Water Quality Index

This presentation will

1. Describe our monitoring program
2. Describe the Water Quality Index
3. Discuss issues for a fresh water quality monitoring work group

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Freshwater Monitoring Unit
Environmental Assessment Program

Part 1. Ecology's ambient monitoring program

Types of stations

- 66 Long-term - trends
- 8 Sentinel - S&T, climate, reference
- 8 Basin – CWA/WQ assessment
- 10 Special – e.g., IMW

Types of Monitoring

- Monthly grab
- Continuous temperature
- Continuous multi-probe

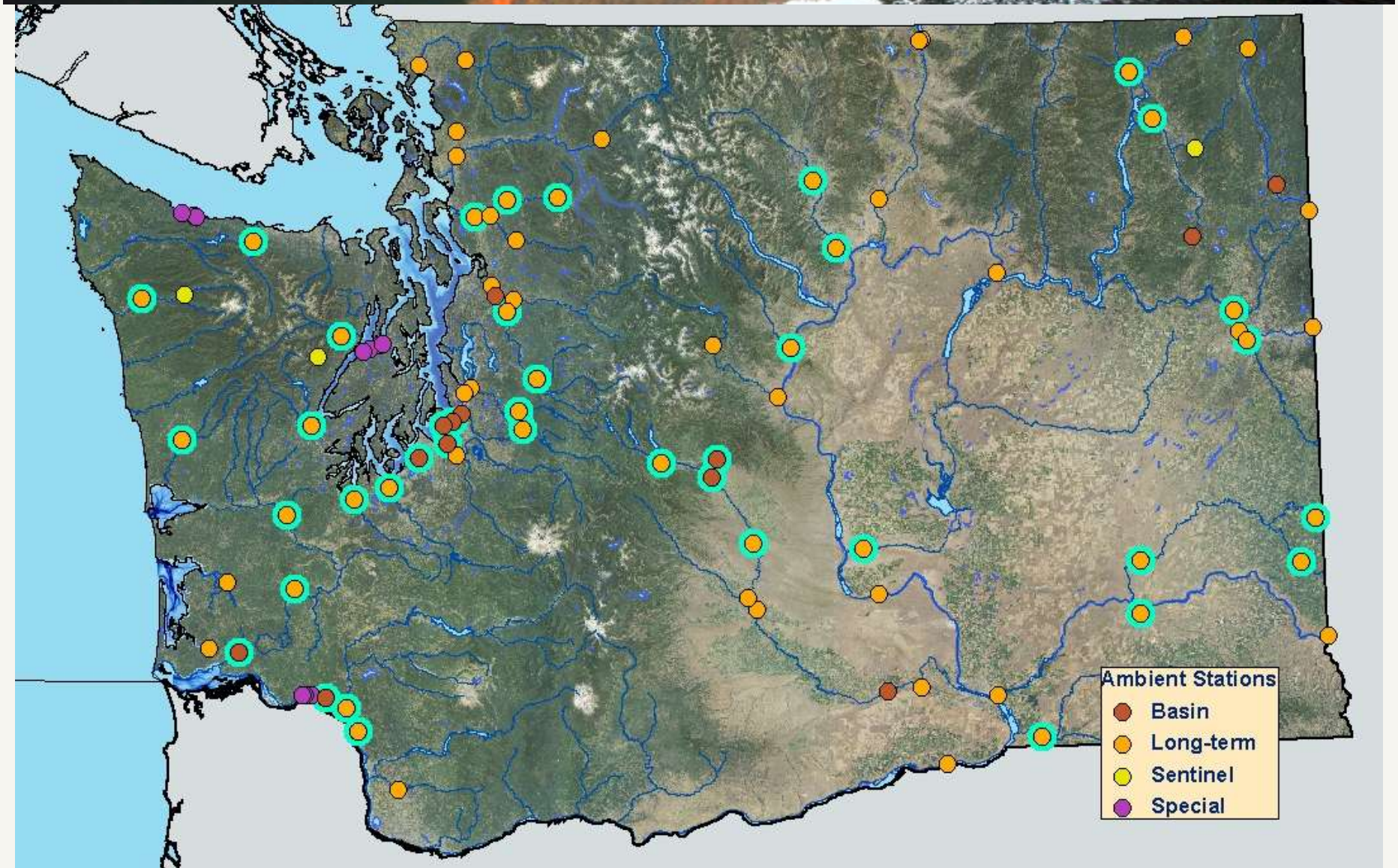
Parameters (**bold** are collected at all stations)

- **Ammonia, total**
- Carbon, dissolved organic
- Carbon, total organic
- Chlorophyll
- **Conductivity**
- **Fecal coliform bacteria**
- Flow
- Hardness
- Metals
- **Nitrate + nitrite, total**
- **Nitrogen, total**
- **Oxygen, dissolved**
- **pH**
- **Phosphorus, soluble reactive**
- **Phosphorus, total**
- **Suspended solids, total**
- Suspended sediment conc.
- **Temperature**
- **Turbidity**

Resources 3.8 FTEs + Lab $

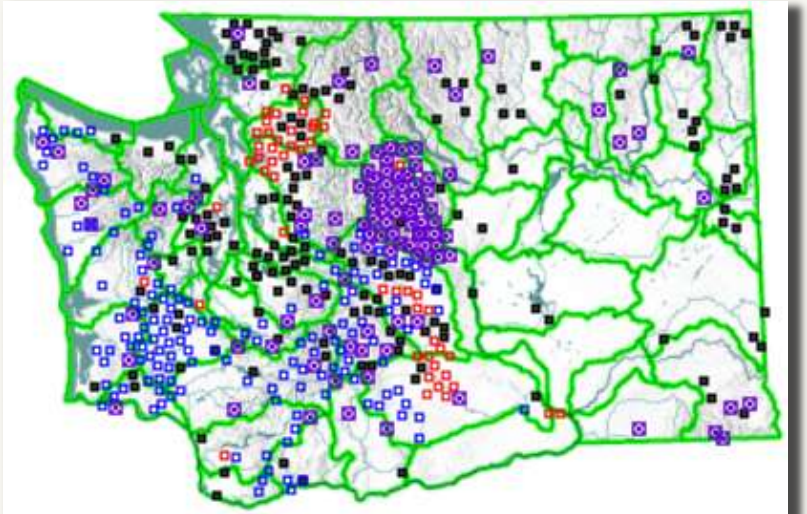
where we sample

(monthly grab samples + 2011 continuous temperature)



