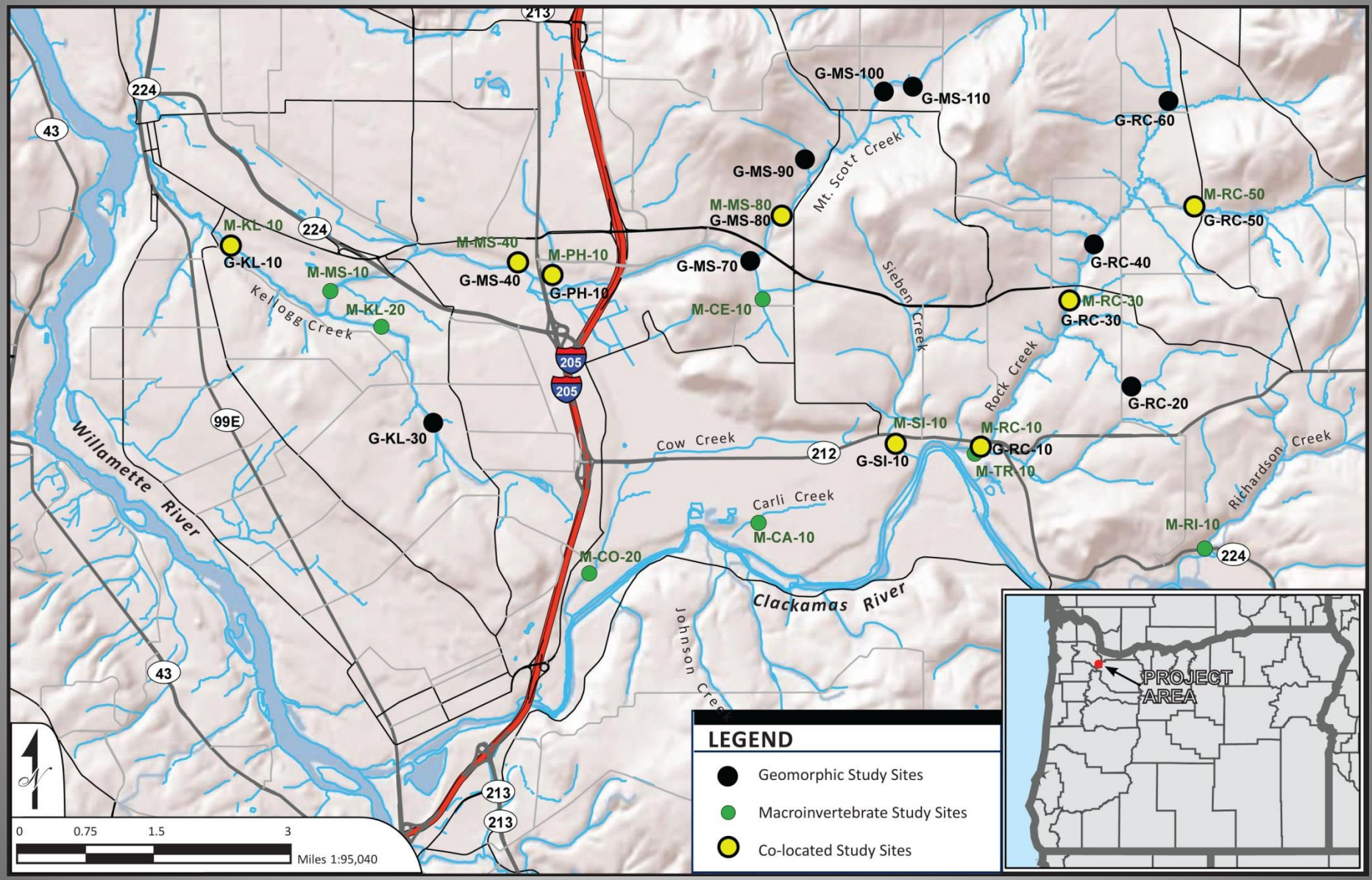
- Is not meant to replace linear assessments of habitat or geomorphic conditions
- Identifies *degree* of impairment, not necessarily the *source* of the impairment
- Will not replace continuous sampling of water quality parameters (necessary to identify specific stressors)

