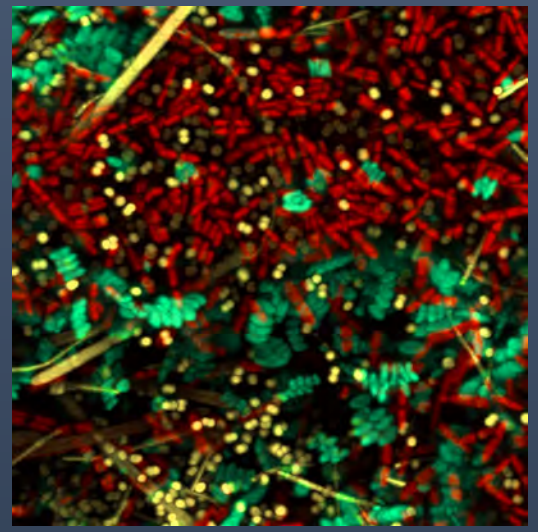
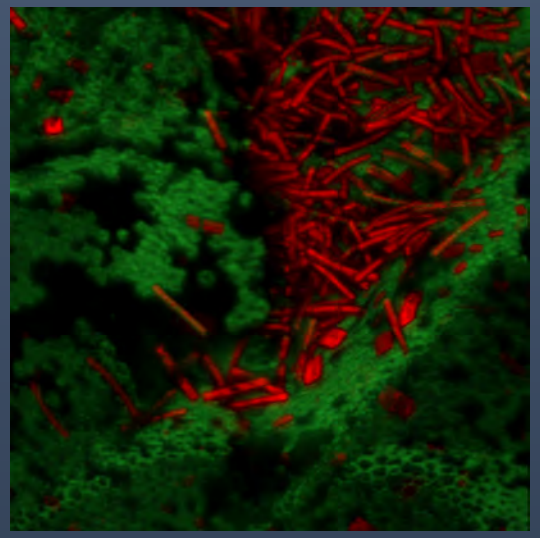
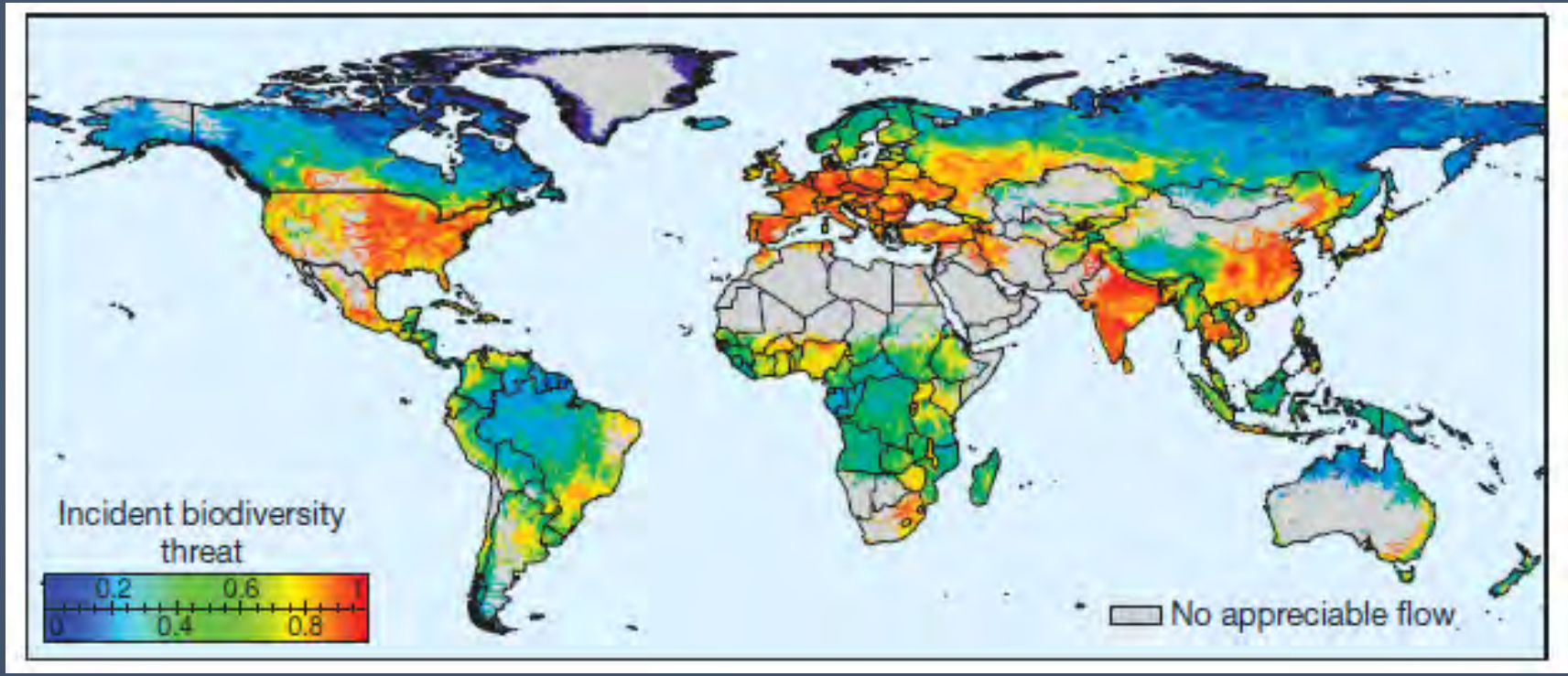
The first statewide stream macroinvertebrate bioassessment in Washington State with a relative risk and attributable risk analysis for multiple stressors

Chad Larson
Environmental Assessment Program
Washington State Department of Ecology