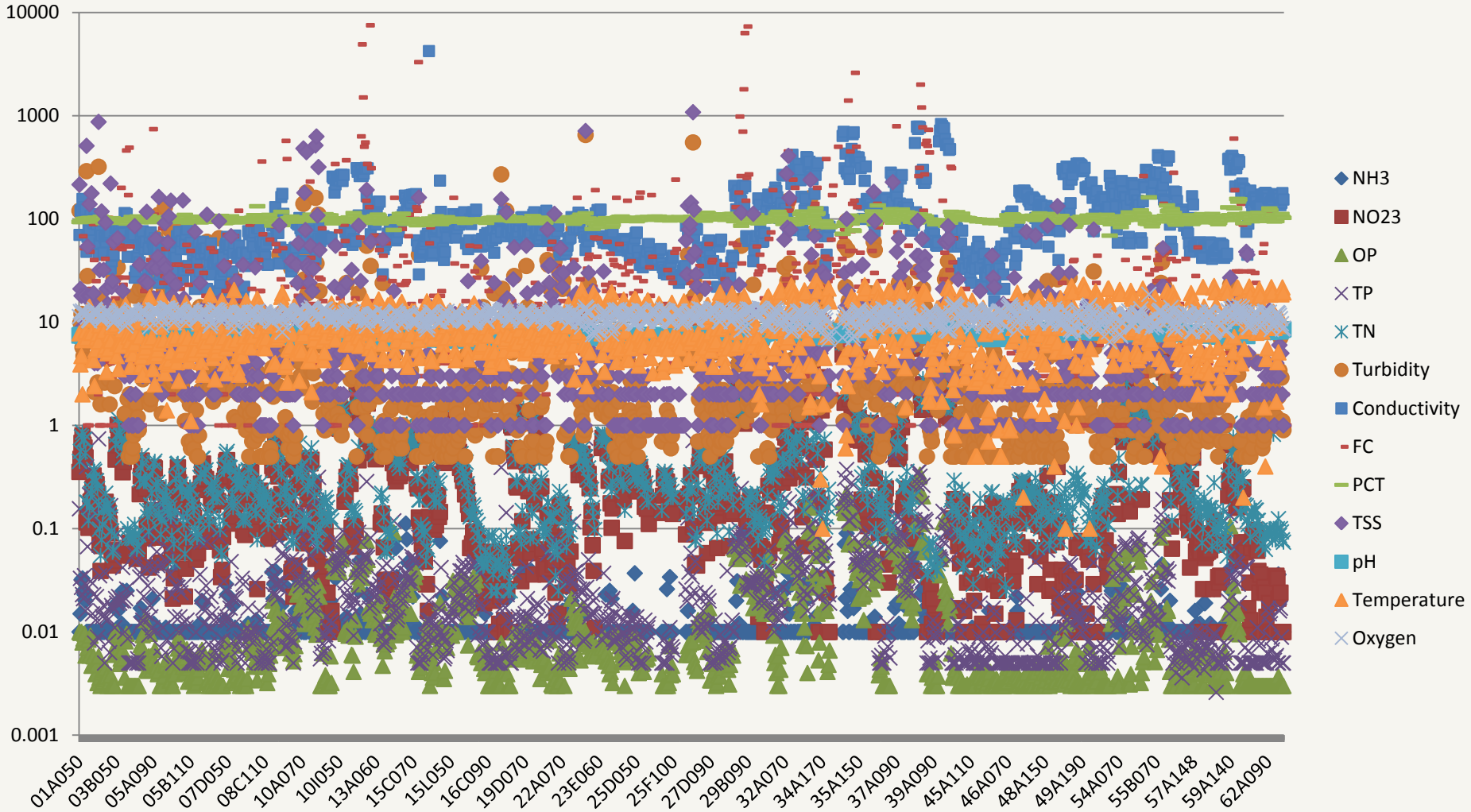
other Ecology ambient monitoring

marine (water, sediment, and "Beach")
effectiveness (1 or 2 projects a year)
toxics
biological (probabilistic and targeted)
Intensively Monitored Watersheds
aquatic plants
No Lakes



