Manzanita Creek: Insights from the B-IBI Restore and Protect Project

Kate Macneale, Environmental Scientist

King County Water & Land Resources Division

Kate.Macneale@kingcounty.gov

Stream Macroinvertebrates: Indicators of Habitat and Water Quality

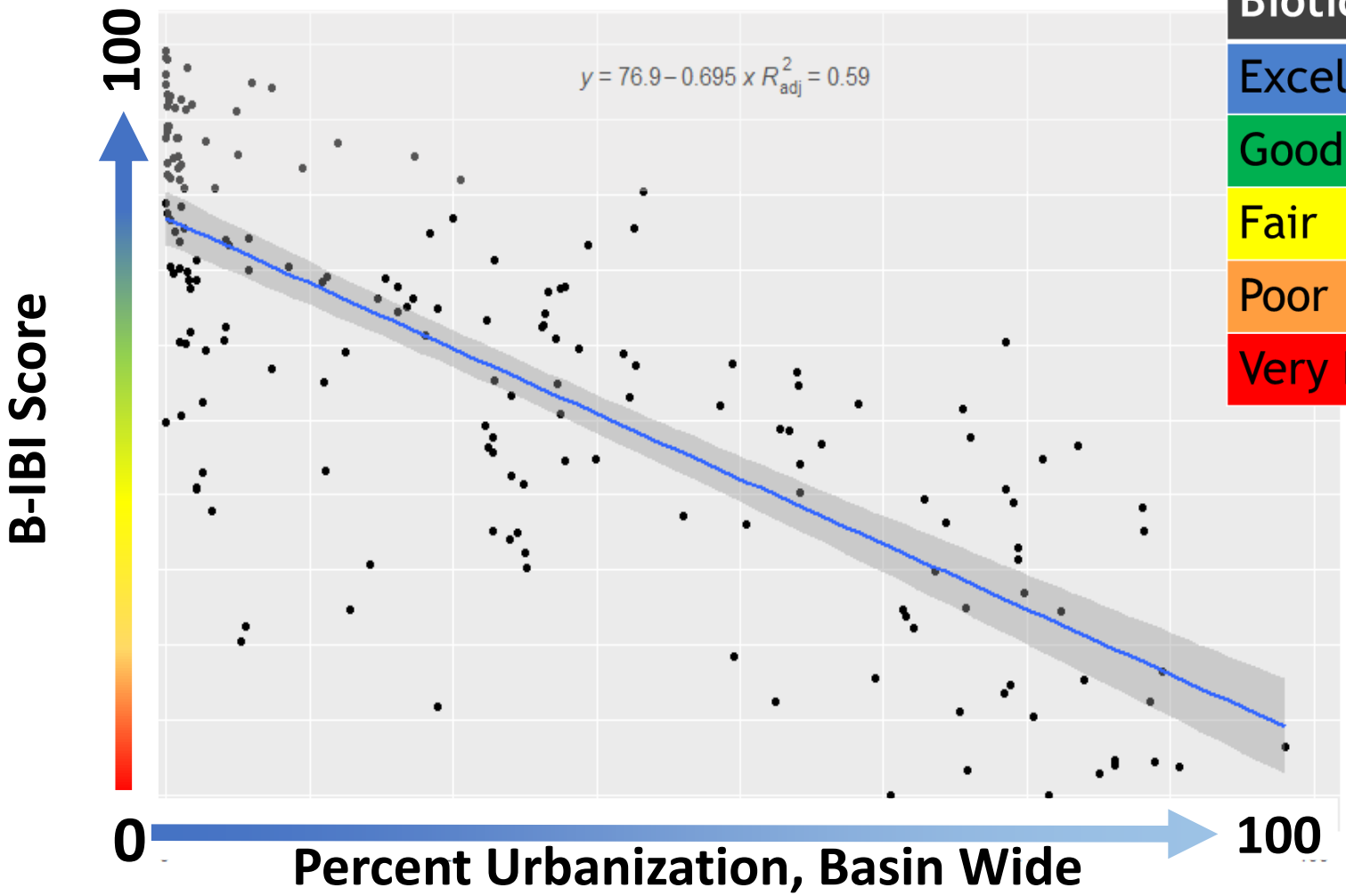
Stream Macroinvertebrate Communities:

- Diverse and complex
- Taxa vary in sensitivity
- Relatively “faithful” to their location
- Relatively long-lived

➢ Stressors reduce habitat and water quality

➢ Macroinvertebrates respond

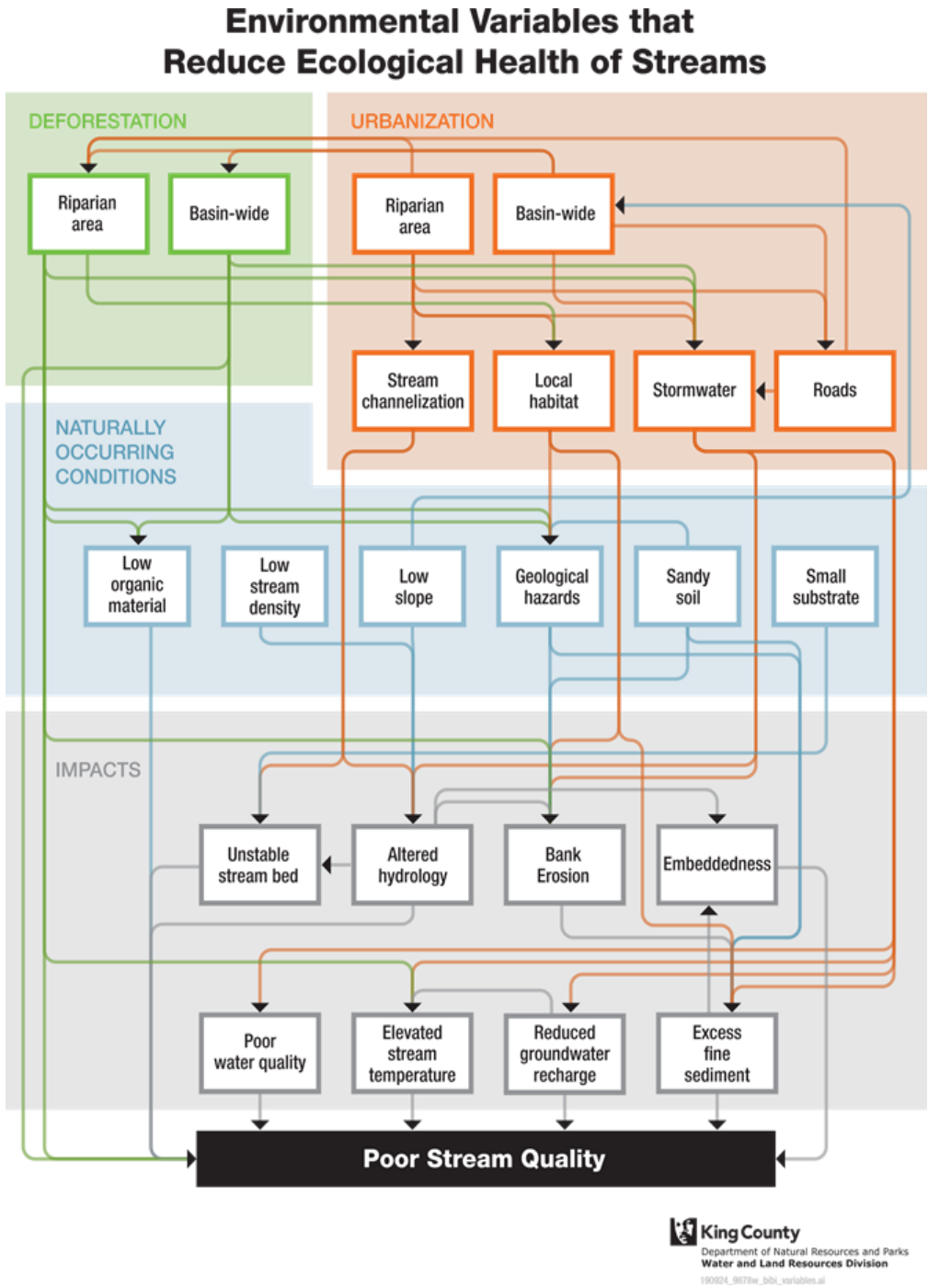
The relationship: Urbanization vs B-IBI scores