SCOPE OF EFFORT

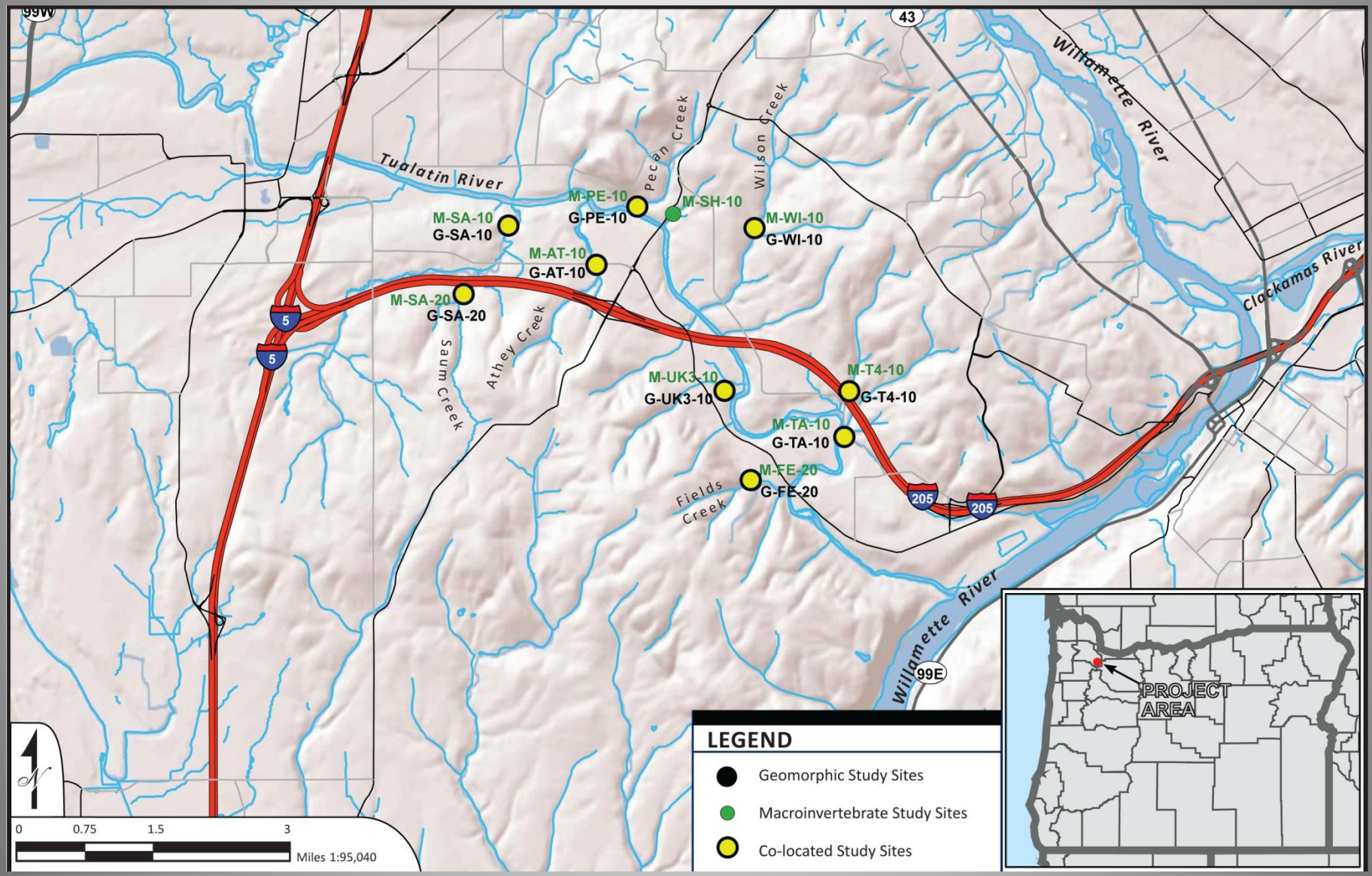
- Monitoring sites established throughout Service District #1 and SWMACC management areas.
- Includes mainstem and smaller tributary sites.

Management Area	Macroinvertabrate Monitoring Sites	Geomorphic Monitoring Sites	Overlapping Sites
Service District #1	15	16	8
SWMACC	10	9	9

Monitoring Sites – Service District #1



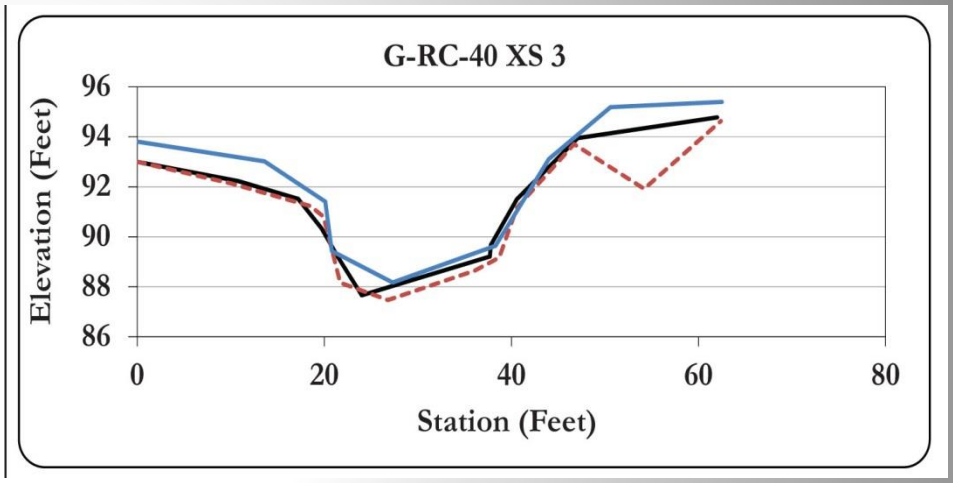
Monitoring Sites – SWMACC

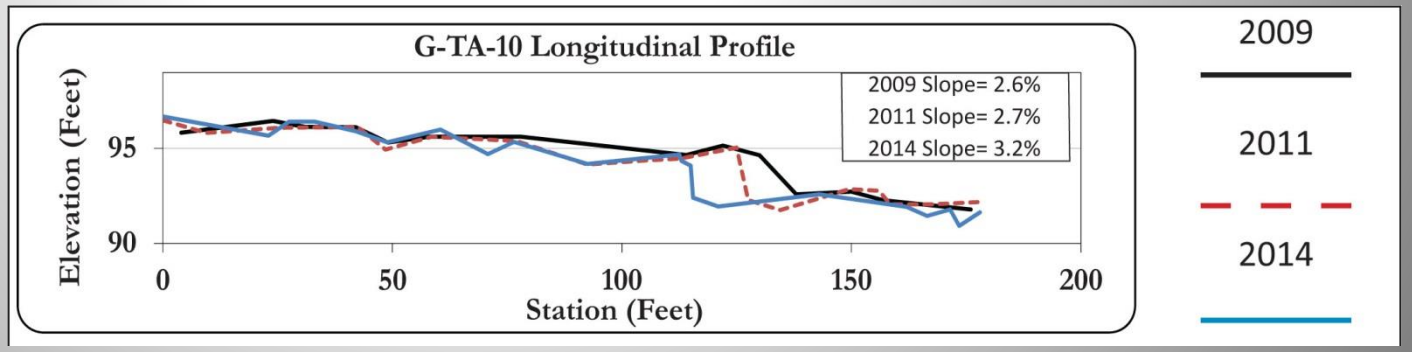


METHODS

- Longitudinal and cross section profile surveys;
- Measurement of surficial substrate conditions;
- Collection of a bulk sample of bed conditions and surficial sample of bar deposits;
- Measurement of pool characteristics, and
- Assessment of bank conditions