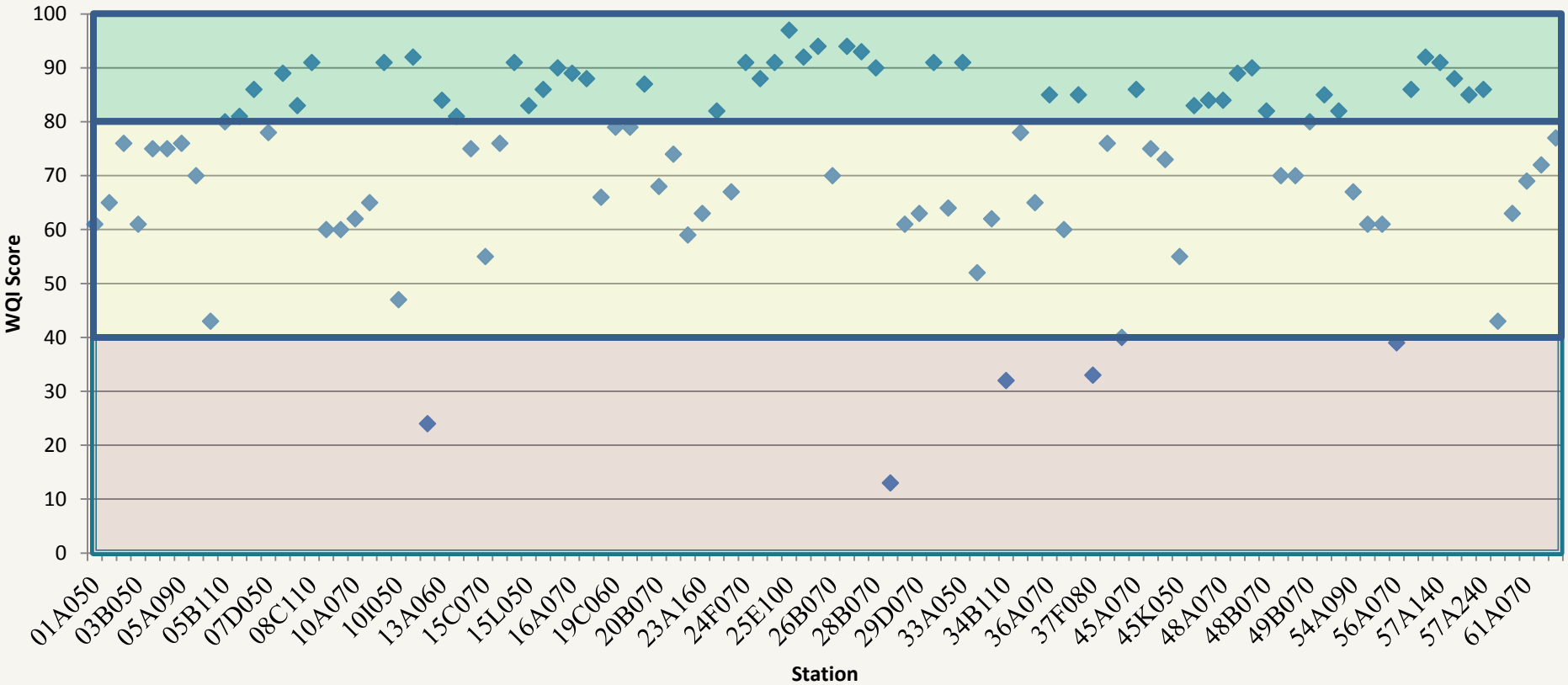
Stream biological monitoring network
(1993 - 2004)

Part 2. water quality index



water quality index

Synthesizes complex information to answer non-technical question about water quality



water quality index

- Indexes are communication tools and not intended for technical applications
- No index is as complete as the underlying data: information is lost
- Most indexes don’t include all available data

[Professionals] prefer to give no answer rather than an imperfect answer that could lead to misunderstanding. Yet the layman usually prefers an imperfect answer to no answer at all (Ott, 1978)

How is the WQI being used?

- Ecology Web Presentation
- Reports for the general public, e.g., state of the environment reports, Comprehensive Monitoring Strategy, Ecology's annual State of Salmon in Watersheds, Annual Enforcement Report, GMAP, Puget Sound Partnership, etc.
- Local governments use it to summarize their own data: Pierce, King, Skagit Counties, others
- Spreadsheet Tool
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Summary of Ecology monitoring data from the Deschutes River

Additional information

- Ecology may have conducted other studies and produced reports about this stream. These reports may be found in a list of Ecology reports pertaining to WRIA 13, Deschutes.
- This station has at least one Category 5 ("polluted waters") listing in the 2008 "Water Quality Assessment". See the "Water Quality Assessment" search page for listing IDs 6576 (temperature), 10894 (oxygen). There may be additional listings as well as listings upstream or downstream of this station.

2 Scores by constituent (1993 to 2010)

	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
fecal coliform bacteria	69	74	76	69	83	87	87	76	82	85	62	83	87	80	86	85	72
oxygen	94	87	92	91	79	83	88	89	88	87	81	88	86	86	95	86	85
pH	96	92	94	92	86	83	90	93	93	89	90	95	92	92	97	96	95
suspended solids	72	81	85	74	85	87	78	92	80	84	75	83	91	88	85	90	81
temperature	78	88	76	84	84	95	95	89	88	84	83	80	74	87	83	77	86
total persulf nitrogen	n/a	7	23	37	35	23	26	57	23	17	32	23	1	1	14	17	21
total phosphorus	73	63	75	59	63	62	61	70	65	67	74	84	83	85	73	71	69
turbidity	77	77	87	71	80	89	78	93	84	82	79	81	89	84	84	88	77
overall WQI	70	67	74	47	61	62	62	72	70	73	61	83	88	88	83	76	74
adjusted for flow	79	69	62	52	64	66	63	78	63	66	60	85	85	83	81	68	85

KEY

blue - good beige - moderate red - poor n/a - not sampled or not calculated

higher scores -> better water quality, maximum possible score: 100

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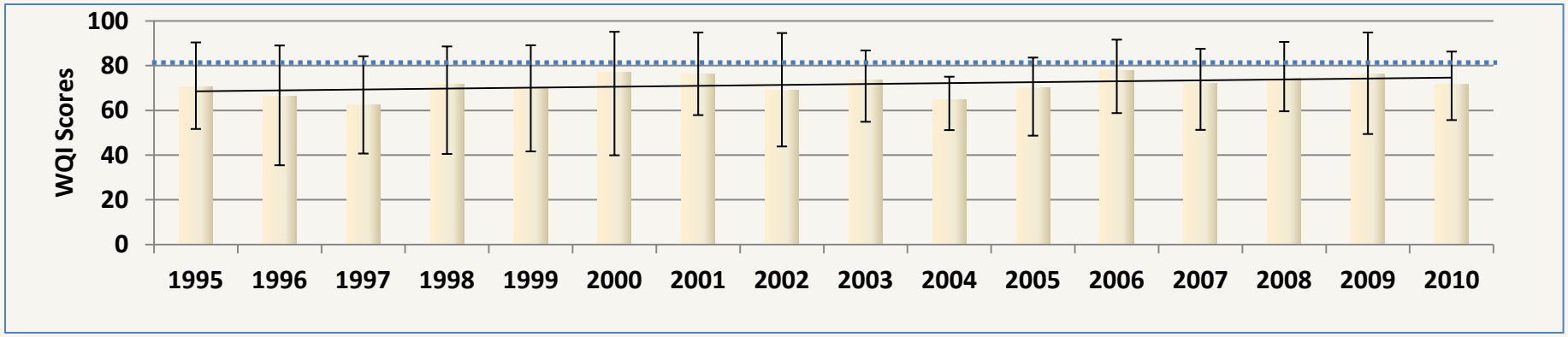
GMAP