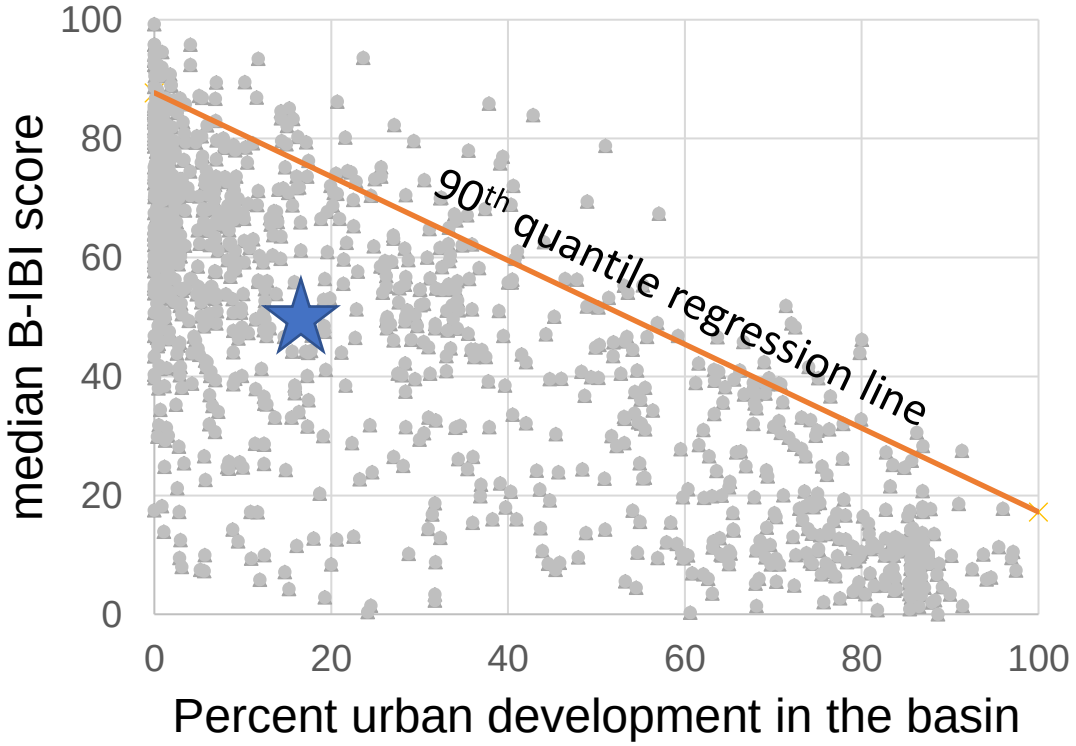
Condition of Biotic Integrity	B-IBI score
Excellent	80 - 100
Good	60 - 80
Fair	40 - 60
Poor	20 - 40
Very Poor	0 - 20

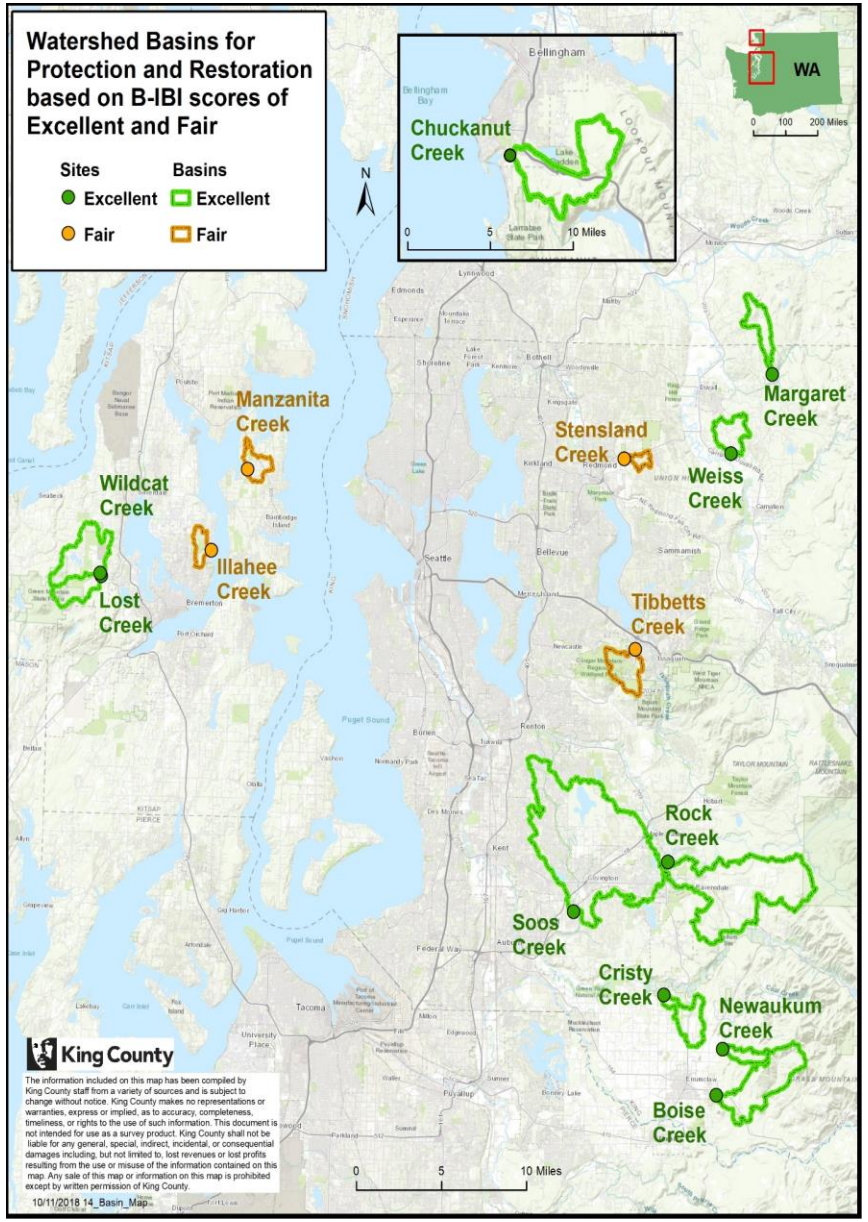
The challenge: Multiple Stressors

- B-IBI: Integrative measure of response to urban development and deforestation
- *But not diagnostic*
- Multiple stressors complicate diagnosis and recovery planning



Restore and Protect Project





How do we go from B-IBI score to prescription for recovery?