- Cross-section and longitudinal profile comparisons between monitoring years
- Comparison of substrate conditions between monitoring years
- Metrics to assess profile variability, bank erosion, pool filling
- Evaluated against antecedent conditions





Channel condition ratings and thresholds

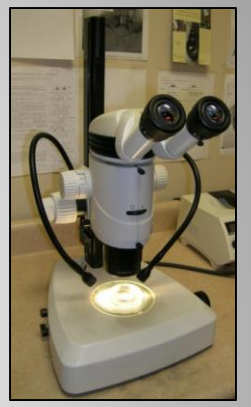
Parameter	Indicator	Threshold Values	Reference
Floodplain Connectivity	Entrenchment	Low: Entrenchment Ratio < 1.4 Moderate: Entrenchment Ratio from 1.4 to 2.2 High: Entrenchment Ratio > 2.2	Rosgen, 1996
Bed Morphology	Pool Depths	Qualitative based on pool depth, channel size and field observations	
Streambank Conditions	Percent Bank Erosion	Stable: < 5% on both banks Stable - At-Risk: from 5-10% on either bank At-Risk: > 10% on either bank	
Degree of Fine Sediment Intrusion	Bulk Sample Results	Low: 6.3mm < 15%; 0.85mm < 10% Moderate: 6.3mm from 15-30%; 0.85mm from 10-20% High: 6.3mm > 30%; 0.85mm > 20%	Kondolf, 2000

- Instream physical habitat:
  - Channel dimensions
  - Habitat composition (% riffle, pools, glides, etc)
  - Substrate and embeddedness
- Riparian assessment
  - Overhead cover (%)
  - Tree cover (%)
  - Non-native cover (%)
  - Riparian buffer width
- Water chemistry parameters
  - Water temperature, dissolved oxygen, specific conductance

- Oregon DEQ's Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams
- An 8-kick composite sample was collected from riffles in reaches that had sufficient riffle habitat.
- Glides were sampled in low-gradient reaches that lacked riffle habitat.

Laboratory methods:

- Sample sorting
- Identification of macroinvertebrates using OR DEQ Level 3 Protocols



Data analysis:

- Both multimetric analysis and predictive model used
- Correlation analysis (env. conditions vs macro. cond.)
- Stressor identification using CADDIS

Multi-metric set and scoring criteria for macroinvertebrates

Metric	Scoring Criteria		
	5 (good)	3 (fair)	1 (poor)
POSITIVE METRICS			
Taxa richness	>35	19–35	<19
Mayfly richness	>8	4–8	<4
Stonefly richness	>5	3–5	<3
Caddisfly richness	>8	4–8	<4
Number sensitive taxa	>4	2–4	<2
Number sediment sensitive taxa	≥2	1	0
NEGATIVE METRICS			
Modified HBI[1]	<4.0	4.0–5.0	>5.0
% Tolerant taxa	<15	15–45	>45
% Sediment tolerant taxa	<10	10–25	>25
% Dominant	<20	20–40	>40

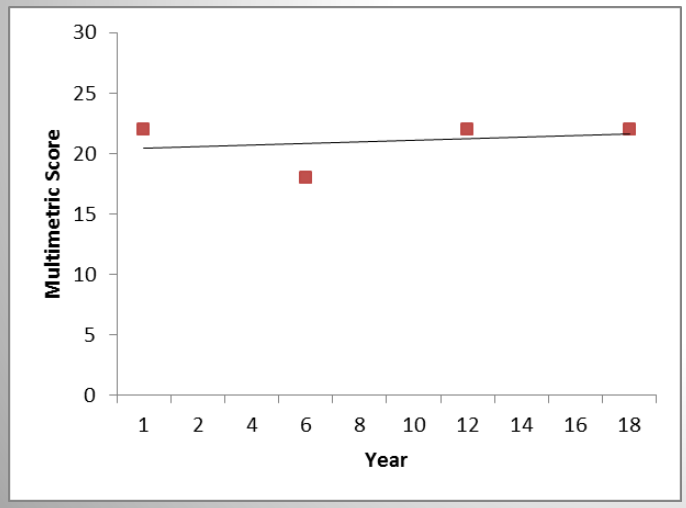
PREDictive Assessment Tool for Oregon (PREDATOR)

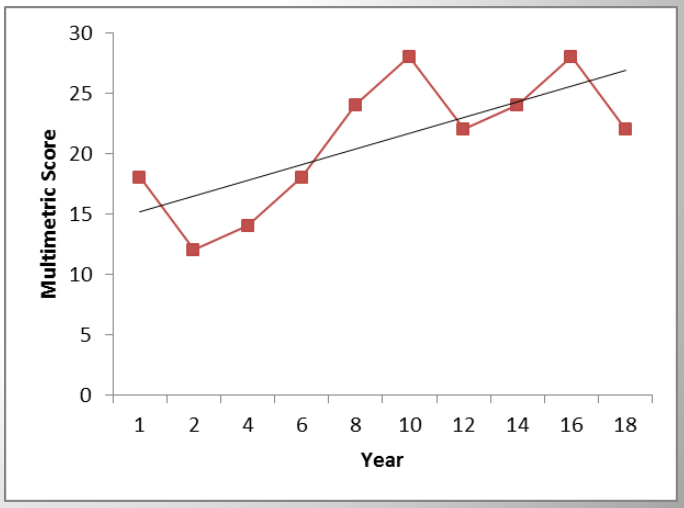
- RIVPACS-type approach, using physical variables to predict expected macroinvertebrate composition.
- Expected occurrence of taxa at a sample site is derived from known occurrence of taxa at regional reference sites that have similar natural conditions to the sample site (e.g. slope, elevation, region).
- The expected (E) taxa list is compared to the sample site observed (O) taxa list as an O/E taxa ratio.
- O/E scores in the lower 25th percentile of reference site scores are deemed moderately to several disturbed.

