Streamflow Duration Assessment Method: Pacific Northwest



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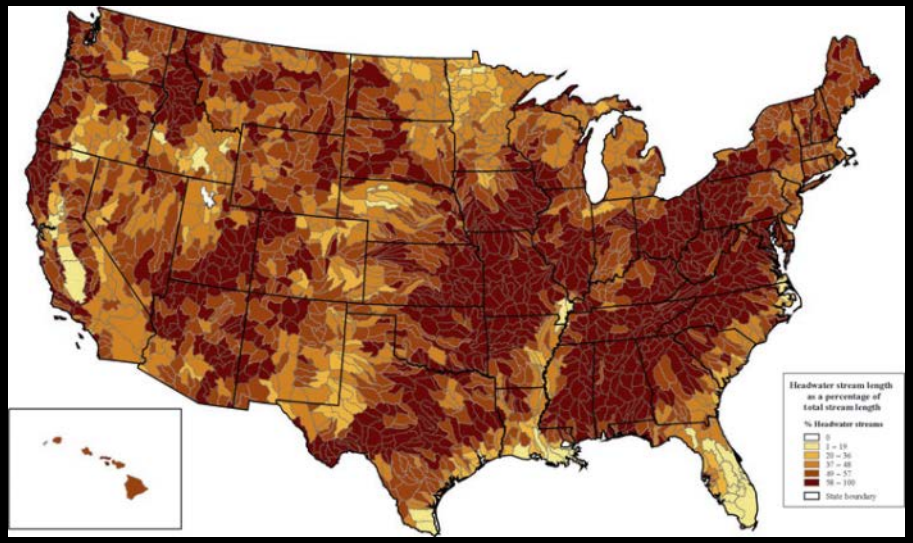
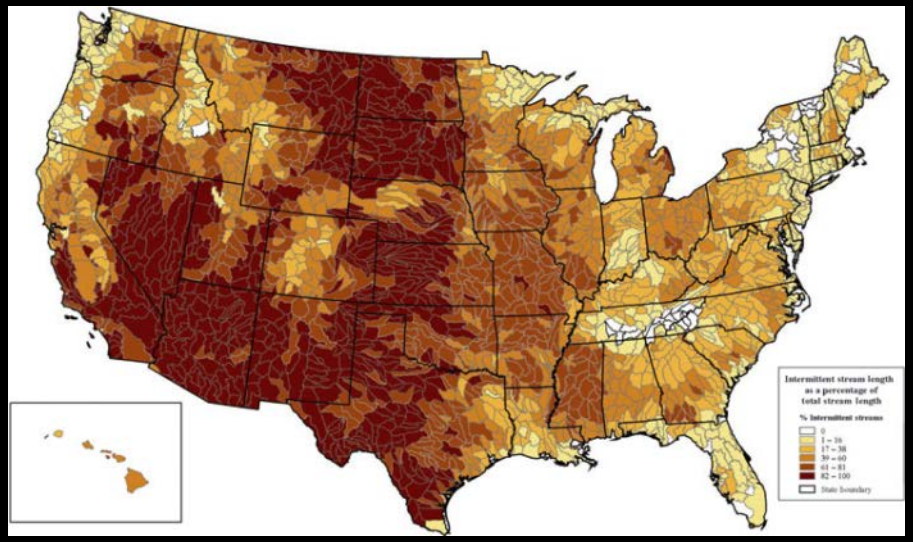
Policy Context – Streams as Emerging Issue

- **U.S. Supreme Court** – *SWANNC* (2001); *Rapanos* (2006) Affect CWA Jurisdiction
  - Continuous surface connection; relatively permanent flow
  - Significant nexus, alone or in combination
- USEPA/USACE – Final Compensatory Mitigation Rule (2008; Section 404)
  - Watershed-based decision making
  - Unavoidable impacts to ALL jurisdictional aquatic resources must be mitigated

Headwater Stream Length



Intermittent and Ephemeral Stream Length



Nadeau & Rains (2007)

Program Implementation?

