Geomorphic and Macroinvertebrate Monitoring

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Gail Shaloum, Clackamas County Water Environment Services

COLE ECOLOGICAL, INC.

WATERWAYS CONSULTING, INC.
Santa Cruz, CA | watways.com | Portland, OR

Agenda

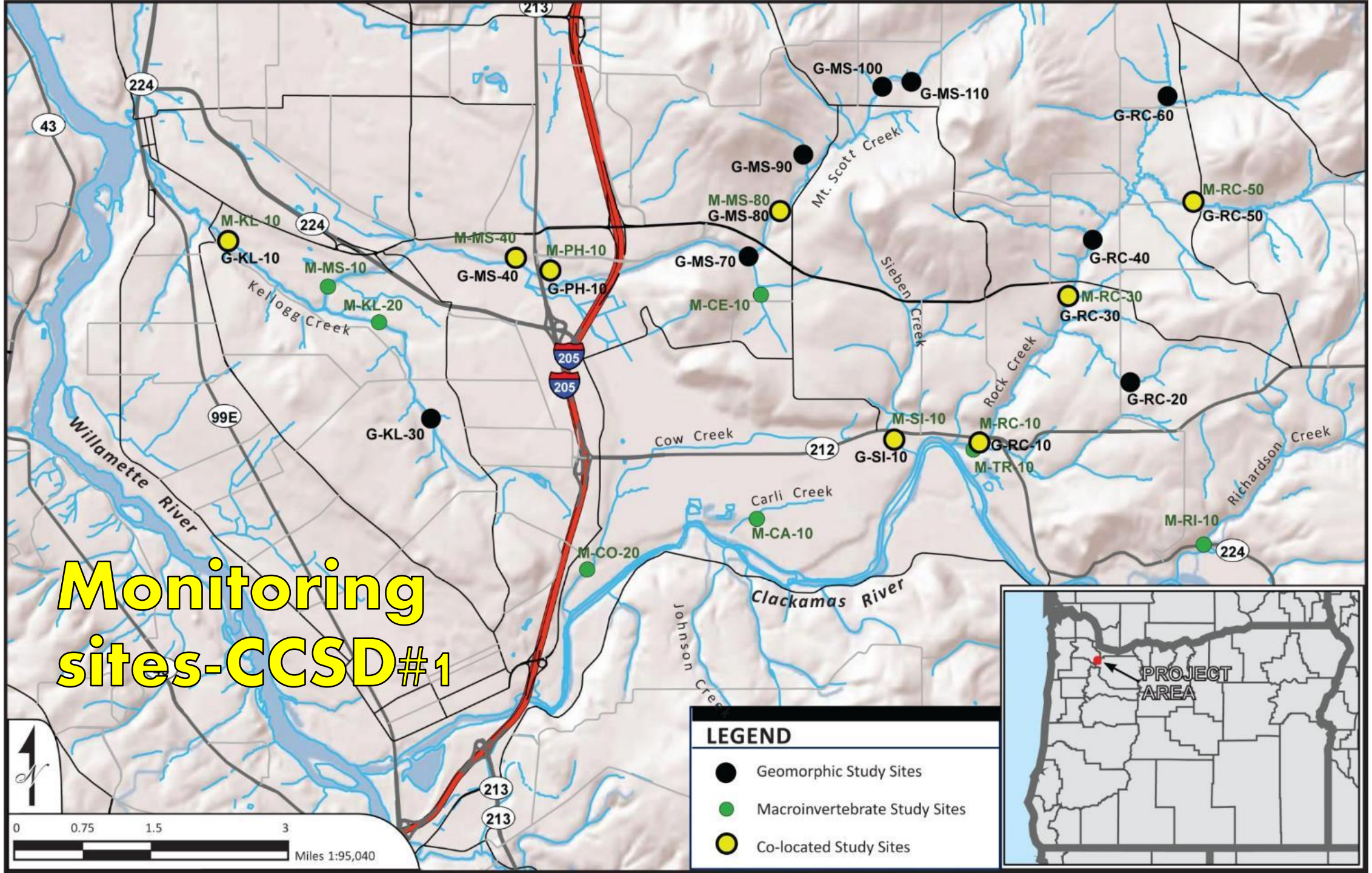
- **What**
- **Why**
- **Methods**
- **Results**

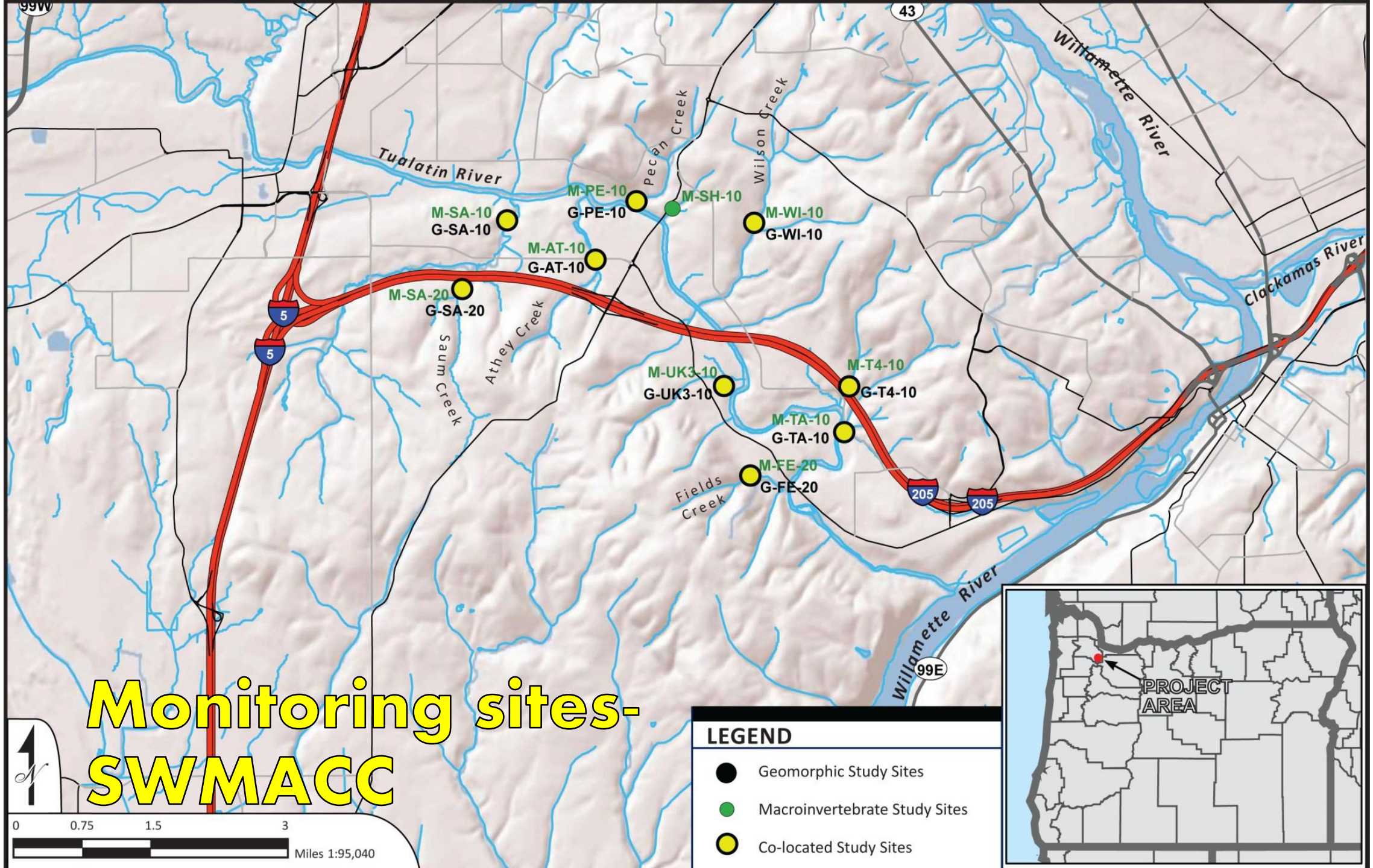
What

Long-term monitoring program to evaluate stream health

Limitations:

- Identifies degree of impairment, not the source of the impairment
- Not long enough or enough data points to establish trends yet


Monitoring sites-CCSD#1
G-MS-100
G-MS-110
G-RC-60
G-MS-90
M-MS-80
G-MS-80
M-RC-50
G-RC-50
M-KL-10
G-KL-10
M-MS-40
G-MS-40
M-PH-10
G-PH-10
G-MS-70
G-RC-40
M-MS-10
M-KL-20
M-CE-10
M-RC-30
G-RC-30
G-KL-30
G-RC-20
M-SI-10
G-SI-10
M-RC-10
G-RC-10
M-TR-10
M-CA-10
M-RI-10
M-CO-20
Mt. Scott Creek
Sieben Creek
Rock Creek
Kellogg Creek
Cow Creek
Carli Creek
Richardson Creek
Willamette River
Clackamas River
Johnson Creek
224
43
213
205
99E
212
0
0.75
1.5
3
Miles 1:95,040
LEGEND
Geomorphic Study Sites
Macroinvertebrate Study Sites
Co-located Study Sites
PROJECT AREA


99W
43
Willamette River
Tualatin River
Pecan Creek
Wilson Creek
M-PE-10
G-PE-10
M-SH-10
M-SA-10
G-SA-10
M-WI-10
G-WI-10
M-AT-10
G-AT-10
Clackamas River
M-SA-20
G-SA-20
5
5
Saum Creek
Athey Creek
M-UK3-10
G-UK3-10
M-T4-10
G-T4-10
M-TA-10
G-TA-10
M-FE-20
G-FE-20
Fields Creek
205
205
Willamette River
99E
Monitoring sites-
SWMACC
N
0
0.75
1.5
3
Miles 1:95,040
LEGEND
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PROJECT AREA

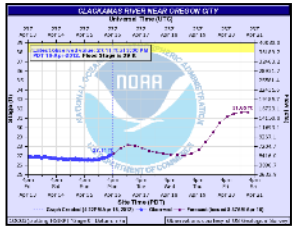
Hydromodification

Urbanization

- Impervious cover
- Infiltration rates
- Runoff

Hydromodification

- Lower base flows
- Higher peak flows



Channel Geomorphology

- Connectivity
- Scour/Incision
- Erosion
- Deposition

Instream Physical Habitat

- Habitat condition & complexity
- Substrate
- Embeddedness

Biological Communities

- Periphyton
- Macroinvertebrates
- Fish

Water Chemistry

Riparian Conditions

Why

- **MS4 requirement**
- **Evaluating hydromodification takes time**
- **Understanding impacts to ecology often best achieved by sampling macroinvertebrates.**

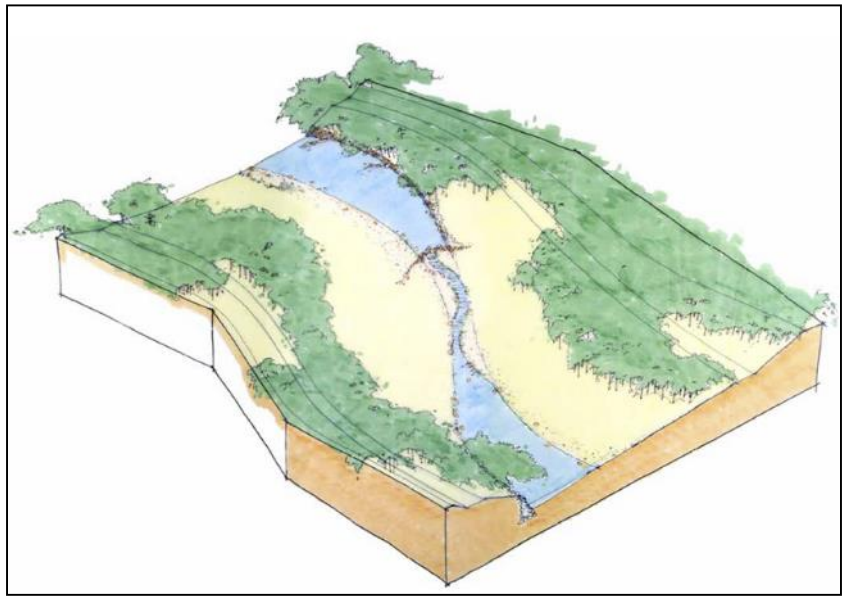
Geomorphology

Urbanization → Hydromodification → **Channel Geomorphology** → **Instream Physical Habitat** → Biological Communities

Measure changes in the shape of stream channels over time

Change can be a sign of degrading physical habitat conditions necessary to support healthy, diverse, native aquatic communities.