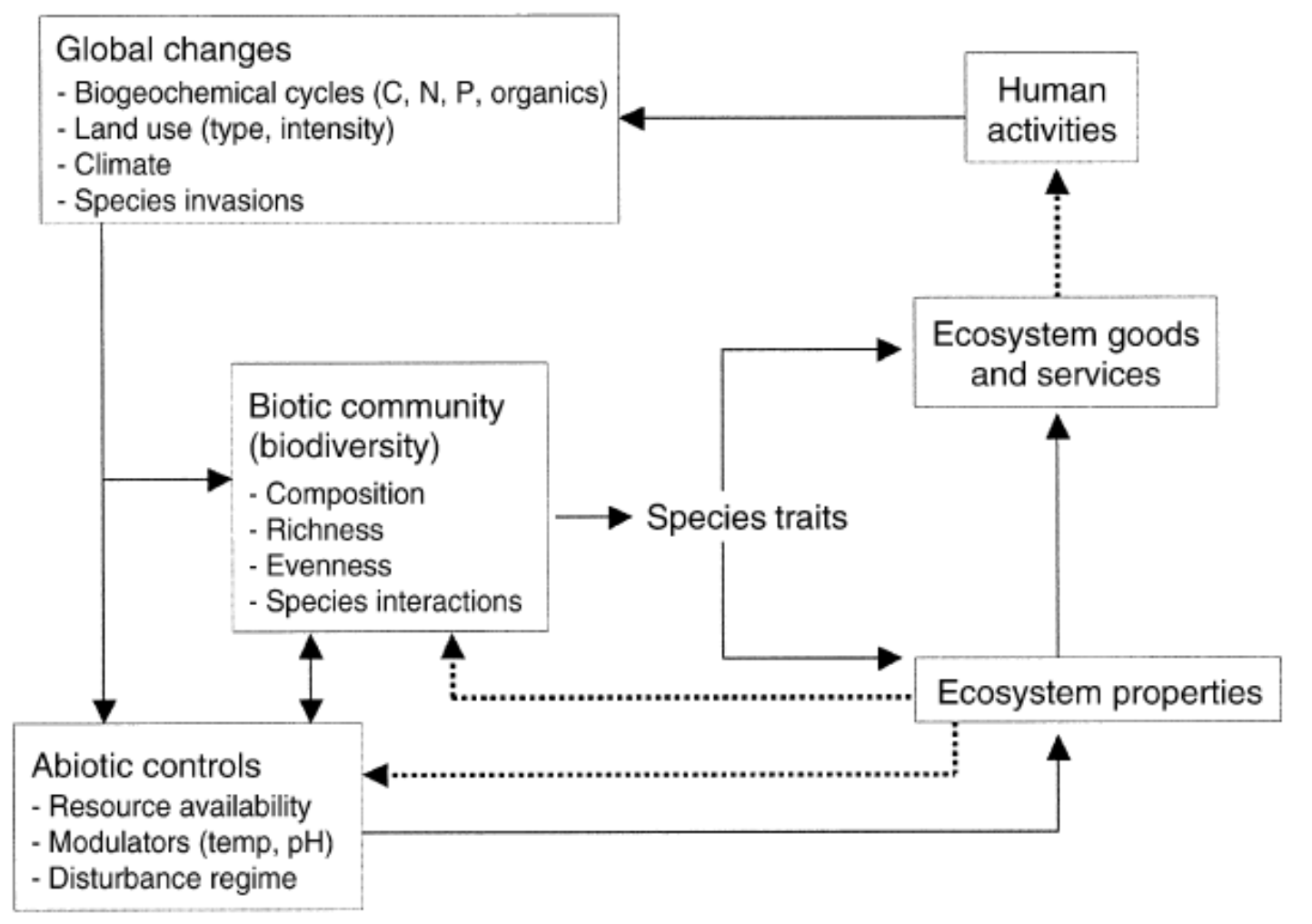
Freshwater systems under threat



Vörösmarty et al. (2010) *Nature*

Freshwater systems comprise only a fraction of the total water found on the planet, yet supply nearly two-thirds of the water used in the world

Biodiversity matters



Hooper et al. (2005) *Ecological Monographs*

Background

Clean Water Act – restore & maintain the chemical, physical and biological integrity of the nation's waters

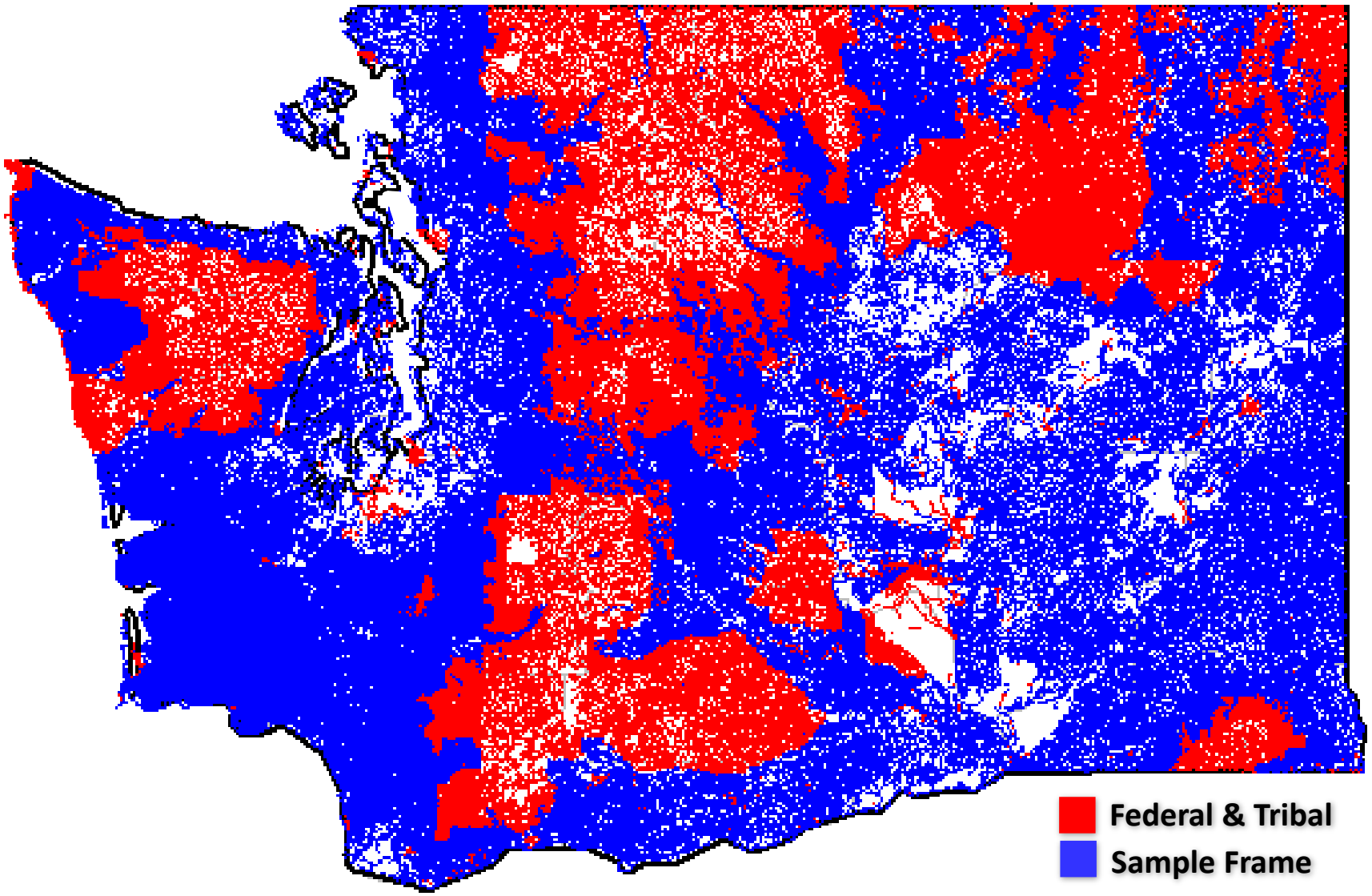
Prior to 2009, WA had no comprehensive stream biological monitoring program

Beginning in 2009, Watershed Health Monitoring Program implemented GRTS random sample survey design

