National Water Quality Monitoring Council Portland Oregon:

Examples of Oregon's Use of Targeted and Probabilistic Monitoring Designs

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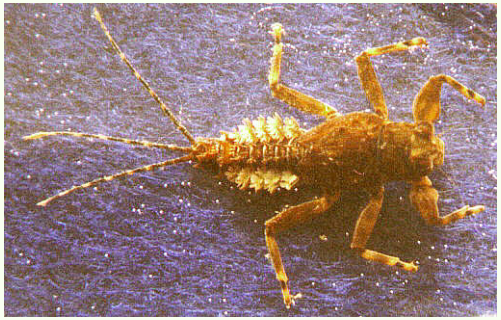
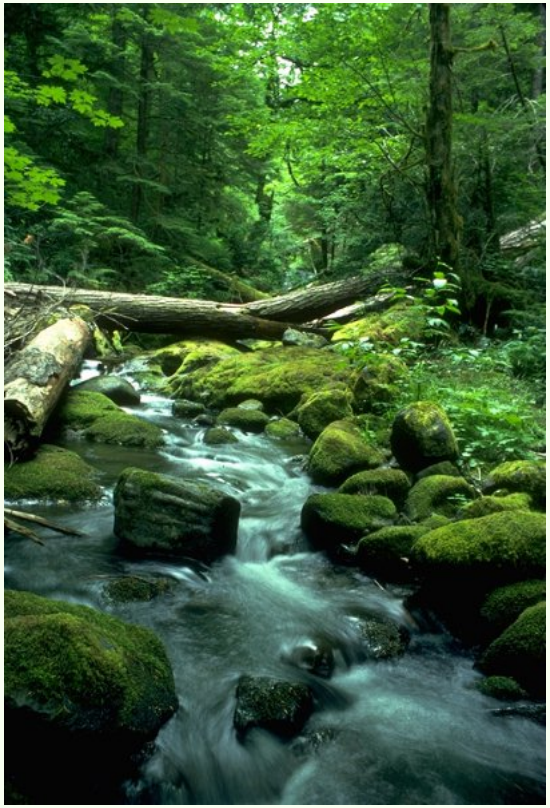
July 21, 2009

DEQ
State of Oregon
Department of
Environmental
Quality

Oregon's Water Quality Monitoring Strategy Objectives

1. Status and trend monitoring
2. Compliance monitoring for standards and permits
3. Effectiveness monitoring of water quality pollution management programs

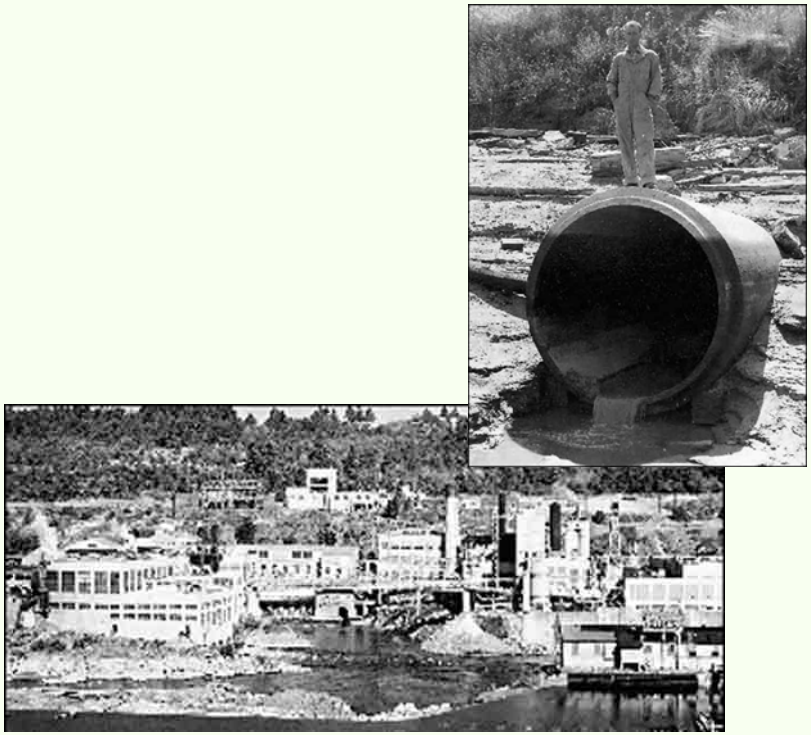




Monitoring Strategy Design:

- Random (probabilistic)
- Targeted

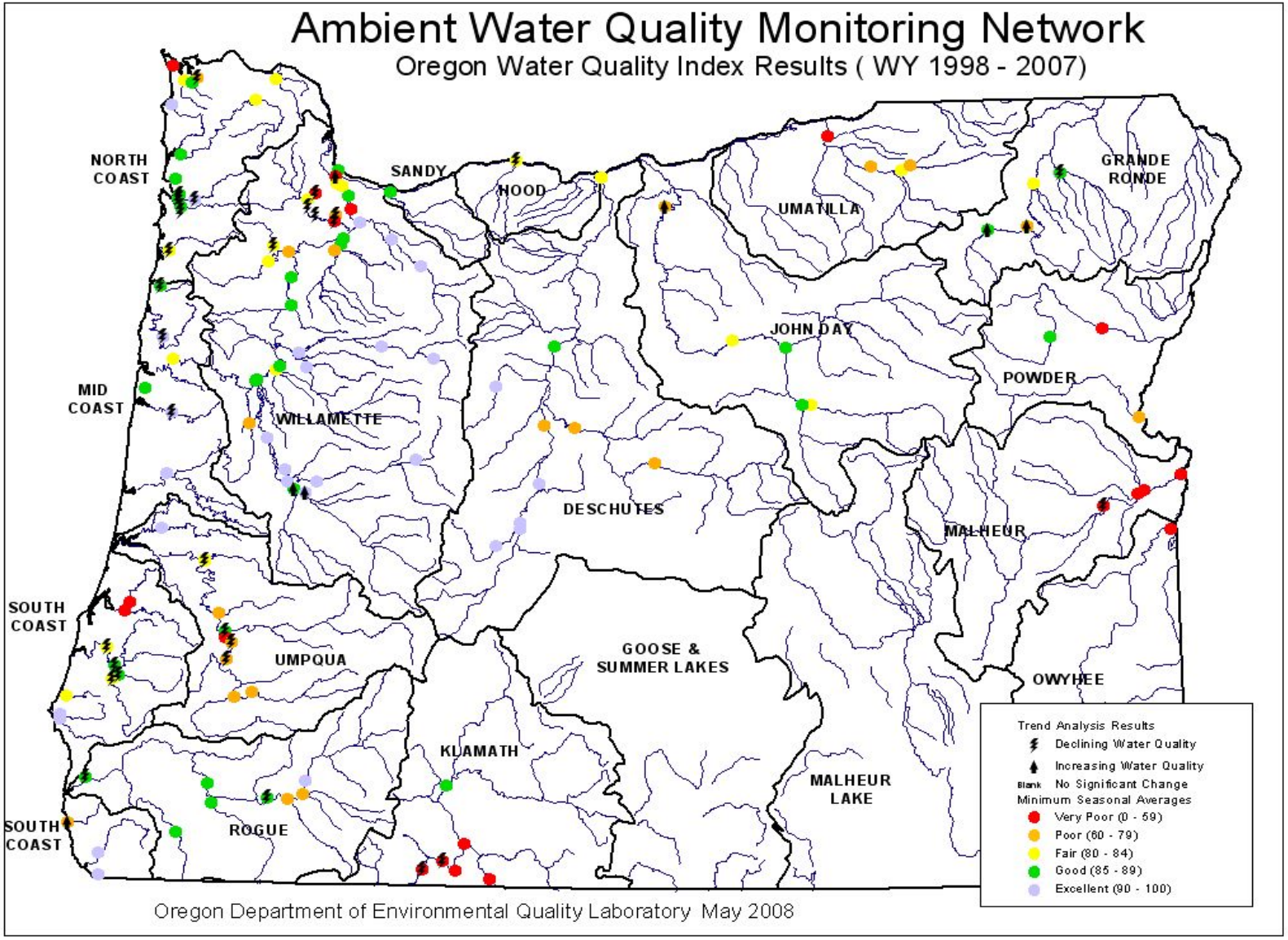
Both designs important for understanding status, trends, and effectiveness



Two Examples

- ***Ambient River Monitoring Network*** –
  - Targeted design, 130 sites, statewide coverage, integrator sites, large rivers only, 30 common water quality indicators
  - status, trends, compliance, TMDLs, source identification

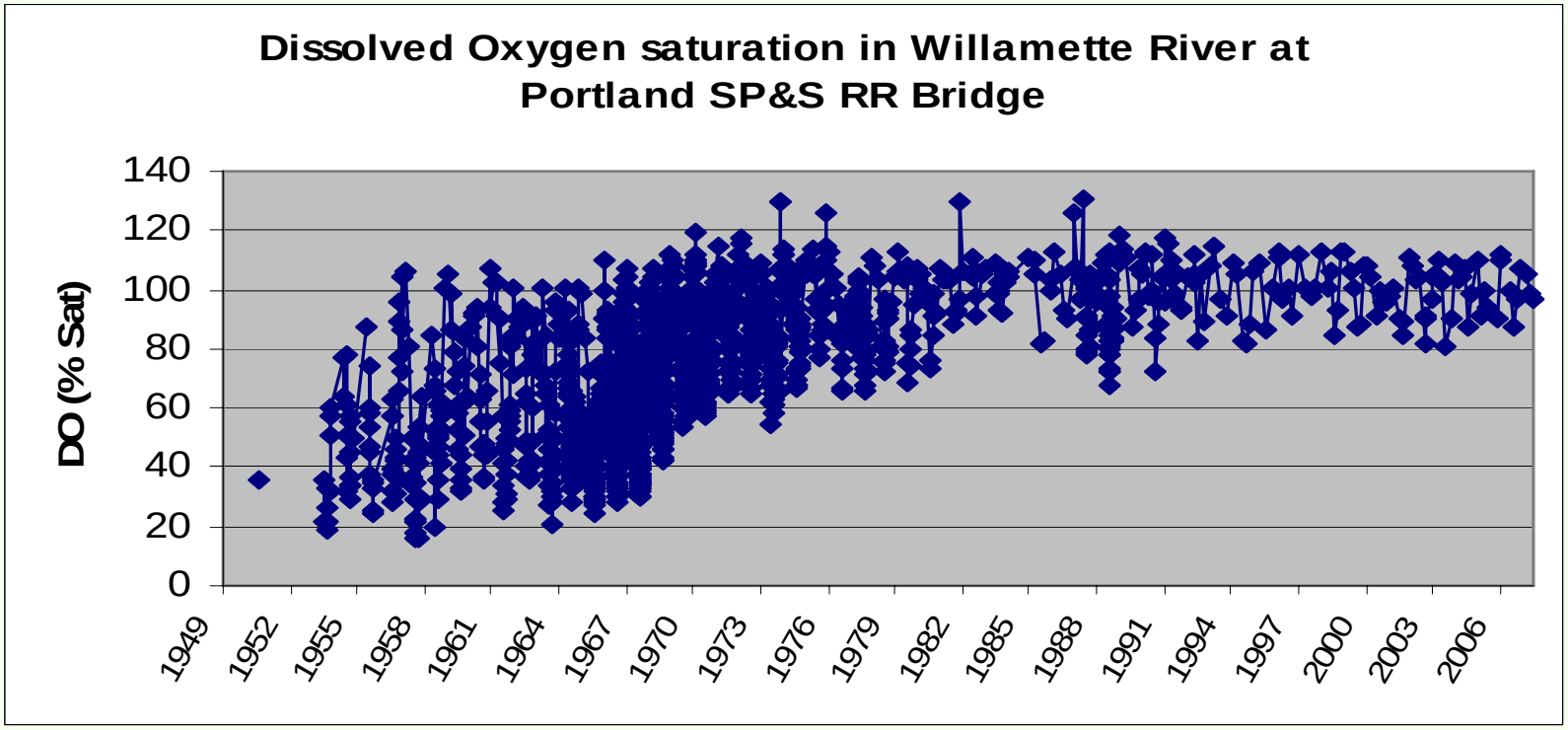
- ***Willamette River Basin Assessment*** –Probabilistic, Willamette Basin, all stream miles, stratified by land use and sub-basins, includes habitat and biology