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



Benthic macroinvertebrates

Urbanization → Hydromodification → Channel Geomorphology → Instream Physical Habitat → **Macroinvertebrates**

- 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 well established and widely used

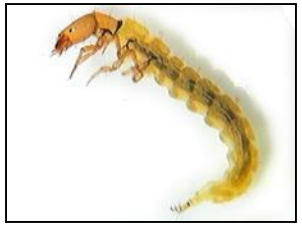
Macros as water quality indicators

Urbanization | Hydromodification | Channel Geomorphology | Instream Physical Habitat | **Macroinvertebrates**

Orders regarded as sensitive:

- Mayflies (Ephemeroptera), Stoneflies (Plecoptera), Caddisflies (Trichoptera)

- Sediment sensitive organisms


Tolerant organisms

- Sediment tolerant organisms




Methods Geomorphic monitoring

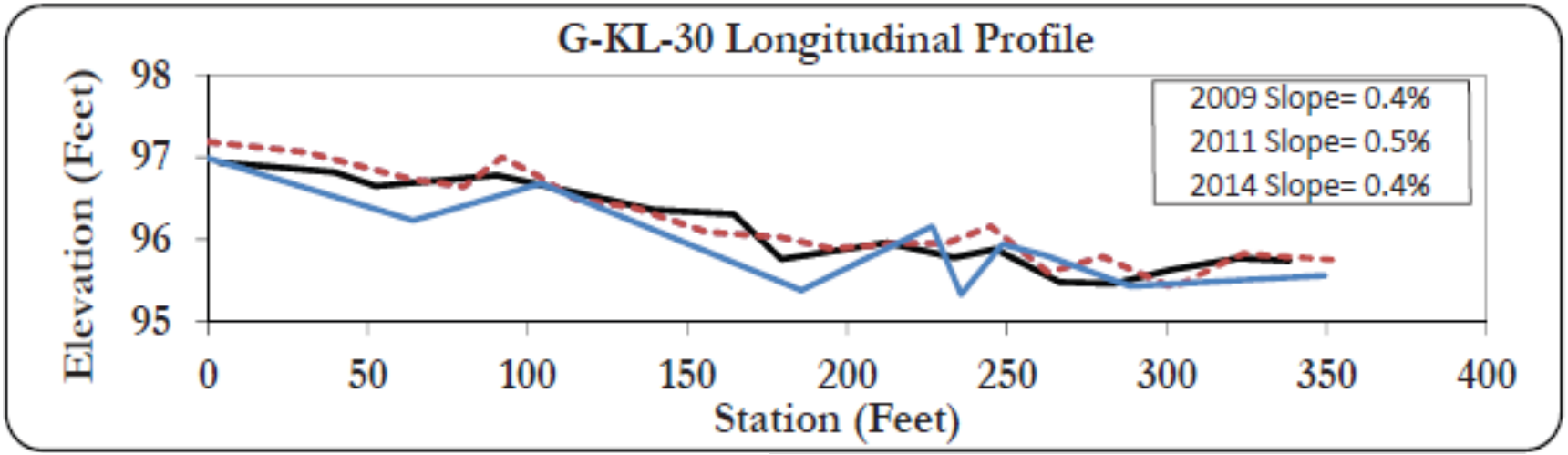
1. **Longitudinal profiles and cross sections**
2. **Surficial substrate (Wolman pebble count)**
3. **Bulk samples in stream bed**
4. **Pool characteristics**
5. **Bank conditions**

Methods Macroinvertebrate monitoring

1. **Instream physical habitat and riparian assessment**
   a. Habitat surveys/Rapid Stream Assessment Technique
   b. Cross section surveys
   c. Riparian surveys
2. **Water chemistry**
3. **Macroinvertebrate collection**
   a. Field sampling
   b. Sample sorting and i.d.
   c. Protocols for samples collected in riffles only

Assessment methods Geomorphic

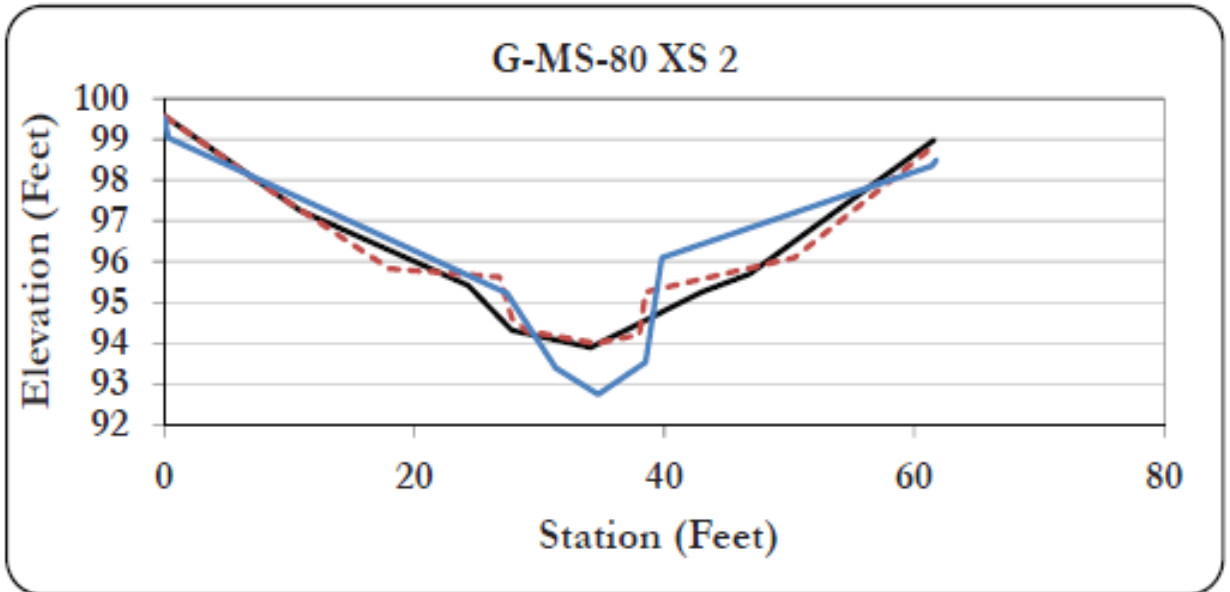
- **Field collected data compiled & compared to previous years**



2009

2011

2014



Assessment methods Geomorphic

- Bankfull width to depth ratio (W/D)
- Entrenchment ratio
- Bed elevation change
- GINI coefficient values
- Channel capacity
- Particle size distribution
- Bulk sediment sizes
- # pools, depth
- % bank erosion

Channel condition ratings & 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

Assessment techniques Macroinvertebrates

- **Lab i.d. using DEQ Level 3 Protocols**
- **Multimetric analysis**
- **Predictive model analysis**
- **Stressor i.d.**

PREDATOR MWCF O/E Scores:

Yr/Habitat	O/E Score	Classification
2002		
2007		
2009/R	0.242	MOST
2011/R	0.630	MOST
2014/R	0.436	MOST

DEQ Multimetric Scores

Yr/Habitat	MM Score	Classification
2002		
2007		
2009/R	16	SEVERE
2011/R	22	MOD
2014/R	22	MOD

Multimetric scoring criteria

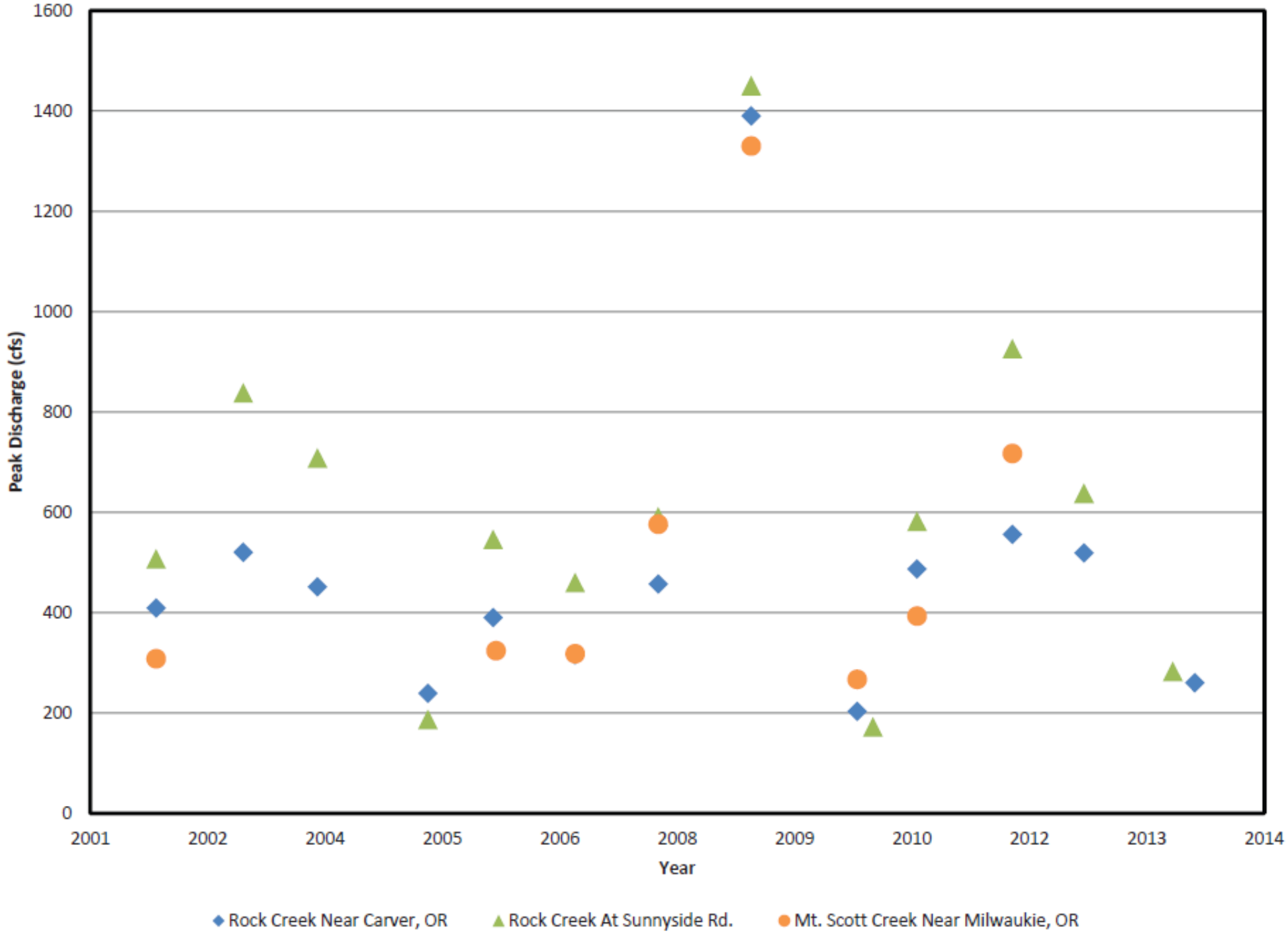
Metric	Scoring Criteria		
	5 (good)	3 (fair)	1 (poor)
POSITIVE METRICS			
Taxa richness	>35	19–35	<19
Mayfly richness	>8	4–8	<4
Stonefly richness	>5	3–5	<3
Caddisfly richness	>8	4–8	<4
Number sensitive taxa	>4	2–4	<2
Number sediment sensitive taxa	≥2	1	0
NEGATIVE METRICS			
Modified HBI[1]	<4.0	4.0–5.0	>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)