1) Determine what defines an excellent stream & identify thresholds

2) Survey the impaired stream & compare conditions to thresholds

3) Identify which actions will most help the specific impairments

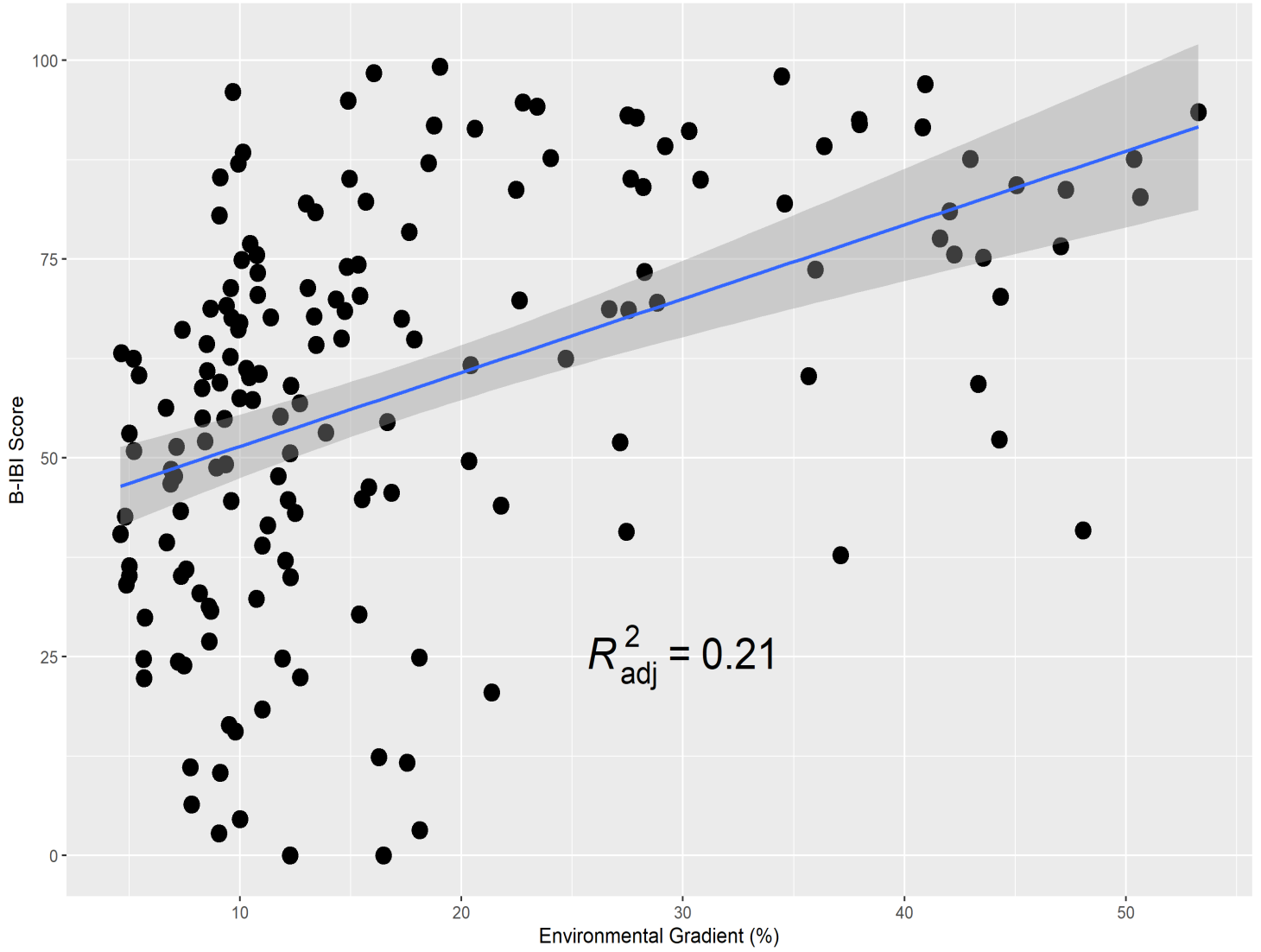
4) Plan restoration and protection actions accordingly

Habitat Surveys and Assessments

Factors we Assessed:
Stream Bed Stability
Embeddedness of Stream Substrate
Fine Sediment in Stream Channel
Flashiness
Forest Health (Riparian and Basinwide)
Large Substrate in Stream Channel
Organic Material in Soil
Roads in Basin
Local habitat
Low Slope
Soil Composition in Basin
Stream Density throughout Basin
Stream Temperature
Urban Development (Riparian and Basinwide)