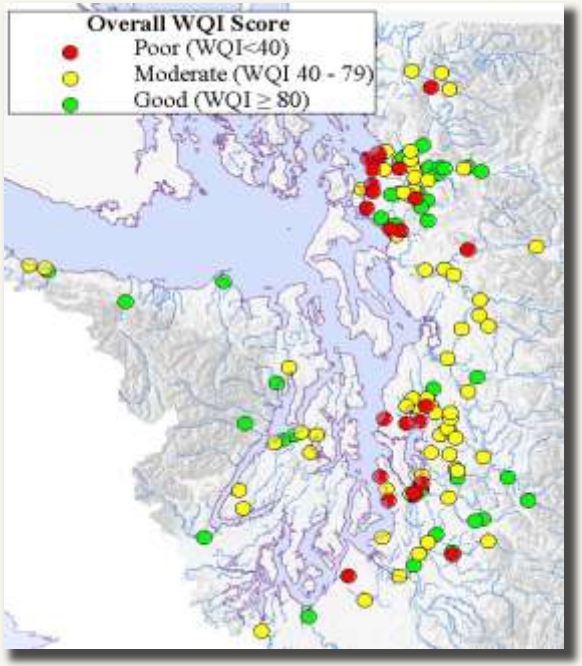


Puget Sound Partnership Dashboard

Meeting Goals	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Avg
Duckabush	93	95	94	90	74	94	89	85	88	96	86	89
Elwha	86	88	83	76	73	74	86	67	66	81	81	78
Skokomish	95	95	94	85	70	67	92	89	89	94	86	87
Snohomish	92	91	89	81	74	75	89	75	81	85	79	83

Borderline	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Avg
Cedar	87	76	60	78	72	84	81	79	79	81	77	78
Upper Skagit	87	86	59	85	64	81	84	75	75	81	56	76
Lower Skagit	89	91	71	76	61	73	77	77	75	76	74	76
Deschutes	62	72	70	73	61	83	88	88	83	76	74	75
Nisqually	40	60	79	79	69	71	74	75	91	74	83	72

Not Meeting Goals	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Avg
Green	82	73	66	67	75	49	72	68	60	69	63	68
Nooksack	65	68	58	57	52	54	61	51	60	69	56	59
Puyallup	60	58	57	55	51	58	59	58	61	49	62	57
Samish	86	75	32	49	34	71	67	74	59	80	63	63
Stillaguamish	81	60	44	72	55	67	71	69	75	75	71	67



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Pierce County WQI Presentation

2010 WY Pierce County Surface Water Management Water Quality Index

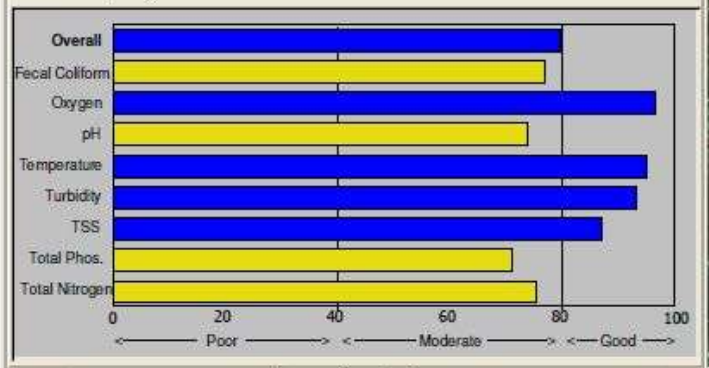
MS067 Year: 2010

MS067 ROCKY CREEK (WQ) Overall Score **80**

Pierce County began implementing the Water Quality Index (WQI) in Feburary of 2008, any of the yearly WQI scores reported before 2008 may not be scored using the same parameters after this date. The stream monitoring Water Quality Index (WQI) is a unitless number ranging from 1 to 100; a higher number is indicative of better water quality relative to expectations. For temperature, pH, fecal coliform bacteria and dissolved oxygen, the index expresses results relative to levels required to maintain beneficial uses (based on criteria in Washington's Water Quality Standards, WAC 173-01A). For nutrient and sediment measures, where standards are not specific, results are expressed relative to expected conditions in a given region. Multiple constituents are combined and results aggregated over time to produce a single score for each sample station. In general, stations scoring 80 and above met expectations for water quality and are of "lowest concern," scores 40 to 80 indicate "marginal concern," and water quality at stations with scores below 40 did not meet expectations and are of "highest concern."

Water Quality Index Graphical Score View

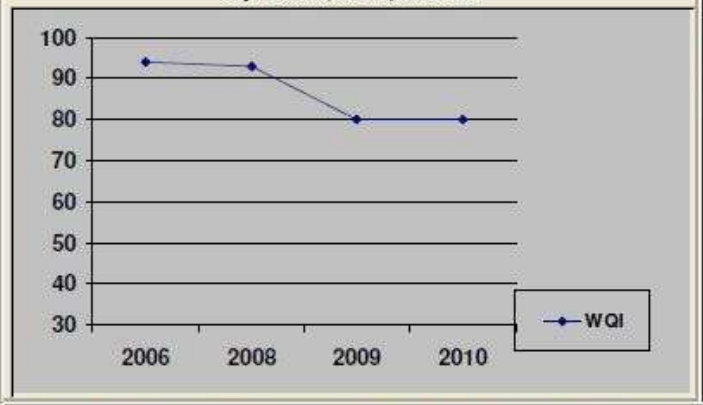
Water quality was GOOD based on data collected 10/1/2009 to 9/30/2010.