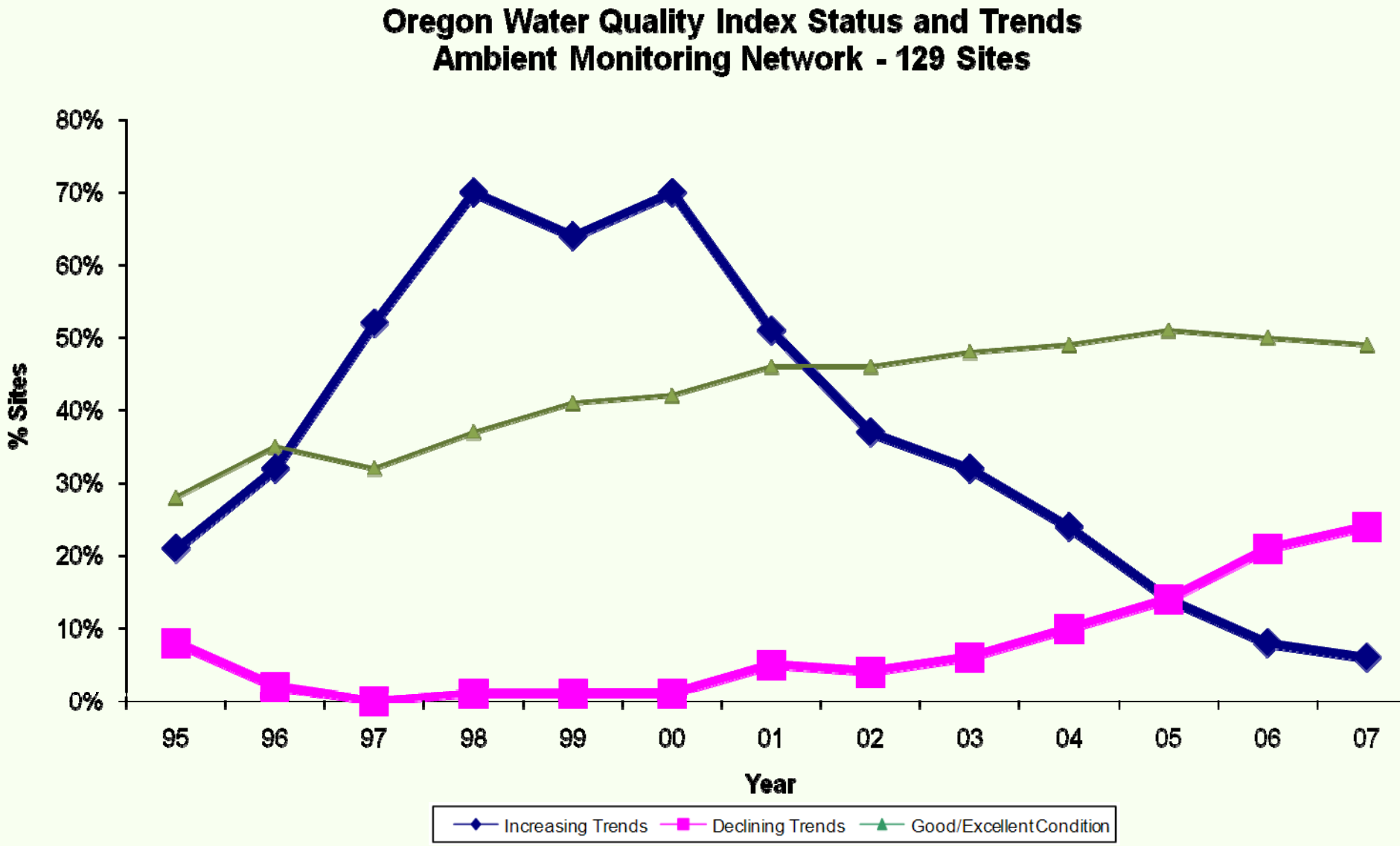


Oregon's Ambient Water Quality Network consists of more than 130 stations that we monitor six times per year for basic water quality parameters. We use this information to trend the water quality of the major rivers of the state using the Oregon Water Quality Index. Our oldest monitoring stations date back to the late 1940's

Trend Analysis Requirements/Challenges

- Long term data collection
- Consistency – methods, accuracy , representation/technology, staff, protocols





Trends based on 10 year Seasonal Kendall Analysis

Willamette Basin Rivers & Streams Assessment

Michael Mulvey
Robin Leferink
Aaron Borisenko

July 14, 2009

THE OREGON PLAN FOR
salmon & watersheds

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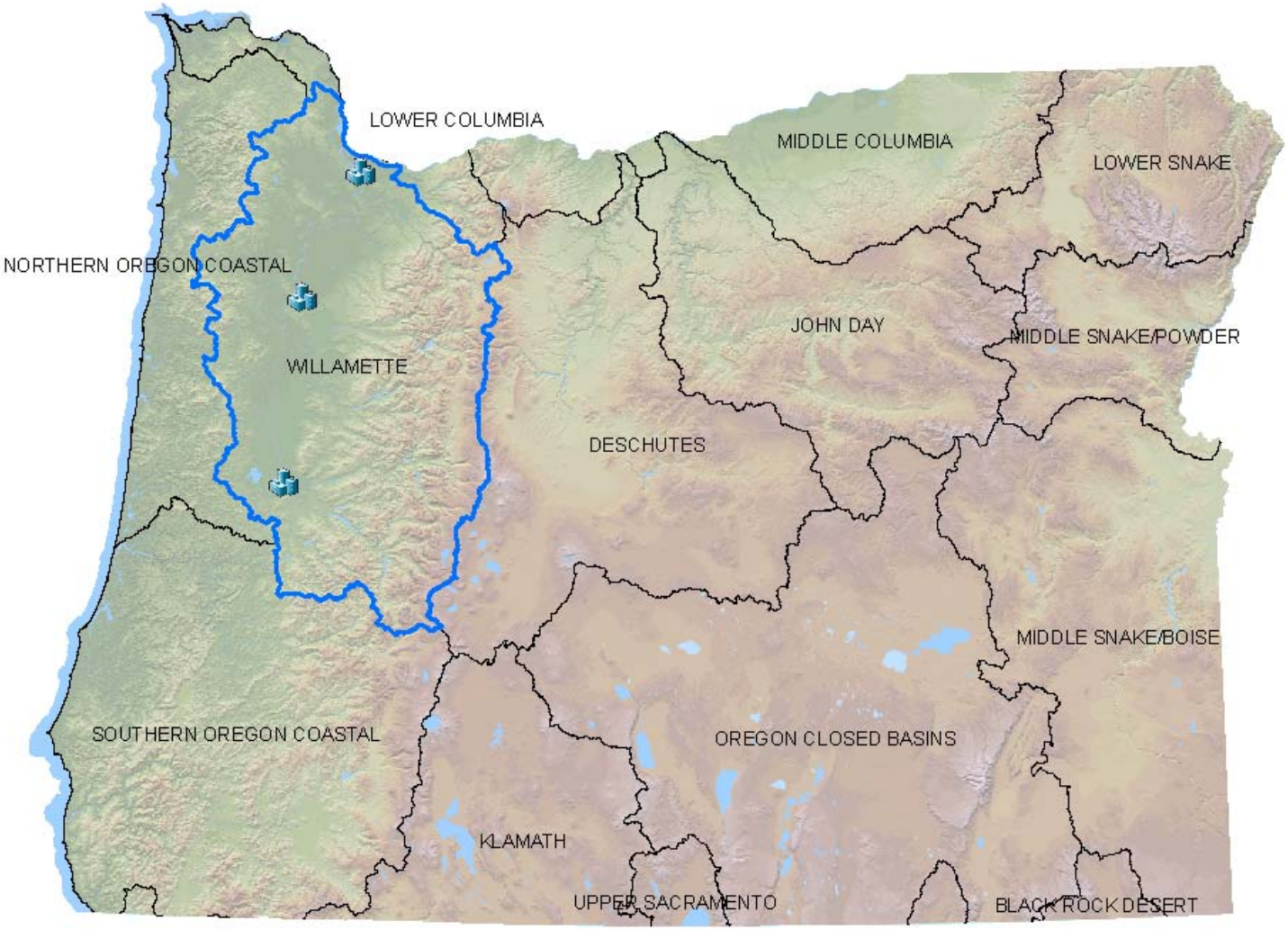
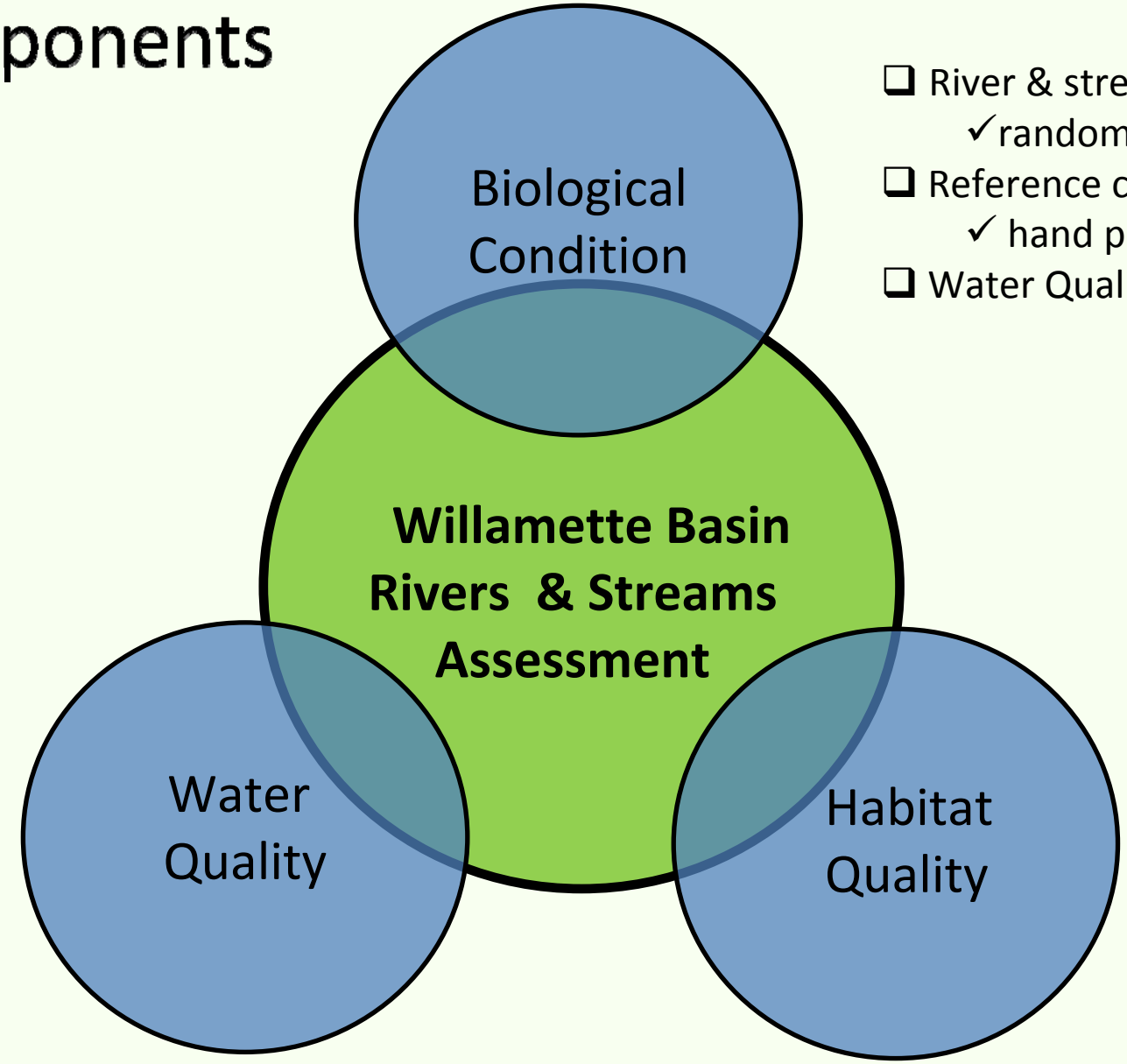
Oregon Basins



Components



- ❑ River & stream 'poll'
  - ✓ randomly selected sites
- ❑ Reference condition:
  - ✓ hand picked best sites
- ❑ Water Quality Standards