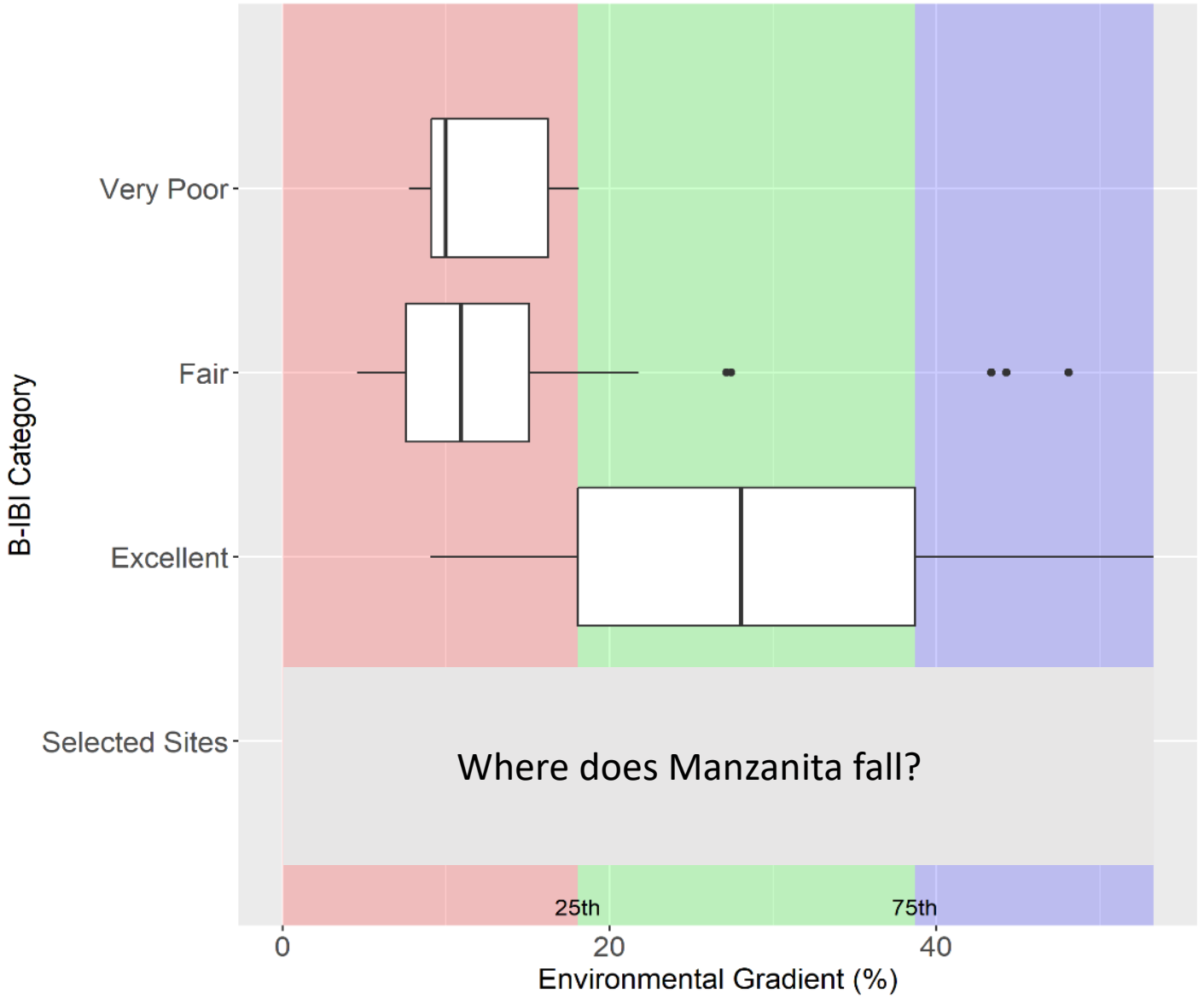
We did not assess:
Water chemistry

Determined strength of correlation between habitat feature and B-IBI



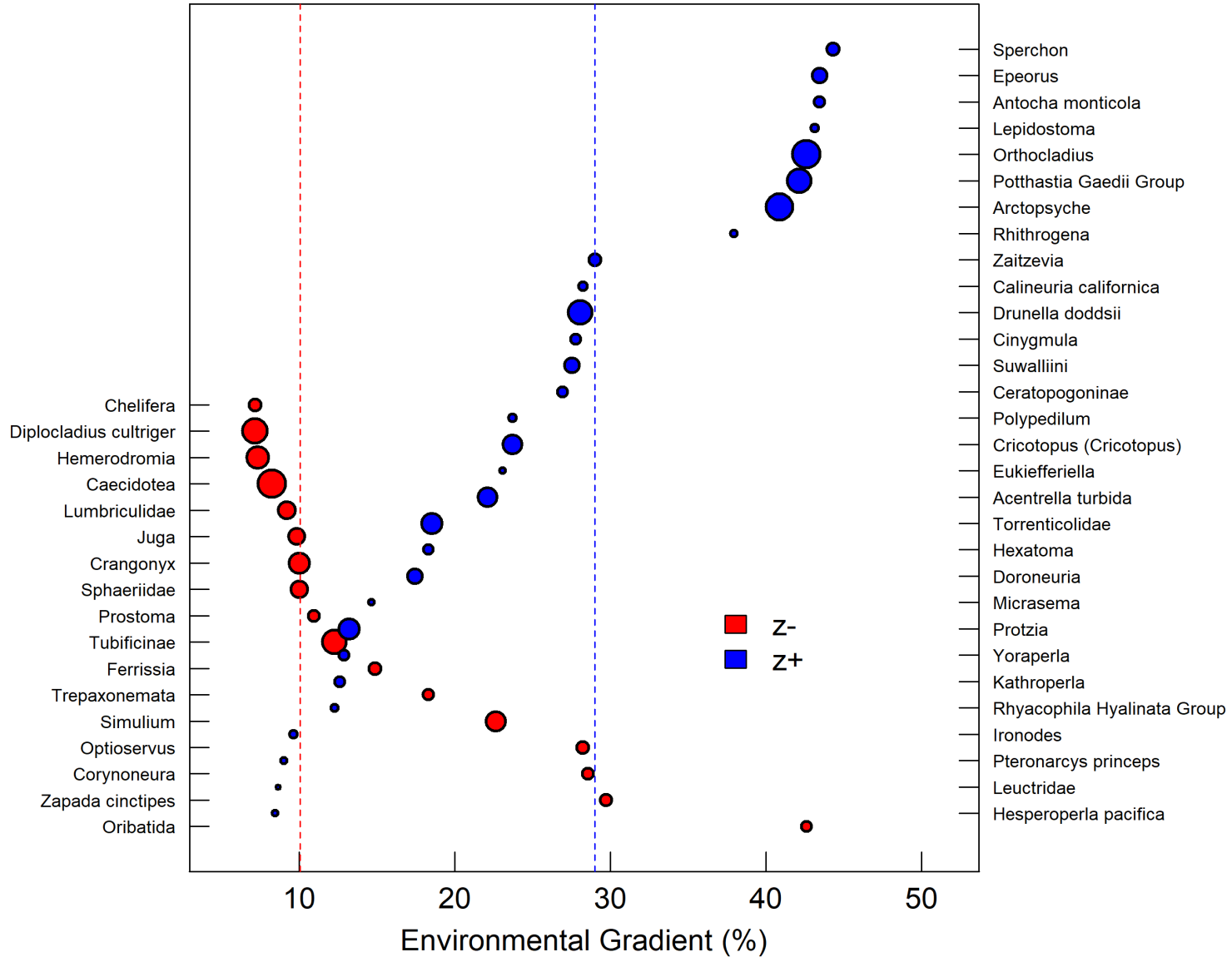
Then looked at conditions, relative to excellent streams