- Diverse geographic distribution of stream type

Connectivity? Significant Nexus? Downstream Contributions? Watershed Context? Relatively Permanent?

- Policies have different reverberations in different parts of the country, and within states

Today's SDAM Talk

- Development
- Validation Study
- Application

Purpose of SDAM

- A rapid field assessment tool to distinguish between ephemeral, intermittent and perennial streams.
- Provide a scientifically supported, rapid assessment framework to support best professional judgment in a consistent, robust, repeatable and defensible way.
- Allow more timely and predictable jurisdictional determinations.

Intended Use

- The method is designed to distinguish ephemeral streams from intermittent and perennial streams in a single site visit.
- It can be used across the range of stream ecosystems found in the Pacific Northwest.
- Use of SDAM is recommended, but not required.
- When the streamflow duration is already known, using the method would be unnecessary.

Development of the Method

2007	Adaptation of North Carolina Method framework for use in Oregon; including review, consultation and field testing
2008	External peer review, first field season validation study
2009	INTERIM METHOD published via joint Public Notice
2008-10	Validation study, Oregon phase (testing Interim Method)
	REVISED *(final)* METHOD results from Oregon study
2010-11	Validation study, ID/WA phase (testing Interim and Revised Methods)
2011	Revised *(final)* Method for Oregon published
2013	Anticipated release Final Method for Pacific Northwest

Interim Method Indicators

Geomorphology *(7)*

Continuous Bed and Bank

In-channel Structure

Soil Texture or Stream Substrate Sorting

Erosional Features*

Depositional Features

Sinuosity

Headcuts and Grade Control*

Interim Method Indicators

Hydrology *(6)*

Groundwater (Wet Channel)

Hyporheic Saturation (Dry-Channel)

Springs and Seeps

Evenly Dispersed Leaf-Litter/Loose Debris*

Debris Piles or Wrack Lines*

Redoximorphic Features in Toe of Bank*

Interim Method Indicators

Biology *(10)*

Wetland Plants In/Near Streambed

Fibrous Roots or Rooted Plants in Streambed (Upland Plants)

Streamer Mosses and Algal Mats*

Iron-oxidizing Bacteria, Fungus, Flocculent

Macroinvertebrates

Amphibians*

Fish

Lichen Line (Arid, Semi-Arid, Alpine)*

Riparian Vegetation Corridor (Arid, Semi-Arid)

Single Indicators

Interim Method

Species that indicate streamflow is at least intermittent, based on requirements for sustained presence of water.

Oregon Streamflow Duration Field Assessment Form (Interim Version – March 2009)

Project # / Name			Evaluator Attended ☐ Orientation ☐ Field Training	
Address			Date	
Waterway Name		Coordinates at downstream end (ddd.mm.ss)	Lat.	N
Reach Boundaries			Long.	W
Precipitation w/in 48 hours (cm)	Channel Gradient (%)		Channel Width (m)	

Observed Hydrology: "Dry Channel" ☐ Water Absent ☐ No surface flow but at least one pool present; "Wet Channel" ☐ Surface flow present but not spatially continuous ☐ Continuous surface flow

☐ Disturbed Site / Difficult Situation (Describe in "Notes")