50 sites in each of 7 Salmon Recovery Regions & 1 unlisted region

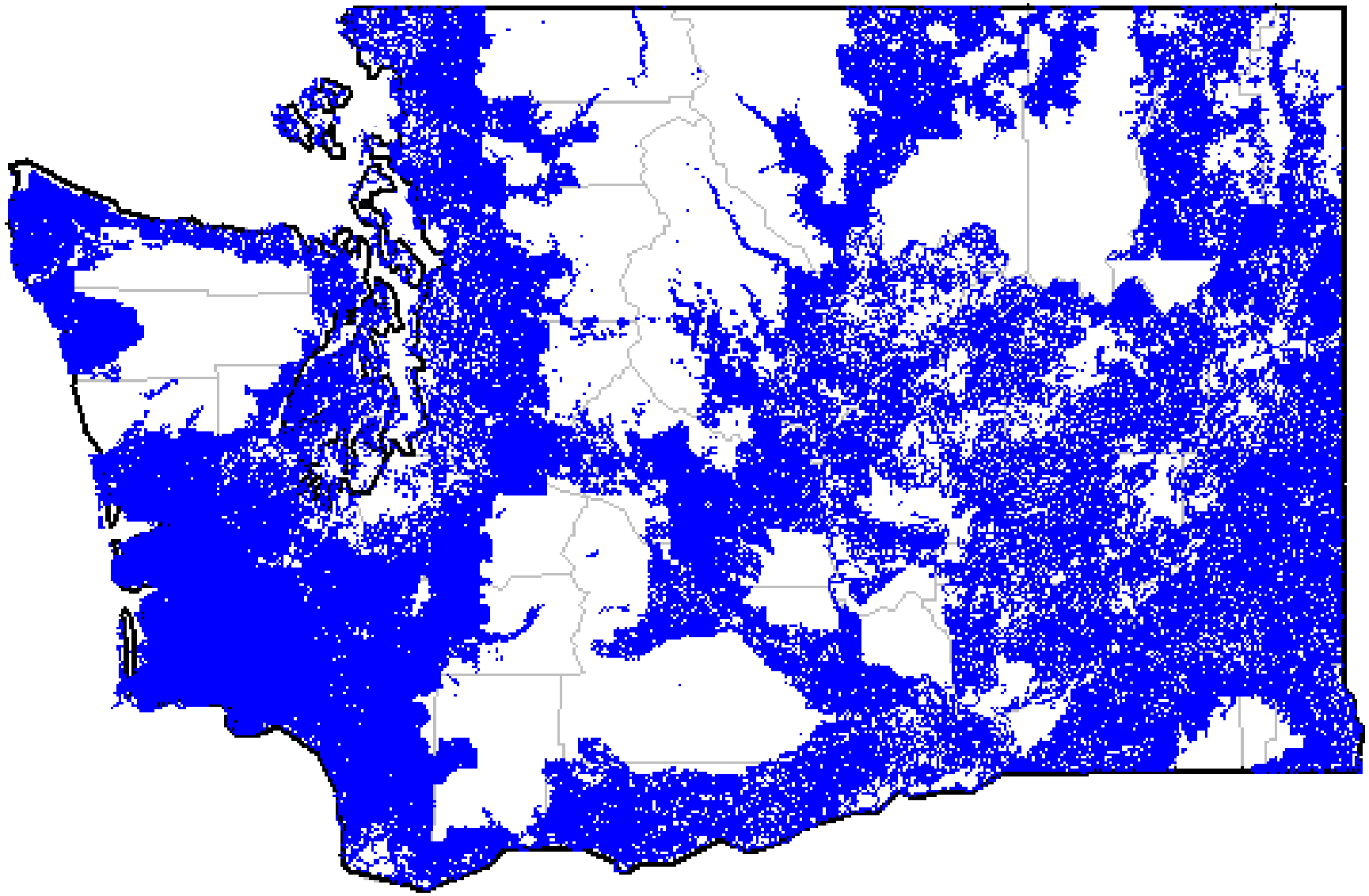
WA master sample points

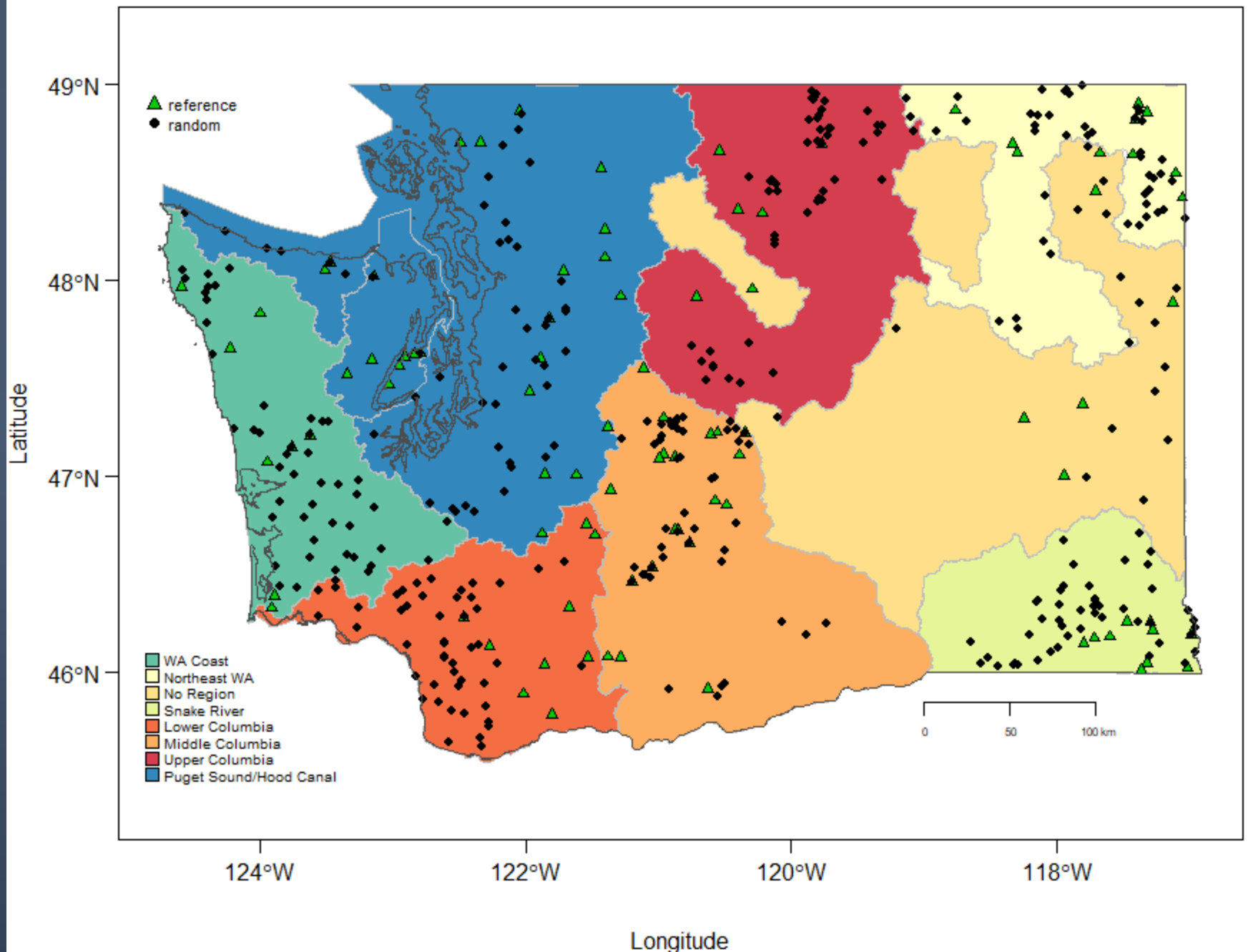
387,543 points

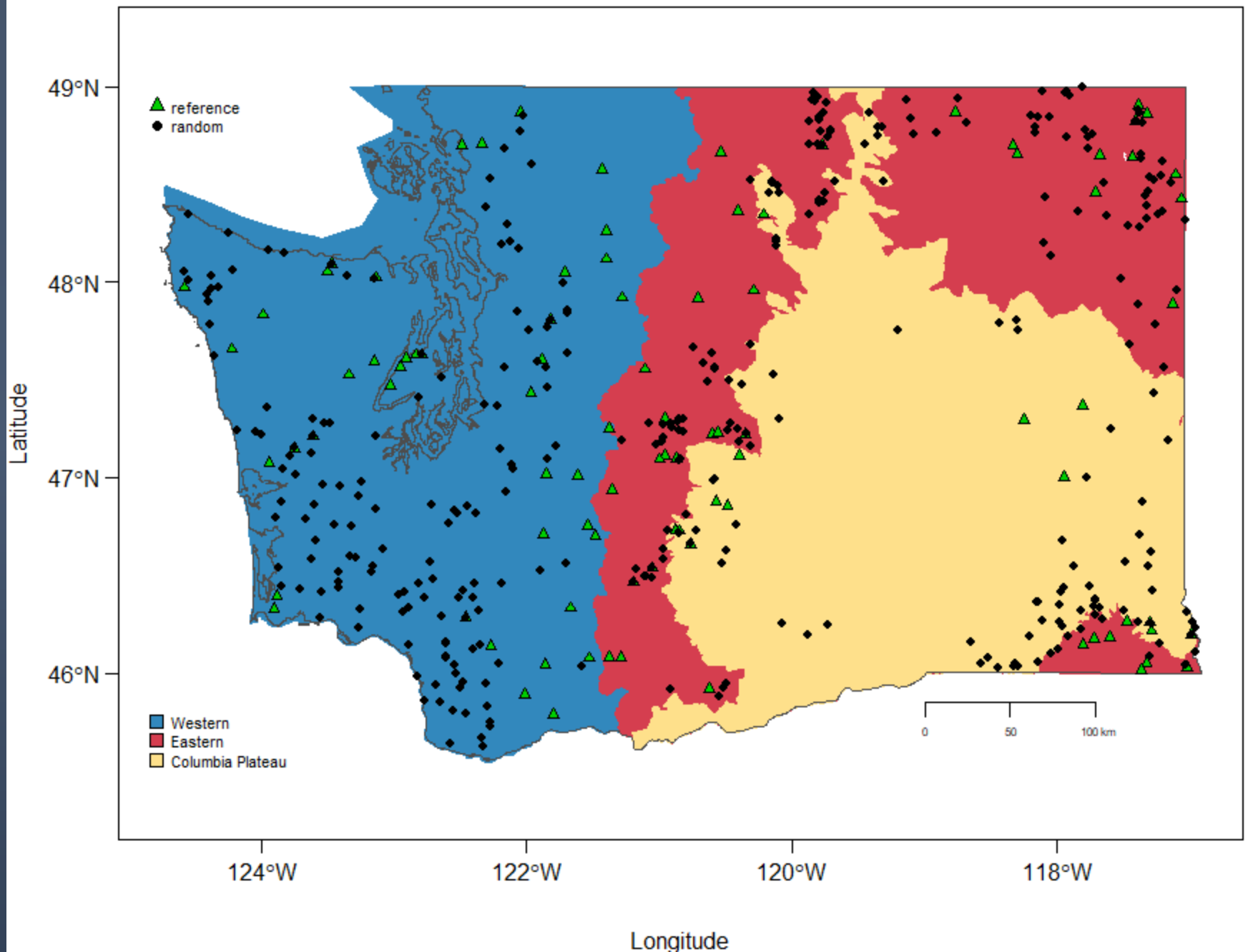