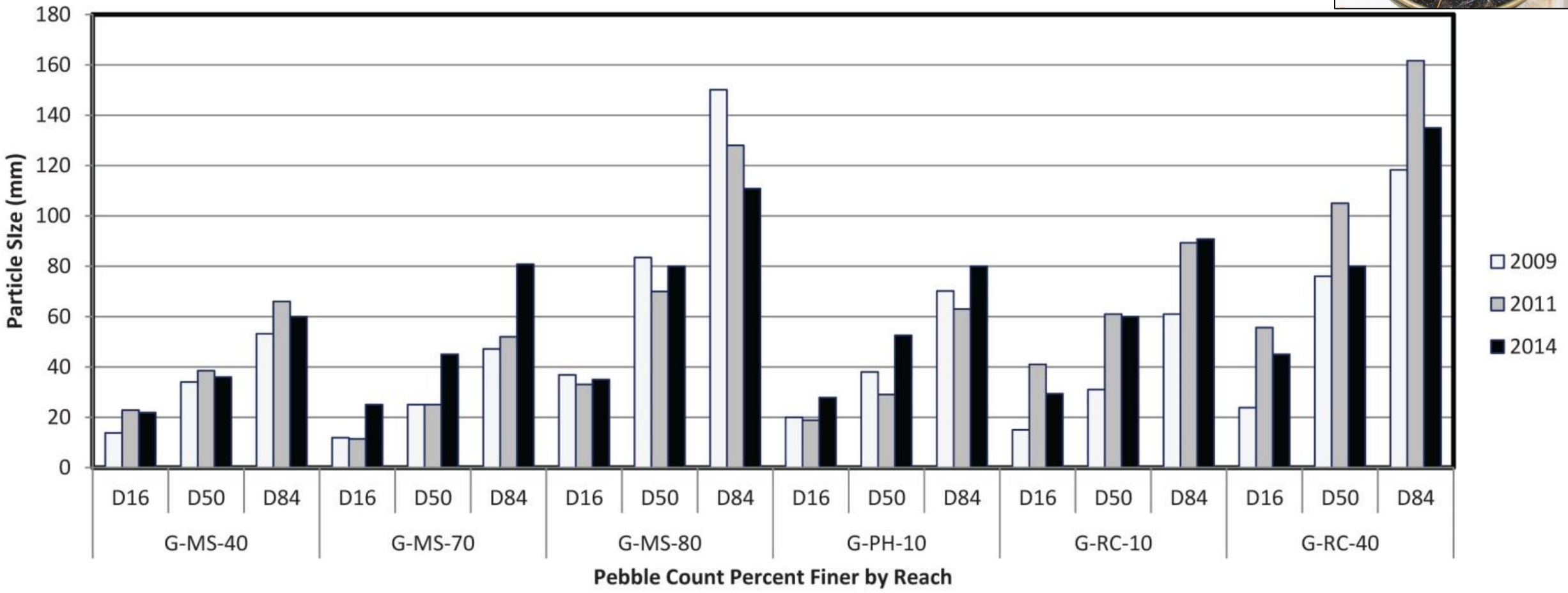
Biological Condition Class	Reference percentile	MWCF	
		O/E	% Common Taxa Loss/Gain
Most disturbed	≤ 10th	≤ 0.85	≤ 15%
Moderately disturbed	> 10th to 25th	0.86 - 0.91	9 – 14%
Least disturbed	> 25th to 95th	0.92 - 1.24	0 - 8% loss 0 - 24% gain
Enriched	> 95th	> 1.24	> 24 % gain

