SWAMP invertebrate sampling protocol: Update with preliminary findings

Slocan Wetland Assessment and Mapping Program

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Outline

- Goals of our program
- Review methods used to monitor invertebrates
- 2015-16 reporting
- Results and application
- Future work & quality control

Photo by Marcy Mahr

Goals of the SWAMP wetland invertebrate monitoring

- Develop a field sampling program that follows CABIN protocol
- Prioritize wetlands for restoration & conservation opportunities
- Assess areas potentially affected by mining, agriculture and development
- Submit data to Environment Canada under CABIN

Toad fest 2015, Photo by Ellen Kinsel

Slocan Lake

Bug Day 2016, Photo by Shanoon Bennett

SWAMP Projects

Initiated by Slocan Streamkeepers, Slocan Solutions Society & Slocan Lake Stewardship Society

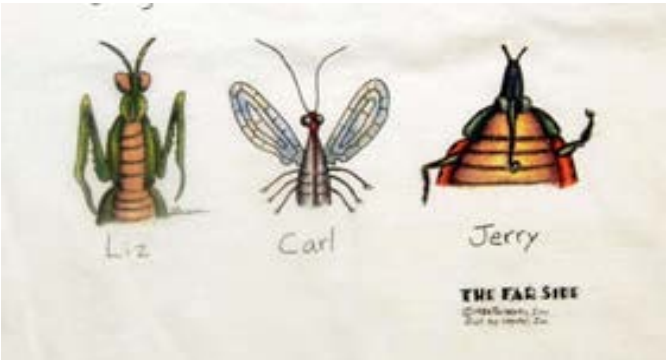
- Sensitive ecosystem mapping Phase I-III
- Classify wetlands using the Canadian System of wetland classification.
- Development of a macroinvertebrate protocol for wetlands.

What are macroinvertebrates?

- Organisms without a backbone
- >5 microns
- Inhabit a variety of microhabitats
- Variable tolerances to stressors- pollution, development & land use

Some are tolerant to stress

It is the community of invertebrates that help us determine wetland health



Some are sensitive to stress

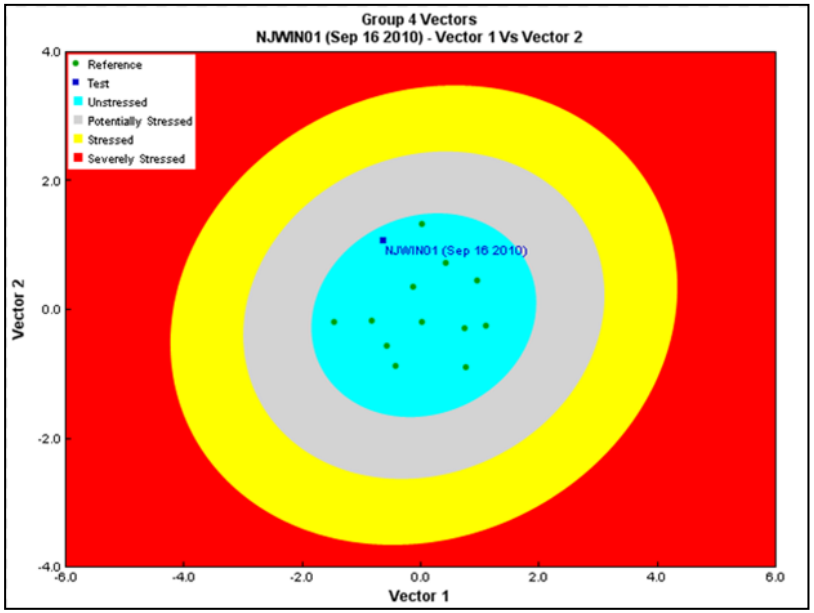
Why monitor macroinvertebrates?