Biological Condition Class	Reference percentile	MWCF	
		O/E	% Common Taxa Loss/Gain
Most disturbed	≤ 10th	≤ 0.85	≤ 15%
Moderately disturbed	> 10th to 25th	0.86 - 0.91	9 – 14%
Least disturbed	> 25th to 95th	0.92 - 1.24	0 - 8% loss 0 - 24% gain
Enriched	> 95th	> 1.24	> 24 % gain

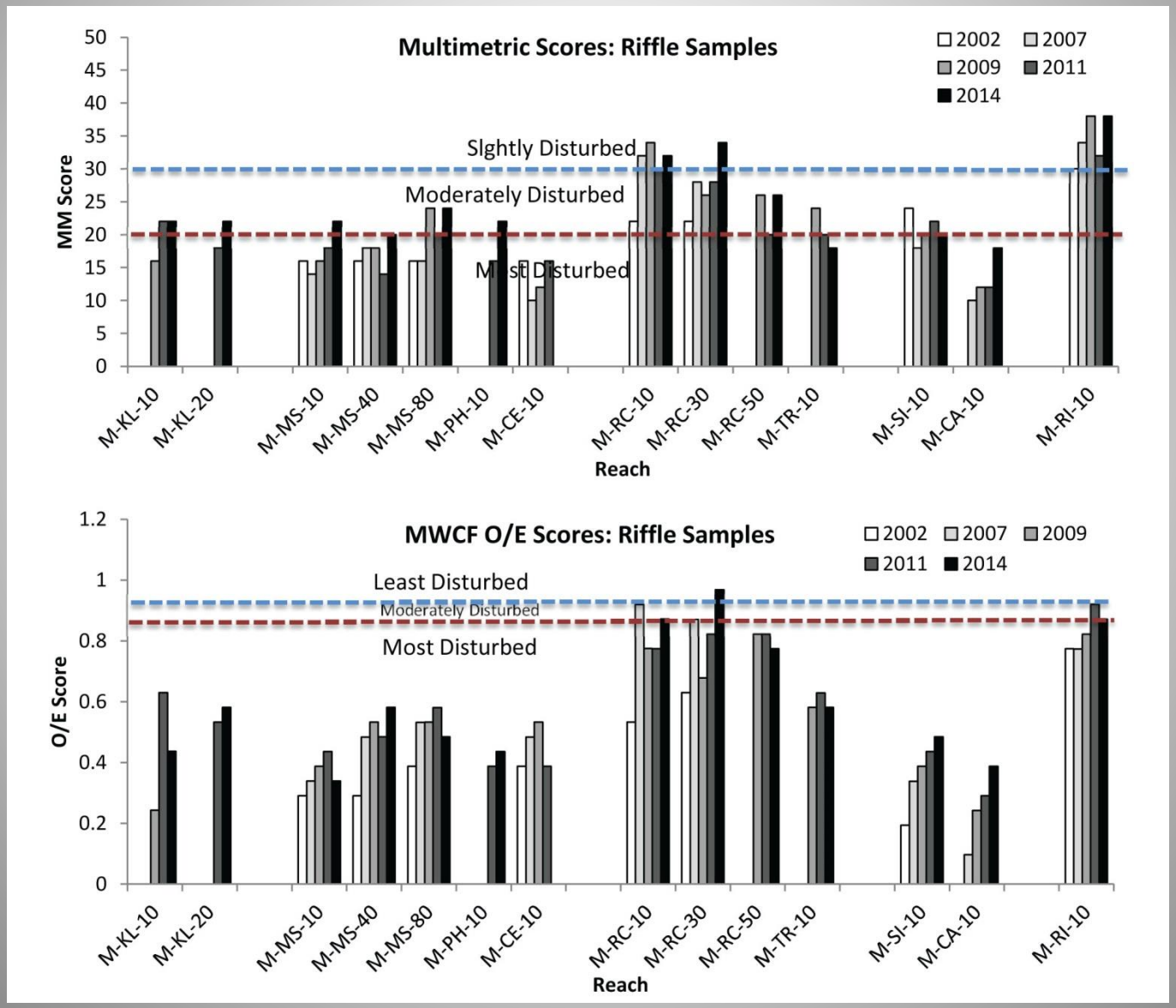
Detecting Change

- Can take time
- Requires sustained, regular effort and long-term management view