Hydrology context

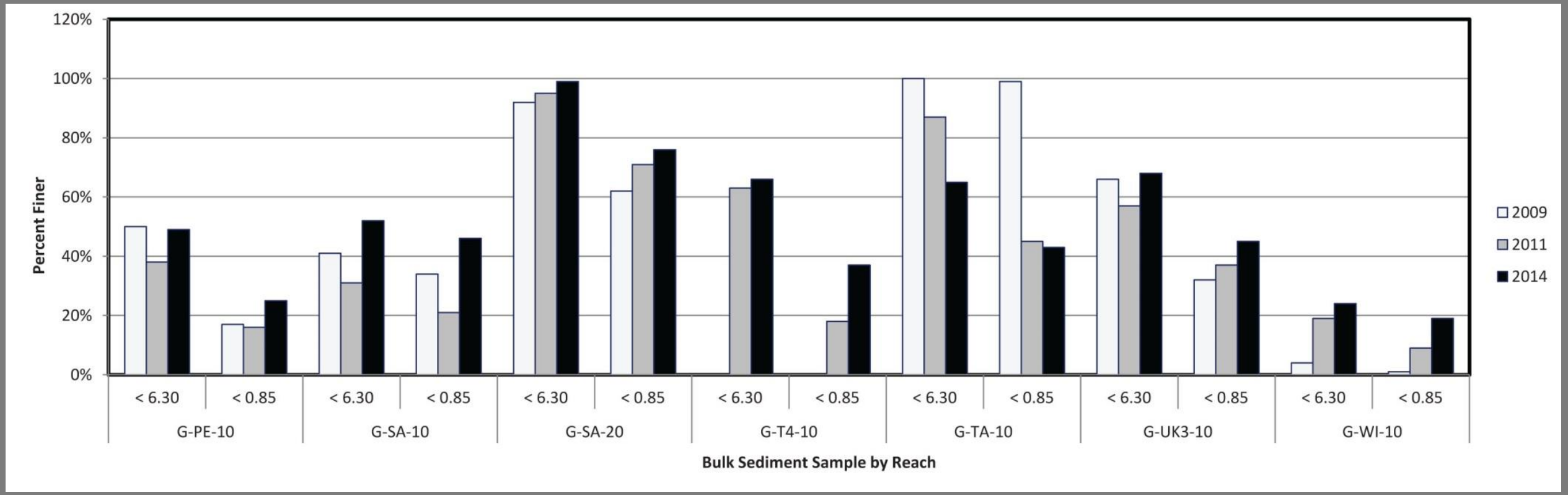
Annual peak flow data from USGS gauges



Results Geomorphic monitoring-CCSD1



Results Geomorphic monitoring-SWMACC



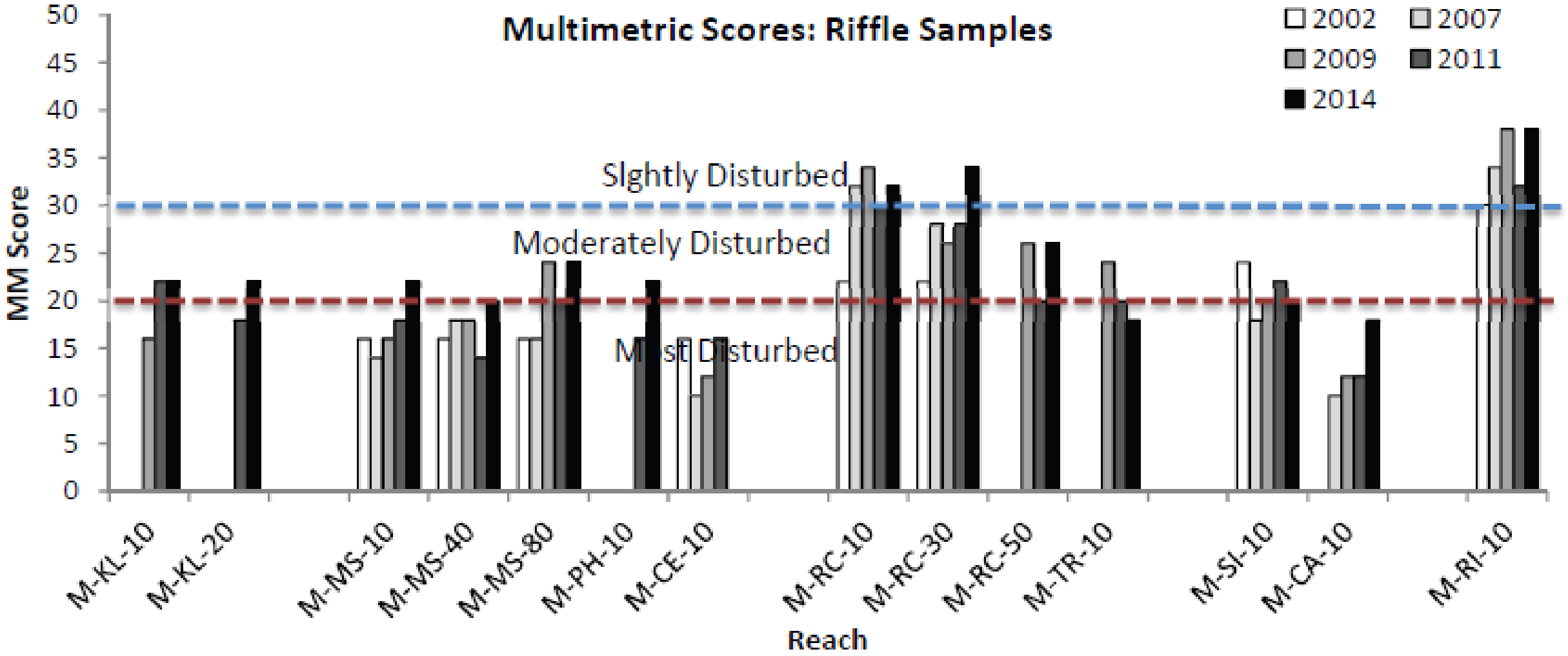
Results Geomorphic monitoring-CCSD1

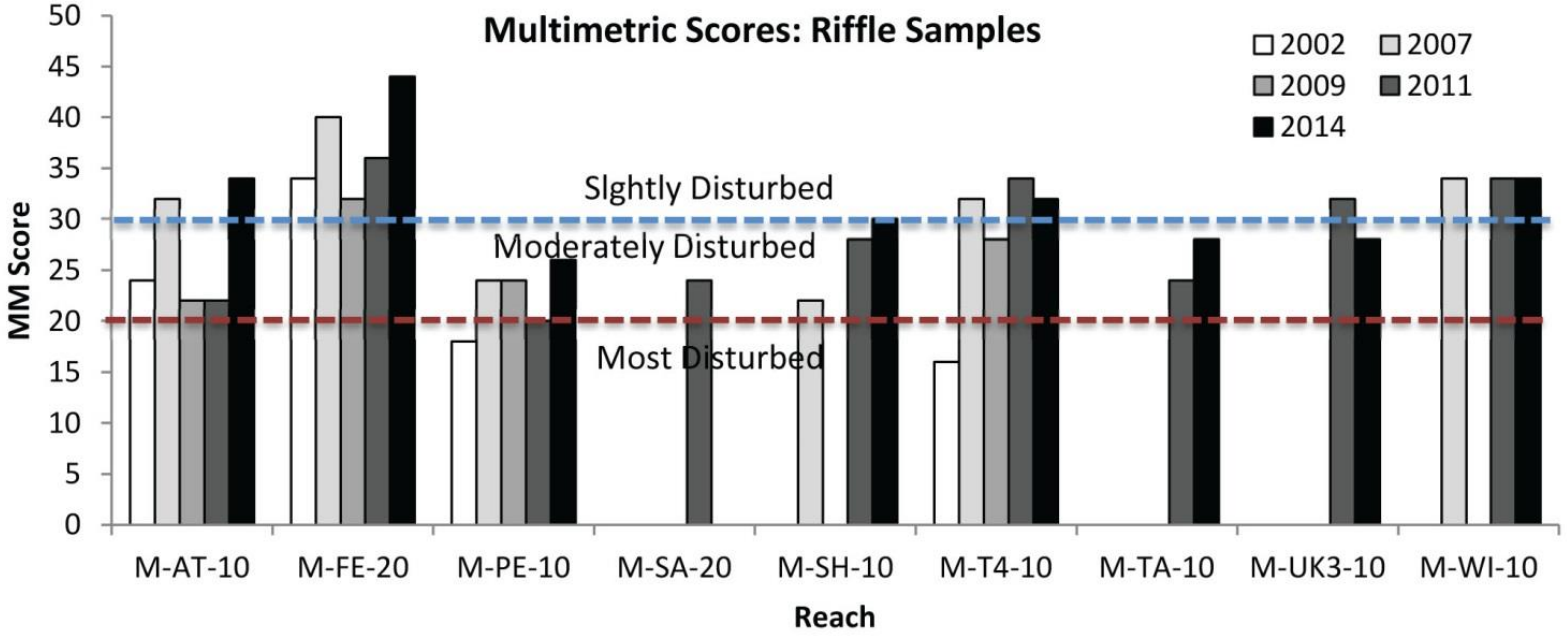
Site ID	Floodplain Connectivity	Bed Morphology	Stream Bank Conditions	Degree of Fine Sediment Intrusion (6.3mm: 0.85mm)	Overall Channel Condition
Kellogg Creek Subbasin					
G-KL-10	Moderate	Pool-Riffle	At Risk	High	Stable – At Risk
G-KL-30	Moderate	Plane Bed	Stable	NA	Stable – At Risk
Mt. Scott Creek 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**

Results Geomorphic monitoring-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

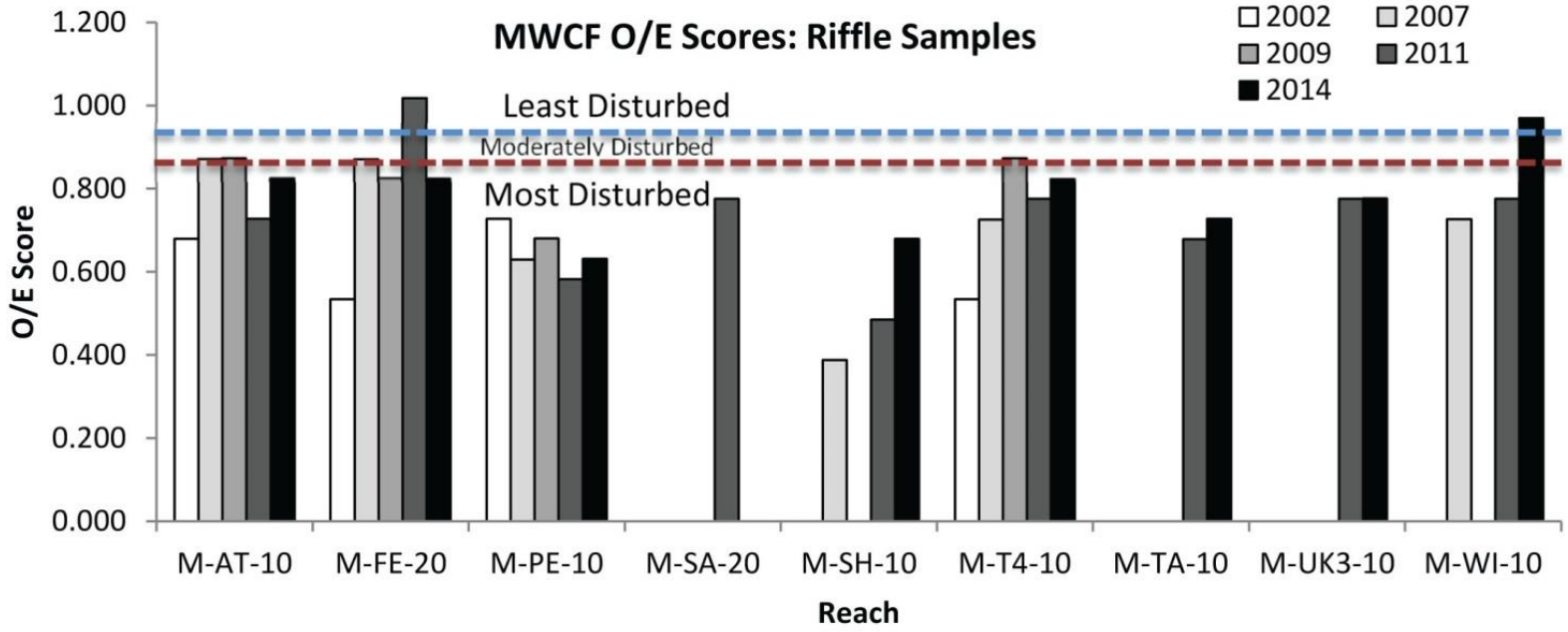
Results Macroinvertebrate monitoring-CCSD1