		Absent	Weak	Moderate	Strong
Geomorphology	1. Continuous Bed and Bank	☐ 0	☐ 1	☐ 2	☐ 3
	2. In-channel Structure / Organized Sequences	☐ 0	☐ 1	☐ 2	☐ 3
	3. Soil texture or stream substrate sorting	☐ 0	☐ 1	☐ 2	☐ 3
	4. Erosional Features (☐ Check this box if >50% of the streambed consists of exposed bedrock)	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	5. Depositional Features	☐ 0	☐ 1	☐ 2	☐ 3
	6. Sinuosity	☐ 0	☐ 1	☐ 2	☐ 3
	7. Headcuts And Grade Controls	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	GEOMORPHOLOGY SUBTOTAL:				_____
Hydrology	8. Groundwater (Wet) / Hyporheic (Dry)	☐ 0	☐ 1	☐ 2	☐ 3
	9. Springs And Seeps (Note Locations)	☐ 0	☐ 1	☐ 2	☐ 3
	10. Evenly Disbursed Leaf Litter / Loose Debris ▼	☐ 1.5	☐ 1	☐ 0.5	☐ 0
	11. Debris Piles And Wrack Lines	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	12. Redoximorphic Features In Toe Of Bank	☐ Absent = 0		☐ Present = 1.5	
	HYDROLOGY SUBTOTAL:				_____
Biology	13. Wetland Plants (Within ½ channel width) ☐ FAC 0.5 ☐ FACW 0.75 ☐ OBL 1.5 ☐ SAV 2 ☐ None				
	14. Fibrous Roots / Rooted Plants In Thalweg ▼	☐ 3	☐ 2	☐ 1	☐ 0
	15. Streamer Mosses And Algal Mats	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	16. Iron Oxidizing Bacteria, Fungus, Flocculent	☐ 0	☐ 1	☐ 2	☐ 3
	17. Macroinvertebrates	☐ 0	☐ 1	☐ 2	☐ 3
	18. Amphibians (Within 1 channel width)	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	19. Fish	☐ 0	☐ 1	☐ 2	☐ 3
	20. Lichen Line (Arid Regions and Alpine Areas Only)	☐ 0	☐ 0.5	☐ 1	☐ 1.5
	21. Riparian Corridor (Arid Regions Only)	☐ 0	☐ 1	☐ 2	☐ 3
	BIOLOGY SUBTOTAL:				_____

Single Indicators: ☐ Fish ☐ Amphibians ☐ Macroinvertebrates

★ *TOTAL SCORE:* _____

Note: Scoring scale is reversed for indicators marked with ▼.

Flow Duration (select only one)

Ephemeral ☐ Total Score < 13

Intermittent ☐ Total Score ≥ 13 or Single Indicator

Perennial ☐ Total Score ≥ 25

Feedback from Training Sessions

Spring 2009 Interagency training sessions in Portland, La Grande, and Medford, Oregon

- Provides scientific framework to discuss stream issues
- Difficult to consistently assess subjective indicators
- Geomorphology indicators overweighted, seem to produce false positives
- Groundwater indicator is difficult to assess
- Macroinvertebrate identification requires training, and a field guide that is directly relevant to the macroinvertebrate indicator would be helpful