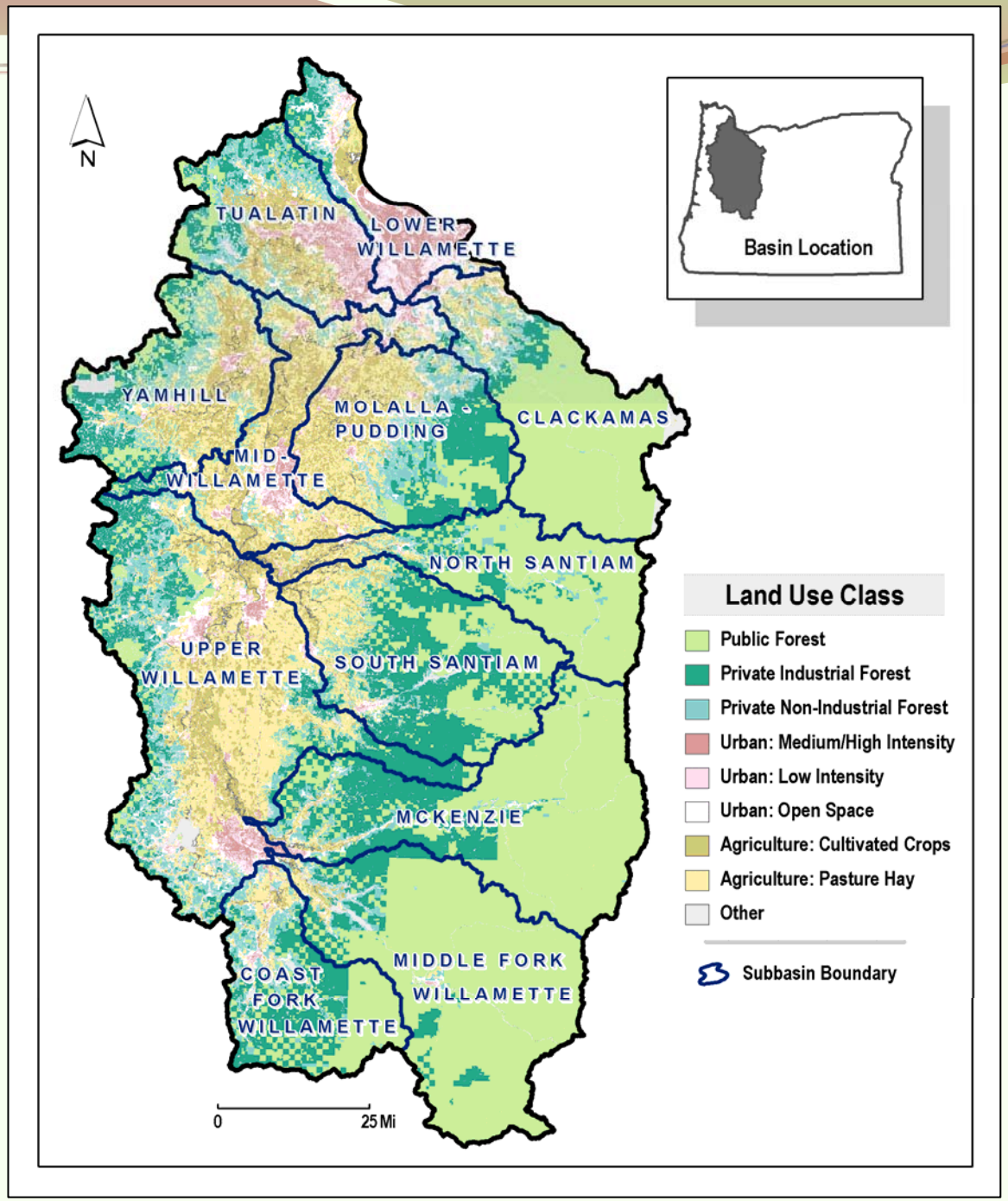
Overview

- **Random sites and reference sites**
  - 450 random sites
  - 230 reference sites
  - 15 different surveys

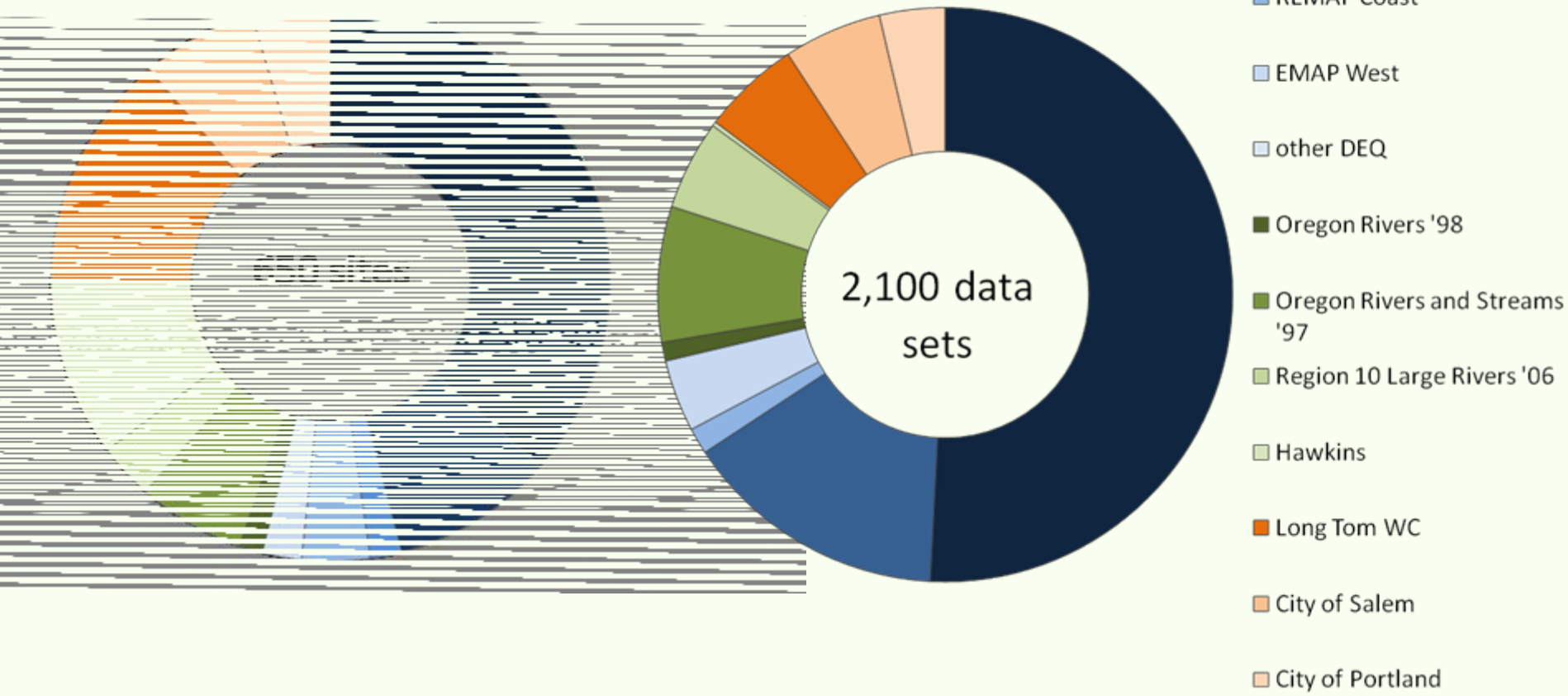
- **Spatial scales**
  - Willamette basin
  - 12 Subbasins
  - 3 Major land use categories
    - 9 Minor
  - Reference condition of basin and subbasins

Land Use

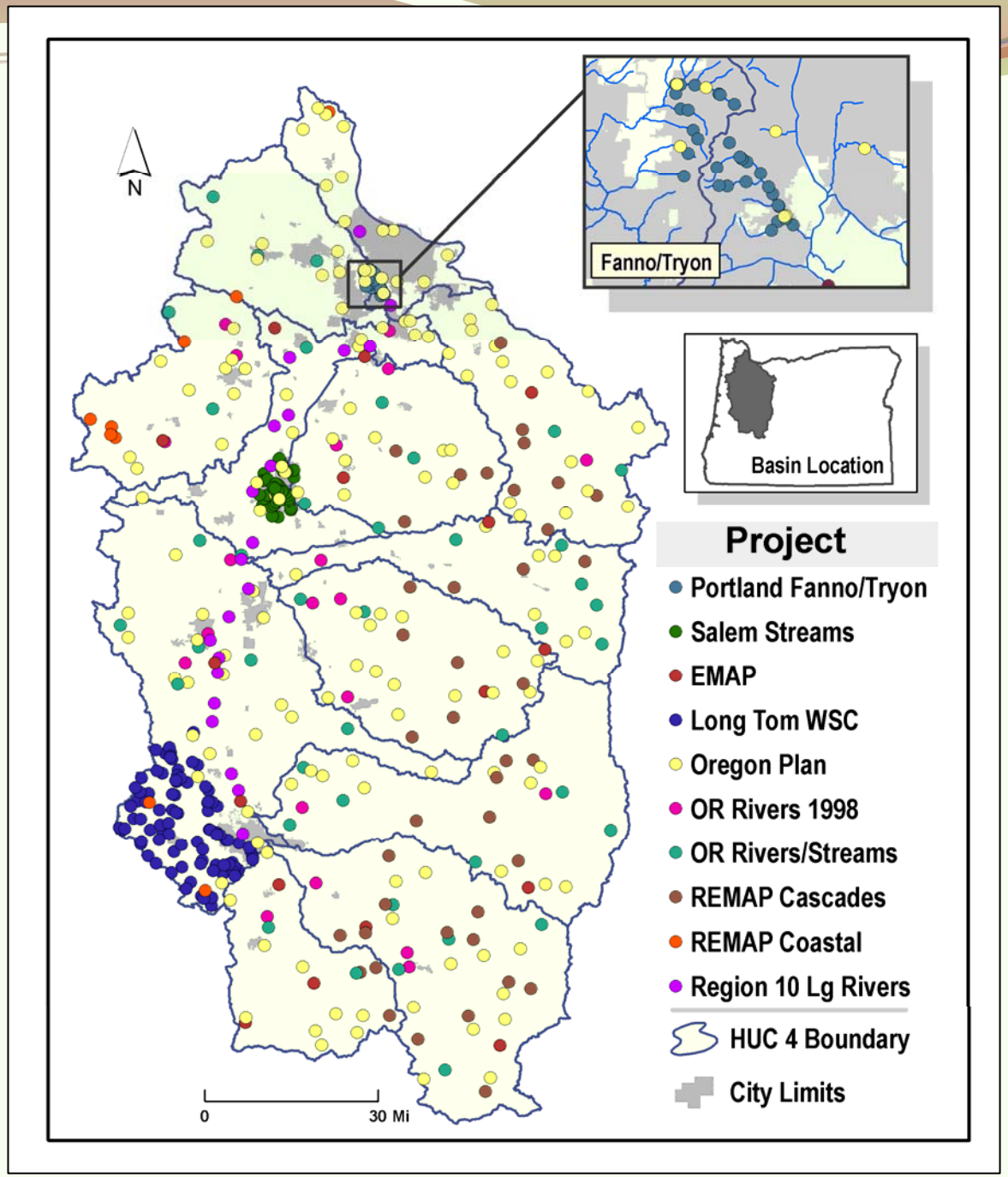
10% Urban
30% Agriculture
60% Forest
33% Public Forest