Monthly Scores for selected Water Year

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
96	96	95	98	84	97	95	85	95	96	72	90

WQI Score Comparison By Water Year



Narrative:

Rocky Creek is approximately five miles long with two major tributaries and several minor tributaries adding 10-12 miles of channel length. The headwaters of Rocky Creek are located in Kitsap County just south of Wye Lake. The stream flows into Rocky Bay and eventually into Case Inlet. The rural basin is characterized by low-density residential housing. In order to protect the basin from further growth, a 1995 Pierce County Council mandate limits development to one dwelling per 20 acres. The stream supports runs of Chinook, coho, steelhead, cutthroat, and chum salmon. Stream team volunteers have voiced concern regarding salmon productivity in the Rocky Creek watershed due to poaching at the mouth of the stream.

Nutrients such as phosphorus and nitrogen are needed by plants to grow, but high levels can be harmful to water quality. Excess nutrient levels can over-stimulate the growth of algae and other aquatic plants, resulting in unpleasant odors, unsightly surface scum, and lowered dissolved oxygen levels from plant decay. Nutrients are most likely to pose a problem in slow moving water such as lakes or sluggish streams. Some forms of algae are toxic to fish and other aquatic organisms and may even cause death in animals that drink affected water. Algae can also cause taste and odor problems in drinking water, foul-smelling odor in ponds and lakes, and problems with clogged water intakes, drains, and pipes. Heavy loading of nutrients into slow-moving waters can adversely affect many beneficial uses of the water.

Pierce County Surface Water Management (253) 798-2725

Explanation of WQI

Description of the waterbody

Discussion of problem parameters

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Spreadsheet Tool

A Water Quality Index for Washington State streams (Version 5: 2009.07.01-TN and TP CURVES MODIFIED TO BE USED FOR SMALL PUGET SOUND STREAMS ONLY).

Station:	Swamp
Recreation Use:	Extraordinary
Aquatic Life (Temperature):	Core(16)
Aquatic Life (Oxygen):	Core
Supplemental Spawning:	None
Ecoregion:	2

Calc Interim WQI scores

Calc Constituent & Overall Scores

KEY
Input
Low Concern
Moderate Concern
High Concern

OutSeason 5

SupSpawn 500

	FC	Oxygen	pH	TP	TSS	Temp	TN	Turbidity	Monthly
Default Curve No.:	53	26	41	72	82	8	62	92	
Curve to Use:	53	26	41	72	82	8	62	92	
Date	col/100mL	mg/L	std. Units	mg/L	mg/L	C	mg/L	NTU	Scores
10/6/1997 10:30	63	8.62	6.95	0.00866	2	13.9	0.149		76
11/3/1997 9:30	70	8.74	6.82	0.014	3	10.6	0.31		77
12/1/1997 9:50	86	10.07	6.78	0.00924		6.8	0.438		84
1/7/1998 10:00	45	11.97	6.29	0.029	4	4.8	1.02		84
4/13/1998 11:15	53	10.97	7.22	0.0197	3	8.9	0.527	3.7	90
5/4/1998 13:40	4900	9.17	7.47	0.0219	2	17.4	0.338	3.5	22
6/10/1998 12:30	570	8.92	7.44	0.0257	2	15	0.328	2.8	57
									0
									0
									0
									0
									0
Constituent Scores	40	70	73	90	99	75	99	95	
								Overall Score:	**52**

Update default curve numbers

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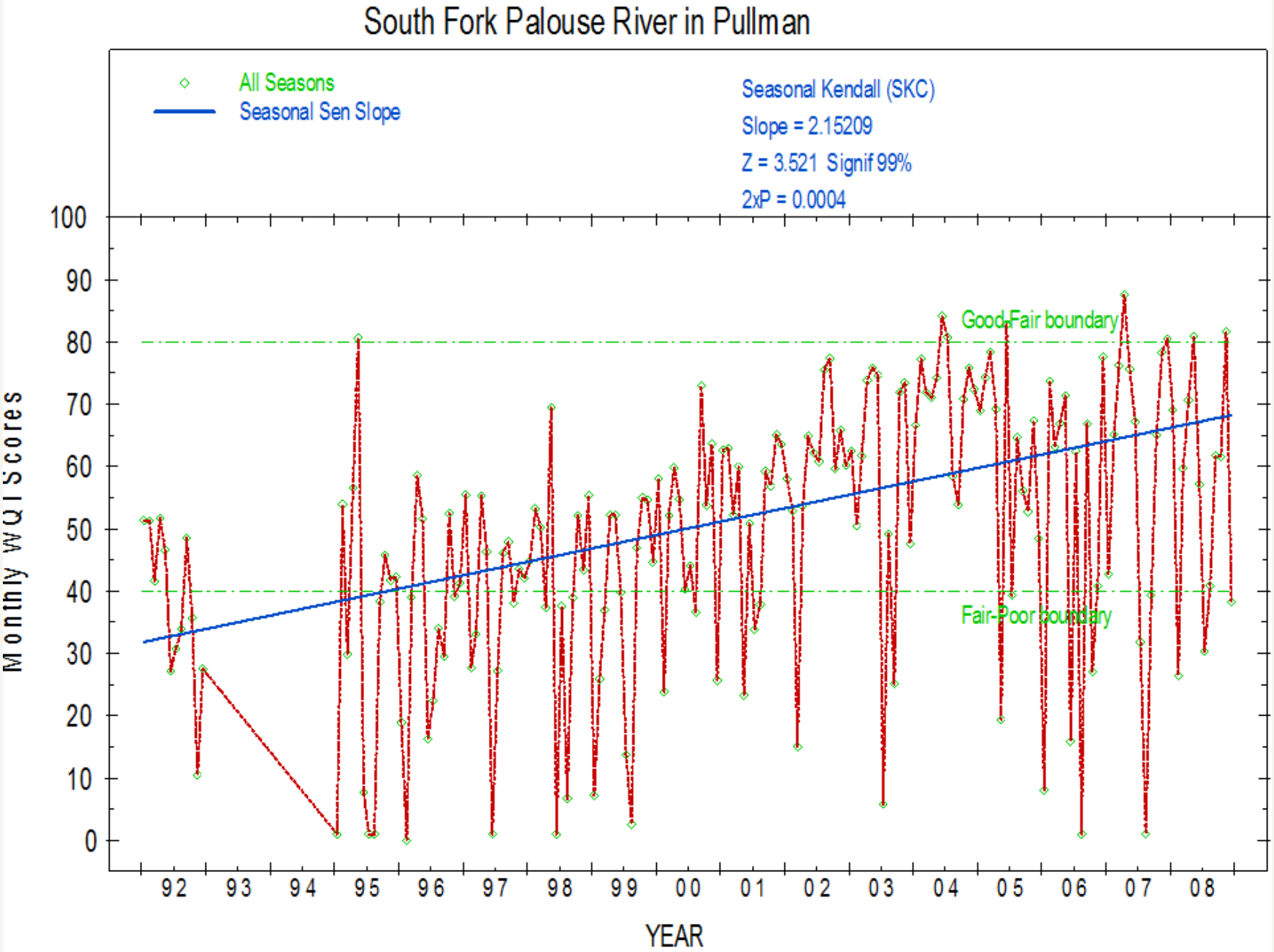
Technical Uses: Trends