- Quantiles
- Change points



Then looked at conditions, relative to excellent streams

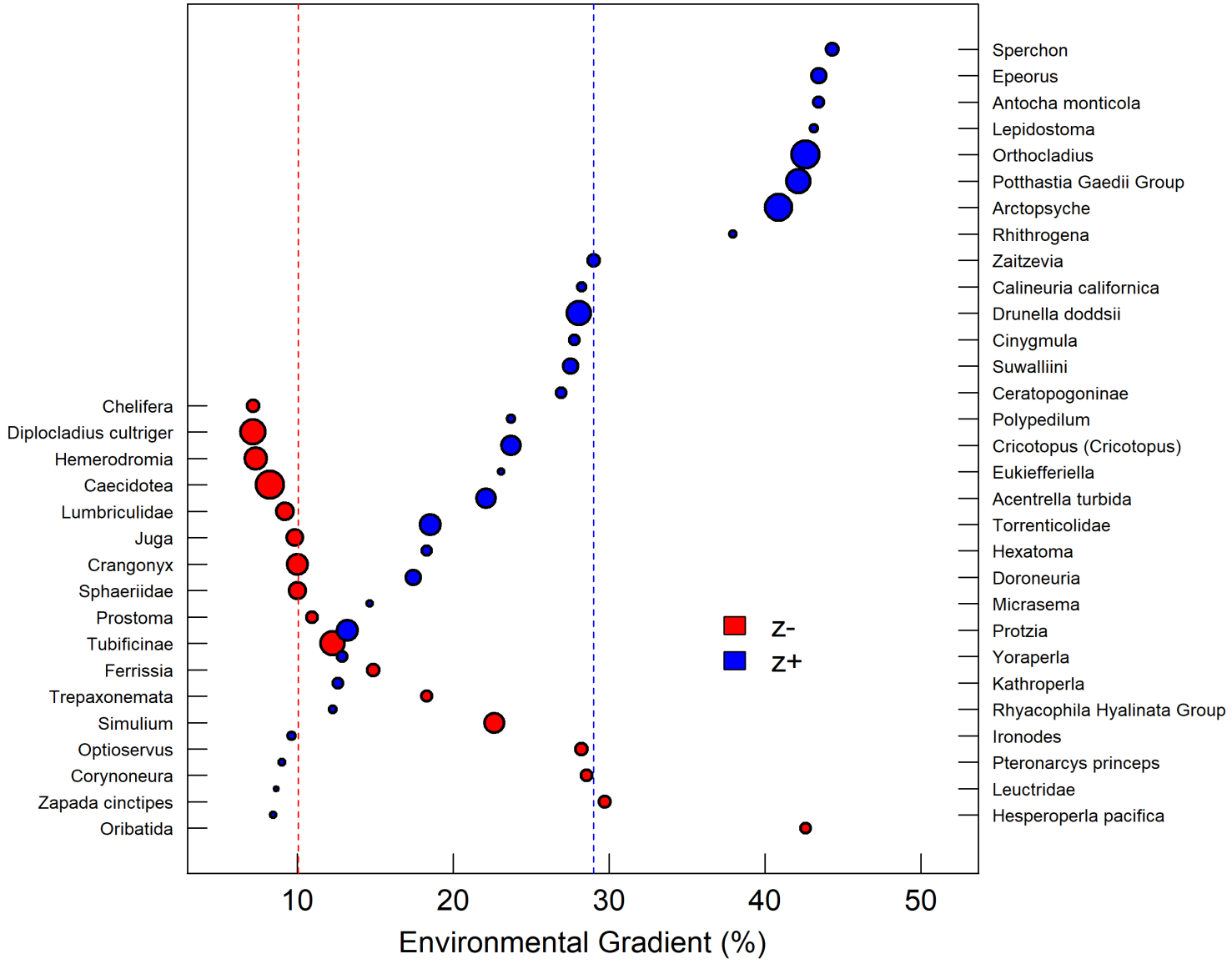
- Quantiles
- Change points



Then looked at conditions, relative to excellent streams

- Quantiles
- Change points

Next step:
Estimated “effective impact” as strength*certainty



Manzanita Creek

Condition	Number of parameters that indicate condition is degraded	Maximum Effective Impact	Action needed to improve condition?
Basin-wide forest health	3 of 5	3.1	Action needed
Riparian urban development	3 of 3	3.0	
Basin-wide urban development	2 of 2	2.9	
Flashiness	2 of 4	1.5	
Large substrate in stream channel	3 of 6	1.4	
Riparian forest health	1 of 5	1.4	
Embeddedness of stream substrate	2 of 2	1.3	
Fine sediment in stream channel	3 of 3	1.2	
Local habitat	2 of 5	1.1	
Roads in basin	0 of 2	NA	No action needed or low priority
Stream bed stability	0 of 2	NA	
Stream Temperature	0 of 3	NA	
Natural condition			
Slope	1 of 2	1.5	Condition may limit recovery
Stream density throughout basin	1 of 1	0.8	
Organic material in soil	0 of 1	NA	Condition not likely to affect recovery
Soil composition in basin	0 of 2	NA	

Manzanita Creek

Condition	Number of parameters that indicate condition is degraded	Maximum Effective Impact	Action needed to improve condition?
Basin-wide forest health	3 of 5	3.1	Action needed
Riparian urban development	3 of 3	3.0	
Basin-wide urban development	2 of 2	2.9	
Flashiness	2 of 4	1.5	
Large substrate in stream channel	3 of 6	1.4	
Riparian forest health	1 of 5	1.4	
Embeddedness of stream substrate	2 of 2	1.3	
Fine sediment in stream channel	3 of 3	1.2	
Local habitat	2 of 5	1.1	
Roads in basin	0 of 2	NA	No action needed or low priority
Stream bed stability	0 of 2	NA	
Stream Temperature	0 of 3	NA	
Natural condition			
Slope	1 of 2	1.5	Condition may limit recovery
Stream density throughout basin	1 of 1	0.8	
Organic material in soil	0 of 1	NA	Condition not likely to affect recovery
Soil composition in basin	0 of 2	NA	