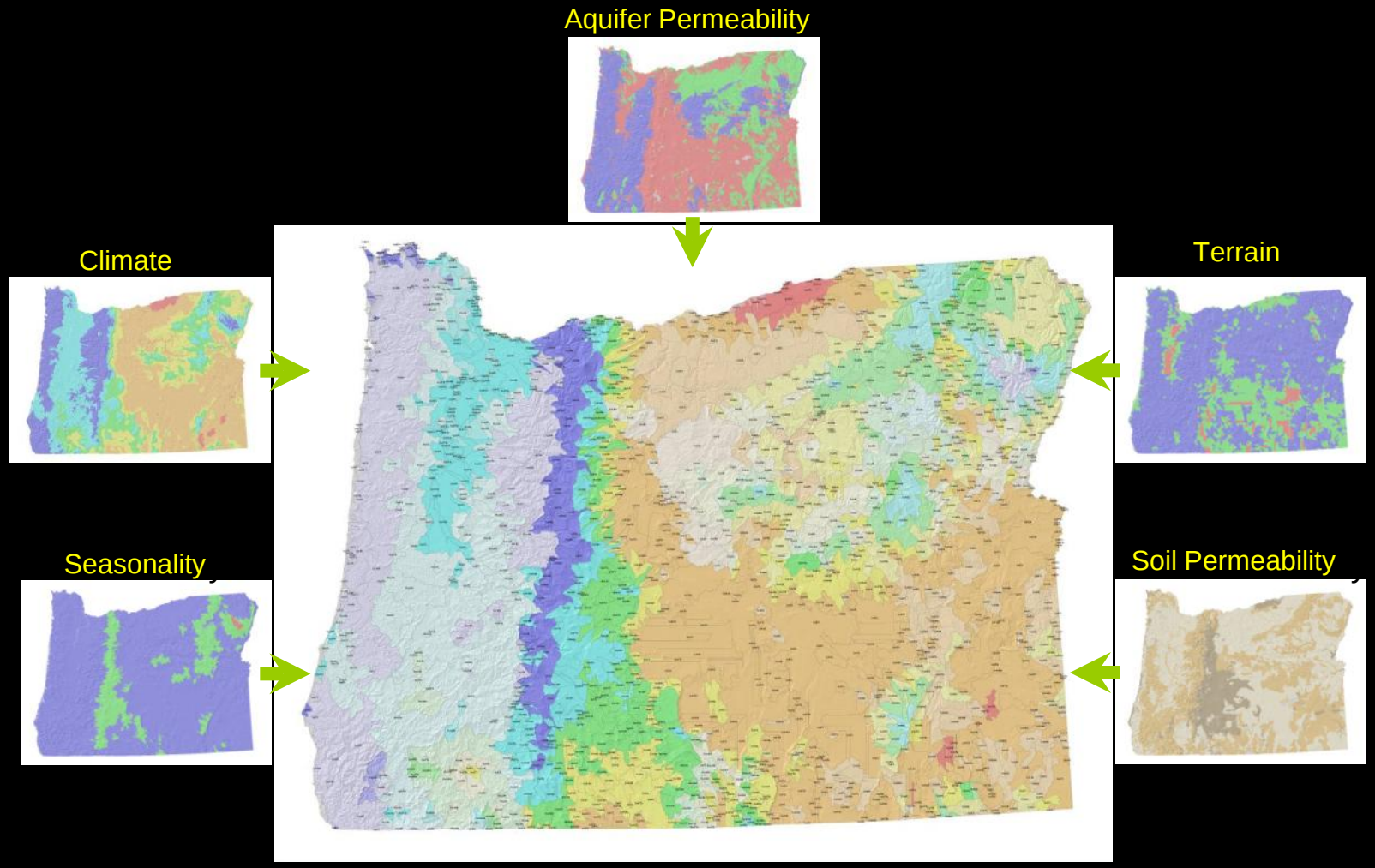
VALIDATION STUDY OBJECTIVES

- Consistent, defensible, robust, repeatable method
- Applicable across the Pacific Northwest
- Research to directly inform the program/policy arena on jurisdictional issues

Study Questions
(Phase I: Oregon)