- Invertebrates respond to a wide range of human stressors
- They have been used as indicators of wetland health
- They complete a large portion of their life cycle within the wetland
- They are an important part of the food web

Photo by John Boulanger

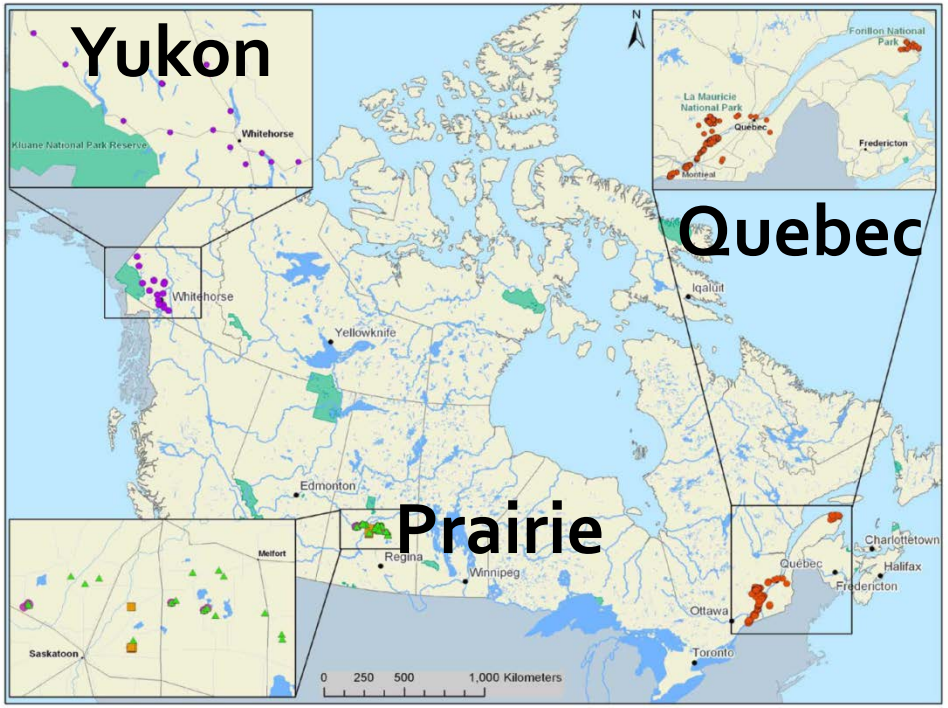
Environment Canada – Canadian Aquatic Biomonitoring Network

- Comprehensive CABIN protocols for streams
- Training program to certify participants
  - Database with tools to analyse data with multivariate statistics
  - However, CABIN methods for wetlands are still in development



-Measures community stress at test sites compared to reference-control sites

SWAMP invertebrate protocol uses CABIN methods for wetlands



- CABIN methods in development on a National level
- Field sheet available this summer
- Official protocol for near release
- Multivariate approach requires 35-50 sites

Map from Emily McIvor, May 2014

CABIN (Canadian Biomonitoring Network)

St. Lawrence River -Tall et al. 2008

Yukon - Bailey, J.L. and Reynoldson, T.B. 2009

Index of biological Integrity for wetlands

- Great Lakes coastal wetlands - Uzarski et al. 2011
- Niagara marshes - Archer et al. 2010
- Montana - Apfelbeck 2000
- Oregon - Mazzacano 2011
- EPA – National Methods for wetlands-2012
- Kinbasket Reservoir -Adama et al. 2013
- Alberta wetlands –(aqu.plant) Rooney & Bayley 2010
- Kamloops wetlands (meiofauna) – Smith et al. 2005

Multimetric approach and use of multivariate analyses.