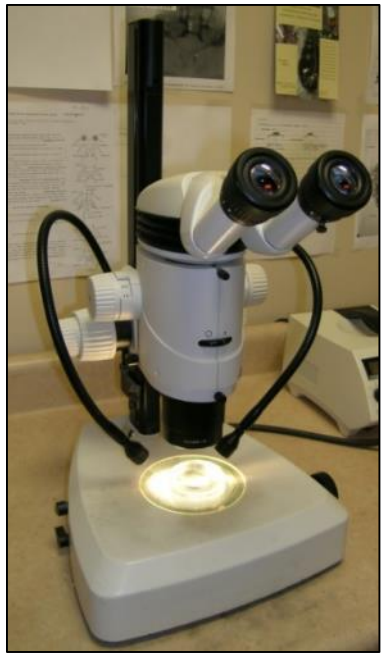
Results

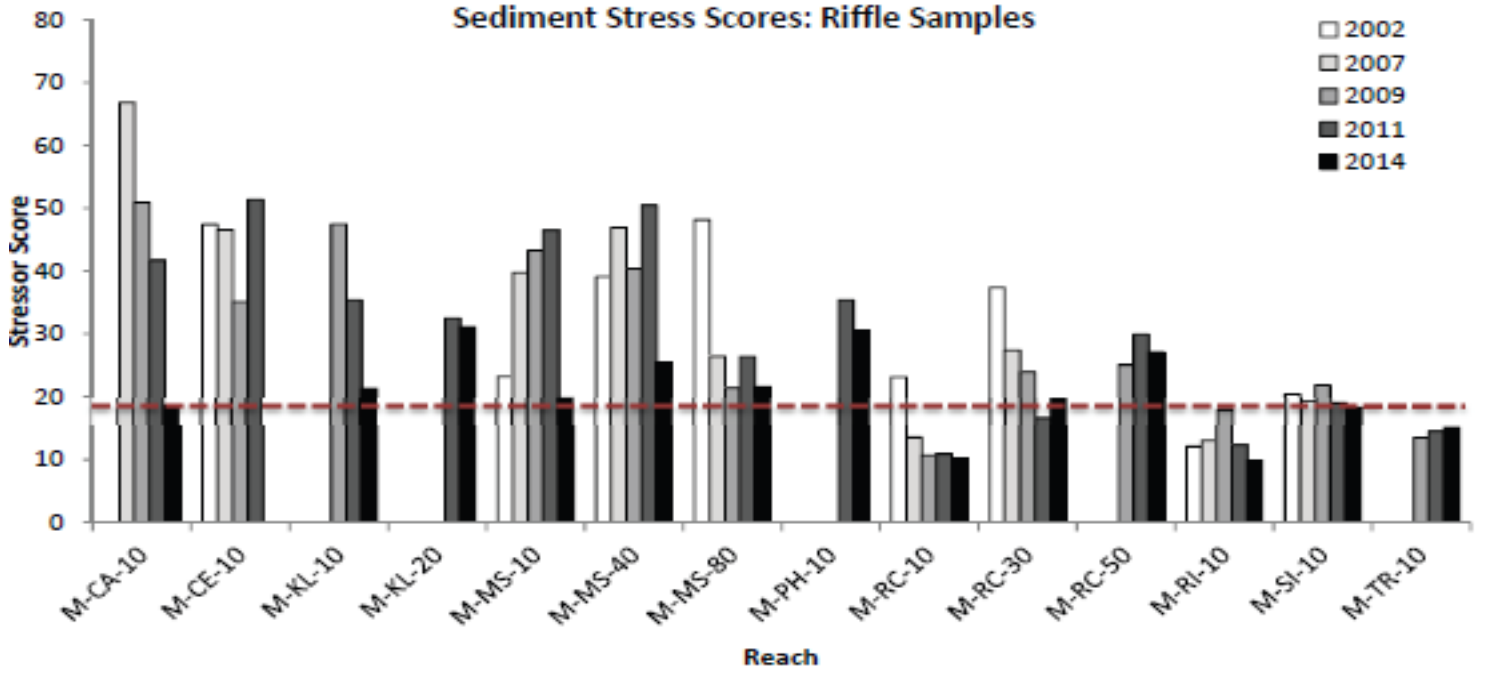
Macroinvertebrate monitoring- SWMACC

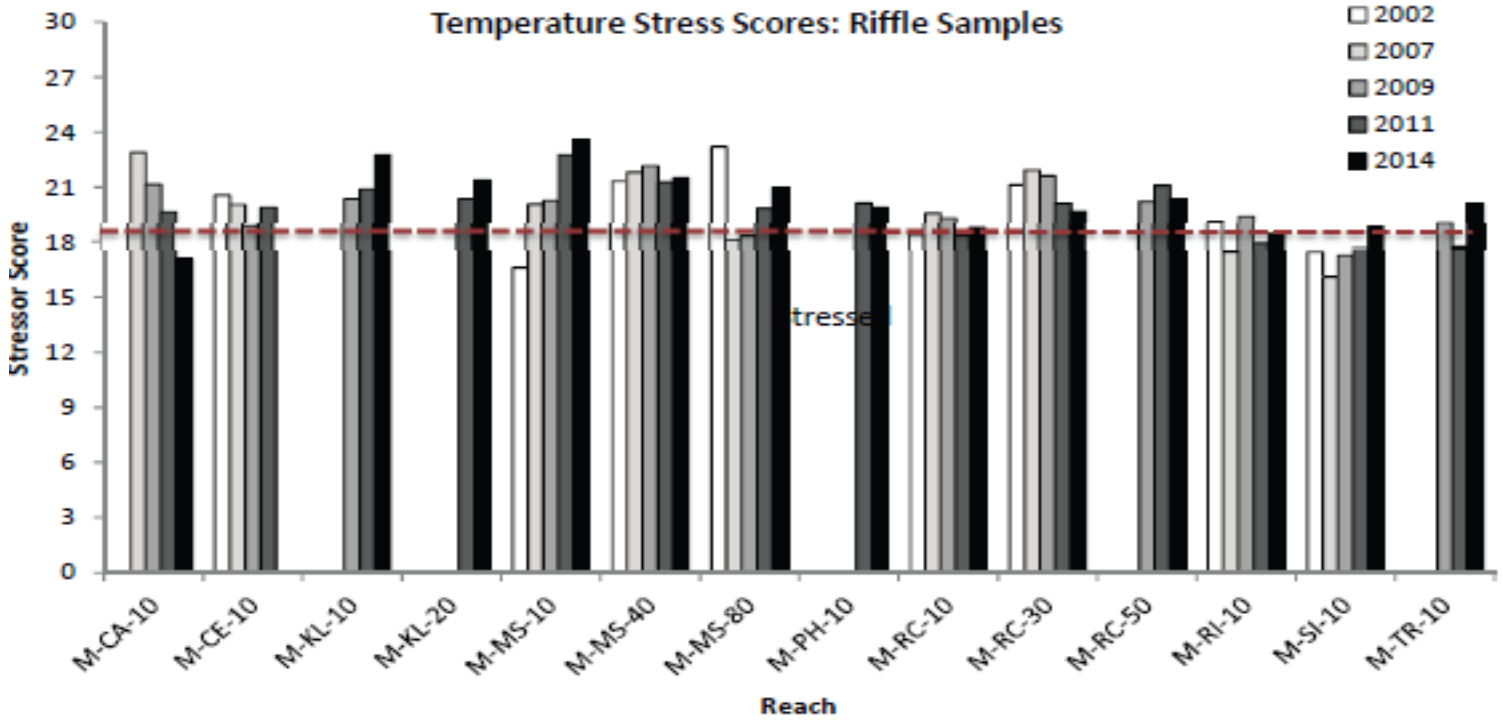


Results

Macroinvertebrate monitoring-CCSD1

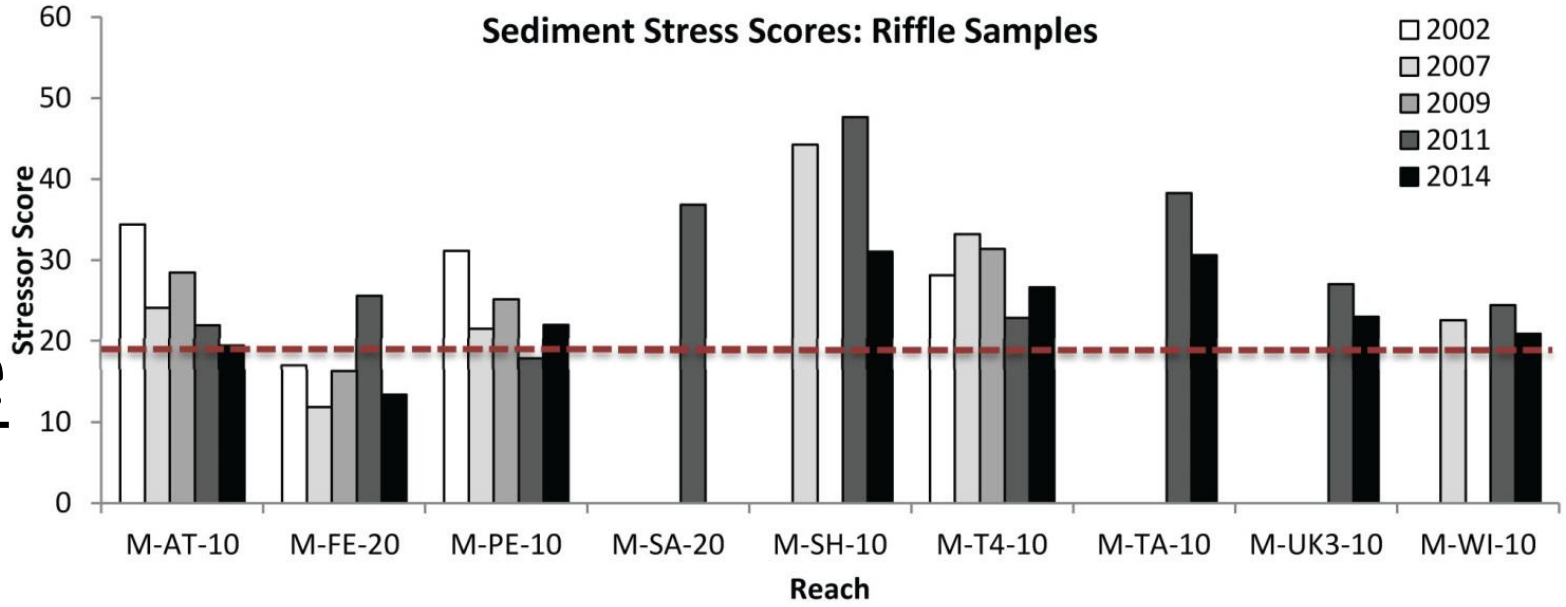


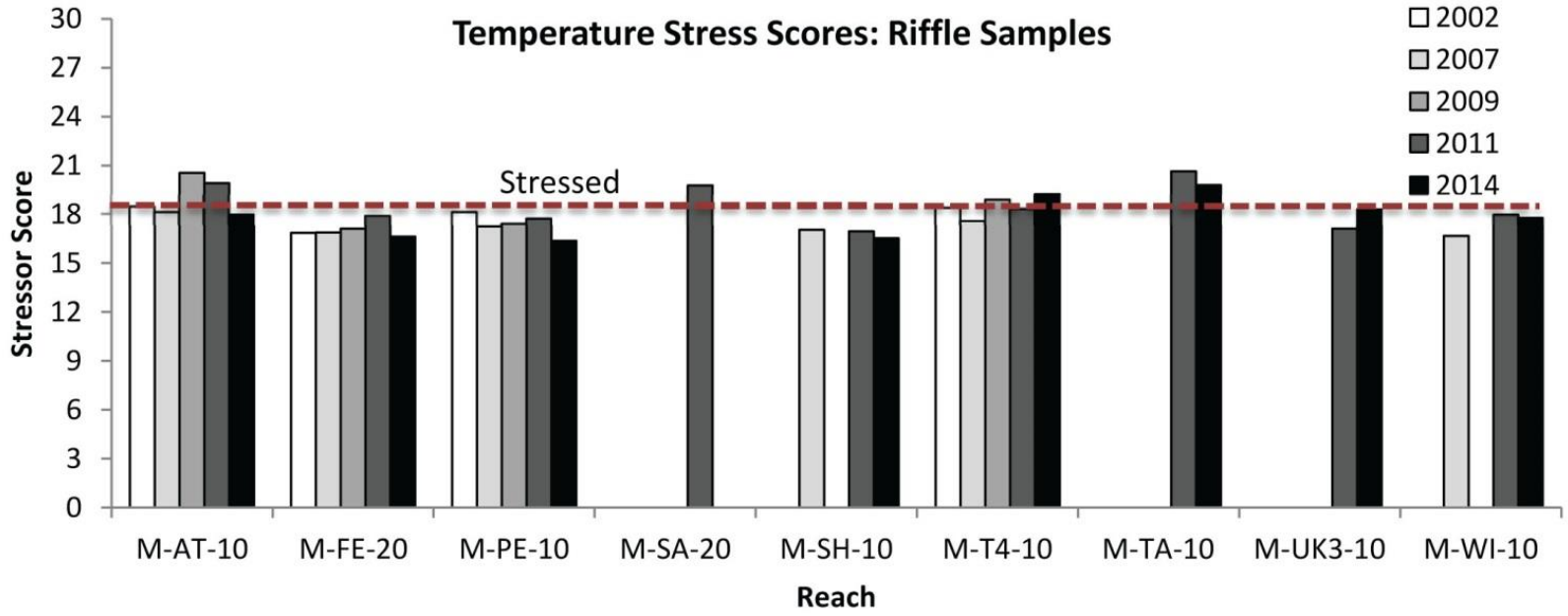




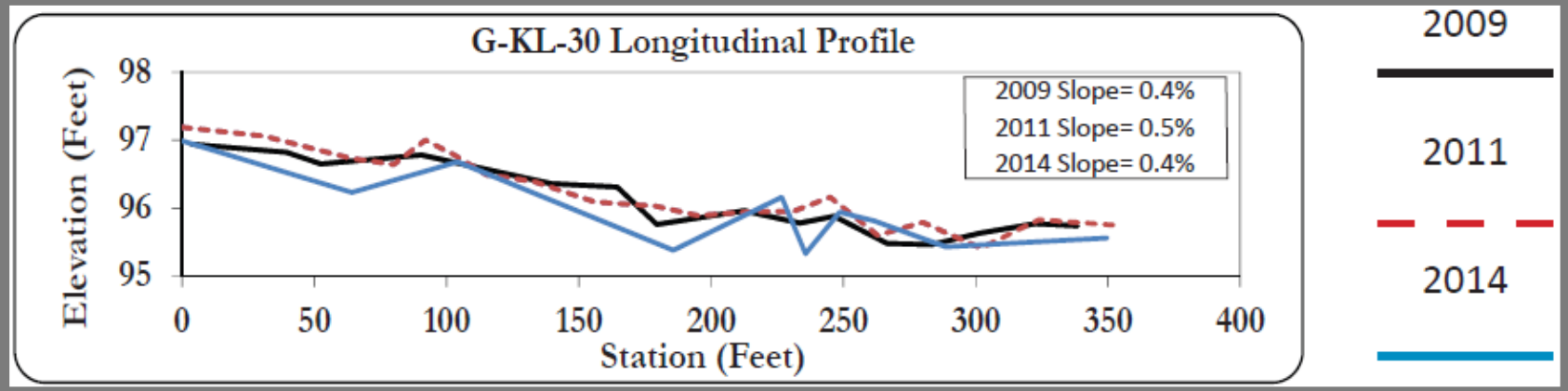
Results

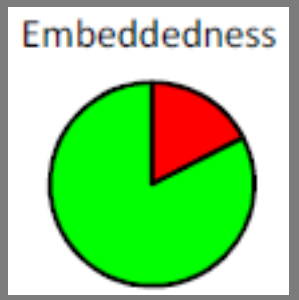
Macroinvertebrate monitoring- SWMACC

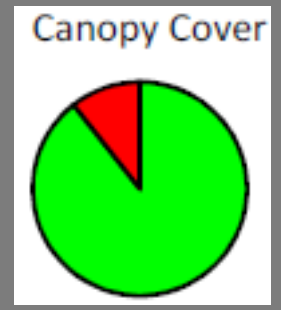


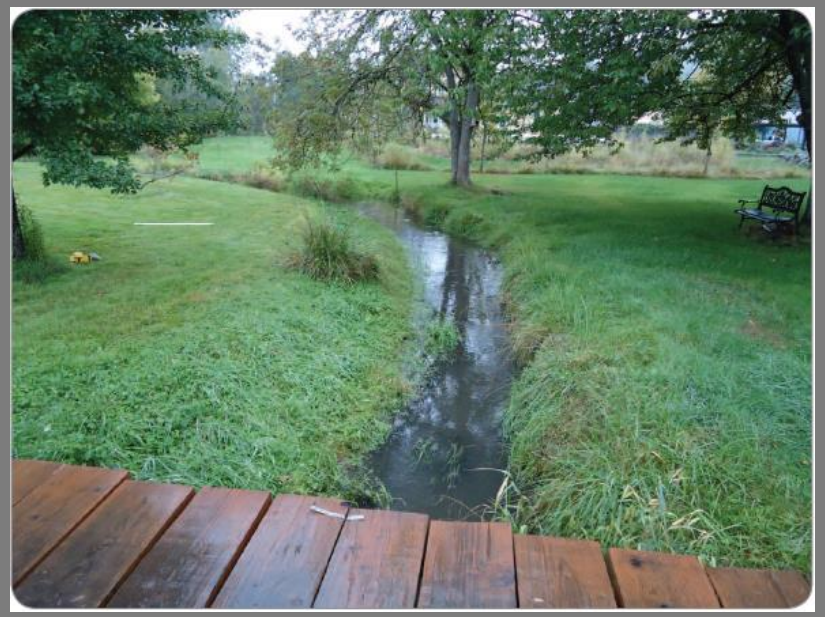


Analysis Upper/Middle Kellogg Creek



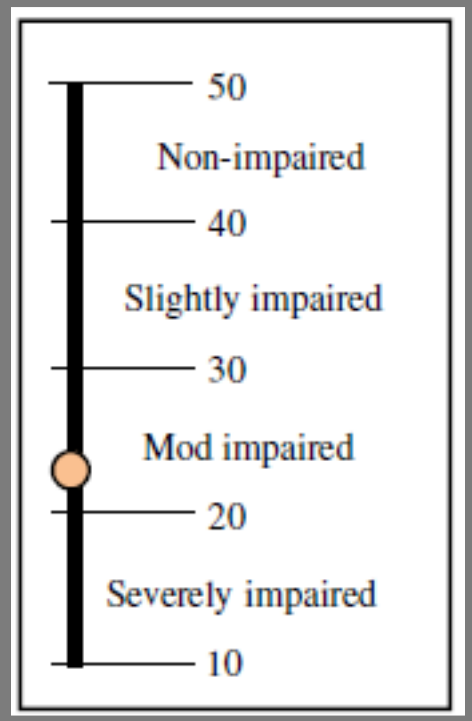




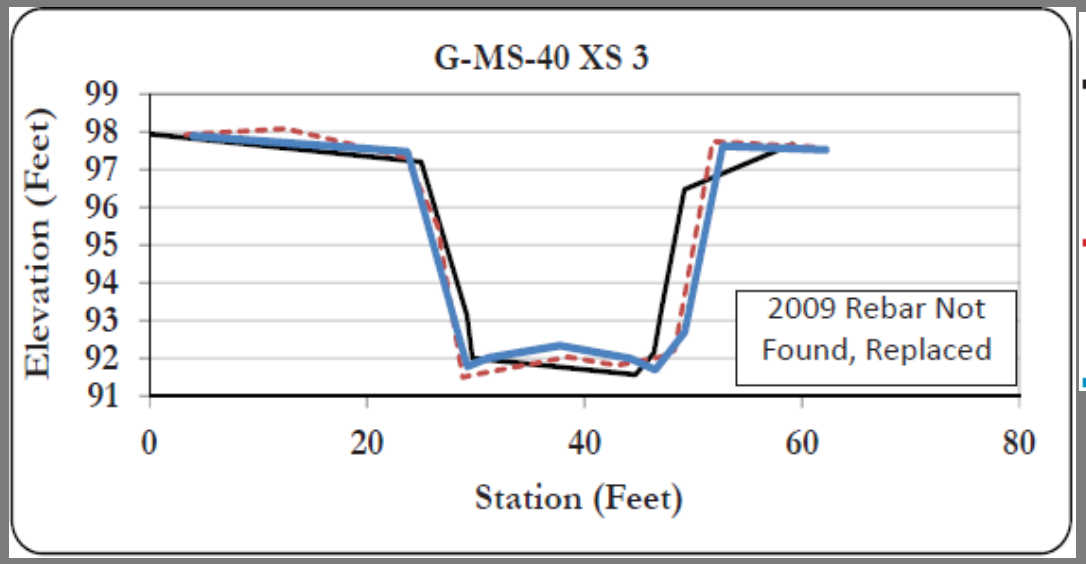


G-KL-30

M-KL-20