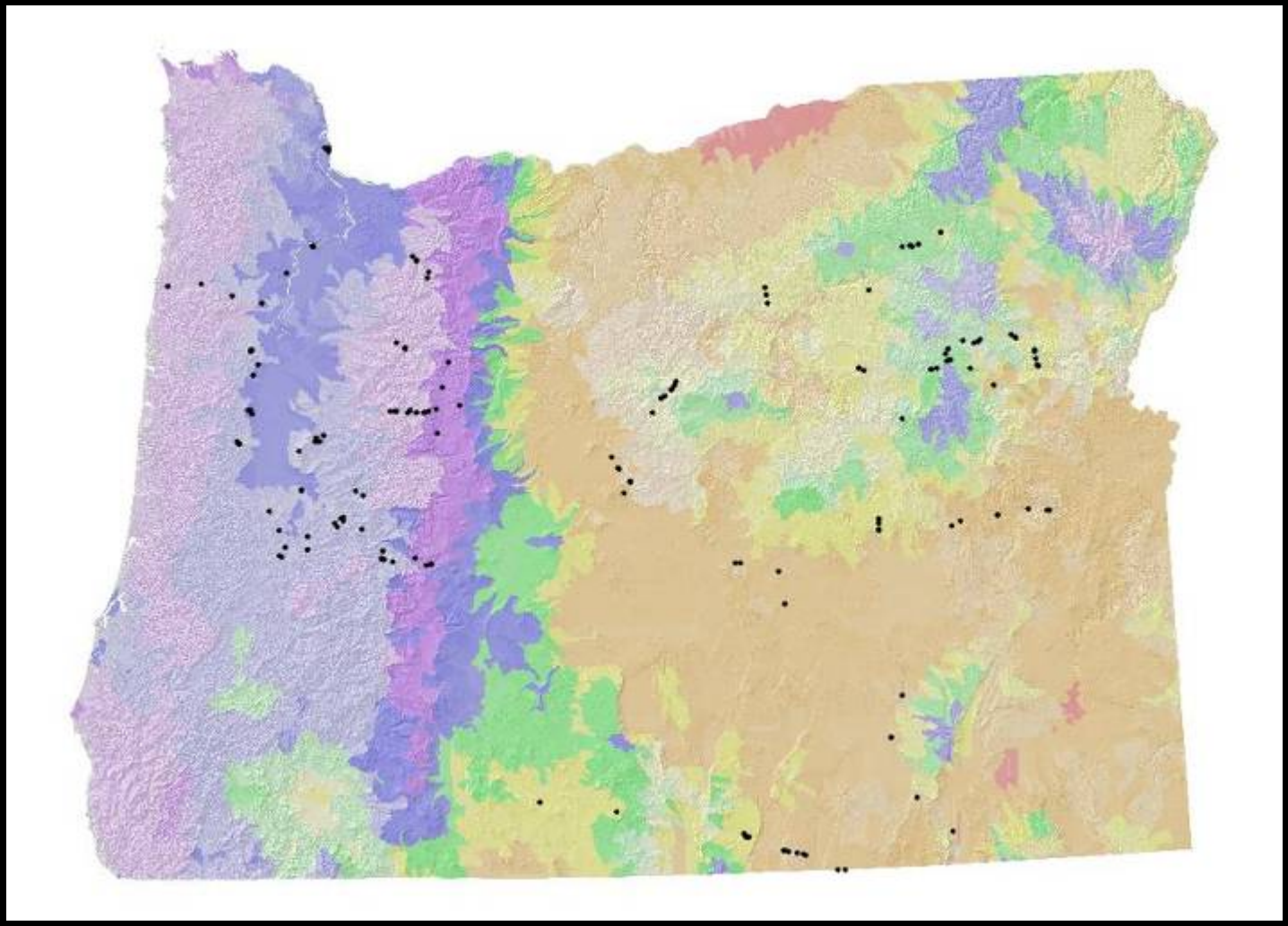
- What is the accuracy of the Interim Method?
- Equally applicable in different (wet/dry) seasons?
- Equally applicable in different hydrologic landscapes across the state?
- Can results be improved by developing an alternative method (statistical analysis of data)?

Hydrologic Landscape Regions



Wigington et al. (2012) ; Leibowitz et al. (2011)

Oregon Validation Study Sites



Validation Study

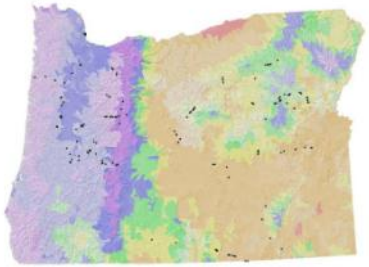
Phase I Oregon: Interim Method

- Sampled across a range of hydrologic settings (177 streams)
  - ~30 streams per E/I/P class arid east side
  - ~30 streams per class west side
- Deployed ER sensors in > 50% of streams
- Wet/Dry season sampling

Supplemental Data Collected *for "problem" indicators*

- Slope of reach
- % streambed bedrock
- Surface water hydrology
- Macroinvert and wetland plant ID
- Alternative sinuosity measurement