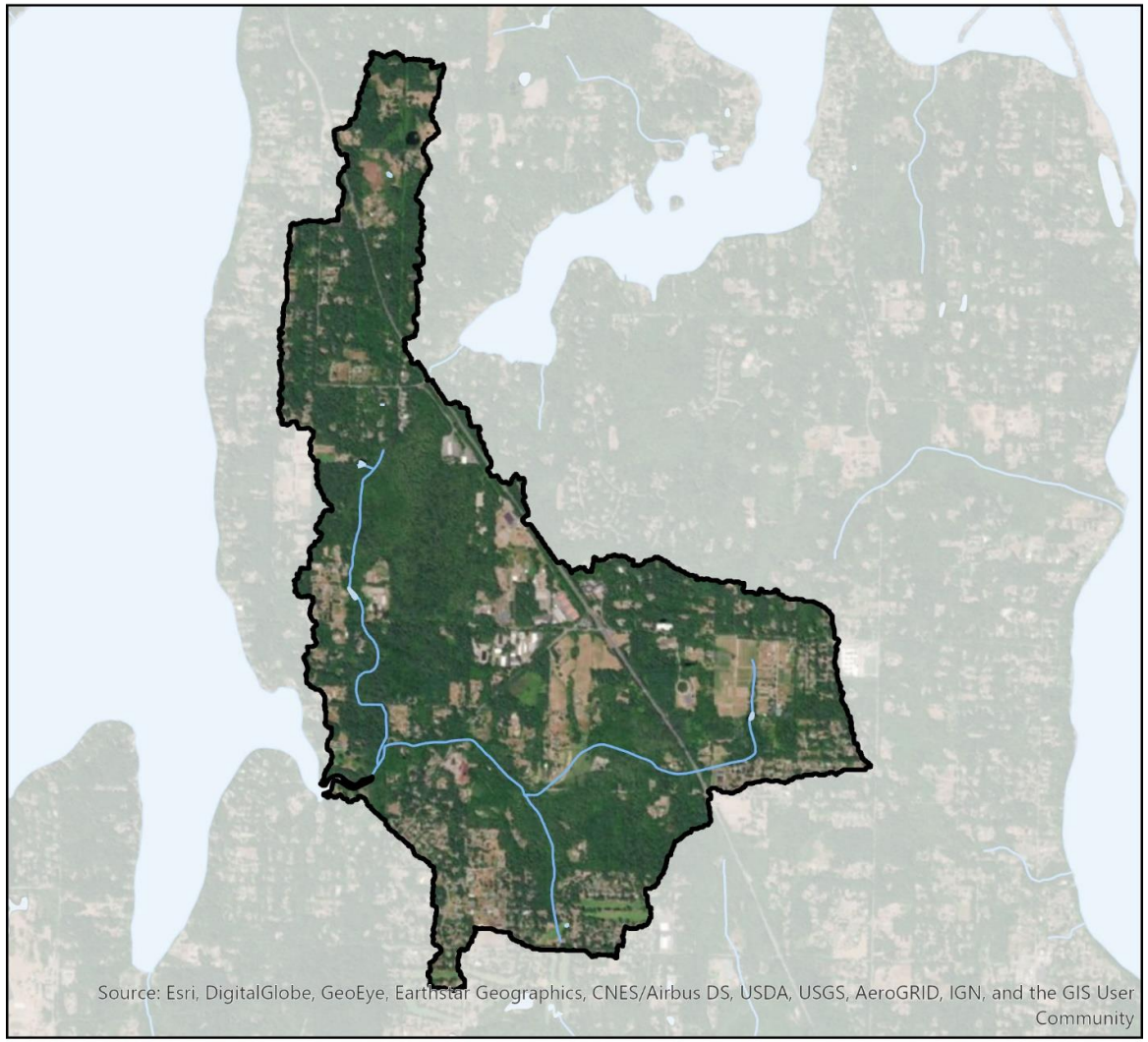
Generic Example

Recommended Actions		Stream conditions												Importance (sum of EI scores)
		Local habitat	Fine sediment in stream channel	Large substrate in stream channel	Stream bed stability	Embeddedness of stream substrate	Riparian forest health	Riparian urban development	Stream temperature	Roads in basin	Basin-wide forest health	Basin-wide urban development	Flashiness	
In-stream	Add large substrate		1.5	0.7	0									2.2
	Stablize stream banks		1.5		0	2.2								3.7
Riparian Buffer	Stablize slopes	0.8	1.5			2.2		1.2						5.7
	Plant vegetation, extend buffer	0.8	1.5			2.2	0.7	1.2	0					6.4
Stormwater Conveyance Systems	Increase stormwater flow control	0.8	1.5		0	2.2			0	0		1.9	1.5	7.9
	Improve stormwater treatment	0.8	1.5			2.2				0		1.9		6.4
	Maintain storage and treatment facilities	0.8	1.5		0	2.2				0		1.9	1.5	7.9
	Minimize impact of road runoff	0.8	1.5		0	2.2				0		1.9	1.5	7.9
Forested Land	Maintain or decomission forest roads	0.8	1.5			2.2				0		1.9		6.4
	Allow existing forest to mature		1.5			2.2					1.1		1.5	6.3
	Plant vegetation		1.5			2.2					1.1		1.5	6.3
Agricultural Land	Exclude livestock	0.8	1.5		0	2.2								4.5
	Manage waste	0.8	1.5			2.2								4.5
	Prevent soil loss	0.8	1.5		0	2.2								4.5
Mining Areas	Enforce mining BMPs		1.5			2.2								3.7

Manzanita Creek

Target Area or Land Use	Management Action	Importance
In-stream	Add large substrate	2.6
	Stablize stream banks	2.5
Riparian Buffer	Stablize slopes	6.6
	Plant vegetation, extend buffer	7.9
Stormwater Conveyance Systems	Increase stormwater flow control	8.0
	Improve stormwater treatment	6.5
	Maintain storage and treatment facilities	8.0
	Minimize impacts of road runoff	8.0
Forested Land	Maintain or decomission forest roads	6.5
	Allow existing forest to mature	7.1
	Plant vegetation	7.1
Agricultural Land	Exclude livestock	3.6
	Manage waste	3.6
	Prevent soil loss	3.6
Mining Areas	Enforce Mining BMPs	2.5

Manzanita Creek

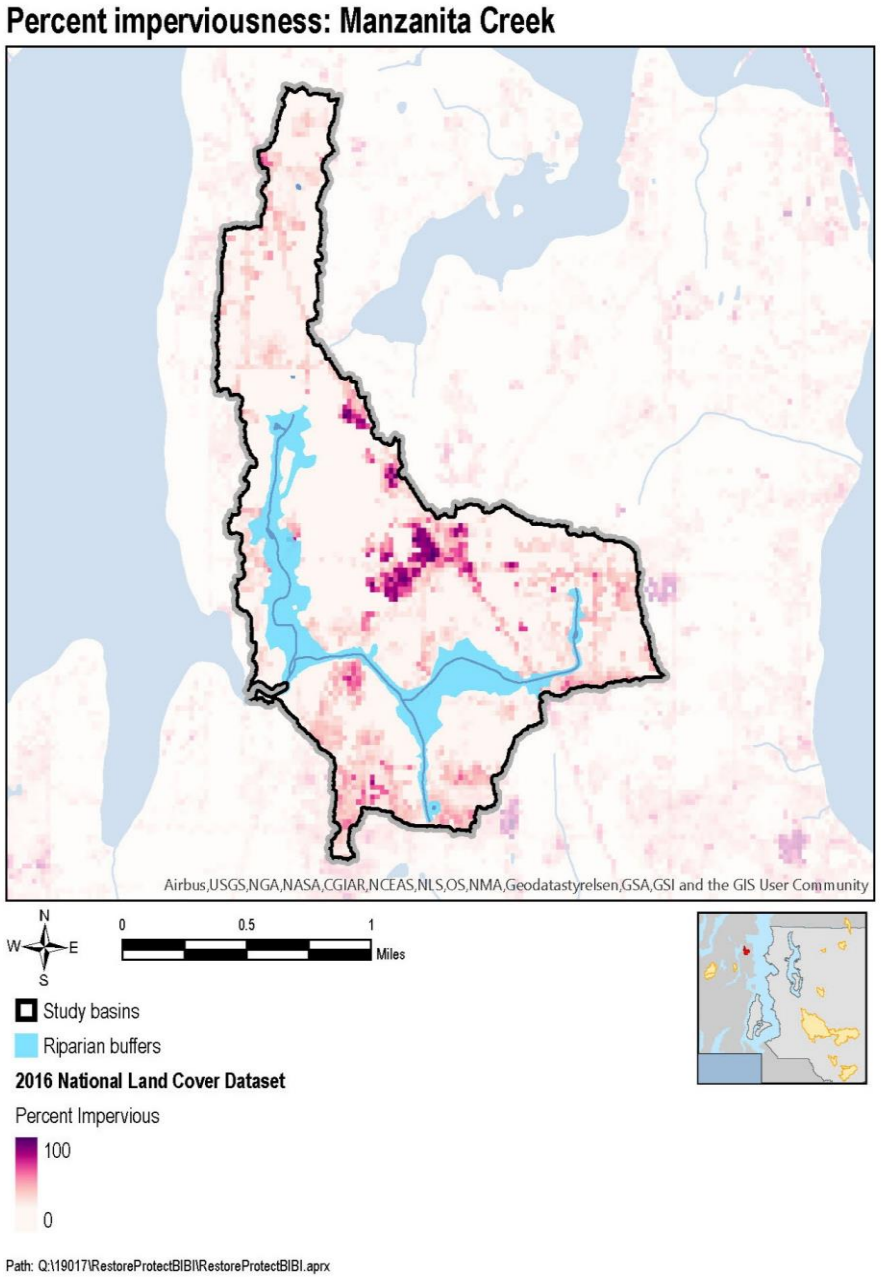


Priorities:

- Stormwater control – both flow and treatment
- Riparian forest – increase extent*
- Basin forest – protect existing forests; increase extent

Other issues highlighted in report:

- Continue work addressing failing septic systems, tree protections
- Address potential hot spots for fine sediments
- Address contaminated sites



Response variables to track?