Part 3. Fresh water quality monitoring workgroup

- Improved efficiency
  avoid duplication of effort
  coordinate station placement for greater coverage

- Share lessons learned
  TP methods bias; dissolved nitrogen filter bias; pH meter woes; new technologies (e.g., LDO)

- Improved comparability of data
  parameters; WY or CY?; more standardized methods and procedures; compatible data management; support some basic assessment (e.g., WQI);

Side-by-Side Monitoring

Please contact Dave Hallock for more information. Our Focus Sheet gives a quick over-view of the program.

Quick Links:

- sampling schedule
- participants' metadata
- results

Contents:

- What is this program?
- How to participate
- Come and sample with us: Locations and Schedule
- Learn more about the participants and their monitoring programs
- Access the data: How do the results compare?
- What results does Ecology typically get at our long-term monitoring stations?
- Meet the samplers
- Links

What is this program?

Many entities collect surface water quality data in Washington State. These include state and federal agencies, counties, conservation districts, tribes, consultants, schools, and volunteer organizations. Although much of the monitoring is conducted under formal Quality Control Project Plans, there is still a potential for bias between sampling methods and laboratories. Even within a single program, issues of method bias can arise whenever changes are made to sample collection, processing, or analytical procedures. This program is intended to allow multiple entities to sample at a common location and time so that they can compare their data to data collected by others.

Besides being a useful quality control element for participating organizations, results can be used by data analysis projects that need to combine datasets to ensure that results are comparable.

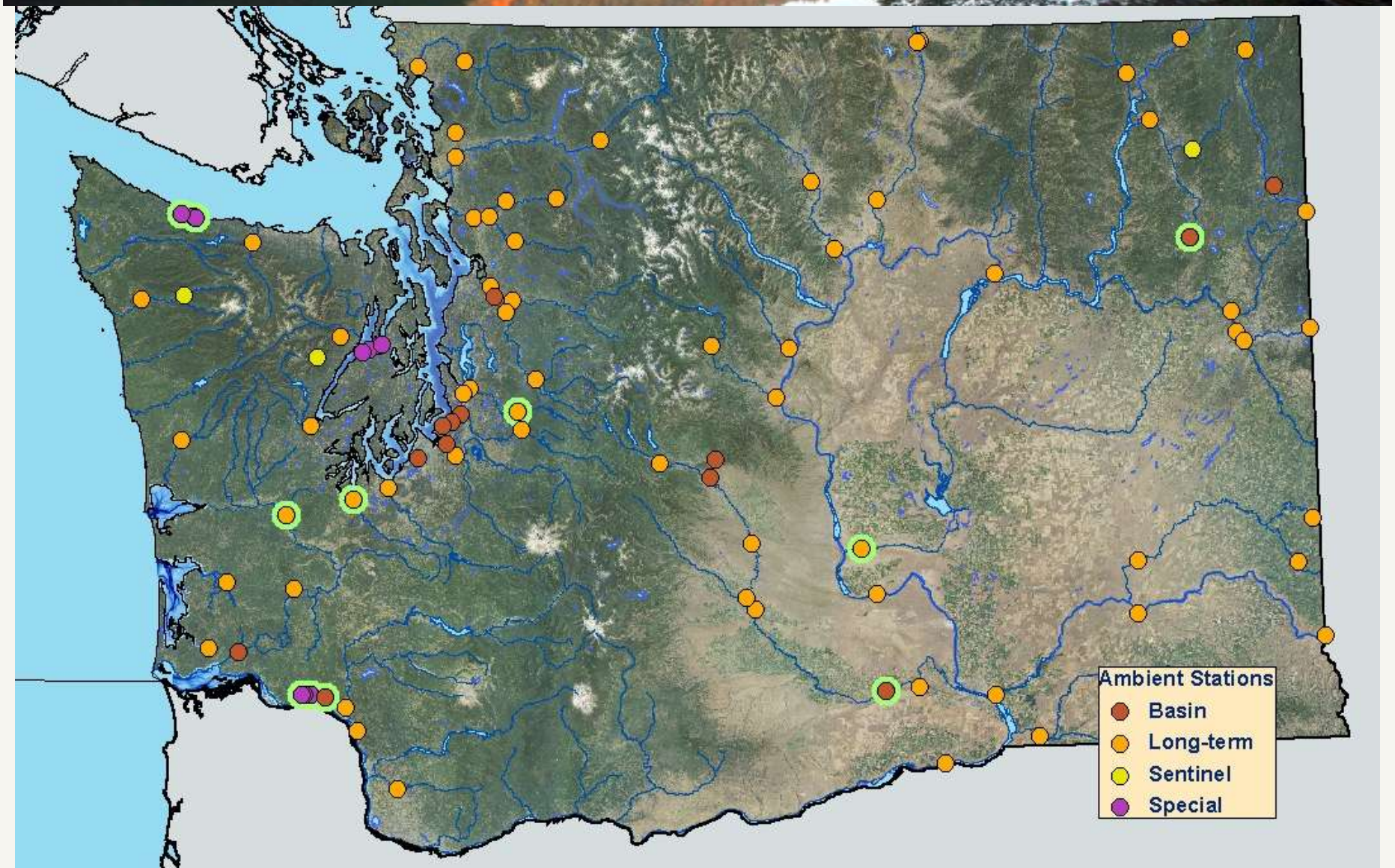
Questions?