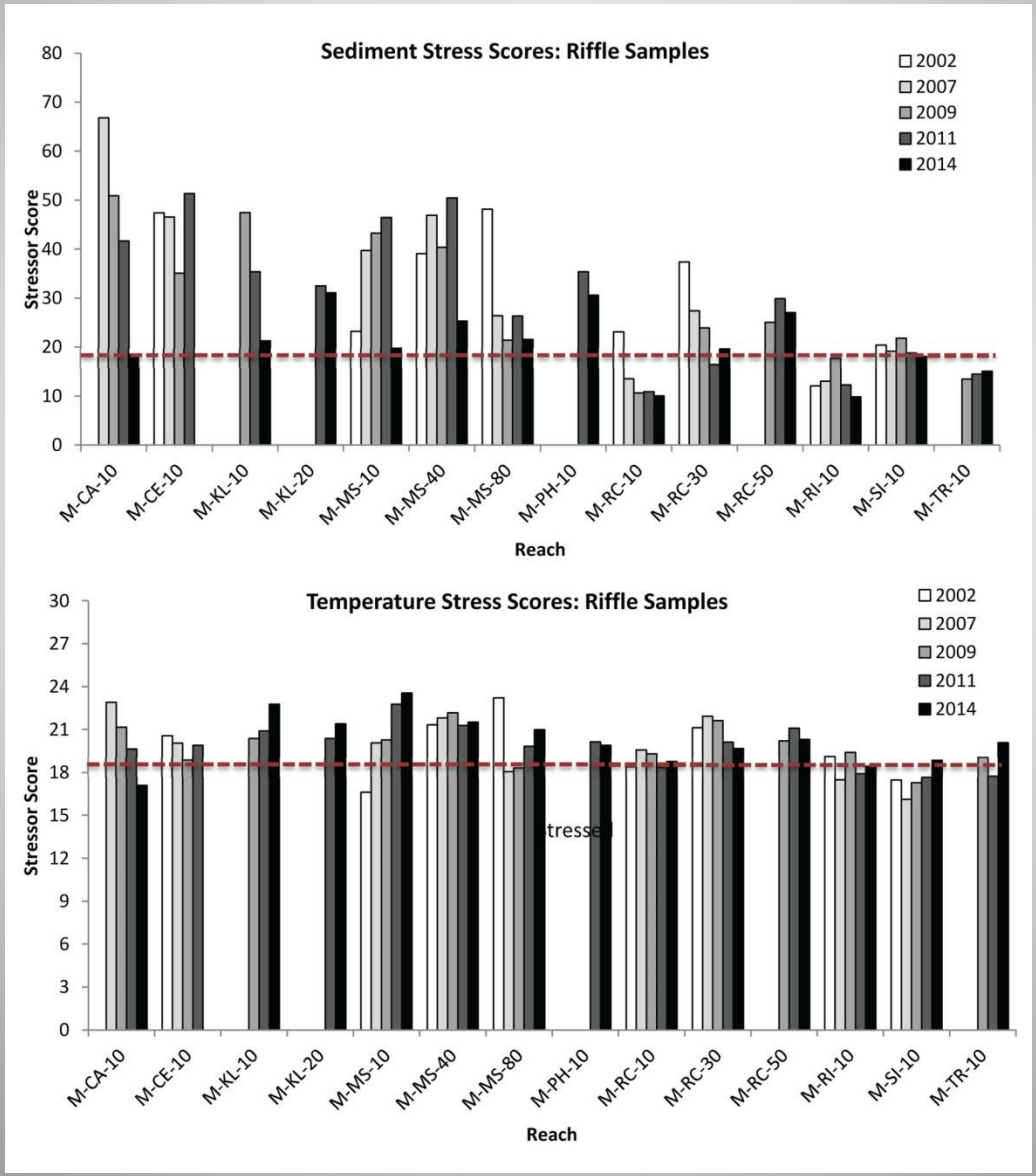




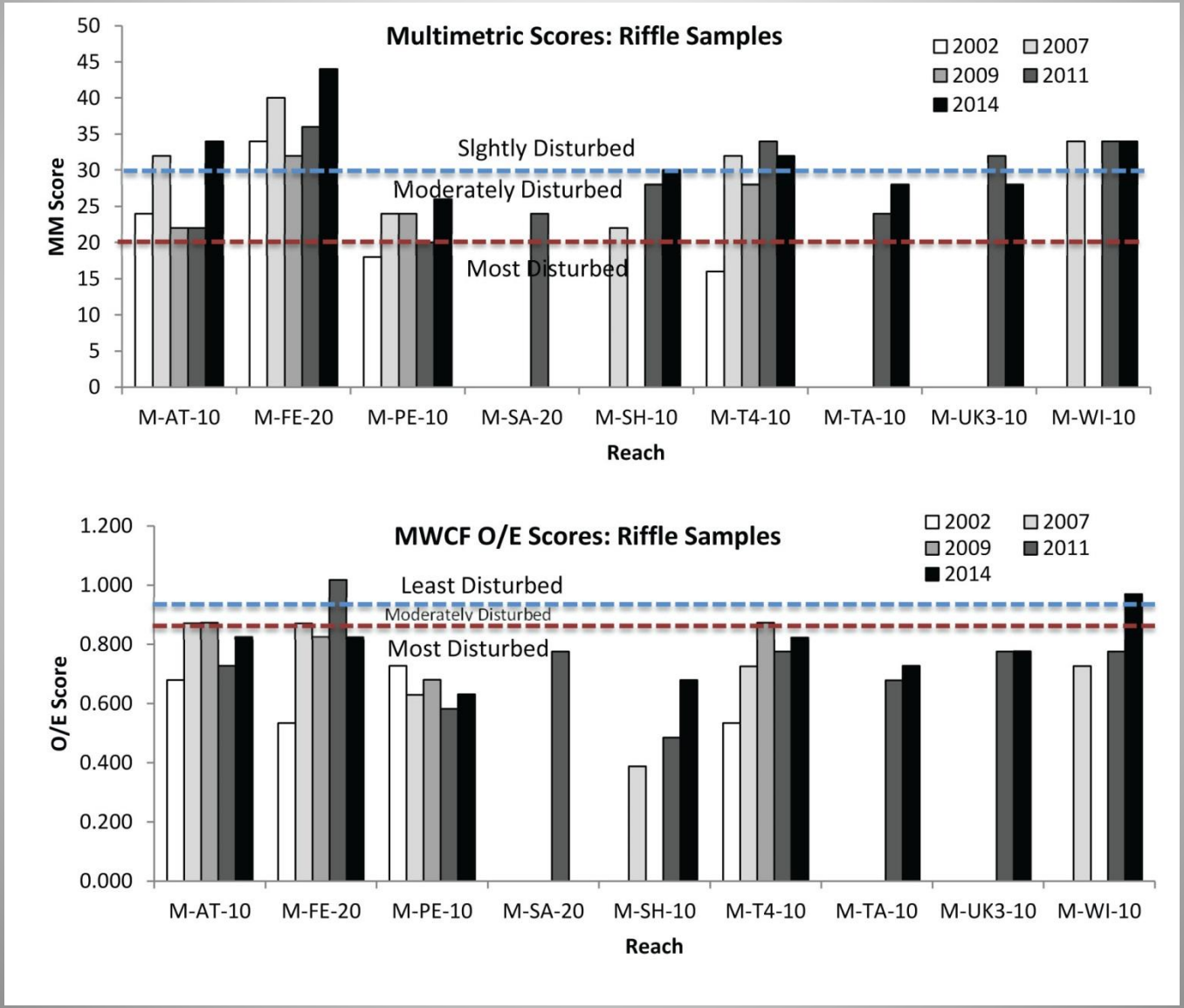
Macroinvertebrate Results – Service District 1