WA master sample points

248,402 points

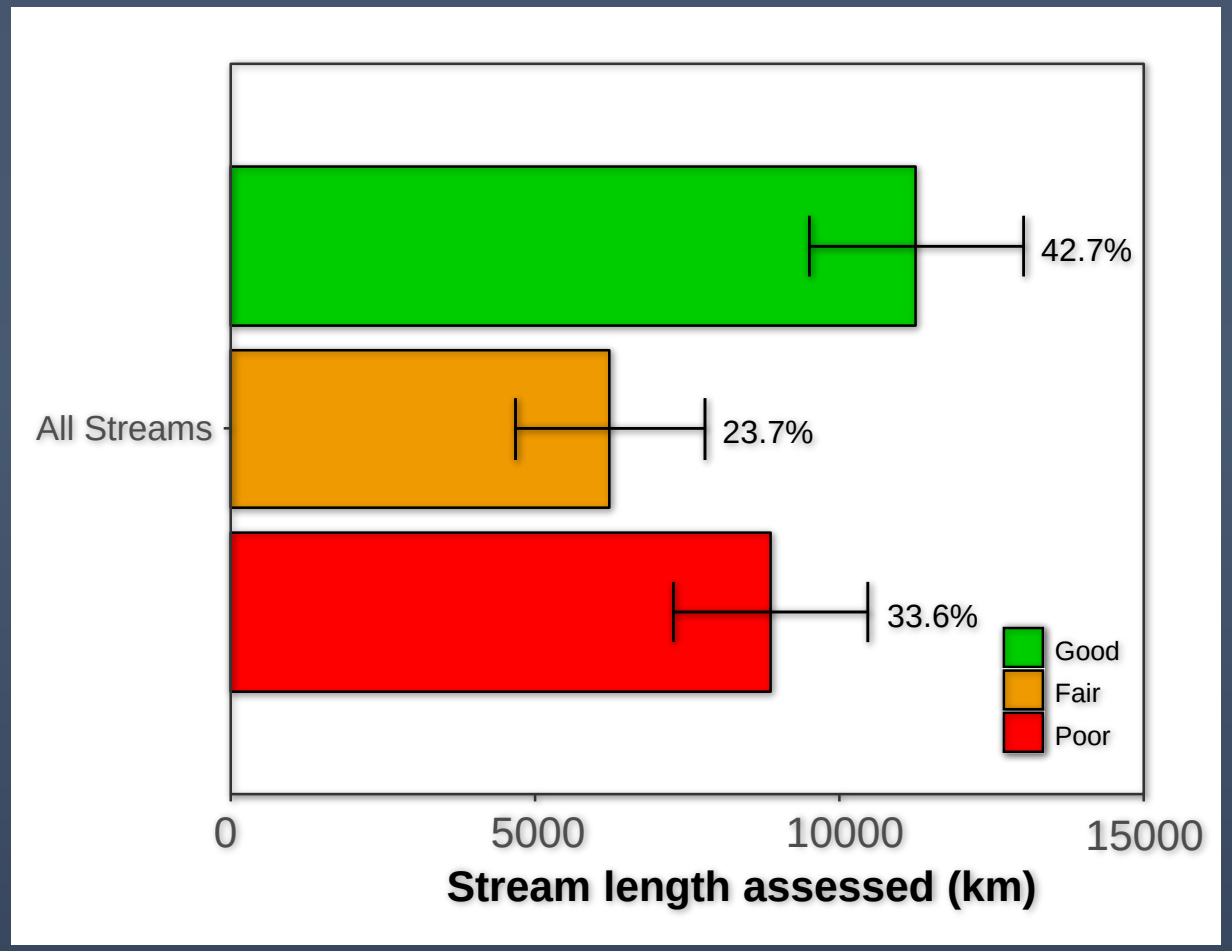


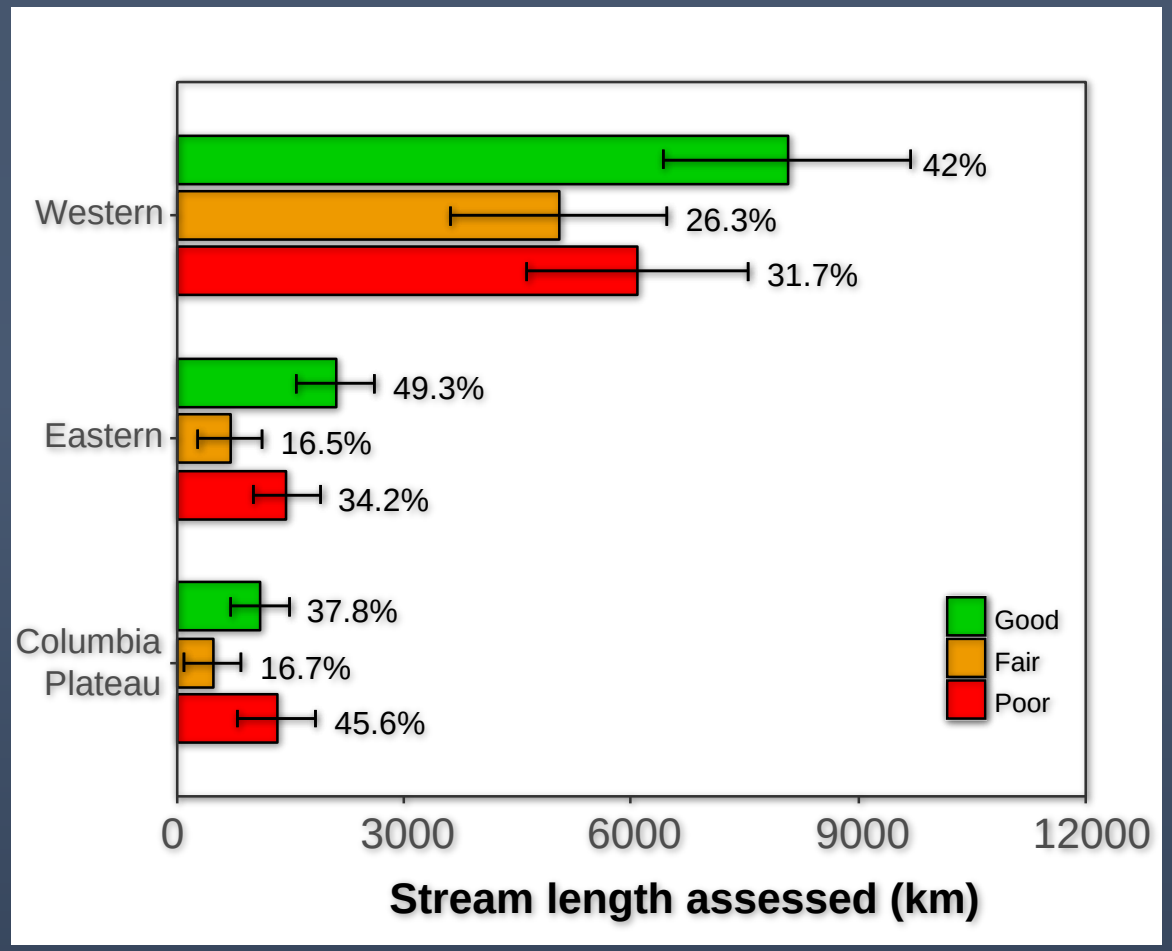

reference
random
WA Coast
Northeast WA
No Region
Snake River
Lower Columbia
Middle Columbia
Upper Columbia
Puget Sound/Hood Canal
0
50
100 km
49°N
48°N
47°N
46°N
Latitude
124°W
122°W
120°W
118°W
Longitude


reference
random
Western
Eastern
Columbia Plateau
0
50
100 km
49°N
48°N
47°N
46°N
Latitude
124°W
122°W
120°W
118°W
Longitude