Maintaining consistency even within our own program is hard

- Standard SOPs
- FWTCT
- “Ambient day”
- Annual “ride-along”
- Document changes in annual report
- Side-by-Side Program

where we sample

(monthly grab samples + 2011 continuous multi-parameter)

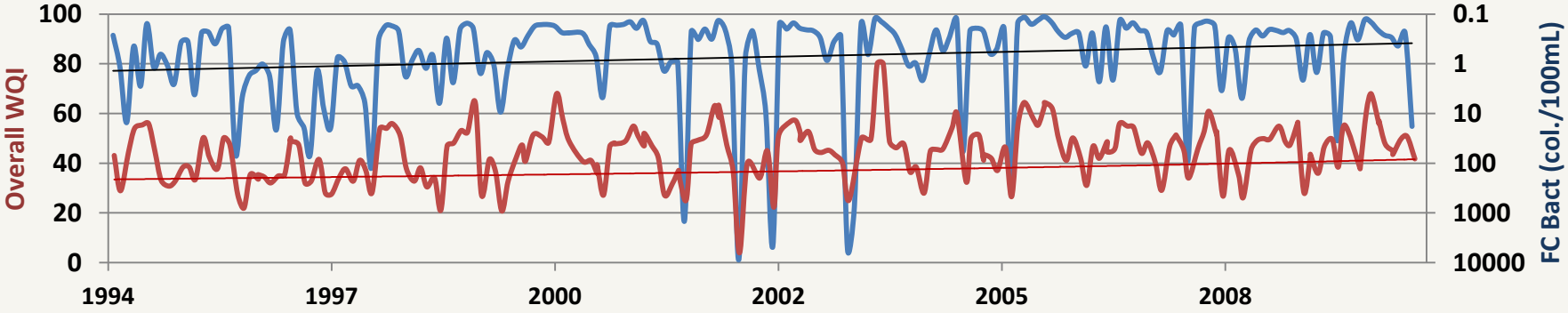


Individual parameters are transformed to a common scale

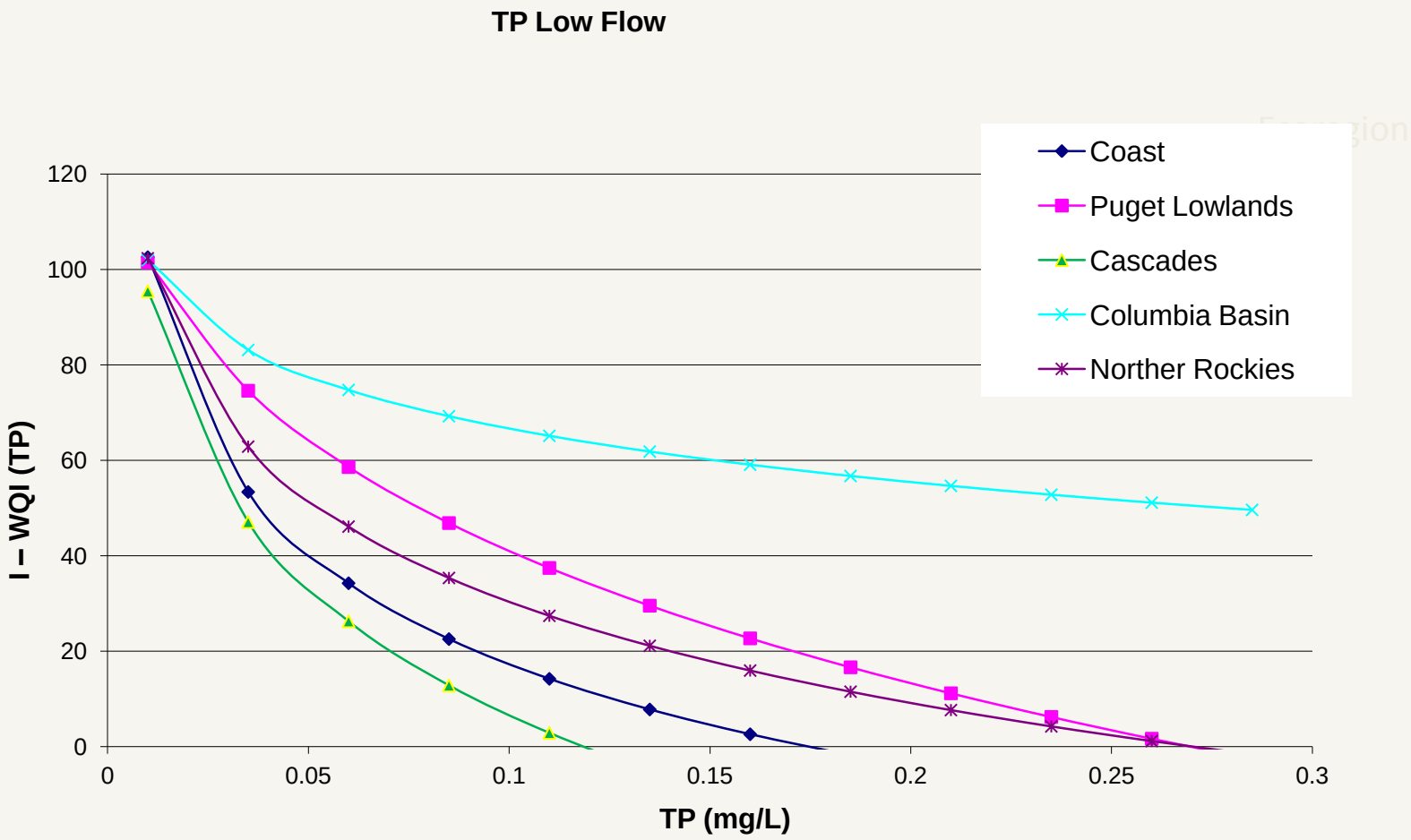
- Results at the Water Quality Standard = 80 → Fecal coliform bacteria, pH, dissolved oxygen, temperature
- Results at the 80th percentile = 80 (stratified by geography and season) → Total phosphorus, total nitrogen, suspended sediment, turbidity