Confusion Matrix Analysis



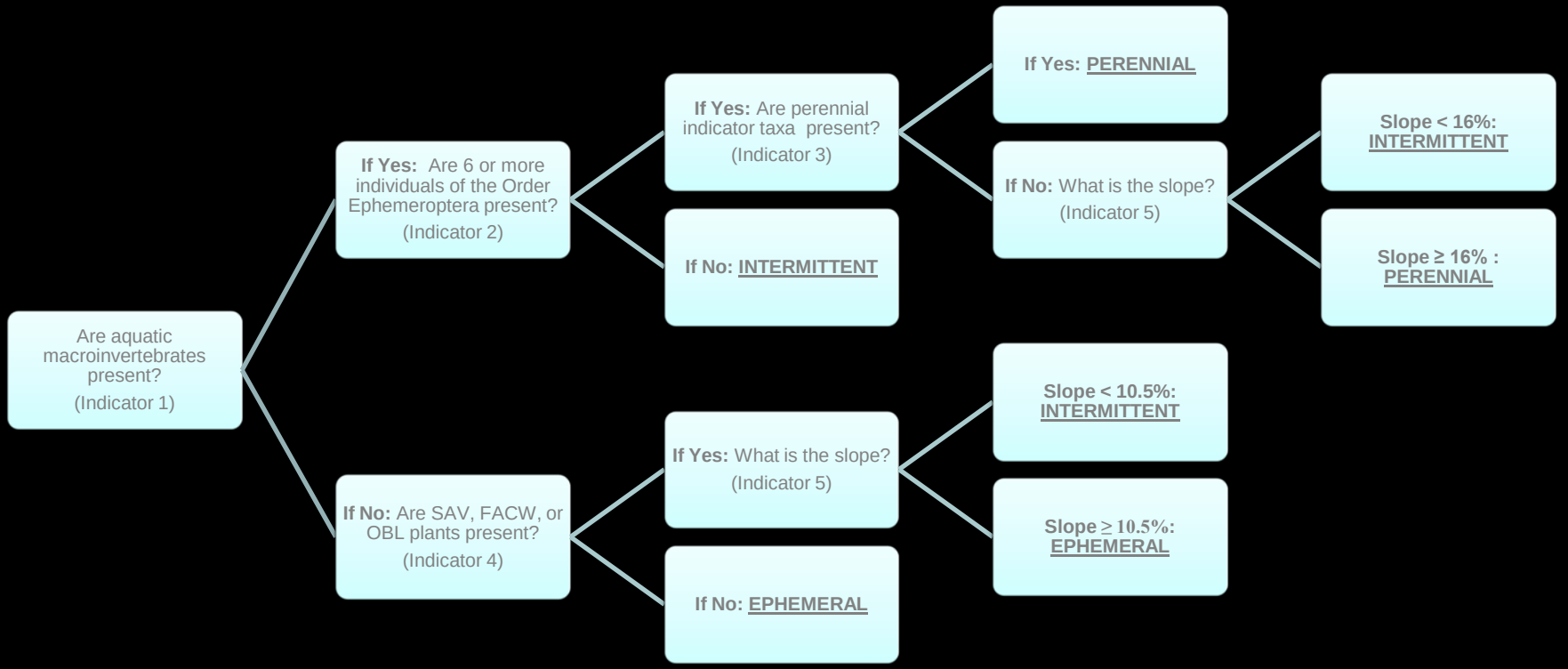
		INTERIM METHOD		
		Ephemeral	**Intermittent**	**Perennial**
ACTUAL	**Ephemeral**	84	56	0
	Intermittent	11	57	58
	Perennial	0	10	80

Correct:	**222**	**62%**
Incorrect:	135	38%
Total:	356	100%

Statistical Analyses

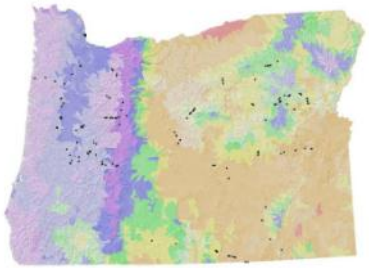
1. Indicators with strongest explanatory power for classifying hydrological permanence (RF)
   - Macroinvertebrate (presence & perennial) (I); Ephemeroptera (S); hydrophytic plants (I); slope (S); leaf litter accumulation (I)
2. Developed a ‘best fit’ classification tree (model; 75% of data)
3. Tested model (25% data)
4. Basis of decision-tree (Revised Method)