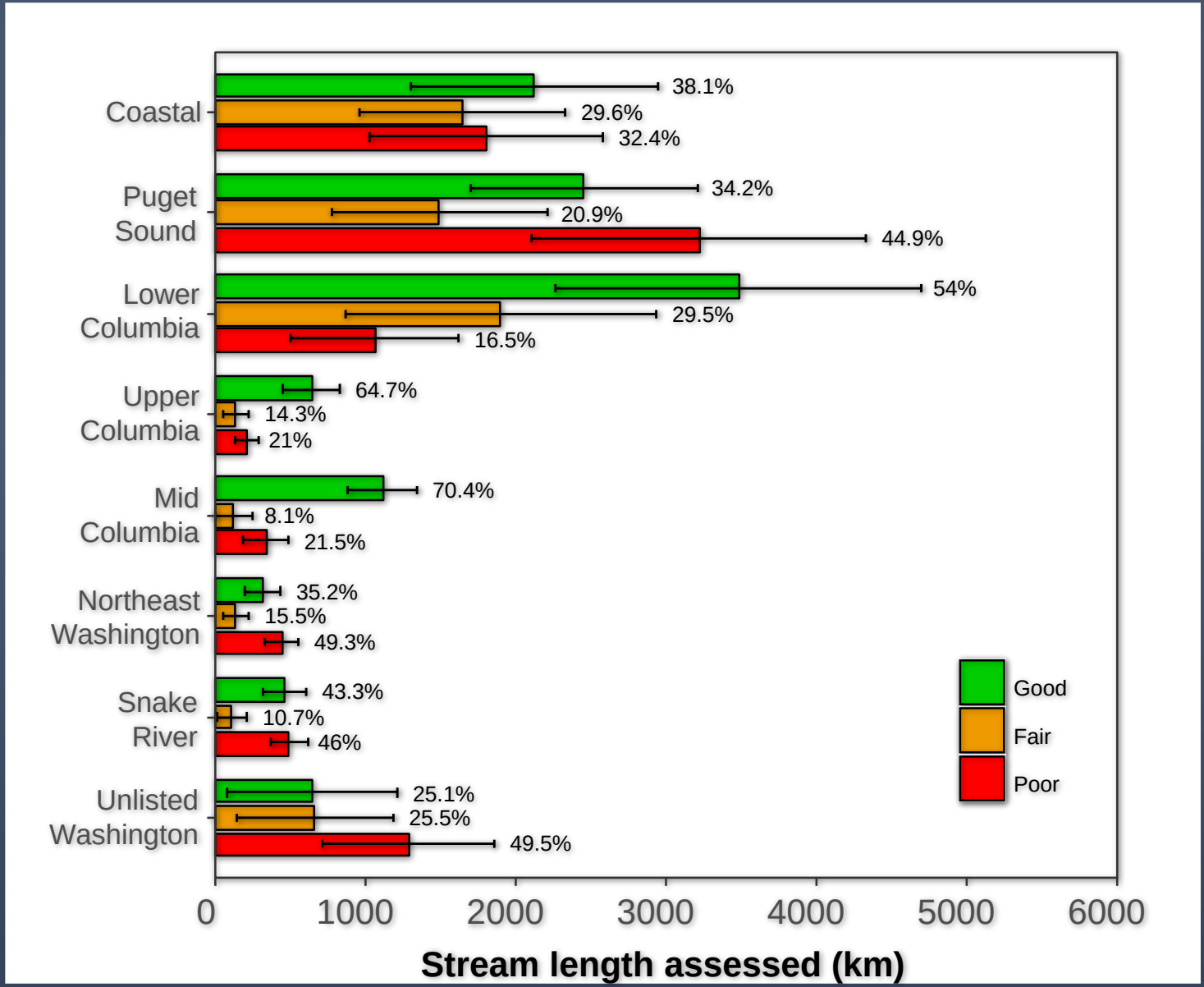
Status

B-IBI ranges from 0-100 with higher scores indicating greater biological health

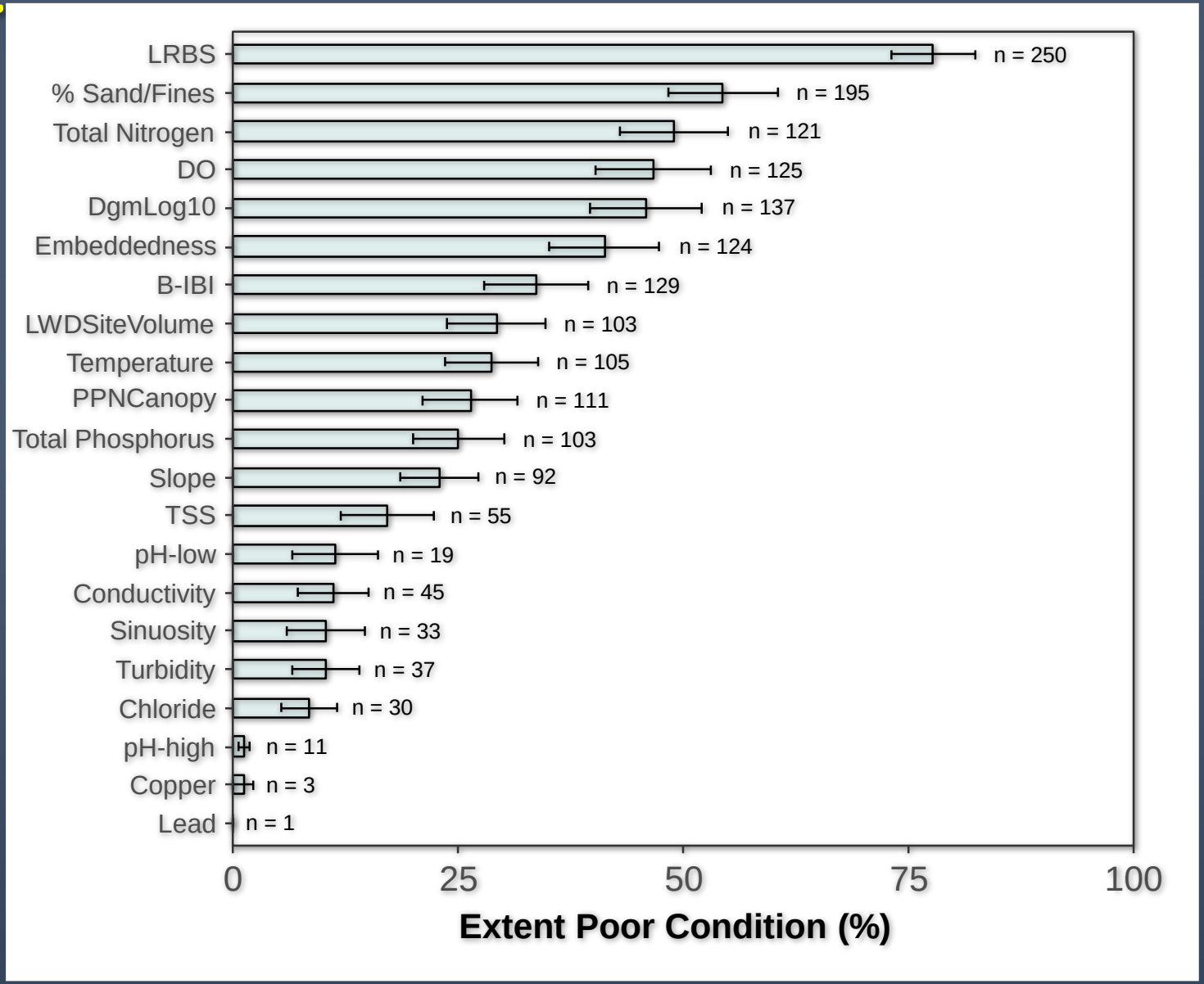




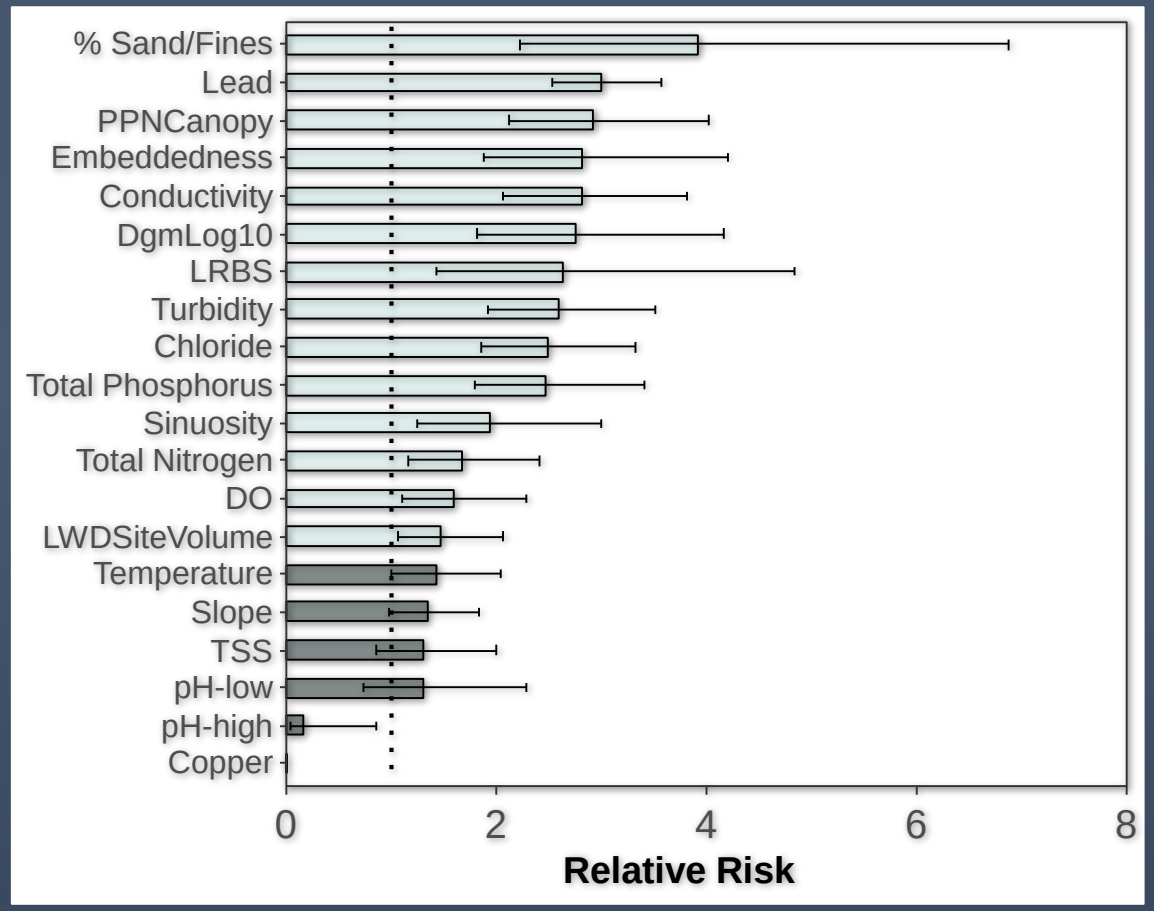
Status

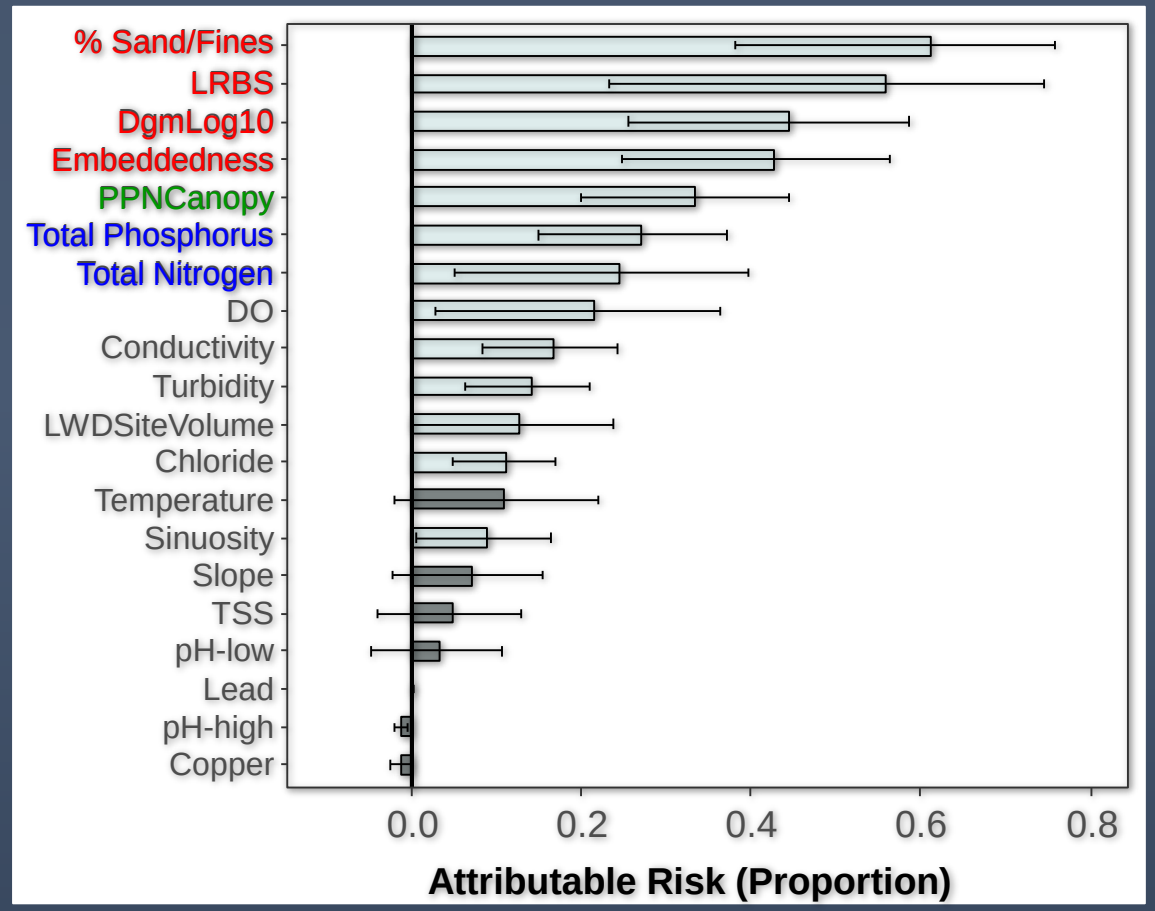

Coastal
38.1%
29.6%
32.4%
Puget Sound
34.2%
20.9%
44.9%
Lower Columbia
54%
29.5%
16.5%
Upper Columbia
64.7%
14.3%
21%
Mid Columbia
70.4%
8.1%
21.5%
Northeast Washington
35.2%
15.5%
49.3%
Snake River
43.3%
10.7%
46%
Unlisted Washington
25.1%
25.5%
49.5%
Good
Fair
Poor
0
1000
2000
3000
4000
5000
6000
Stream length assessed (km)

Extent


LRBS
% Sand/Fines
Total Nitrogen
DO
DgmLog10
Embeddedness
B-IBI
LWDSiteVolume
Temperature
PPNCanopy
Total Phosphorus
Slope
TSS
pH-low
Conductivity
Sinuosity
Turbidity
Chloride
pH-high
Copper
Lead
n = 250
n = 195
n = 121
n = 125
n = 137
n = 124
n = 129
n = 103
n = 105
n = 111
n = 103
n = 92
n = 55
n = 19
n = 45
n = 33
n = 37
n = 30
n = 11
n = 3
n = 1
0
25
50
75
100
Extent Poor Condition (%)