Data Sources



Site locations



Fish and Amphibians

Habitat

Bugs
Bugs

Chemistry

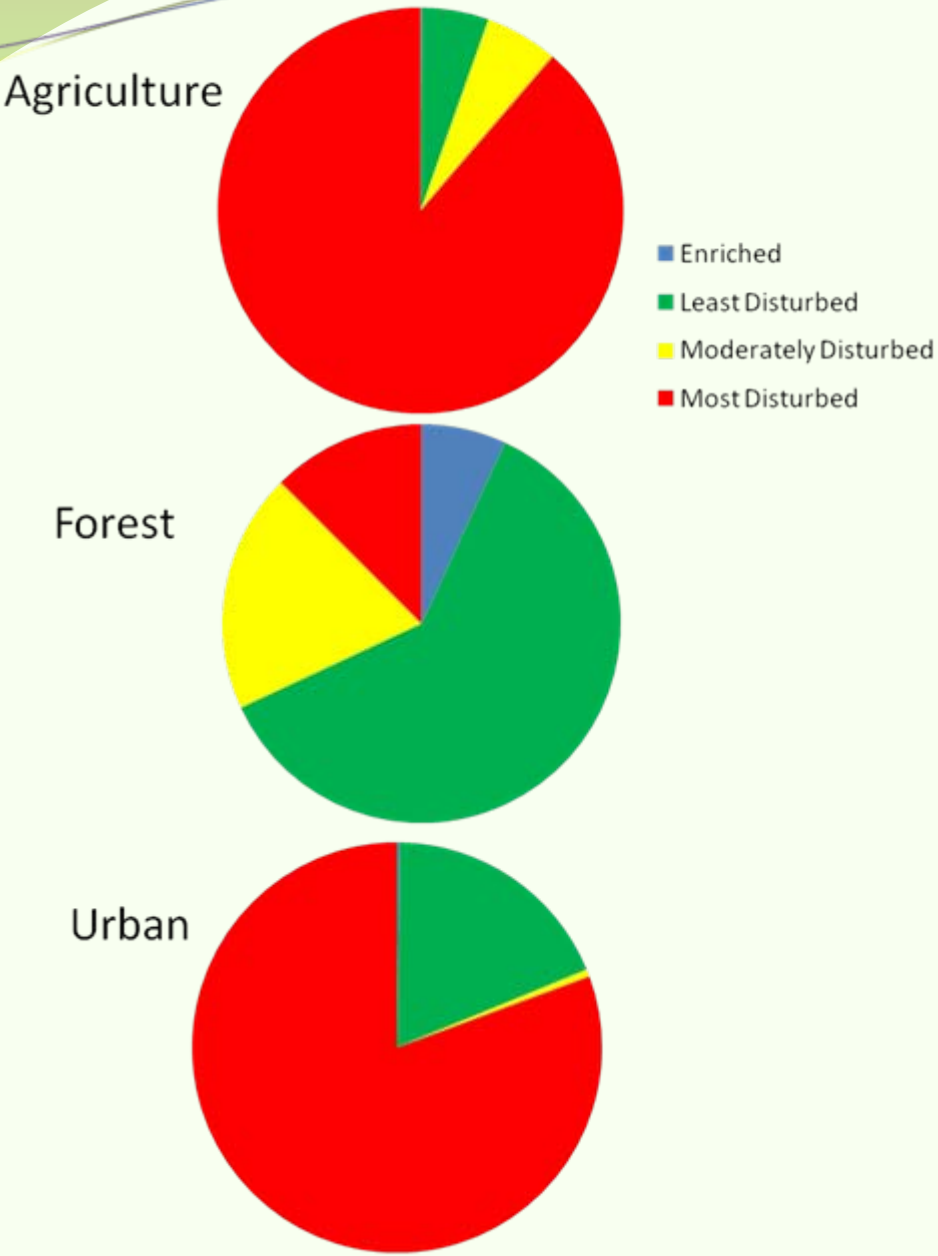
Tualatin River

An agricultural stream
05/29/2003

An urban stream

A forest stream
Cascades Reference site
05/20/2003

Basin Land Use Condition



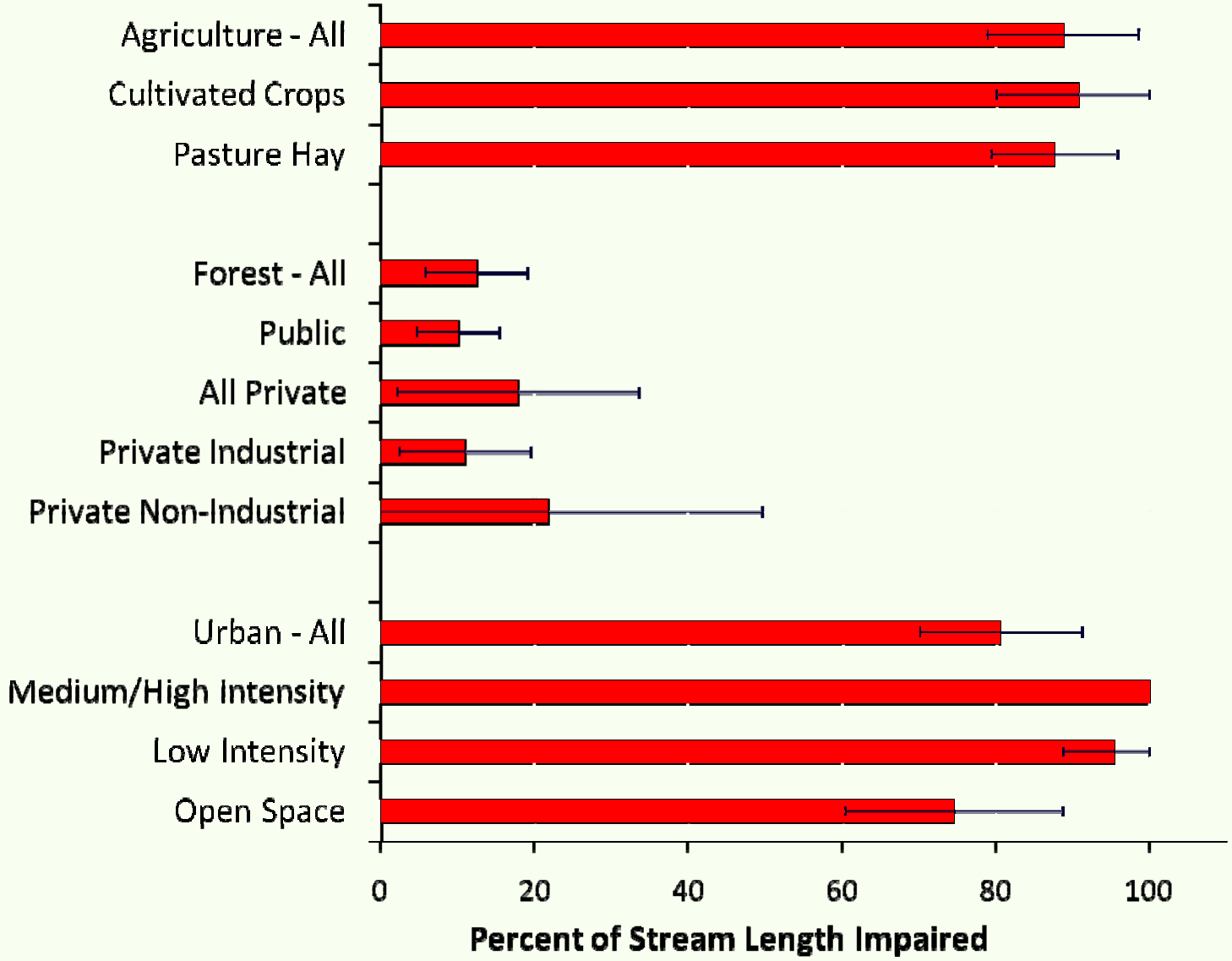
Major Stressors

- Temperature
- Riparian vegetation and disturbance
- Fine sediment
- Dissolved oxygen

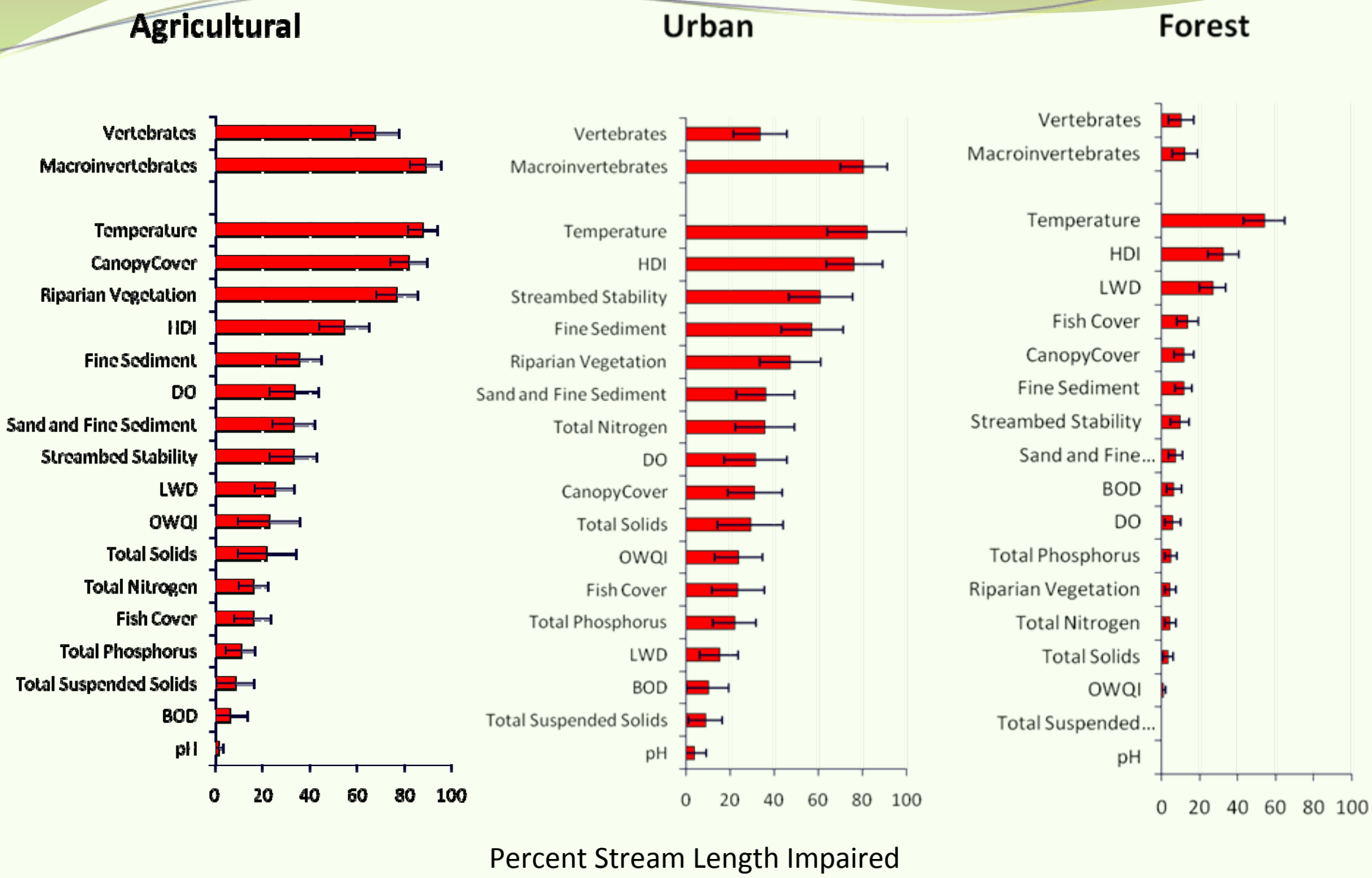
- Temperature
- Riparian disturbance
- Fish habitat complexity
- Fine sediment and streambed stability

- Temperature
- Riparian disturbance
- Fine sediment and streambed stability
- Nutrients (nitrogen)