- B-IBI scores
  - Biological potential ~ 76
- Mayfly and stonefly richness and intolerant taxa richness
- Flow metrics
- Riparian forest extent and age
- Note it will likely take 5-10 years to see a trend or change

Site Code, Location	Year, Project	Quantities												Scores										
		Taxa Richness	*Ephemeroptera Richness*	*Plecoptera Richness*	*Trichoptera Richness*	*EPT Richness*	*Clinger Richness*	*Long-Lived Richness*	*Intolerant Richness*	*Percent Dominant*	*Predator Percent*	*Tolerant Percent*	*Organisms*	*Overall Score*	*Taxa Richness*	*Ephemeroptera Richness*	*Plecoptera Richness*	*Trichoptera Richness*	*Clinger Richness*	*Long-Lived Richness*	*Intolerant Richness*	*Percent Dominant*	*Predator Percent*	*Tolerant Percent*
15MZ01, Manzanita Creek	2018, Restoration and Protection of Select B-IBI Basins - ...	48	3	4	9	16	15	7	1	32.8%	23.8%	1.8%	500	66.1	7.2	2.9	4.3	10.0	4.7	6.2	1.4	9.8	10.0	9.6
15MZ01, Manzanita Creek	2018, Restoration and Protection of Select B-IBI Basins - ...	54	4	3	12	19	17	8	1	31.8%	24.8%	1.6%	500	70.9	9.3	4.3	2.9	10.0	5.9	7.5	1.4	10.0	10.0	9.6
15MZ01, Manzanita Creek	2017, Restoration and Protection of Select B-IBI Basins - ...	55	4	6	8	18	12	6	2	33.1%	20.0%	0.5%	405	69.7	9.7	4.3	7.1	8.8	2.9	5.0	2.9	9.7	9.5	9.9
15MZ01, Manzanita Creek	2017, Restoration and Protection of Select B-IBI Basins - ...	41	3	4	7	14	15	9	1	36.4%	30.3%	1.4%	492	62.8	4.8	2.9	4.3	7.5	4.7	8.8	1.4	8.8	10.0	9.7
ENVVEST-32, Manzanita Creek	2003, Navy's Envvest Benthic Monitoring in Kitsap	29	3	4	6	13	14	4	0	67.4%	36.8%	11.2%	500	38.5	0.7	2.9	4.3	6.2	4.1	2.5	0.0	0.4	10.0	7.4
LwrManzBain, Manzanita Creek	2020, Water Quality and Flow Monitoring Program	41	4	4	5	13	13	6	1	30.2%	11.0%	2.0%	500	52.9	4.8	4.3	4.3	5.0	3.5	5.0	1.4	10.0	5.0	9.5
LwrManzBain, Manzanita Creek	2019, Water Quality and Flow Monitoring Program	35	3	4	6	13	11	5	0	35.2%	20.6%	2.0%	500	50.7	2.8	2.9	4.3	6.2	2.4	3.8	0.0	9.1	9.8	9.5
LwrManzBain, Manzanita Creek	2018, Water Quality and Flow Monitoring Program	38	0	4	10	14	14	4	1	37.9%	40.2%	0.9%	448	54.3	3.8	0.0	4.3	10.0	4.1	2.5	1.4	8.4	10.0	9.8
LwrManzBain, Manzanita Creek	2017, Water Quality and Flow Monitoring Program	36	2	5	6	13	14	8	1	52.2%	24.4%	0.2%	500	54.0	3.1	1.4	5.7	6.2	4.1	7.5	1.4	4.5	10.0	10.0
LwrManzBain, Manzanita Creek	2016, Water Quality and Flow Monitoring Program	50	3	5	8	16	17	8	0	33.2%	24.0%	0.8%	500	68.1	7.9	2.9	5.7	8.8	5.9	7.5	0.0	9.7	10.0	9.8
LwrManzBain, Manzanita Creek	2015, Water Quality and Flow Monitoring Program	44	3	5	7	15	15	8	1	40.2%	14.6%	2.2%	500	59.6	5.9	2.9	5.7	7.5	4.7	7.5	1.4	7.8	6.8	9.5
ManzBain, Manzanita Creek	2013, Water Quality and Flow Monitoring Program	38	3	5	6	14	18	6	0	49.4%	33.2%	0.4%	500	55.3	3.8	2.9	5.7	6.2	6.5	5.0	0.0	5.3	10.0	9.9
ManzBain, Manzanita Creek	2012, Water Quality and Flow Monitoring Program	38	3	4	4	11	15	5	0	48.6%	12.8%	1.2%	500	44.3	3.8	2.9	4.3	3.8	4.7	3.8	0.0	5.5	5.9	9.7
ManzBain, Manzanita Creek	2011, Water Quality and Flow Monitoring Program	33	3	4	7	14	14	3	0	57.6%	9.6%	2.4%	500	38.9	2.1	2.9	4.3	7.5	4.1	1.2	0.0	3.1	4.3	9.4
ManzBain, Manzanita Creek	2010, Water Quality and Flow Monitoring Program	37	2	7	7	16	12	6	3	53.2%	19.8%	2.2%	500	56.3	3.4	1.4	8.6	7.5	2.9	5.0	4.3	4.3	9.4	9.5
ManzBain, Manzanita Creek	2008, Water Quality and Flow Monitoring Program	30	2	3	7	12	12	4	0	62.2%	11.2%	1.2%	500	34.9	1.0	1.4	2.9	7.5	2.9	2.5	0.0	1.8	5.1	9.7