Revised Method



Single Indictors for “at least intermittent” maintained - Presence of fish or herpetological species’ life history stages requiring sustained presence of water

Confusion Matrix Analysis

		REVISED METHOD		
		Ephemeral	**Intermittent**	**Perennial**
ACTUAL	**Ephemeral**	128	12	0
	Intermittent	6	113	7
	Perennial	0	24	66

Correct:	307	**86%**
Incorrect:	49	14%
Total:	356	100%

I/P combined: 94.9%

Conclusions

Phase I

- Interim Method has some subjective indicators that are difficult to assess
- Interim Method overweighted geomorphic indicators—led to false conclusions because flow magnitude, rather than flow duration, was scored
- Revised Method based on measurable, rather than subjective indicators

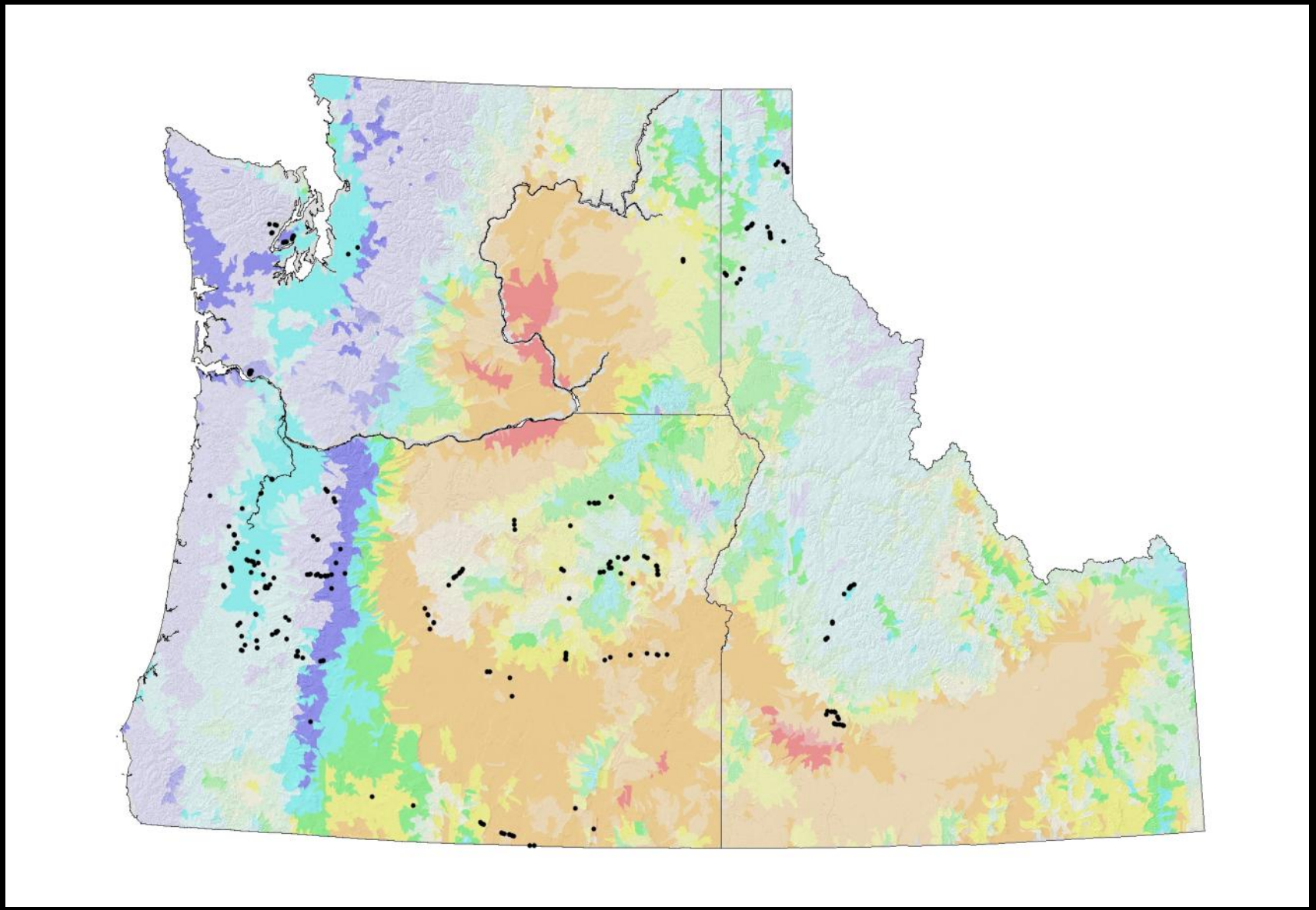
Study Questions
(Phase II: Washington, Idaho)