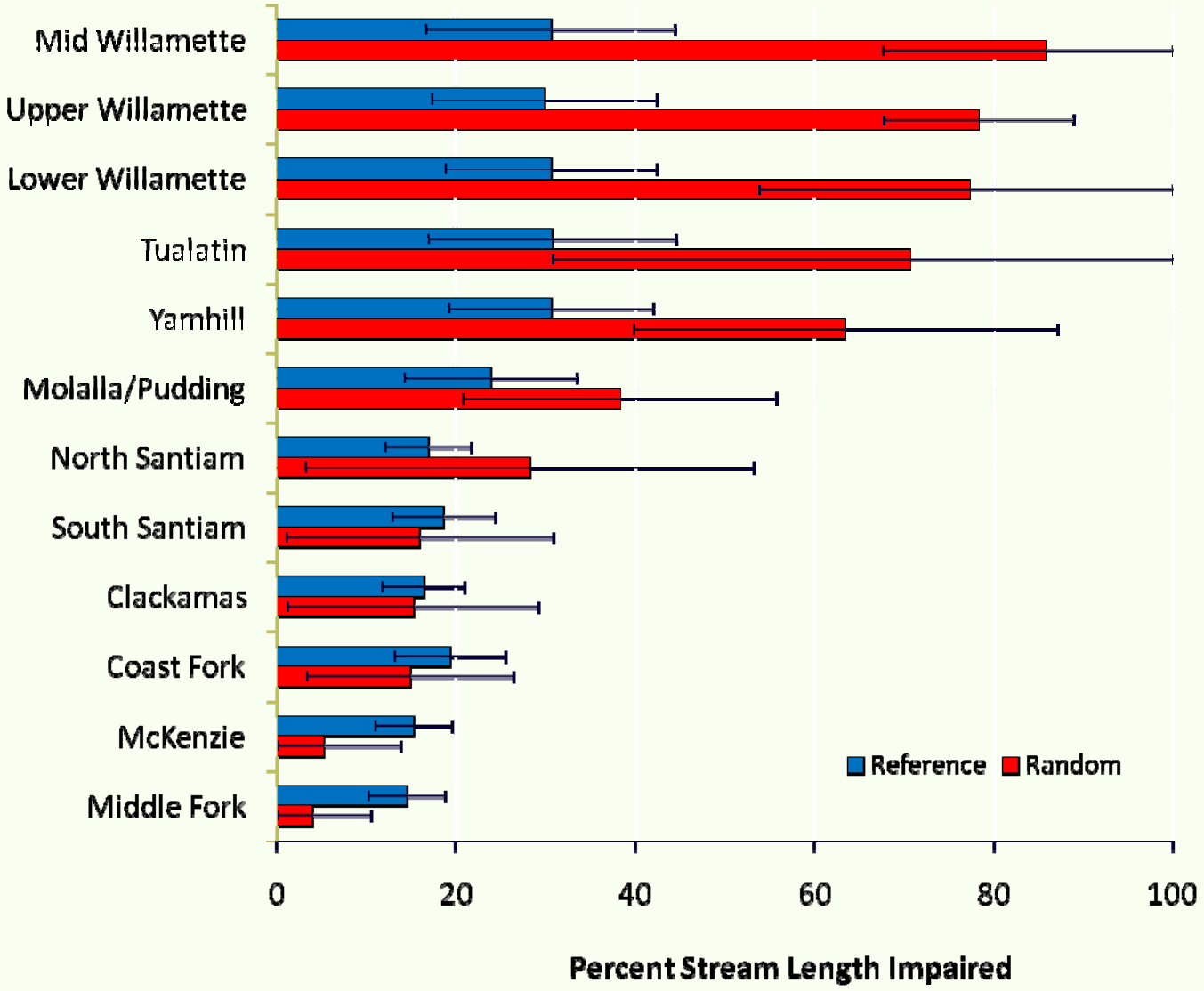
Biological Condition by Land Use



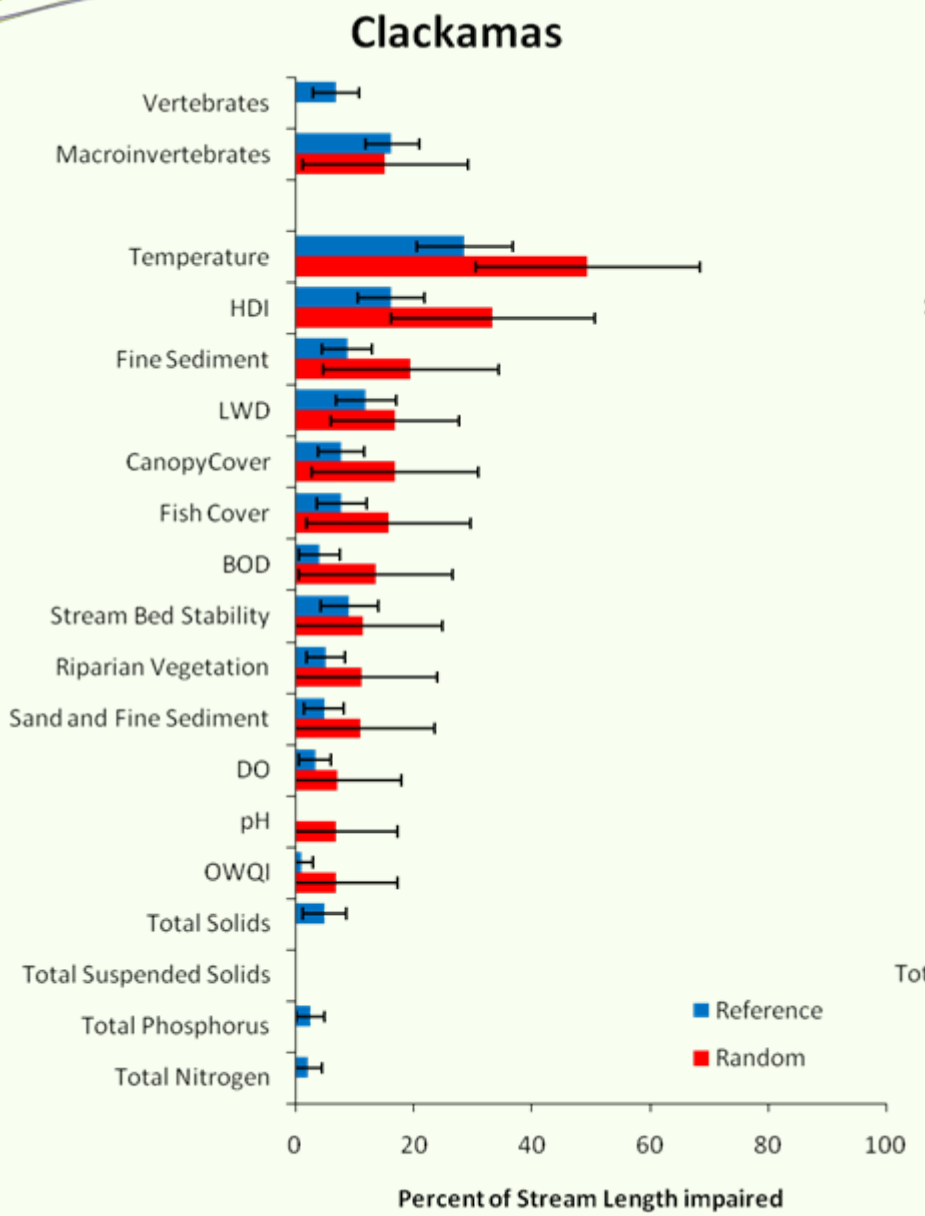
Major Land Uses

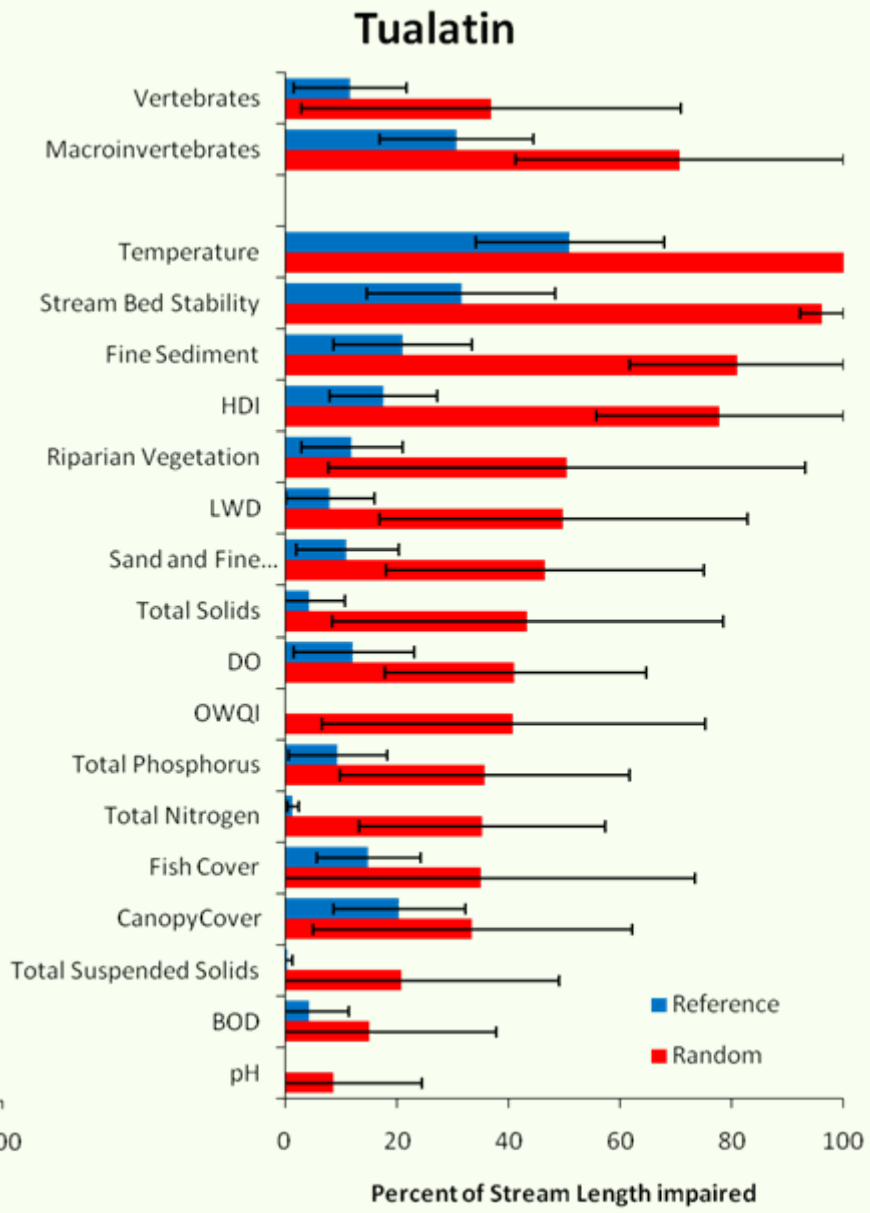


Subbasins


Mid Willamette
Upper Willamette
Lower Willamette
Tualatin
Yamhill
Molalla/Pudding
North Santiam
South Santiam
Clackamas
Coast Fork
McKenzie
Middle Fork
Reference
Random
0
20
40
60
80
100
Percent Stream Length Impaired

Subbasins


Clackamas
Vertebrates
Macroinvertebrates
Temperature
HDI
Fine Sediment
LWD
CanopyCover
Fish Cover
BOD
Stream Bed Stability
Riparian Vegetation
Sand and Fine Sediment
DO
pH
OWQI
Total Solids
Total Suspended Solids
Total Phosphorus
Total Nitrogen
Reference
Random
0
20
40
60
80
100
Percent of Stream Length impaired


Tualatin
Vertebrates
Macroinvertebrates
Temperature
Stream Bed Stability
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HDI
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Sand and Fine...
Total Solids
DO
OWQI
Total Phosphorus
Total Nitrogen
Fish Cover
CanopyCover
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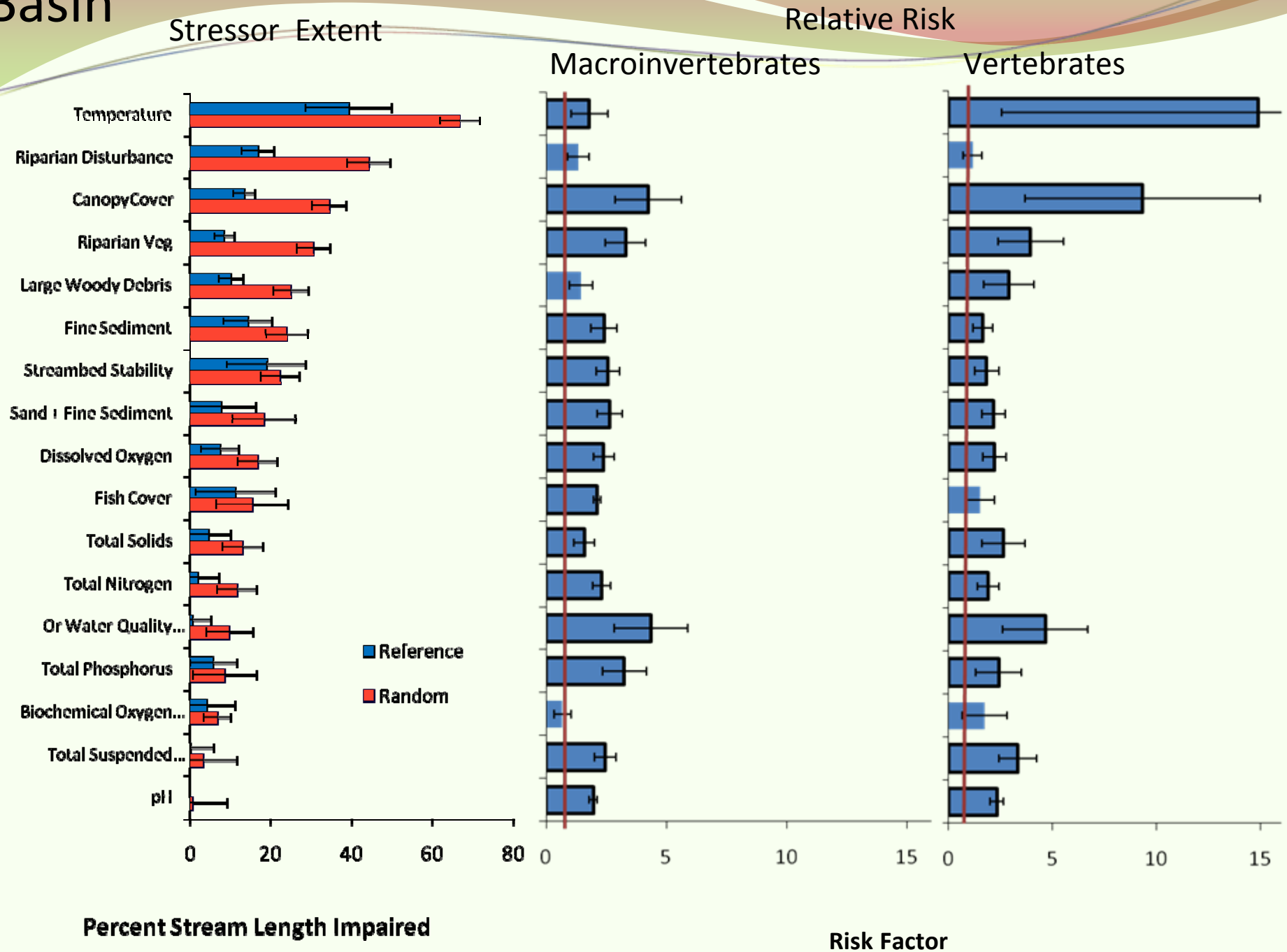
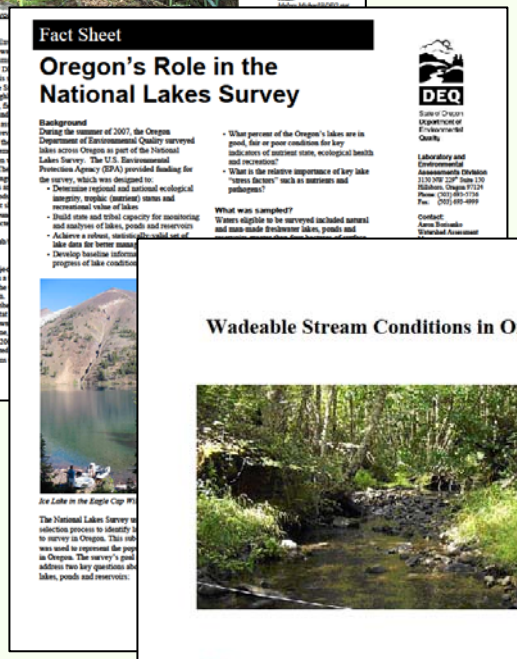
BOD
pH
Reference
Random
0
20
40
60
80
100
Percent of Stream Length impaired