Manzanita Creek

Condition	Parameter	Correlation with B-IBI	Pearson r^2 with B-IBI	Effective Impac	Certainty	Unit	Relationship	Titan Change Point	Quantile Threshold	Mean Observed Value	Mean Observed Value – TITAN Change Point	Mean Observed Value – Quantile Threshold
Basin-wide forest health	**% Canopy Cover**	**0.72**	**0.52**	**3.12**	**6**	**mean %**	**Positive**	**53.29**	**64.57**	**50.87**	**-4.60**	**-15.88**
Basin-wide forest health	**% Forest Cover**	**0.70**	**0.50**	**2.97**	**6**	**%**	**Positive**	**67.56**	**72.39**	**60.28**	**-9.10**	**-13.94**
Basin-wide forest health	Mean Basal Area	0.68	0.46	1.39	3	mean m2/hectare	Positive	25.56	29.52	34.18	6.98	3.03
Basin-wide forest health	Mean Forest Age	0.56	0.32	1.26	4	mean years	Positive	62.92	44.35	49.97	**-15.59**	2.97
Basin-wide forest health	**Old Growth Structure Index**	**0.68**	**0.46**	**2.31**	**5**	**mean**	**Positive**	**18.42**	**18.50**	**18.42**	**-1.08**	**-1.15**
Basin-wide urban development	**% Impervious Surface**	**-0.77**	**0.59**	**2.93**	**5**	**%**	**Negative**	**NA**	**6.27**	**8.70**		**2.43**
Basin-wide urban development	**% Urban Cover**	**-0.76**	**0.58**	**2.92**	**5**	**%**	**Negative**	**2.60**	**4.03**	**17.33**	**14.74**	**13.30**
Embeddedness	**Embeddedness, Center Channel**	**-0.38**	**0.15**	**1.03**	**7**	**%**	**Negative**	**38.48**	**39.09**	**54.14**	**15.65**	**15.05**
Embeddedness of stream substrate	**Embeddedness**	**-0.43**	**0.18**	**1.29**	**7**	**%**	**Negative**	**42.75**	**53.31**	**69.33**	**26.58**	**16.02**
Fine Sediment	**% Fine Gravel and Below**	**-0.45**	**0.20**	**1.22**	**6**	**%**	**Negative**	**36.58**	**44.59**	**57.36**	**20.78**	**12.77**
Fine Sediment	**% Fine Sediment**	**-0.39**	**0.16**	**0.93**	**6**	**%**	**Negative**	**9.52**	**9.52**	**8.01**	**-1.52**	**-1.52**
Fine Sediment	**Pct SandFine Sediment**	**-0.43**	**0.19**	**1.12**	**6**	**%**	**Negative**	**23.38**	**27.71**	**35.93**	**12.55**	**8.23**
Flashiness	High Pulse Count	-0.35	0.12	0.62	5	count	Negative	NA	12.00	15.00		**3.00**
Flashiness	High Pulse Duration	0.35	0.12	0.60	5		Positive	NA	3.48	3.33		**-0.14**
Flashiness	**RBI**	**-0.55**	**0.30**	**1.51**	**5**		**Negative**	**NA**	**0.22**	**0.43**		**0.20**
Flashiness	**T-Q Mean**	**0.50**	**0.25**	**1.25**	**5**		**Positive**	**NA**	**0.33**	**0.27**		**-0.06**
Large substrate in stream channel	% Boulder	0.30	0.09	0.28	3	%	Positive	1.95	0.00	1.08	**-0.87**	1.08
Large substrate in stream channel	% Coarse Gravel	0.43	0.18	0.55	3	%	Positive	NA	26.84	32.68		5.84
Large substrate in stream channel	**% Coarse Gravel and Above**	**0.48**	**0.23**	**1.39**	**6**	**%**	**Positive**	**61.47**	**50.22**	**41.99**	**-19.48**	**-8.23**
Large substrate in stream channel	**% Cobble**	**0.31**	**0.10**	**0.68**	**7**	**%**	**Positive**	**15.80**	**6.49**	**8.01**	**-7.79**	**1.52**
Large substrate in stream channel	% Small Boulder	0.32	0.10	0.30	3	%	Positive	1.95	0.00	0.65	**-1.30**	0.65
Large substrate in stream channel	**Log10 estimated geometric mean sub**	**0.46**	**0.21**	**1.25**	**6**		**Positive**	**0.86**	**0.86**	**0.57**	**-0.29**	**-0.29**
Local habitat	**% Disturbance**	**-0.39**	**0.15**	**1.07**	**7**	**%**	**Negative**	**9.09**	**27.27**	**29.55**	**20.46**	**2.28**
Local habitat	Proportion Mixed Canopy	0.38	0.14	0.57	4	%	Positive	0.41	0.45	0.52	0.11	0.07
Local habitat	Proportion Mixed Understory	0.32	0.11	0.32	3	%	Positive	NA	0.36	0.45		0.09
Local habitat	Proportion Understory	0.31	0.10	0.29	3	%	Positive	NA	1.00	1.00		0.00
Local habitat	**Weighted Proximity of Human Influen**	**-0.38**	**0.15**	**1.04**	**7**		**Negative**	**0.08**	**0.48**	**0.72**	**0.64**	**0.24**
Low slope	**Slope**	**0.46**	**0.21**	**1.47**	**7**	**mean %**	**Positive**	**29.01**	**15.95**	**6.92**	**-21.62**	**-8.56**
Low slope	Slope, Riparian	0.32	0.10	0.51	5	mean %	Positive	NA	14.75	4.07		**-10.68**
Organic material in soil	Organic Material	0.45	0.20	0.60	3	mean %	Positive	9.30	7.56	9.92	1.25	3.00
Riparian forest health	% Canopy Cover, Riparian	0.54	0.30	1.19	4	mean %	Positive	51.32	61.16	58.20	6.88	**-2.97**
Riparian forest health	**% Forest Cover, Riparian**	**0.52**	**0.28**	**1.38**	**5**	**%**	**Positive**	**85.27**	**74.66**	**70.47**	**-14.80**	**-4.19**
Riparian forest health	Mean Basal Area, Riparian	0.44	0.20	0.59	3	mean m2/hectare	Positive	38.67	30.63	41.18	2.51	10.55
Riparian forest health	Mean Forest Age, Riparian	0.48	0.23	0.93	4	mean years	Positive	66.73	50.65	59.01	**-7.72**	8.36
Riparian forest health	Old Growth Structure Index, Riparian	0.48	0.24	0.71	3	mean	Positive	18.85	19.66	19.92	1.07	0.26
Riparian urban development	**% Impervious Surface, Riparian**	**-0.64**	**0.41**	**2.03**	**5**	**%**	**Negative**	**2.24**	**2.99**	**3.40**	**1.16**	**0.41**
Riparian urban development	**% Urban Cover, Riparian**	**-0.71**	**0.50**	**2.98**	**6**	**%**	**Negative**	**2.46**	**3.15**	**7.56**	**5.11**	**4.42**
Riparian urban development	**Developed Open Space, Riparian**	**-0.35**	**0.13**	**0.88**	**7**	**%**	**Negative**	**0.68**	**0.15**	**7.65**	**6.97**	**7.50**
Roads in basin	Road Crossings/ Stream Length (miles)	-0.51	0.26	0.79	3	#/mile	Negative	NA	2.37	2.32		-0.05
Roads in basin	Road Density	-0.68	0.47	1.40	3	miles/acre	Negative	NA	0.01	0.01		0.00
Soil composition in basin	% Sand	-0.34	0.12	0.35	3	mean %	Negative	62.96	63.19	59.08	-5.33	-5.56
Soil composition in basin	% Silt	0.33	0.11	0.43	4	mean %	Positive	32.31	27.49	31.14	0.48	5.30
Stream Bed Stability	Log-transformed Relative Bed Stability	0.54	0.29	0.58	2		Positive	-1.22	-1.85	-0.92	0.30	0.93
Stream density throughout basin	**Stream Density**	**0.41**	**0.17**	**0.83**	**5**	**miles/acre**	**Positive**	**NA**	**0.01**	**0.00**		**0.00**
Stream temperature	Average Daily Spring Temperature	-0.39	0.15	0.46	3	°C	Negative	NA	10.34	9.45		-0.89
Stream temperature	Frequency of Spring Temperature Exceedin	-0.42	0.18	0.53	3	count	Negative	NA	50.00	39.00		-11.00
Stream temperature	Frequency of Summer Temperature Exceed	-0.34	0.12	0.58	5	count	Negative	NA	92.00	92.00		0.00