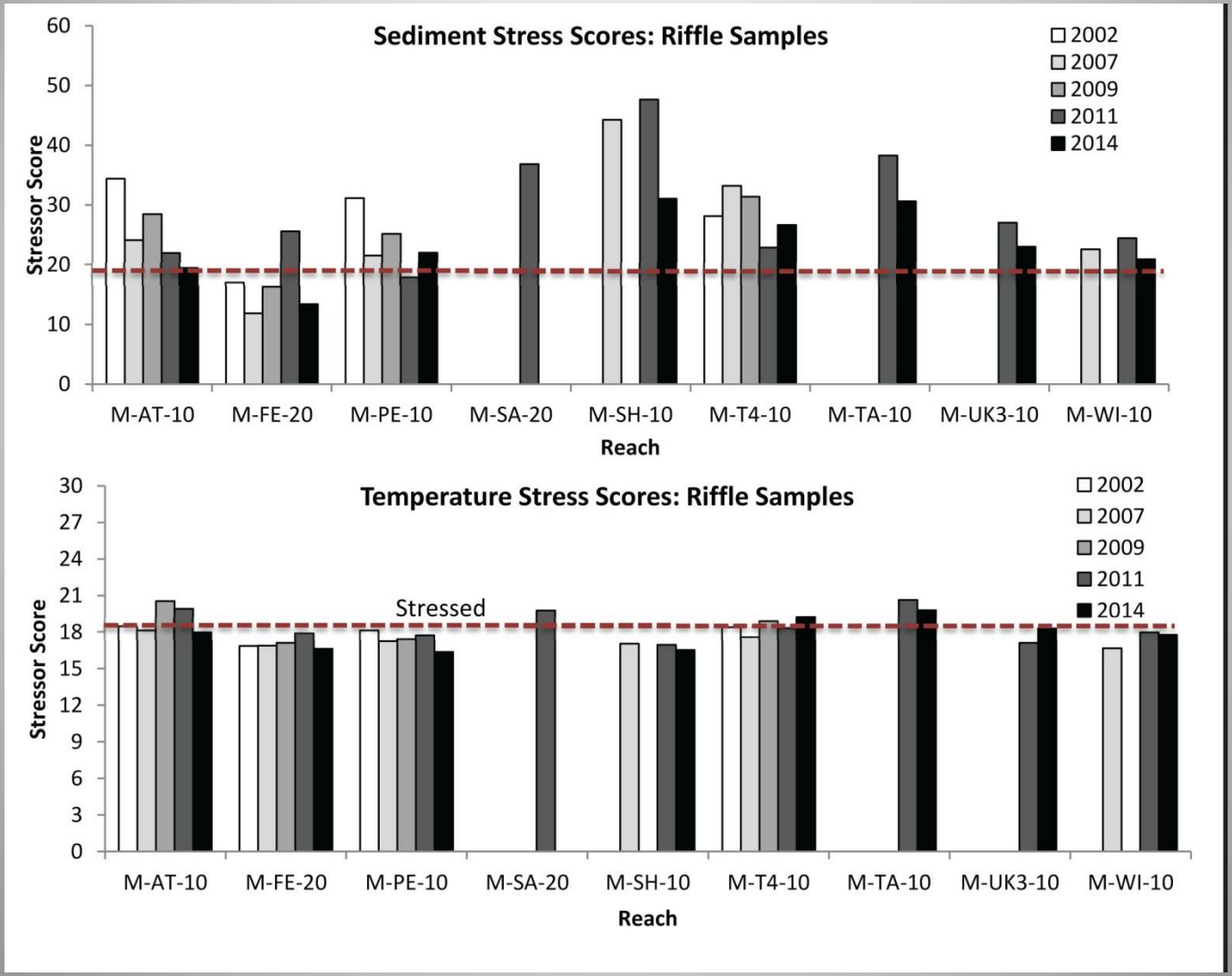
Macroinvertebrate Results – Service District 1