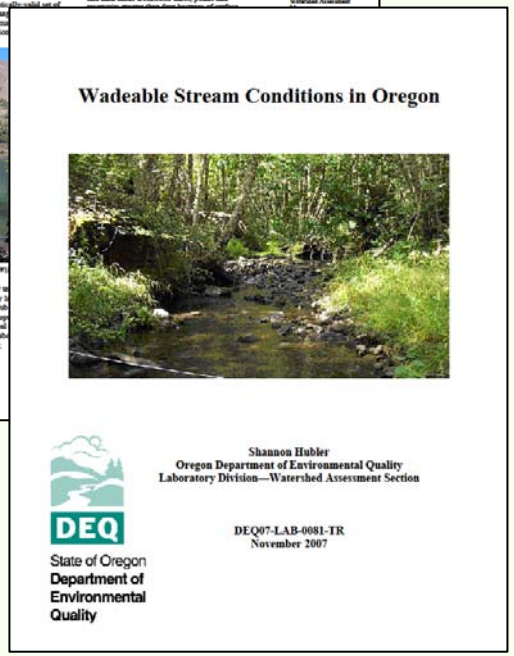
Basin

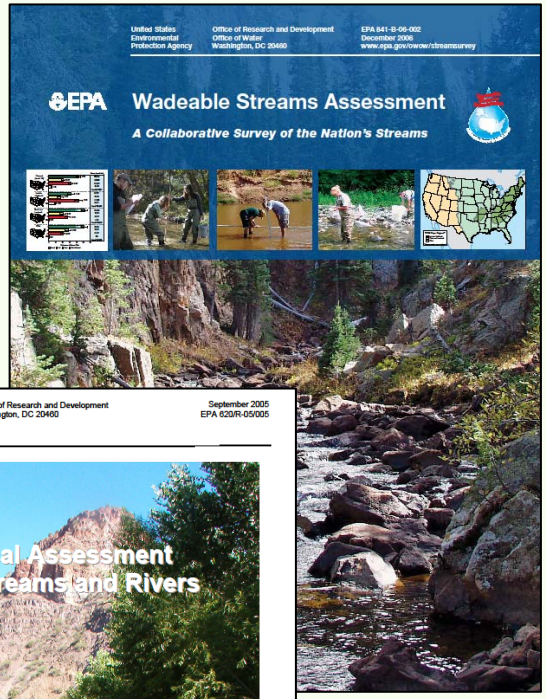

Stressor Extent
Relative Risk
Macroinvertebrates
Vertebrates
Temperature
Riparian Disturbance
CanopyCover
Riparian Veg
Large Woody Debris
Fine Sediment
Streambed Stability
Sand + Fine Sediment
Dissolved Oxygen
Fish Cover
Total Solids
Total Nitrogen
Or Water Quality...
Total Phosphorus
Biochemical Oxygen...
Total Suspended...
pH
Reference
Random
0
20
40
60
80
0
5
10
15
0
5
10
15
Percent Stream Length Impaired
Risk Factor

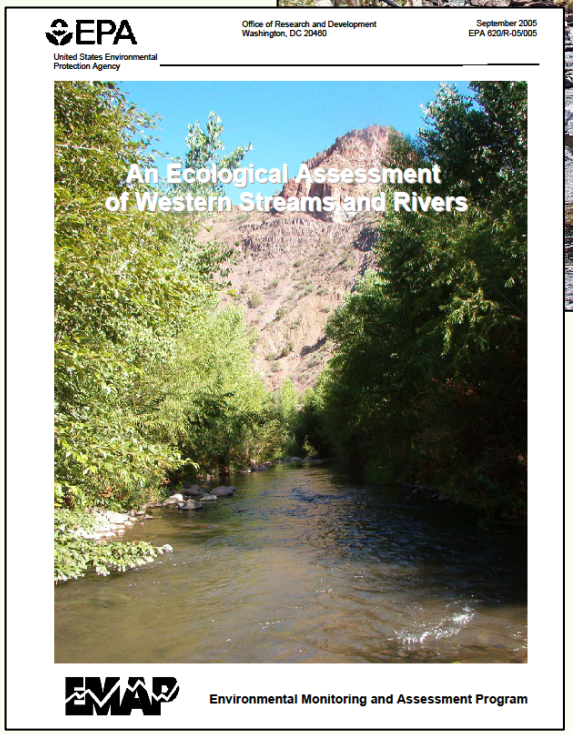
Other Related Reports

available on DEQ and EPA web sites









Thank You

Survey Design

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- Tony Olson, EPA
- Phil Larsen, EPA

Data Analysis

- Don Stevens, OSU
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- Shannon Hubler, DEQ

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- Phil Kaufmann, OSU

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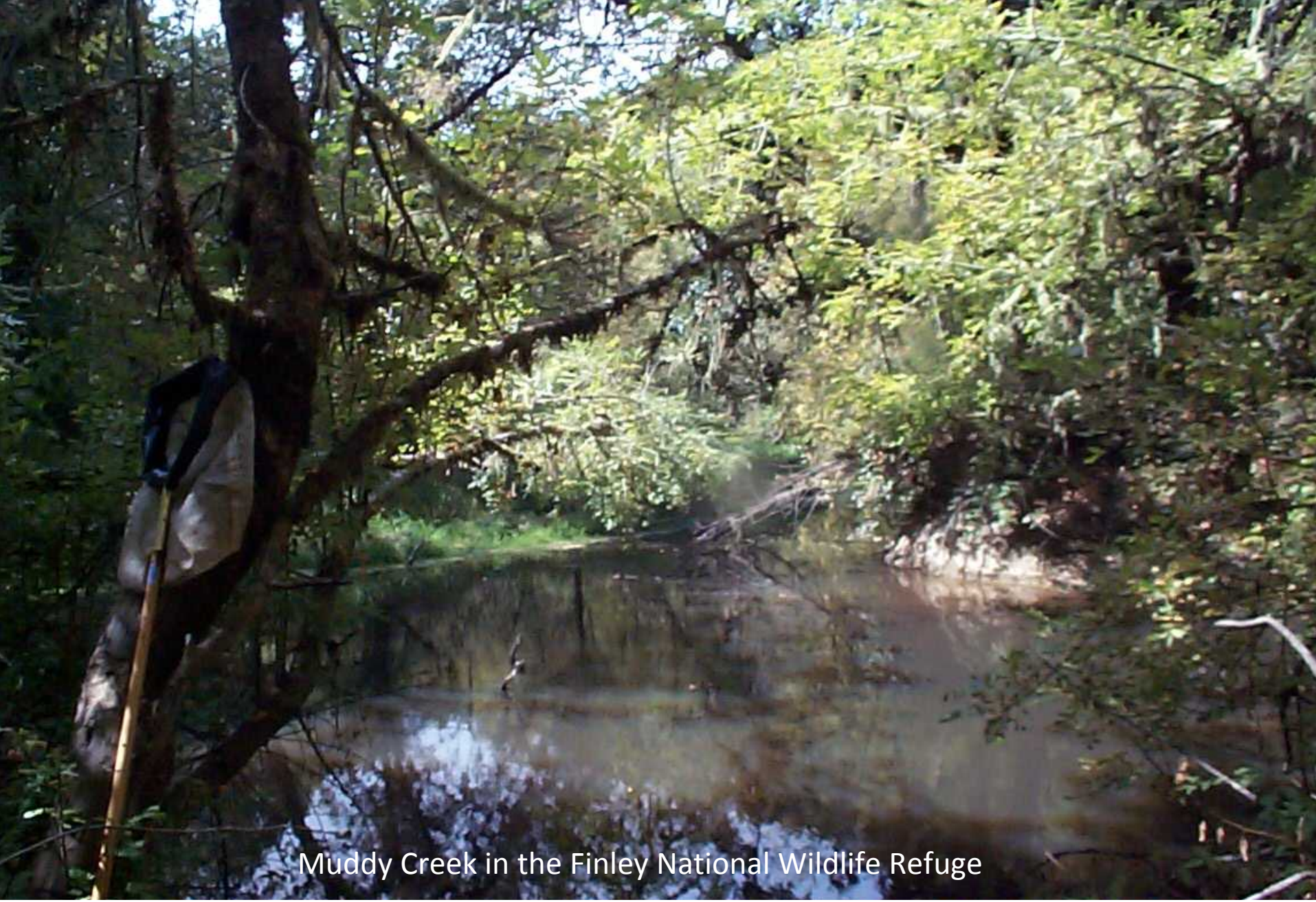
- Ken Roley, City of Salem
- Chris Prescott, City of Portland
- Cindy Theiman, Long Tom Watershed Council



Questions?

State of Oregon
Department of
Environmental
Quality

High Level Indicators of Forest Conditions

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Robin Leferink
Sarah Miller
Lesley Merrick
Aaron Borisenko

Background

- The Montreal Process adopted in 1995
  - 12 member countries
  - Temperate and boreal forests
- Oregon Indicators of Sustainable Forest Management
  - Economic
  - Social
  - Environmental
    - Strategy D: Protect, maintain, and enhance the soil and water resources of Oregon's forests
      - Water quality
      - Biological integrity
      - Forest road risks
        - Not assessed in this report

Objectives

- Assess the status of water quality (OWQI) and Biological Integrity (Bugs) on forested lands in Oregon
- Spatial scales
  - Statewide
  - Basin (3rd field HUCs)
  - Ownership
- Report back to Board of Forestry and public
  - This report = baseline

Sites included in analyses

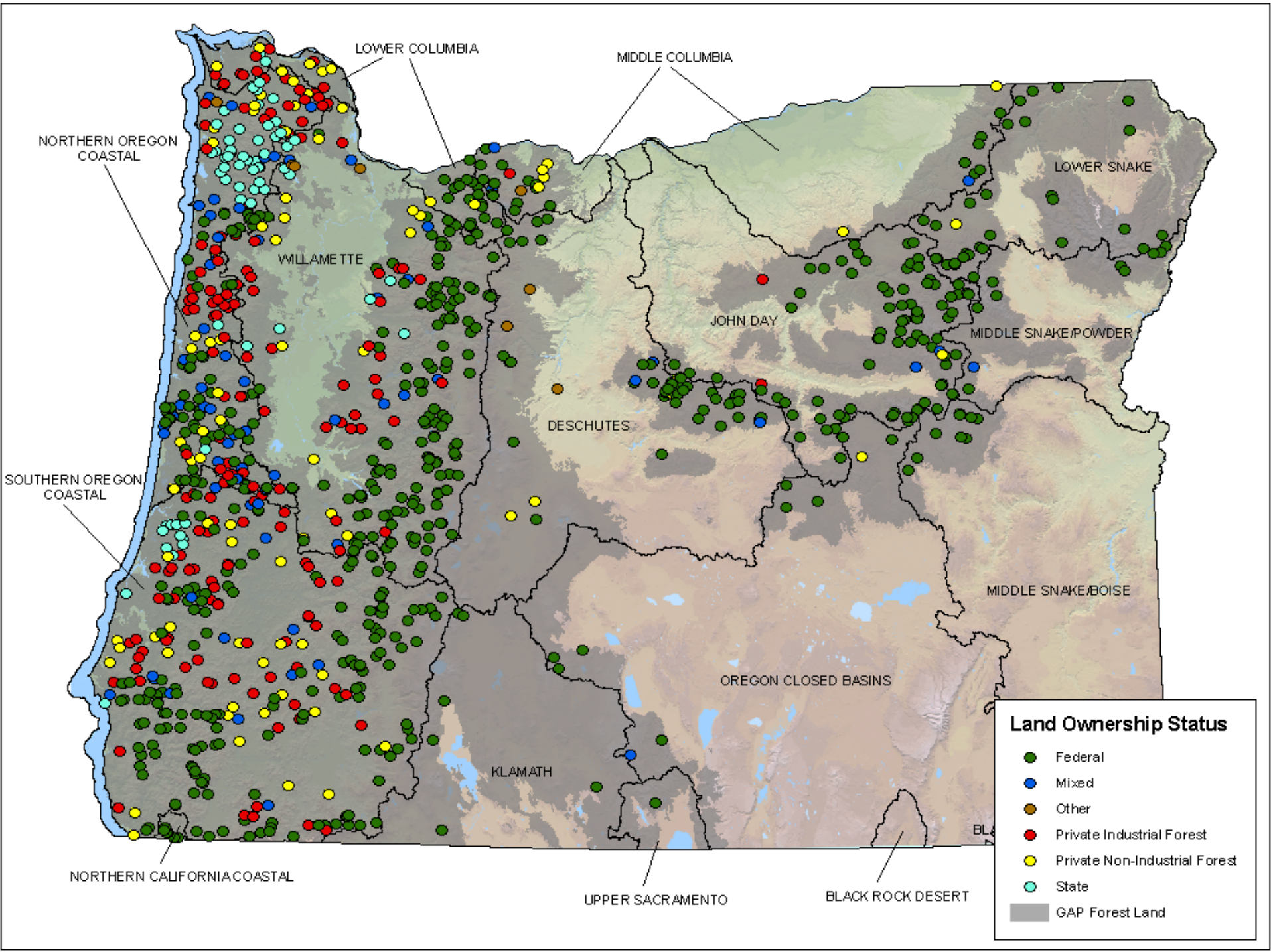
- Criteria:
  - 1) previous 10 years = 1998 - 2007
  - 2) Dominant land use = forestry
  - 3) Water chemistry and/or macroinvertebrate sample
- 67% Random
- 33% Targeted
- Percent of sites only
  - Provides a baseline for future reports