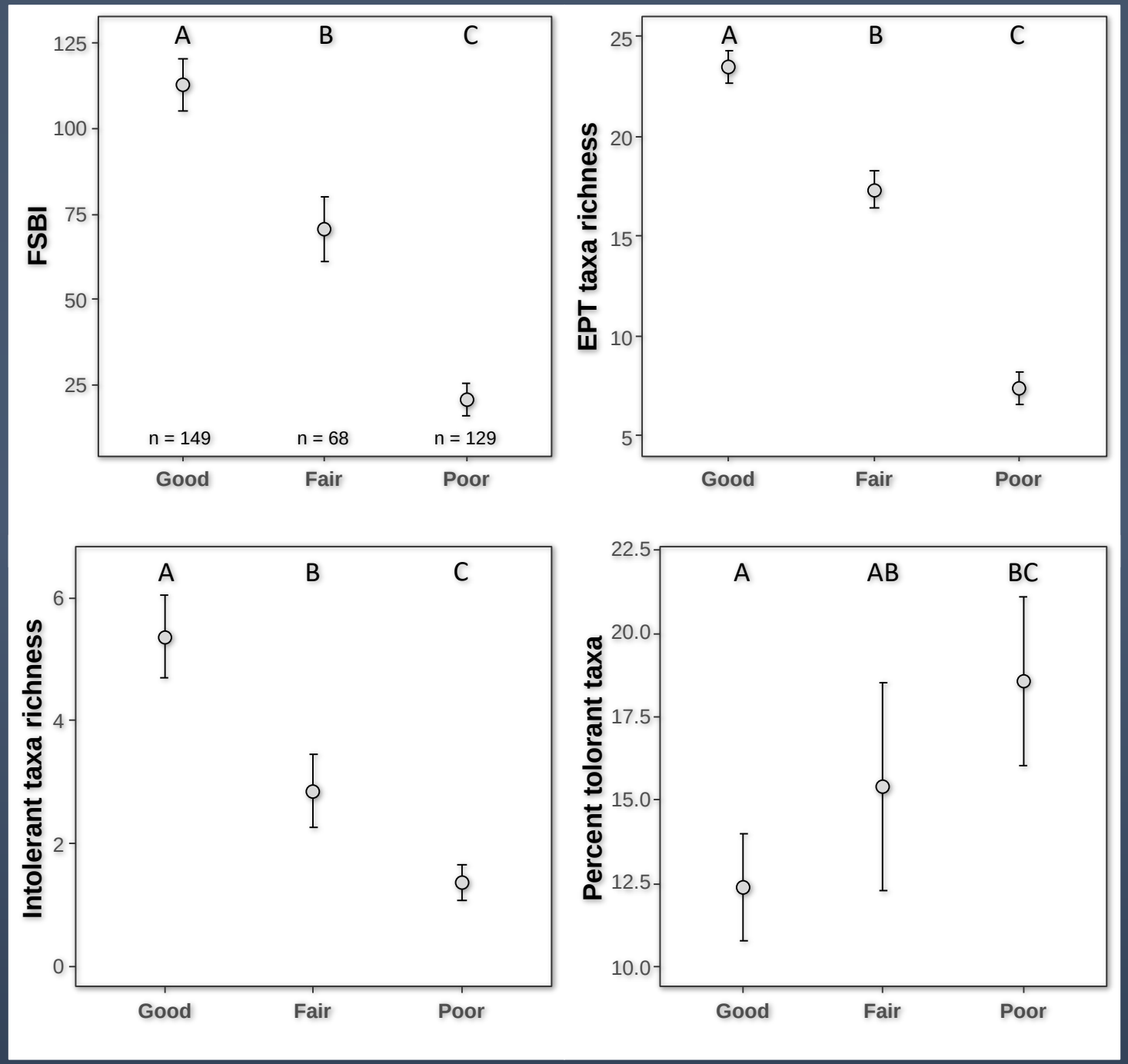
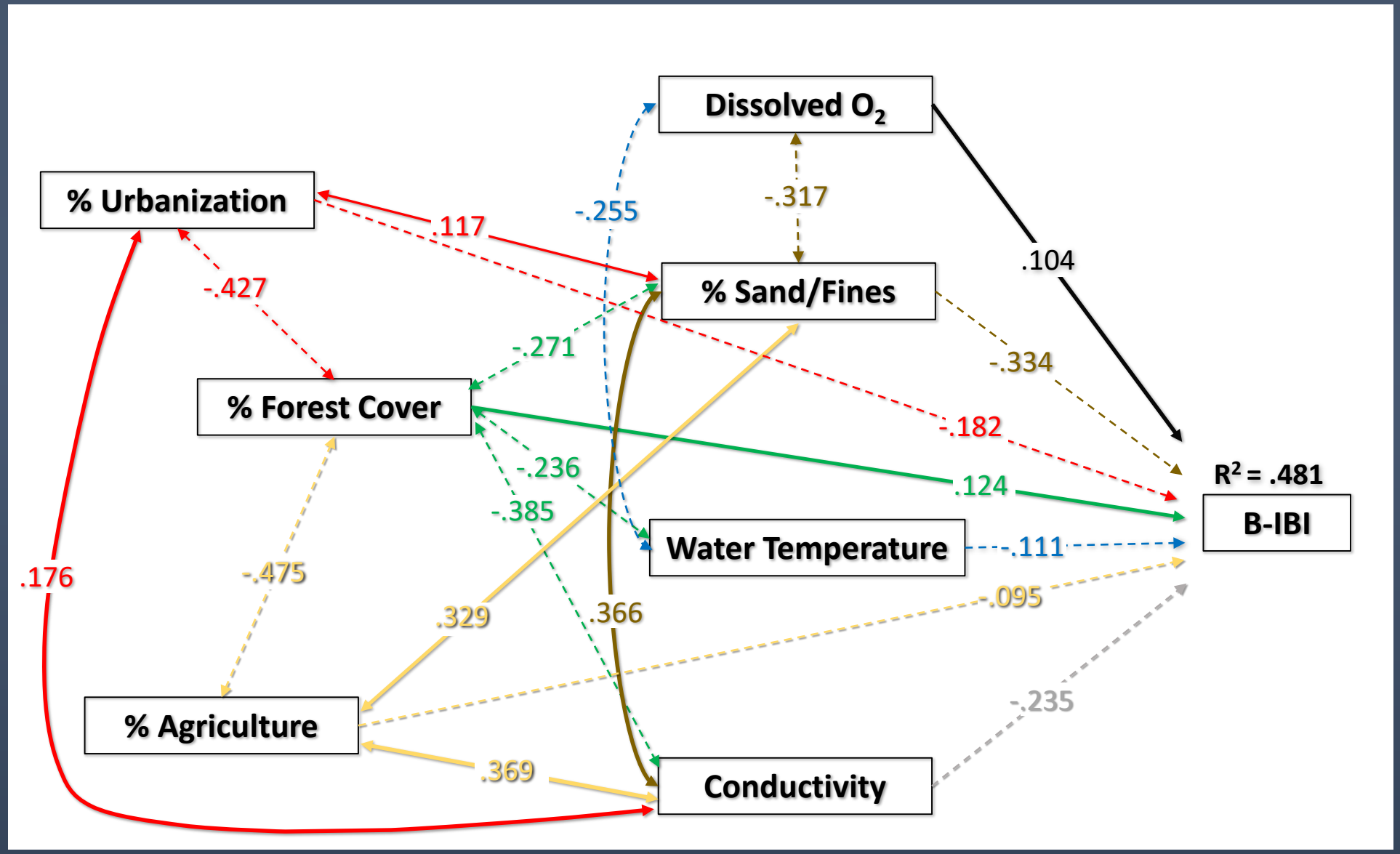
Stressor Identification





Summary:

- In general, nearly 1/3 of stream kilometers assessed in WA in poor biological condition
- Regionally, Puget Sound and far eastern WA had highest proportion of stream kilometers in poor biological condition
- Poor substrate conditions prevalent across the state
- Poor B-IBI scores 4 times more likely when associated with elevated % sand/fines
- AR suggests that nearly 60% of streams now in poor biological condition could be improved with reduction of sand/fines
- *Ecological Indicators* 102 (2019) 175-185


FSBI
125
100
75
50
25
A
B
C
n = 149
n = 68
n = 129
Good
Fair
Poor
EPT taxa richness
25
20
15
10
5
A
B
C
Good
Fair
Poor
Intolerant taxa richness
6
4
2
0
A
B
C
Good
Fair
Poor
Percent tolorant taxa
22.5
20.0
17.5
15.0
12.5
10.0
A
AB
BC
Good
Fair
Poor

Causal Analysis: Structural Equation Model