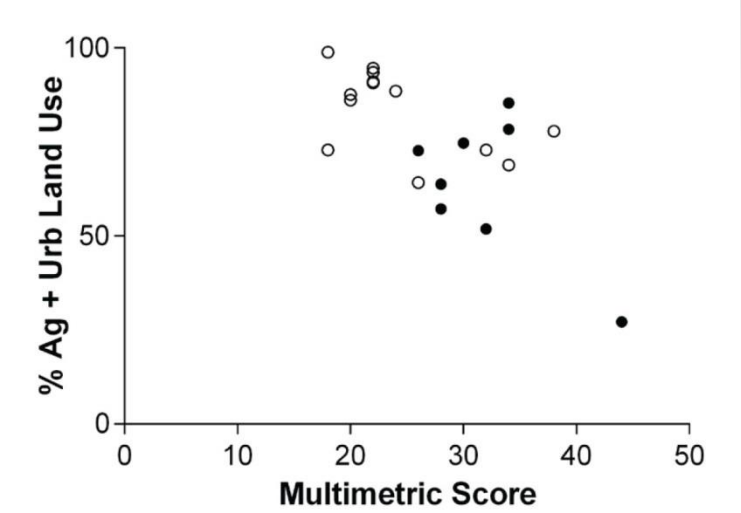
Macroinvertebrate Results – SWMACC

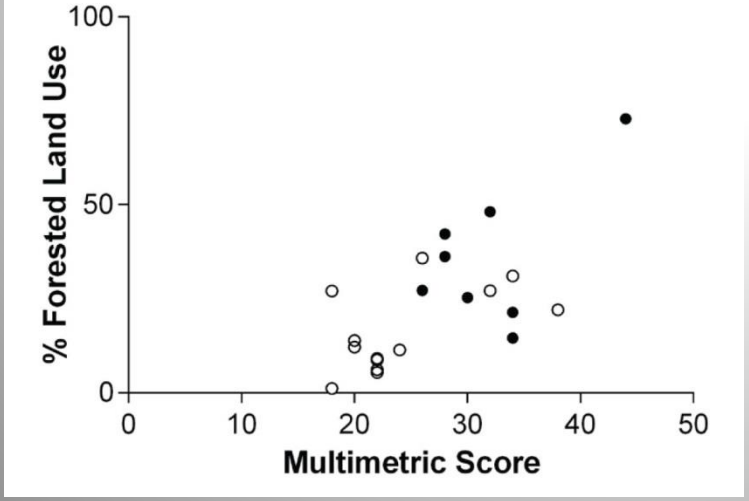


Macroinvertebrate Results – SWMACC



Macroinvertebrate Results – All sites



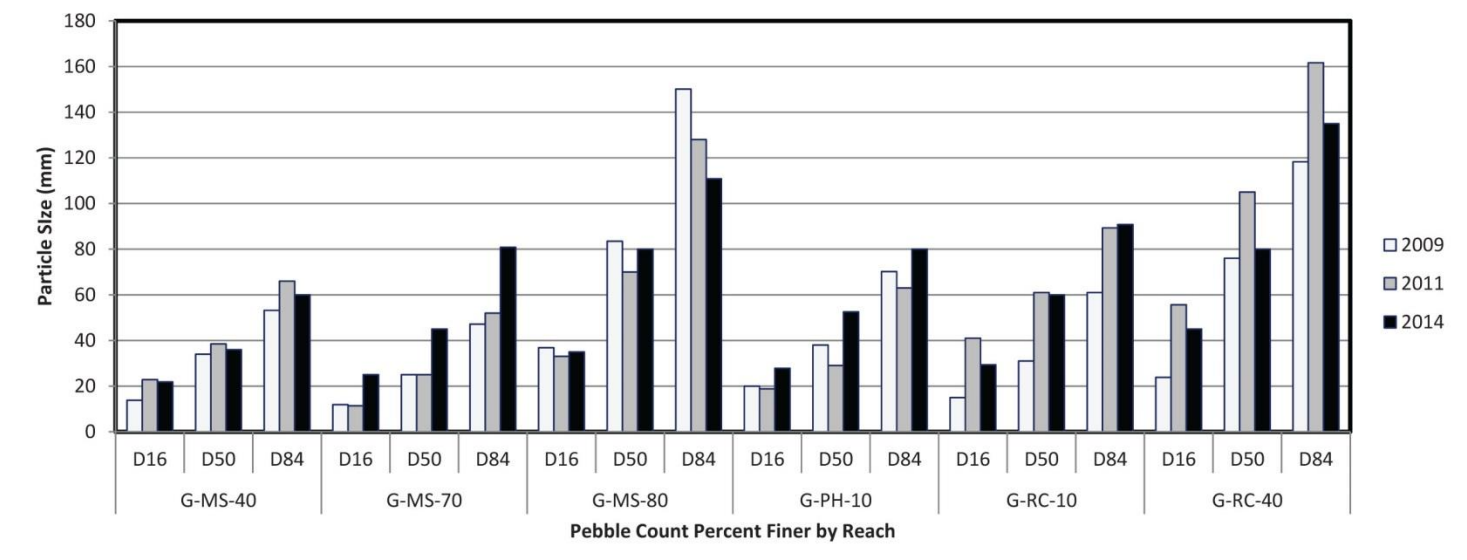


SWMACC Sites - Solid circles

SD1 Sites – Open Circles

Geomorphic Results – Service District 1

- General trends suggests:
  - Increase in fine sediment in streambed from 2009-2011
  - Coarsening of streambed from 2011-2014
- Related to underlying hydrology: Last significant event was in 2008 with a moderate event in 2011
- Larger runoff events result in fine sediment delivery associated with bank erosion and poor BMP's at construction sites, etc.
- Over time, the finer material flushes from system