Analysis Mt. Scott Creek at 3-Creeks



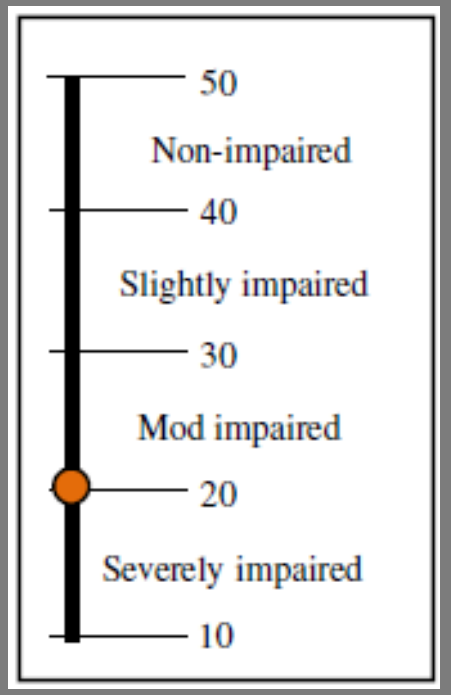
2009

2011

2014

Embeddedness

Canopy Cover



PREDATOR MWCF O/E Scores:

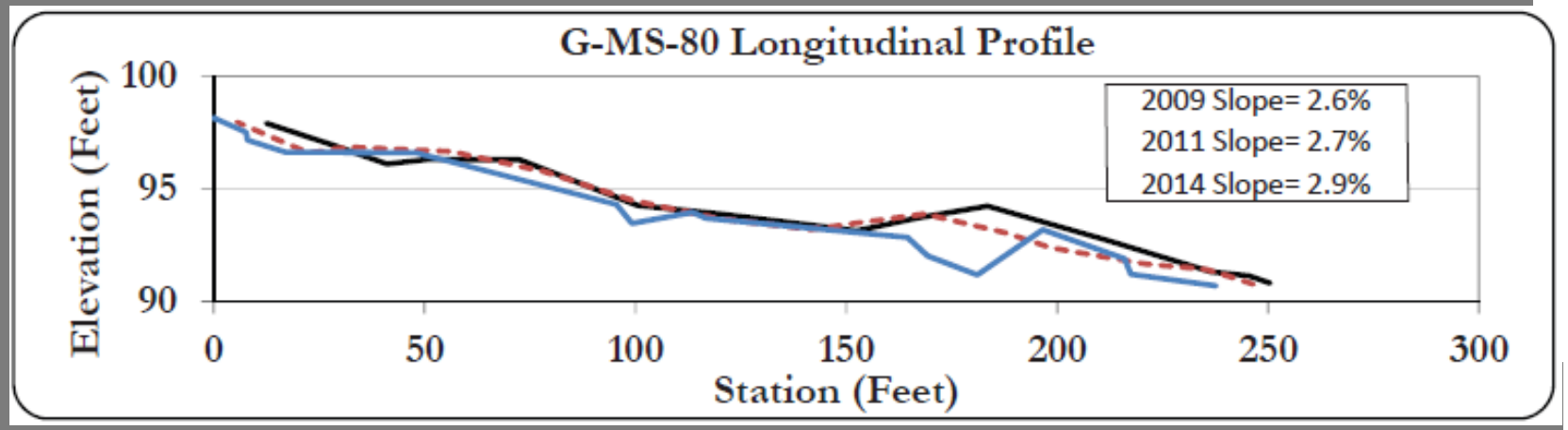
Yr/Habitat	O/E Score	Classification
2002/R	0.291	MOST
2007/R	0.483	MOST
2009/R	0.533	MOST
2011/R	0.484	MOST
2014/R	0.581	MOST

DEQ Multimetric Scores

Yr/Habitat	MM Score	Classification
2002/R	16	SEVERE
2007/R	18	SEVERE
2009/R	18	SEVERE
2011/R	14	SEVERE
2014/R	20	MOD

Analysis Mt Scott Creek near 122nd

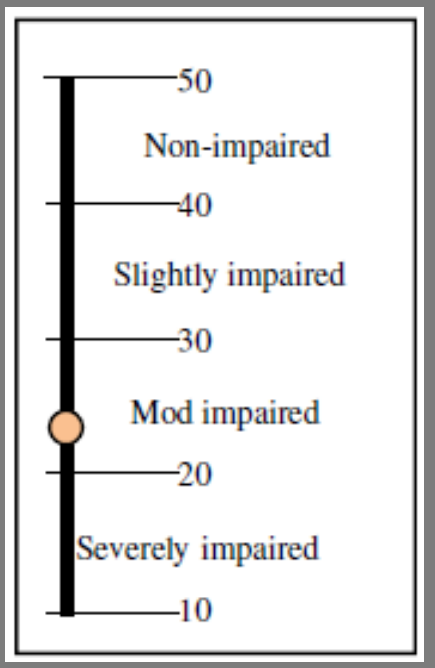
Channel Capacity Flow: Between the **2-year and 5-year** Event



2009

2011

2014



Embeddedness

Canopy Cover

PREDATOR MWCF O/E Scores:

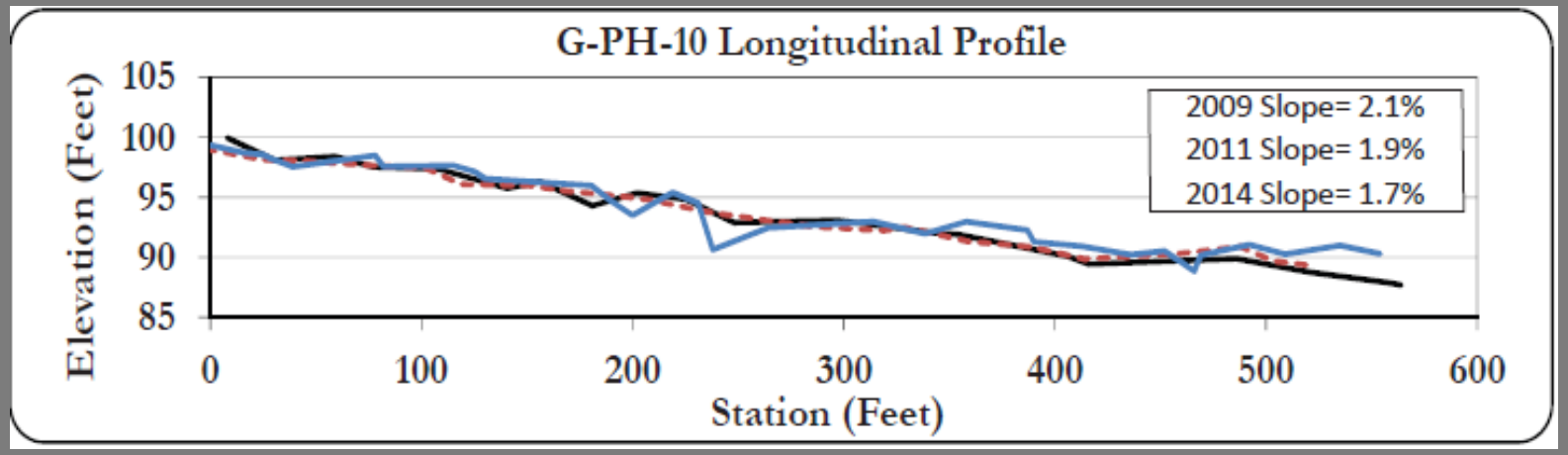
Yr/Habitat	O/E Score	Classification
2002/R	0.387	MOST
2007/R	0.532	MOST
2009/R	0.533	MOST
2011/R	0.580	MOST
2014/R	0.484	MOST

DEQ Multimetric Scores

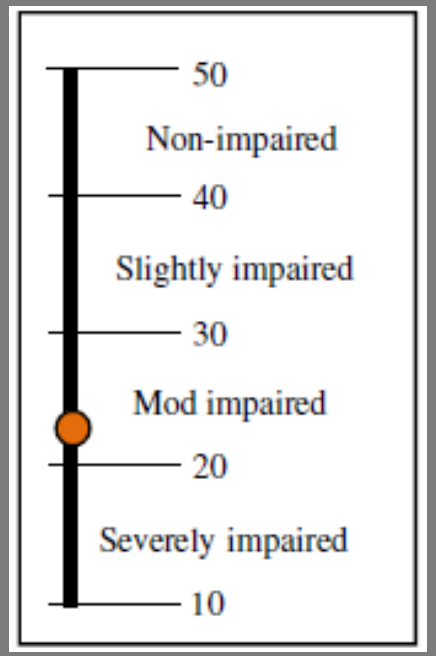
Yr/Habitat	MM Score	Classification
2002/R	16	SEVERE
2007/R	16	SEVERE
2009/R	24	MOD
2011/R	20	MOD
2014/R	24	MOD

Analysis Phillips Creek upstream of 84th

Channel Capacity Flow: (For the Inset Channel): Less than the **2-year** Event



Variable	Bed Elev. Change (ft)	GINI Coeff*
2009-2011	+1.2	0.017
		0.019
2011-2014	+0.3	0.019
		0.017
2009-2014	+1.5	0.017
		0.017



Average Bankfull Width, Depth and Width/Depth Ratio:

Year	Average W_{BF}	Average D_{BF}	Average W/D
2009	23.1	1.7	14.5
2011	24.4	1.7	16.4
2014	21.6	1.6	20.1

Analysis Lower Rock Creek G-RC-10, M-RC-10

Channel Capacity Flow: Greater than the **100-year** Event (Calculated at XS 2)

Pebble Counts and Bulk Sediment:

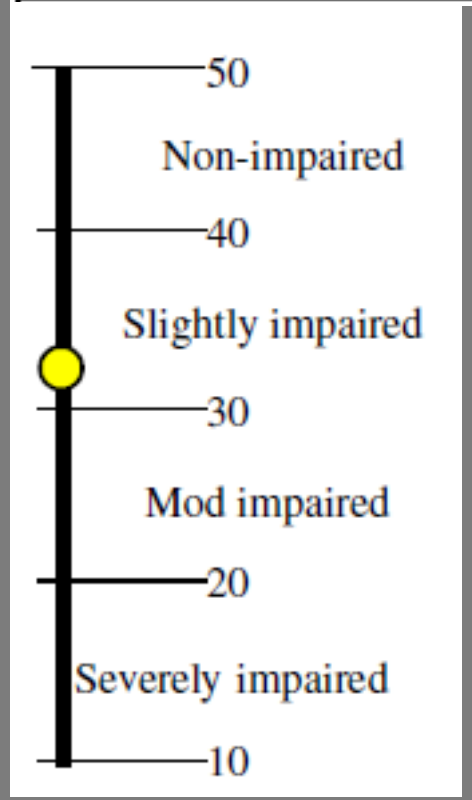
Year	Pebble Count			Bulk Sediment	
	D_{16}	D_{50}	D_{84}	< 6.30 mm	<0.85 mm
2009	15 mm	31 mm	61 mm	18%	3%
2011	41 mm	61 mm	89 mm	30%	7%
2014	29 mm	60 mm	91 mm	19%	14%

Pebble Count: Significant Difference in Mean (from t-test, p=0.05)

YES: between 2009 and 2014, 2009 and 2011 ***NO***: between 2011 and 2014

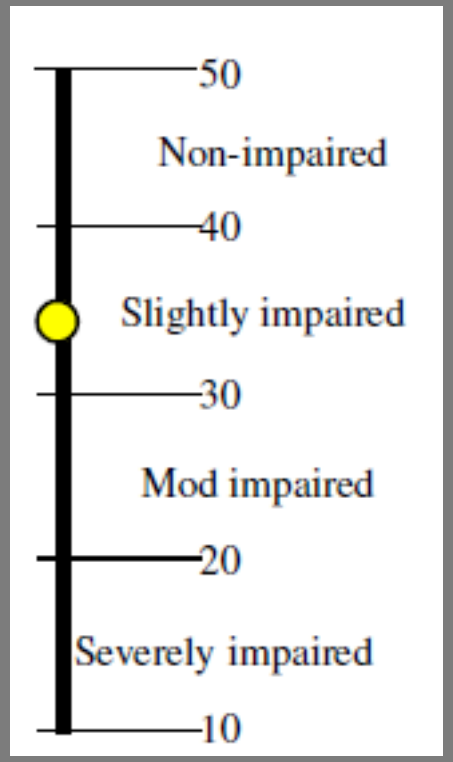
DEQ Multimetric Scores

Yr/Habitat	MM Score	Classification
2002/R	22	MOD
2007/R	32	SLIGHT
2009/R	34	SLIGHT
2011/R*	30	SLIGHT
2014/R*	32	SLIGHT



Analysis Rock Creek DS of Sunnyside *General trend of improvement

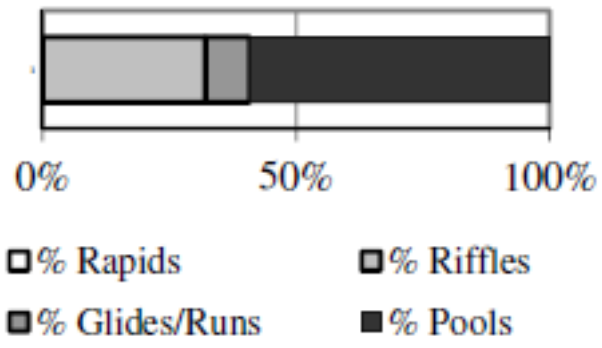
DEQ Metric Scores	Raw	Stand.
Richness	42	5
Mayfly Richness	9	5
Stonefly Richness	5	3
Caddisfly Richness	4	3
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	4.2	3
% Tolerant Taxa	21.8	3
% Sed Tol Taxa	4.8	5
% Dominant (1)	17.8	5
TOTAL		**34**



Survey start, facing upstream

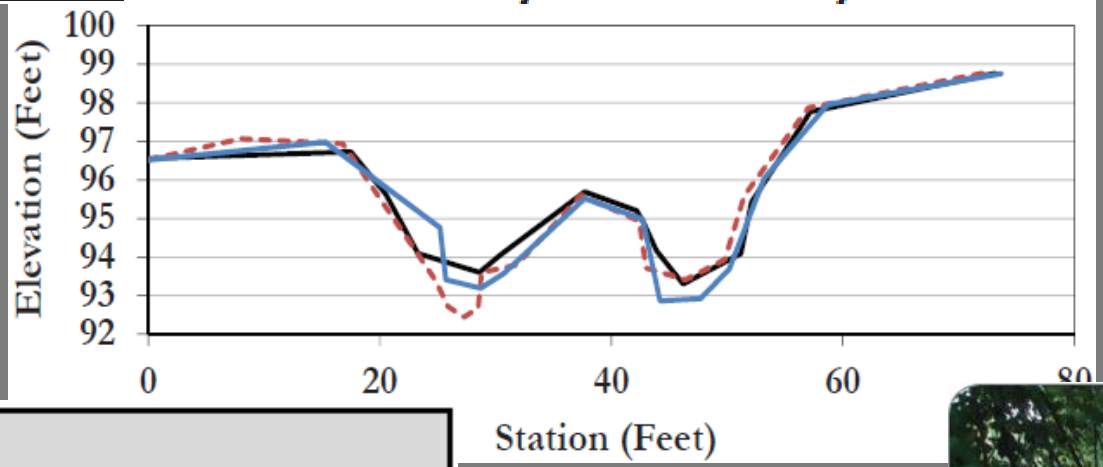
Survey end, facing downstream

DEQ Multimetric Scores		
Yr/Habitat	MM Score	Classification
2002/R	22	MOD
2007/R	28	MOD
2009/R	26	MOD
2011/R	28	MOD
2014/R	34	SLIGHT

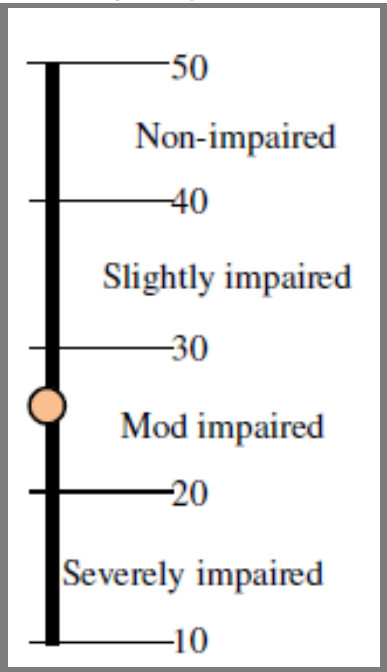


Analysis Rock Creek at Troge Rd.