Defining Forest Lands

- Identify forest lands
  - Interagency Mapping and Assessment Project
  - Watershed scale ≥ 70% Forest in Watershed
  - Delineated pour-point
  - 6th field HUCs
  - Local scale≥ 70 Forest at the Local scale
  - 300 m diameter buffer

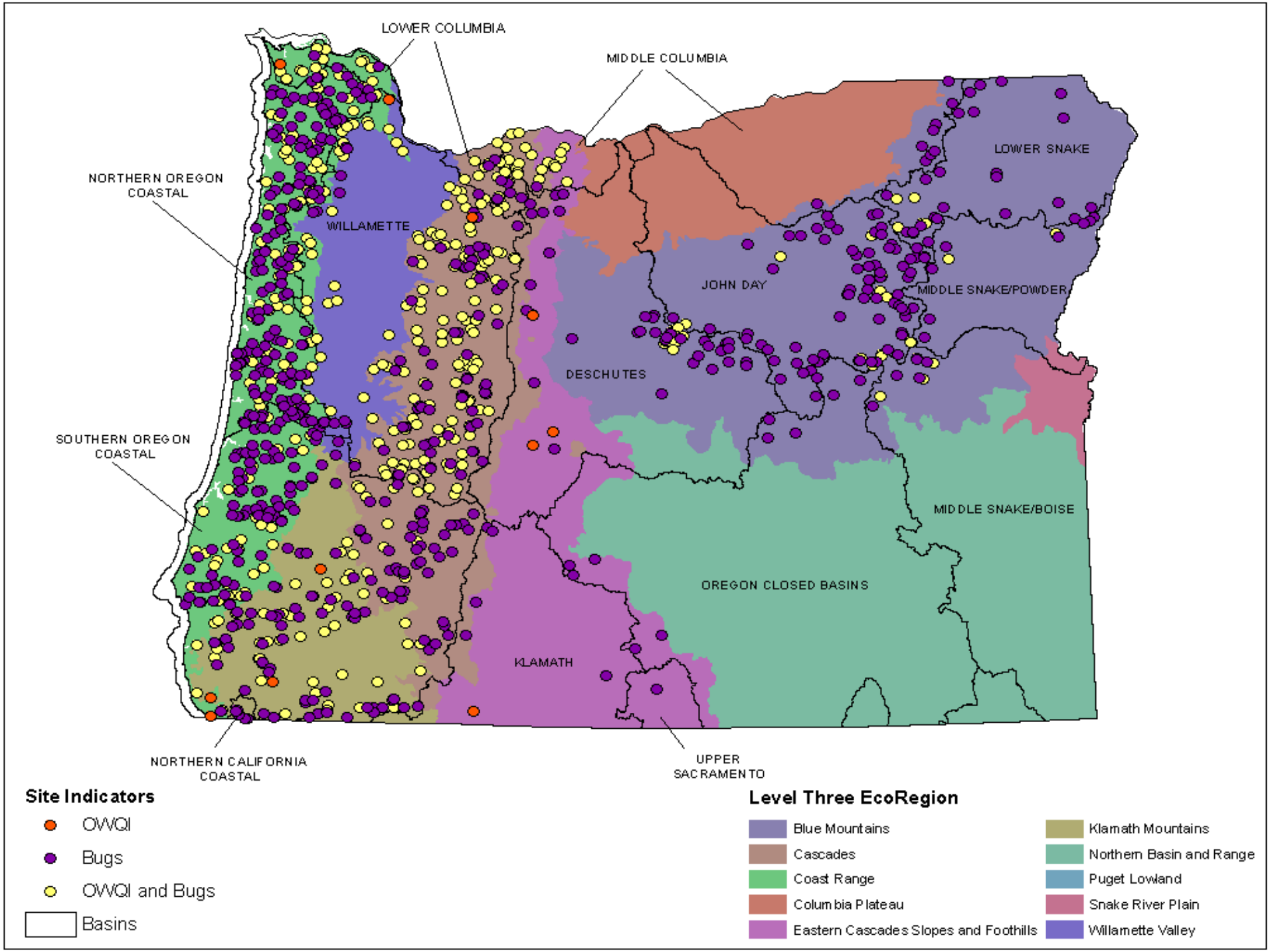
Defining ownership

- ODF forest ownership coverage
- 4 classes
  - Federal
  - State
  - Private industrial
  - Private non-industrial
- Only determined at the local scale
  - Criteria:
    - ≥ 70% of a single ownership class locally
  - We recognize the deficiencies


LOWER COLUMBIA
MIDDLE COLUMBIA
NORTHERN OREGON COASTAL
LOWER SNAKE
WILLAMETTE
JOHN DAY
MIDDLE SNAKE/POWDER
DESCHUTES
SOUTHERN OREGON COASTAL
MIDDLE SNAKE/BOISE
OREGON CLOSED BASINS
KLAMATH
NORTHERN CALIFORNIA COASTAL
UPPER SACRAMENTO
BLACK ROCK DESERT
Land Ownership Status
Federal
Mixed
Other
Private Industrial Forest
Private Non-Industrial Forest
State
GAP Forest Land

Assessment tools

- To assess water quality conditions:
  - Oregon Water Quality Index (OWQI)
- To assess biological conditions:
  - Predictive Assessment Tool for Oregon (PREDATOR)
  - Stressor ID models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SOUTHERN OREGON COASTAL
MIDDLE SNAKE/BOISE
OREGON CLOSED BASINS
KLAMATH
NORTHERN CALIFORNIA COASTAL
UPPER SACRAMENTO
Site Indicators
OWQI
Bugs
OWQI and Bugs
Basins
Level Three EcoRegion
Blue Mountains
Cascades
Coast Range
Columbia Plateau
Eastern Cascades Slopes and Foothills
Klamath Mountains
Northern Basin and Range
Puget Lowland
Snake River Plain
Willamette Valley

Statewide

- Water quality is predominantly in excellent condition
  - 77% Excellent
  - 5% Poor/Very Poor

- Biological condition is generally good
  - 53% Least disturbed
  - 24% Most disturbed

Hydrologic Units

Reporting Unit	PREDATOR *Most disturbed*	Temperature Score *≥18.0 °C*	Fine Sediment Score *> 10% fines*	Oregon Water Quality Index *Poor + Very Poor*
Middle Columbia	1	1	1	1
Willamette	2	3	2	2
Lower Columbia	3	2	3	4
North Coast	5	7	6	3
John Day	4	5	7	--
Deschutes	7	8	8	--
Lower Snake	5	4	4	--
South Coast	8	6	4	5

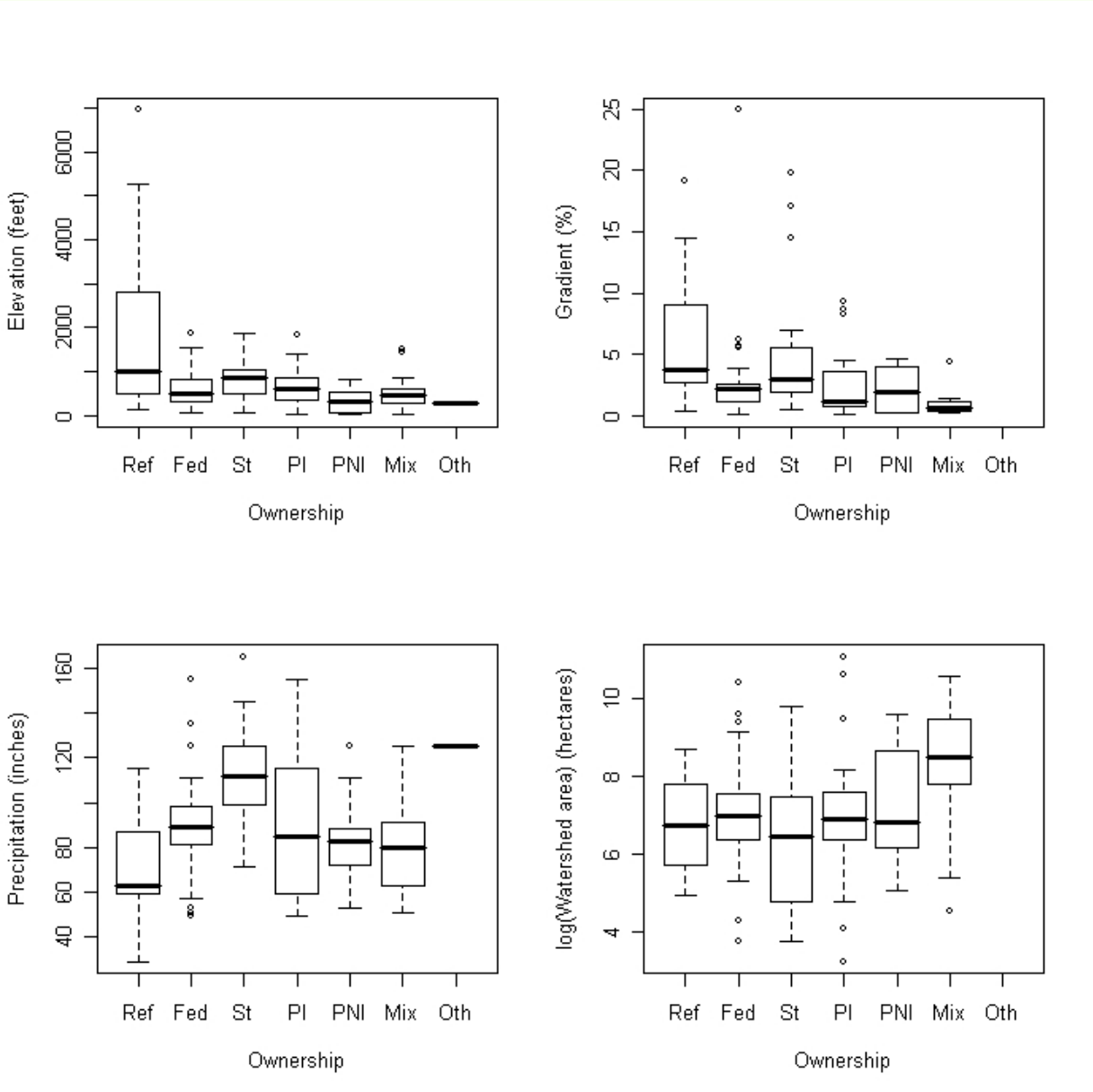
Ownership--Statewide

Ownership class (n)	OWQI (% Excellent)	PREDATOR (% Least disturbed)
Federal (623)	86	55
State (69)	75	51
Private Industrial (171)	66	58
Private Non-industrial (80)	59	35

Ownership—North Coast

Ownership class (n)	PREDATOR (Least disturbed)	Inferred Temperature (< 16 oC)	Inferred Fine Sediments (0-10%)
Federal (68)	69%	12%	69%
State (46)	54%	37%	87%
Private Industrial (57)	61%	12%	49%
Private Non-industrial (24)	38%	0%	46%

Natural factors



Future work

- Increase sample sizes
  - Eastern Oregon
    - Incorporate USFS and BLM datasets
- Probability design
  - Statistical confidence
  - Include ownership classes
- Better identify ownership
  - Local and watershed scales
- Add natural expectations and reference condition to Stressor ID models

Acknowledgements

- Peter Leinenbach (USEPA Region 10)
- Chuck Hawkins (USU)
- John Van Sickle (USEPA-ORD)
- Yangdong Pan and Chris Parker (PSU)
- David Morman & Jeremy Groom (ODF)
- Jeff Adams (Xerces)

05/20/2003

OWQI

- 9 sub-indices
- Each scored on 0-100 scale
- OWQI
  - 10 - 100
  - Unweighted harmonic square mean
- Based on a one-time grab sample
- 424 sites

Parameter	Units
Temperature	^{o}C
Dissolved Oxygen	mg/l
Dissolved Oxygen Percent Saturation	%
Biochemical Oxygen Demand (BOD-5)	mg/l
pH	SU
Total Solids	mg/l
Ammonia	mg/l
Nitrate + Nitrite	mg/l
Total Phosphate	mg/l