Transformed scores aggregated by parameter, time, location

- Aggregation designed to avoid good scores masking a bad score
- Results can be explored by disaggregating

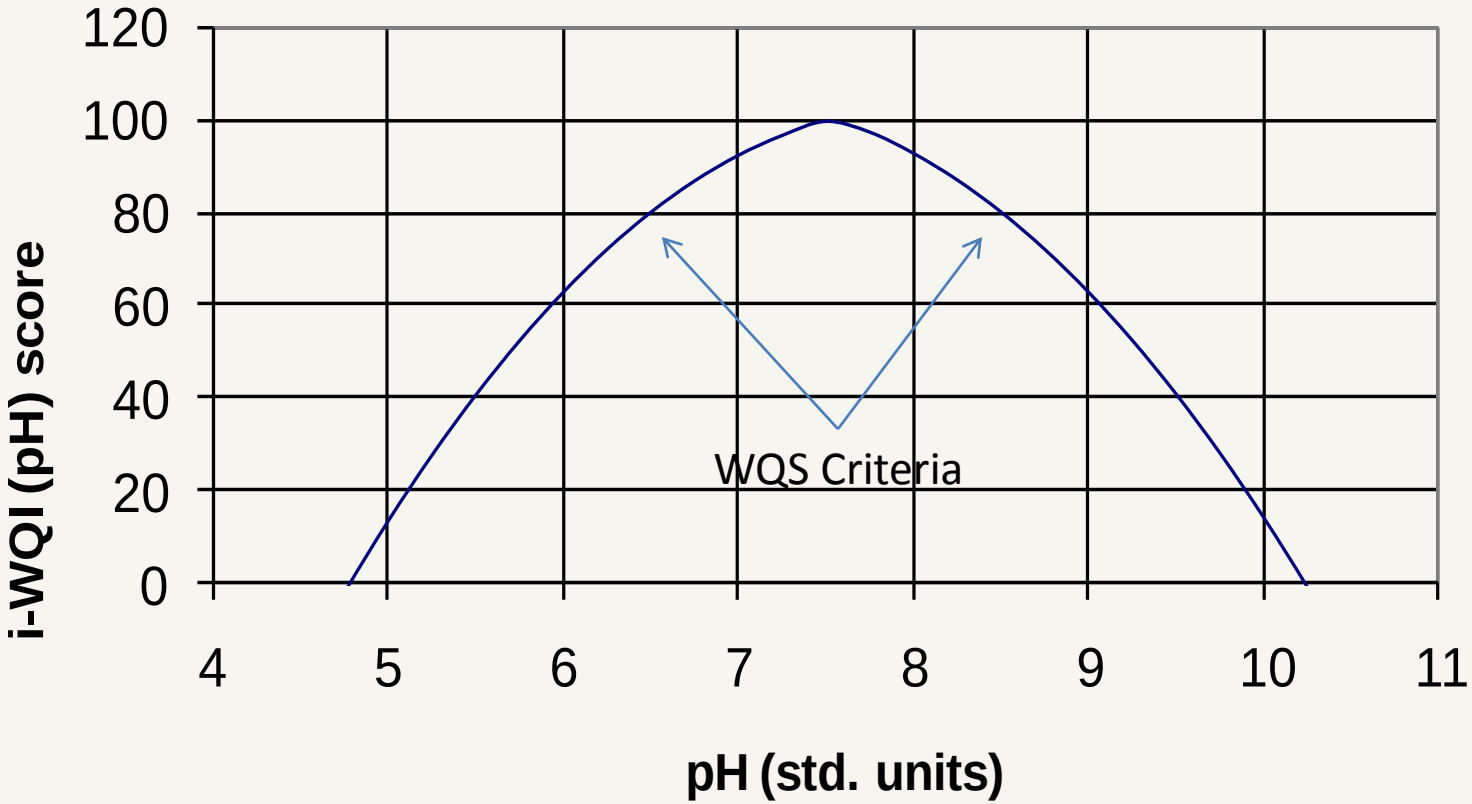


Converting results to an index score
e.g., low-flow TP: curves vary by ecoregion



Converting results to an index score

e.g., pH > 7.5, $iWQI(pH)=-339 + 129*pH - 9.33*pH^2$



Aggregate the data

- Monthly scores calculated by averaging the scores of the constituents. A penalty is subtracted for scores < 80.
- The overall score is the average of the three lowest monthly scores.
- A constituent score is also calculated as the average of the three lowest individual scores for that constituent.

Miscellaneous Rules

- Turbidity and TSS scores are combined using the harmonic mean before aggregation
- The score for the likely limiting nutrient (TP or TN) is used (or the lower of the two scores if uncertain).
- Maximum penalty for nutrient and sediment scores is set to 20

Pros…

- Includes data with WQI scores > criterion
- Can be rolled up or disassembled into constituent scores
- Related to WQS and support of beneficial uses
- Can add stations/constituents without affecting other scores

… and Cons

- Curves are subjective
- WQI scores are relative to *expected* conditions
- May not be consistent with other assessment techniques (e.g., 303d)
- Local conditions may differ from those used to develop the index

Still to do

•Already developed TN curves for Small Puget Sound streams; are there other populations needing different nutrients or sediment curves?

•EIM-based calculator and Statewide web presentation for all data in EIM

• Incorporate continuous temperature/oxygen data

• Are sediment and nutrient scores driving the index? Can they be based on biological impact rather than distribution?

•Should TMDL Targets trump criteria in WQS?