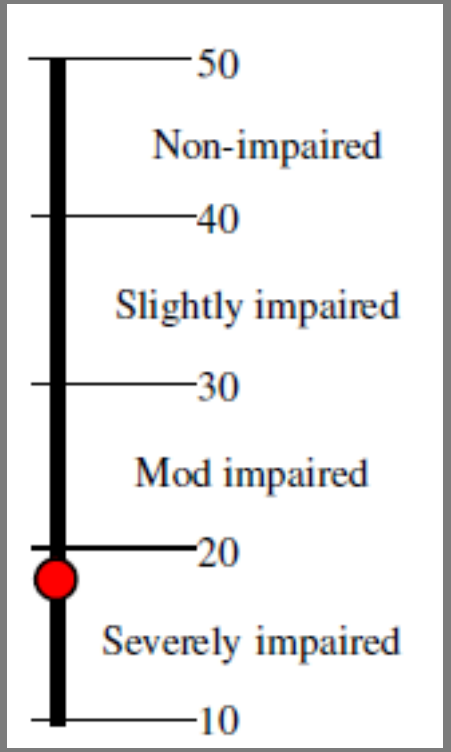
Channel Capacity Flow: Between the **10-year and 100-year** Events



DEQ Metric Scores	Raw	Stand.
Richness	33	3
Mayfly Richness	7	3
Stonefly Richness	3	3
Caddisfly Richness	4	3
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	4.4	3
% Tolerant Taxa	29.6	3
% Sed Tol Taxa	13.0	3
% Dominant (1)	25.5	3
TOTAL		**26**



Analysis Carli Creek



PREDATOR MWCF O/E Scores:

Yr/Habitat	O/E Score	Classification
2002/R		
2007/R	0.097	MOST
2009/R	0.242	MOST
2011/R	0.290	MOST
2014/R	0.387	MOST

DEQ Multimetric Scores

Yr/Habitat	MM Score	Classification
2002/R		
2007/R	10	SEVERE
2009/R	12	SEVERE
2011/R	12	SEVERE
2014/R	18	SEVERE

Instream Physical Characteristics

Reach Gradient (%)	2.7
Wetted Width (m)	1.9
Bankfull Width (m)	8.8
% Rapids	0.0
% Riffles	37.3
% Glides/Runs	16.0
% Pools	46.7
Substrate	
% Fines (FN)	0.0
% Sand (SA)	0.0
% Gravel, Fine (GF)	4.8
% Gravel, Coarse (GC)	53.8
% Cobble (CB)	41.3
% Boulder (BL)	0.0
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Other (OT)	0.0
% Embeddedness	1.2
Large Wood Tally (pieces/m)	0.01
Eroding Banks (%)	3
Undercut Banks (%)	8

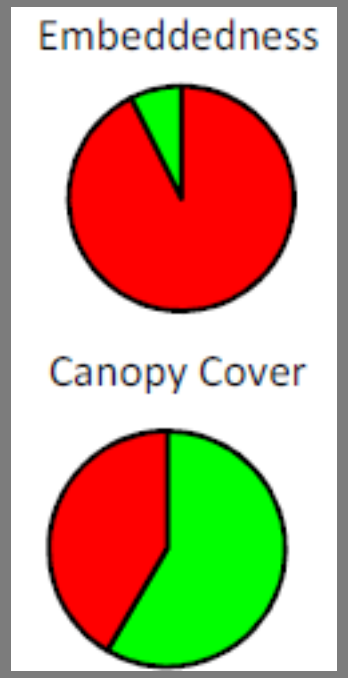
Riparian Zone Characteristics

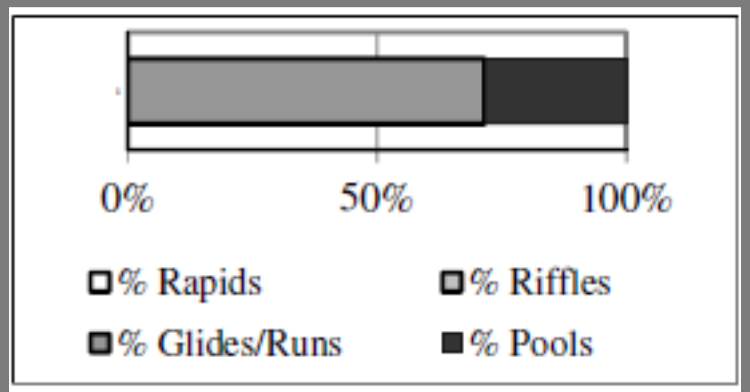
Canopy Cover (%)	94.85
Riparian Buffer Width (m)	11
Riparian Zone Tree Cover (%)	80
Riparian Zone Non-Native Cover (%)	30
Dom Adjacent Land Use	IND

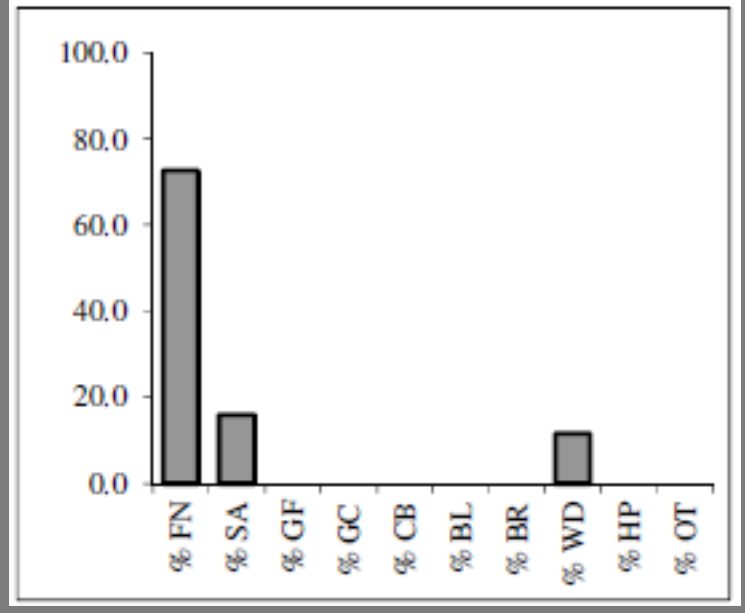
Chemical Characteristics

Time of measurement	9:30
Water Temperature (°C)	16.74
Dissolved Oxygen (%)	84.8
Dissolved Oxygen (mg/L)	8.23
Specific Cond. (µS/cm)	253

Analysis Cow Creek



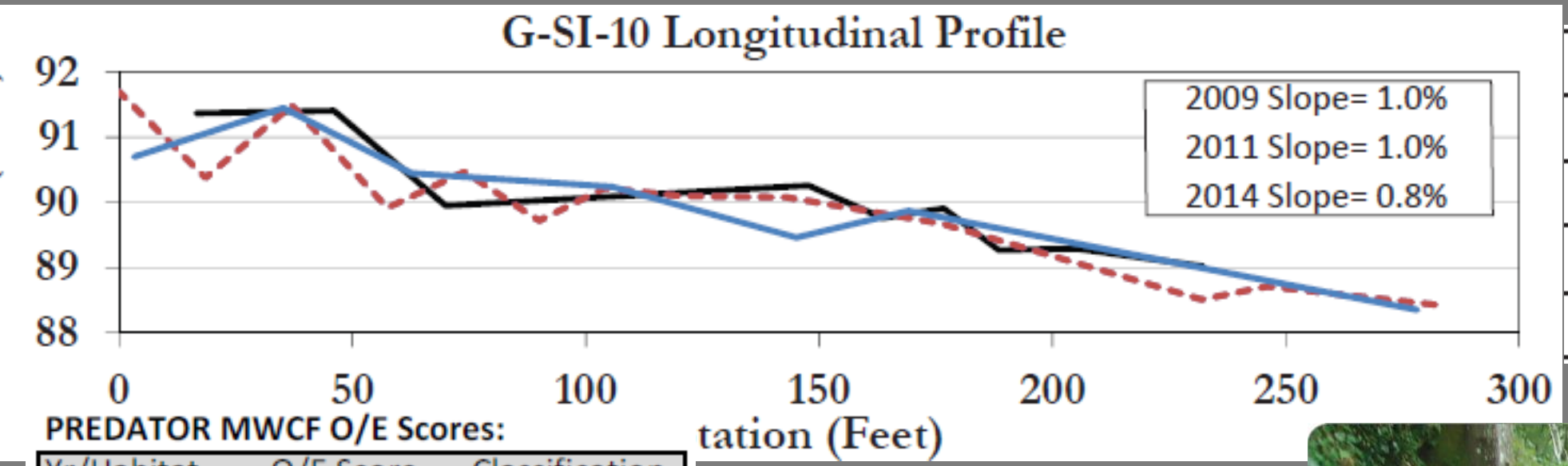




PREDATOR O/E Score:

Sample	O/E Score
2007/G*	0.19
2009/G*	0.29
2011/G	0.29
2014/G	0.44

Analysis Sieben Creek



Erosion	
Left Bank	Right Bank
0%	53.3%
17.7%	31.9%
0%	49.1%

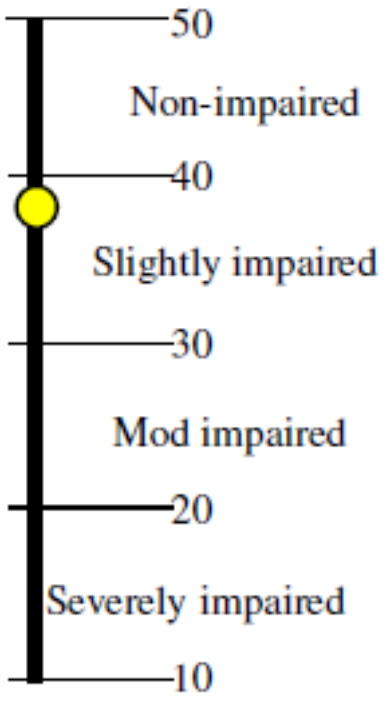
PREDATOR MWCF O/E Scores:

Yr/Habitat	O/E Score	Classification
2002/R	0.194	MOST
2007/R	0.338	MOST
2009/R	0.387	MOST
2011/R	0.436	MOST
2014/R	0.484	MOST

DEQ Multimetric Scores

Yr/Habitat	MM Score	Classification
2002/R	24	MOD
2007/R	18	MOST
2009/R	20	MOD
2011/R	22	MOD
2014/R	20	MOD

Analysis Richardson Creek



PREDATOR MWCF O/E Scores:

Yr/Habitat	O/E Score	Classification
2002/R	0.774	MOST
2007/R	0.773	MOST
2009/R	0.823	MOD
2011/R	0.919	LEAST
2014/R	0.871	MOD

DEQ Multimetric Scores

Yr/Habitat	MM Score	Classification
2002/R	30	SLIGHT
2007/R	34	SLIGHT
2009/R	38	SLIGHT
2011/R	32	SLIGHT
2014/R	38	SLIGHT

DEQ Metric Scores	Raw	Stand.
Richness	34	3
Mayfly Richness	5	3
Stonefly Richness	9	5
Caddisfly Richness	6	3
# Sensitive Taxa	3	3
# Sed Sens Taxa	2	5
Modified HBI	3.9	5
% Tolerant Taxa	43.4	3
% Sed Tol Taxa	3.5	5
% Dominant (1)	35.4	3
TOTAL		**38**

Questions/comments?

WATER ENVIRONMENT SERVICES

Gail Shaloum gshaloum@clackamas.us (503) 742-4597

Definitions

Entrenchment Ratio

A decrease in entrenchment ratio is indicative of a loss of floodplain connection.

An increase in entrenchment ratio indicates an increase in floodplain connection.

GINI Coefficient

A decrease in the GINI coefficient suggests a flattening and widening of the channel.

An increase in the GINI coefficient means the channel is becoming deeper and narrower.