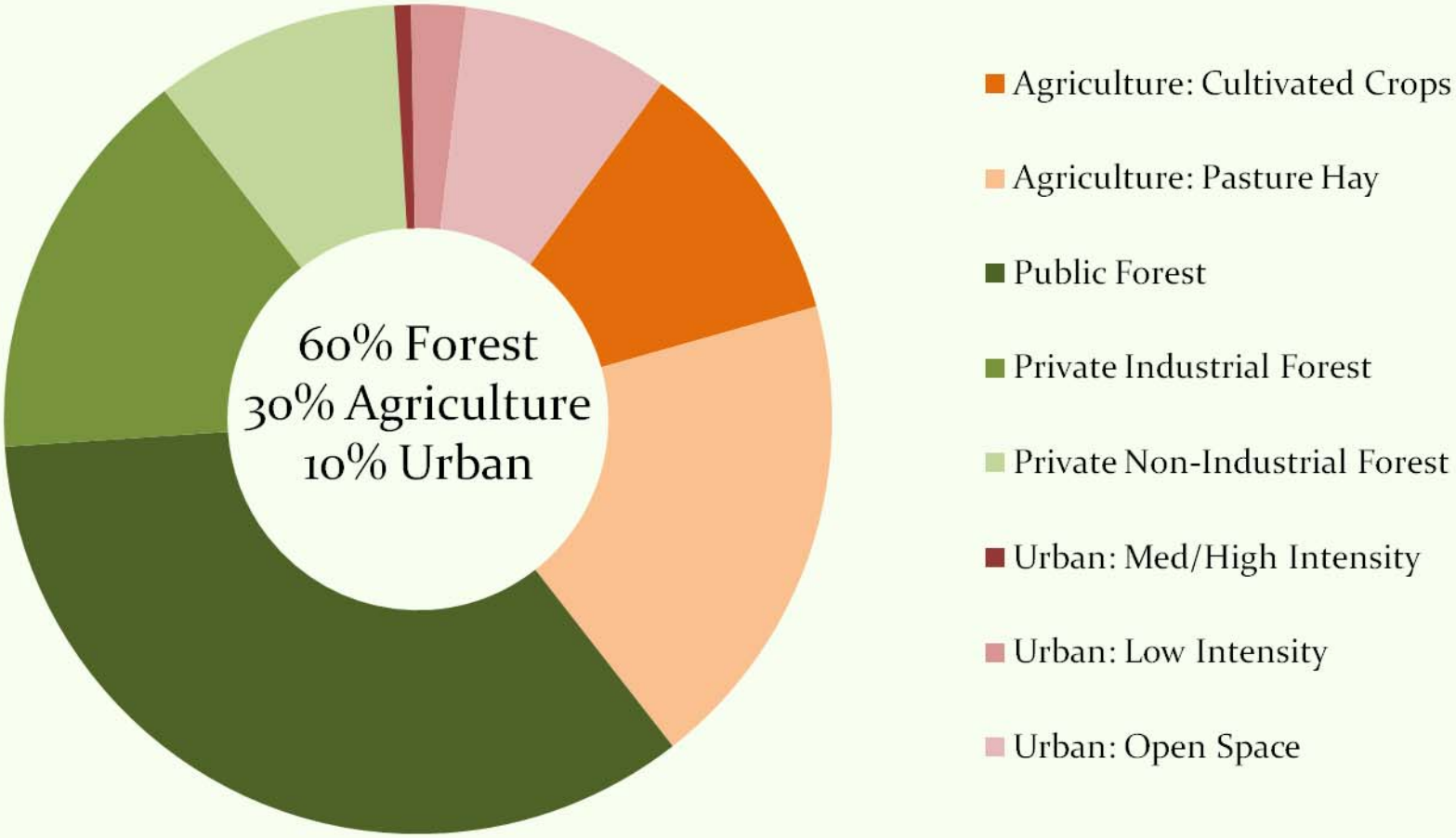
Score	Category
90 - 100	Excellent
85 – 89	Good
80 – 84	Fair
60 – 79	Poor
< 60	Very Poor

		PREDATOR O/E					Temperature Stress				Fine Sediment Stress			
	Sample size	Least Disturbed	Enriched	Moderately Disturbed	Most Disturbed	Not assessed	< 16	16.0 - 17.9	18.0 - 19.9	>= 20	0 - 10	11 - 20	21 - 30	> 30
Oregon	1025	53	3	16	24	3	32	30	24	14	69	21	7	3
Federal	623	55	3	17	20	5	42	27	20	12	77	17	4	2
State	69	51	1	12	35	1	28	43	26	3	71	17	6	6
Private Industrial	171	58	4	13	25	1	15	35	36	14	56	29	9	6
Private Non-industrial	80	35	3	18	44	1	10	23	34	34	44	30	23	4
Northern Oregon Coastal	230	59	3	13	26	0	14	38	36	12	63	24	10	3
Federal	68	69	3	12	16	0	12	43	38	7	69	24	7	0
State	46	54	2	11	33	0	37	43	17	2	87	7	2	4
Private Industrial	57	61	2	14	23	0	12	32	40	16	49	32	14	5
Private Non-industrial	24	38	4	17	42	0	0	29	54	17	46	29	25	0
Southern Oregon Coastal	289	42	2	15	33	8	26	28	28	18	67	22	6	4
Federal	167	45	1	18	25	11	37	29	22	12	81	16	1	2
State	12	--	--	--	--	--	--	--	--	--	--	--	--	--
Private Industrial	71	42	4	15	37	1	13	32	34	21	55	27	11	7
Private Non-industrial	24	29	4	8	58	0	13	13	33	42	33	38	21	8
Willamette	216	63	6	16	13	2	46	36	14	4	82	14	2	1
Federal	145	62	6	16	12	3	60	31	8	1	92	8	1	0
State	9	--	--	--	--	--	--	--	--	--	--	--	--	--
Private Industrial	29	83	7	7	3	0	24	41	34	0	69	28	0	3
Private Non-industrial	15	--	--	--	--	--	--	--	--	--	--	--	--	--
Lower Columbia	42	62	2	14	17	5	64	19	14	2	81	12	5	2
Middle Columbia	31	68	3	16	10	3	71	16	6	6	90	6	3	0
Lower Snake	31	42	3	29	26	0	42	23	6	29	68	26	6	0
Deschutes	52	48	2	23	27	0	17	27	19	37	44	35	17	4
John Day	90	56	6	17	22	0	37	19	28	17	62	28	6	4

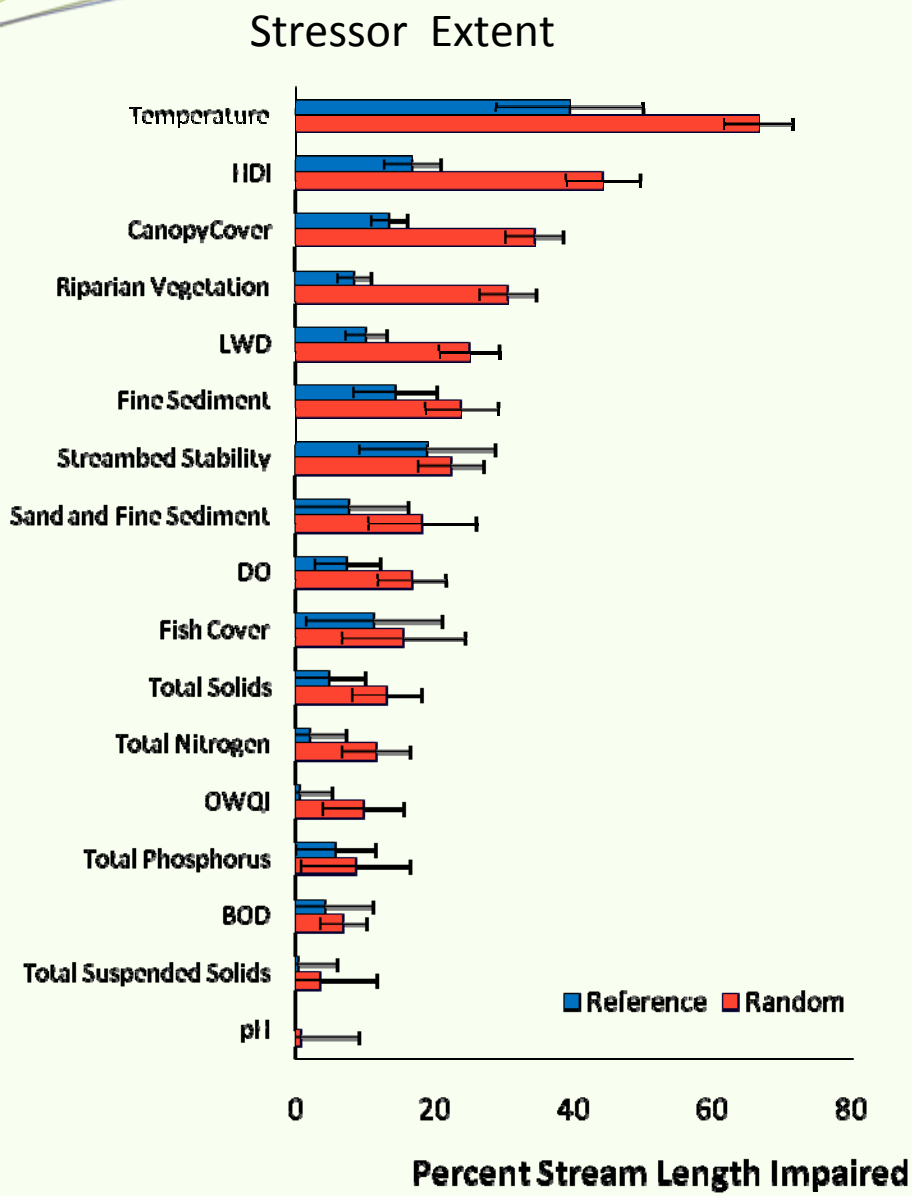
PREDATOR

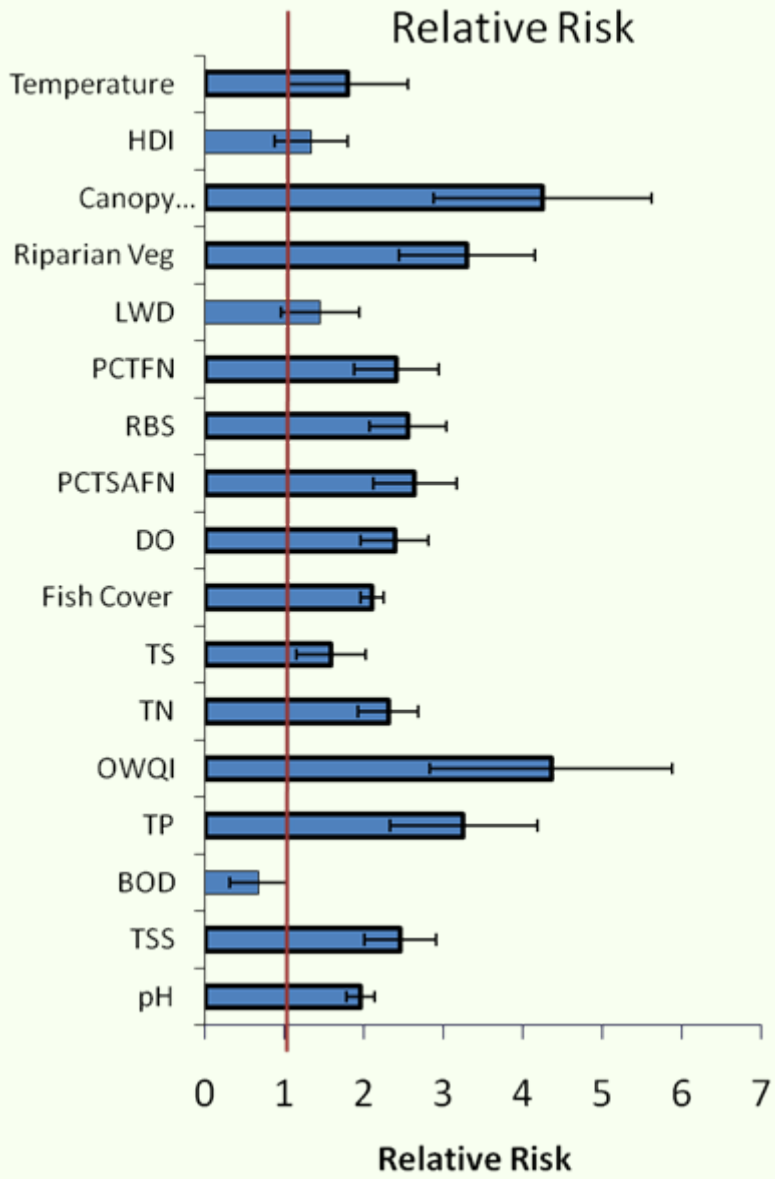
- Predicts the types of bugs that should be found if a site were in reference condition
- Reference: least disturbed
  - Not pristine
  - Lowest levels of human activities in a region
- Observed/Expected (O/E)
  - Taxa Loss model
- Predictor variables
  - Day of year, longitude
  - East of Cascade crest, elevation, annual precipitation, air temperature
- Statistics
  - Cluster analysis
  - Discriminant functions analysis

Proportion of Rivers and Streams by land use



Basin


Stressor Extent
Temperature
HDI
CanopyCover
Riparian Vegetation
LWD
Fine Sediment
Streambed Stability
Sand and Fine Sediment
DO
Fish Cover
Total Solids
Total Nitrogen
OWQI
Total Phosphorus
BOD
Total Suspended Solids
pH
Reference
Random
0
20
40
60
80
Percent Stream Length Impaired


Relative Risk
Temperature
HDI
Canopy...
Riparian Veg
LWD
PCTFN
RBS
PCTSAFN
DO
Fish Cover
TS
TN
OWQI
TP
BOD
TSS
pH
0
1
2
3
4
5
6
7
Relative Risk