Evaluate regional applicability of methods developed in Oregon

- What is the performance accuracy of the Interim and Revised Methods in Washington and Idaho in similar and dissimilar hydrologic landscapes?

- Does statistical analyses of 3 state data provide a model that outperforms model (Revised Method) developed from Oregon data alone?

Washington, Idaho Validation Study Sites



Validation Study

Phase II: Washington, Idaho

- Sampled across a range of hydrologic settings at ~90 study sites in three clusters
- Interim, Supplemental, Revised, and Single Indicator data collected
- Wet/Dry season sampling

Confusion Matrix Analysis

ACCURACY (%)		*Combined Data Set – 3 states*	
		Interim	**Revised***
STREAMFLOW DURATION CLASS	**Ephemeral**	89.3	92.5
	Intermittent	48.7	76.1
	Perennial	59.1	84.1
	Average	65.7	84.2

Analyses of 3-state data did not provide model (method) that significantly outperforms method (Revised) developed using Oregon data alone

Confusion Matrix Analysis

ACCURACY (%)	SINGLE INDICATOR	
	Herpetological life history stages	Fish
ALL DATA	*Presence I/P streams* 48.5	42.8
	Presence Accuracy 97.1	100

While the *absence* of fish or identified herpetological species is not significant, their *presence* is; thus they are maintained as single indicators denoting “at least intermittent” status.

Confusion Matrix Analysis

ACCURACY (%)		Interim	Revised
ALL		62.3 (81.6)	83.9 (93.8)
REGION	ID_c	63.3 (78.3)	80.0 (88.3)
	ID_n	62.5 (87.5)	73.2 (89.3)
	OR_e	59.7 (81.3)	91.5 (97.2)
	OR_w	64.4 (81.1)	81.1 (92.8)
	WA_w	62.5 (82.1)	83.9 (96.4)

Accuracy parsed by study area regions; upper number is overall, lower number is I/P accuracy.

Conclusions

Phase II

- Effective model (method) from empirical design
- Method developed using BPJ (Interim) establishes testable hypothesis; study points to importance of field testing
- In PNW, biological indicators are good indicators of streamflow duration
- Provides defensible, repeatable method applicable across PNW (and wet/dry seasons*)

Companion Macroinvertebrate Field Guide, Studies

- Xerces report (EPA funded) – identified family-level differences in macroinvertebrate communities sufficient to allow use as indicators to discriminate between P, I, E stream types (OR 2008; WA, ID 2011).
- Resulted in P, I, E indicator taxa list, and Field Guide, for SDAM for the PNW.
- Provides consistent collection methodology.

SDAM Application

Beyond informing jurisdictional determinations, informs:

- Restoration prioritization
- Stream buffer requirements
- Water quality assessment method application

Acknowledgments

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Further information

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http://yosemite.epa.gov/R10/ecocomm.nsf/wetlands/sdam