Geomorphic Results – Service District 1

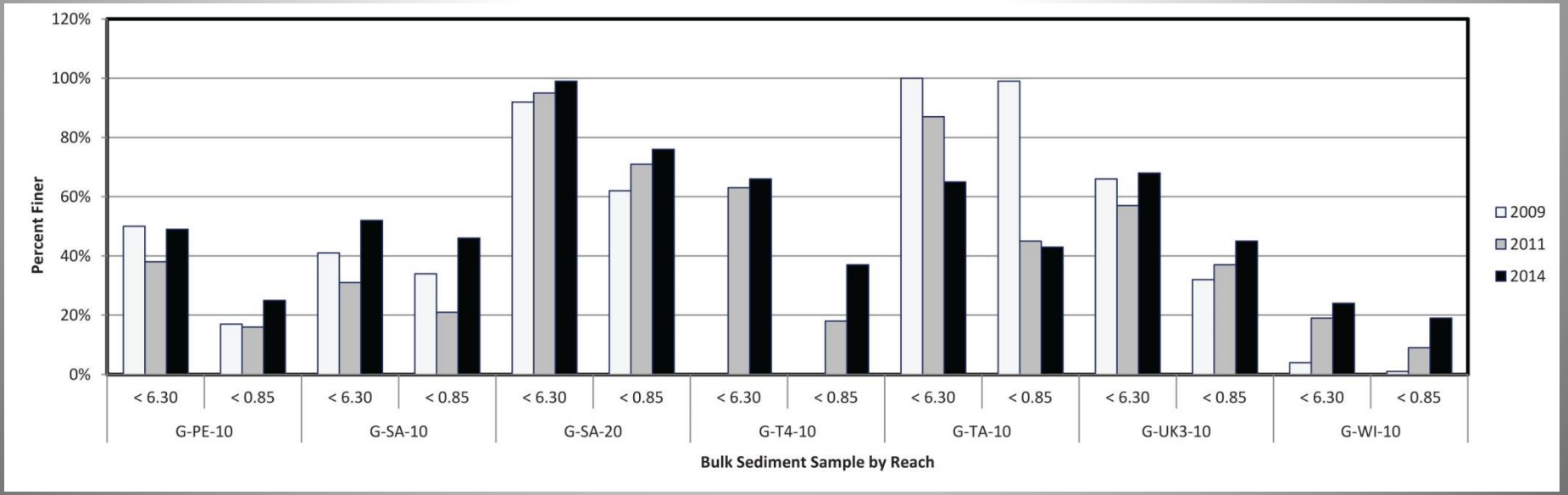
Site ID	Floodplain Connectivity	Bed Morphology	Stream Bank Conditions	Degree of Fine Sediment Intrusion (6.3mm: 0.85mm)	Overall Channel Condition
Kellogg Creek Subbasin					
G-KL-10	Moderate	Pool-Riffle	At Risk	High	Stable – At Risk
G-KL-30	Moderate	Plane Bed	Stable	NA	Stable – At Risk
Mt. Scott Creek Subbasin					
G-MS-40	Low	Pool-Riffle	Stable – At Risk	Moderate	**At Risk**
G-MS-70	Moderate	Pool-Riffle	At Risk	High	Stable – At Risk
G-MS-80	High	Pool-Riffle	Stable	Moderate	Stable
G-MS-90	High	Plane Bed	Stable – At Risk	High	Stable
G-MS-100	Moderate	Plane Bed	Stable	NA	Stable – At Risk
G-MS-110	High	Plane Bed	Stable	NA	**At Risk**
G-PH-10	Moderate	Pool-Riffle	Stable	Moderate: Low	Stable – At Risk
Rock Creek Subbasin					
G-RC-10	Moderate	Pool-Riffle	Stable	Moderate	Stable – At Risk
G-RC-20	High	Plane Bed	Stable	NA	Stable
G-RC-30	Low	Plane Bed	Stable – At Risk	NA	Stable - At Risk
G-RC-40	Moderate	Pool-Riffle	Stable – At Risk	High	Stable – At Risk
G-RC-50	Moderate	Pool-Riffle	Stable – At Risk	High	Stable – At Risk
G-RC-60	High	Backwatered	Stable	NA	Stable – At Risk
Tributaries to the Clackamas River					
G-SI-10	Low	Plane Bed	At Risk	Moderate: Low	**At Risk-Unstable**

At Risk/Unstable Sites – Service District 1

- Site G-MS-40 (Three Creeks) – At Risk
  - 2014 results show some widening and an increase in bank erosion
  - Significant risk for widening in the future; Potentially moderated by healthy riparian corridor and cohesive bank material
- Site G-MS-110 (Happy Valley Park) – At Risk
  - At risk due to a combination of observed incision downstream (G-MS-100) and an increase in impervious watershed upstream
  - Being addressed by WES via headcut repairs downstream and stormwater management in contributing watershed
- Site G-SI-10 (Lower Sieben Creek) – At Risk/Unstable
  - A measureable increase in bank erosion; loss of riparian trees
  - High risk of bank failure along the entire reach between Hwy 224/212 and the Clackamas River
  - Somewhat moderated by hardened bank toe which reduces the rate of undercutting

Geomorphic Results – SWMACC

- General trend toward an increase in fine sediment in the SWMACC subwatersheds.
- Function of the material properties of the bed, banks, and floodplain of the lower Tualatin
- Also attributable to the nature and pattern of development in the SWMACC area



Geomorphic Results – SWMACC

Site ID	Floodplain Connectivity	Bed Morphology	Stream Bank Conditions	Degree of Fine Sediment Intrusion	Overall Channel Condition
G-AT-10	Moderate	Plane Bed	Stable	NA	Stable
G-FE-20	Moderate	Pool-Riffle	At Risk	NA	**At Risk - Unstable**
G-PE-10	Moderate	Plane Bed	At Risk	High	Stable - At Risk
G-SA-10	Moderate	Backwatered	At Risk	High	**At Risk**
G-SA-20	Moderate	Plane Bed	Stable - At Risk	High	Stable - At Risk
G-T4-10	High	Plane Bed	Stable - At Risk	High	Stable
G-TA-10	High	Plane Bed	At Risk	High	**Unstable**
G-UK3-10	High	Plane Bed	At Risk	High	Stable – At Risk
G-WI-10	High	Pool-Riffle	Stable - At Risk	Moderate	Stable

At Risk/Unstable Sites – SWMACC

- Site G-FE-20 (Fields Creek) – At Risk/Unstable
  - Incised channel presents a significant risk of upstream movement of headcuts
  - Heacutting would have the potential to breach a remnant dam and pond with significant downstream risks
- Site G-SA-10 (Lower Saum) – At Risk
  - Data from 2014 shows some channel aggradation and widening associated with an undersized downstream culvert
  - Home on property is in the floodplain and has been bank owned/unoccupied since before 2009
- Site G-TA-10 (Tate Creek) –Unstable
  - A headcut, observed since 2009 has been migrating upstream at a rate of approximately 10 feet per year
  - Continued movement of the headcut may result in impacts to infrastructure and a significant delivery of fine material (bed and banks) to the Tualatin

Comments and Questions