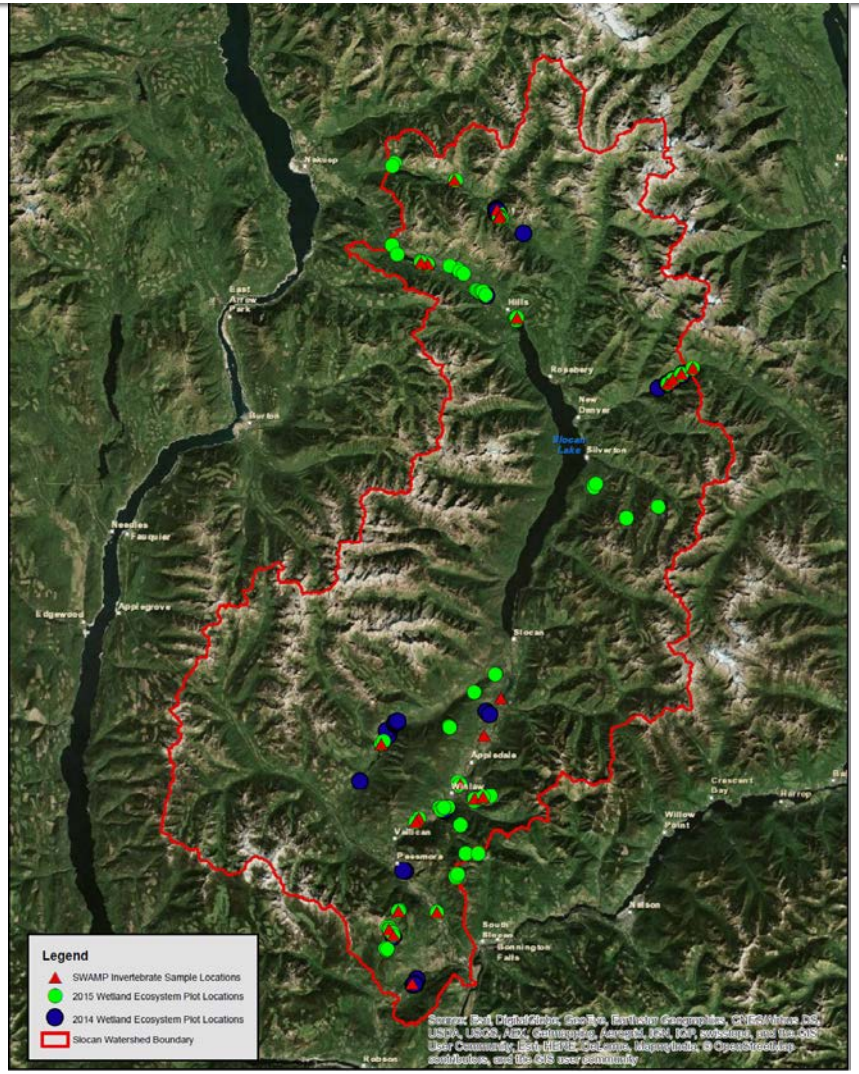
Invertebrate component, 2014-16

- **Funding from:,**
  - National Wetland Conservation Fund General
  - National Wetland Conservation Fund Top-up
  - Columbia Basin Fish and Wildlife Compensation Program
  - Columbia Basin Trust
- Sampled 24 wetlands in 2014-15
- Macroinvertebrates were identified by taxonomist (**Rhithron)**
- **The Royal BC museum** has agreed to house our reference collection in perpetuity.
- Rebecca Rooney (**U. of Waterloo**) –advice/peer review

Special thanks to SWAMP members, SRSS, SLSS, Slocan Solutions, Rhia MacKenzie, Richard Johnson, Ryan Durand, Tyson Ehlers, Marcy Mahr, Gregoire Lamoureaux, Margaret Hartley, Jennifer Yeow and the SWAMP technical committee.

Sites monitored in 2015

- 20 sites in 2015
- 4 sites in 2014
- North/South Distribution
- Lower/Upper Elevations Max 1500 m



Invertebrate sites

2014 Ecosystem sites

2015 Ecosystem sites

Wetlands described in Phase III of SWAMP, map from Durand 2015

Parameters monitored:

Special thanks to Marcy Mahr, Rhia MacKenzie, Tyson Ehlers and Ryan Durand.

- Invertebrates from emergent vegetation
- Water chemistry
- Sediment chemistry
- Composition of emergent vegetation
- Habitat variables/stressors

Invertebrate sampling:

3 minute travelling kick

5 x 5 m quadrate

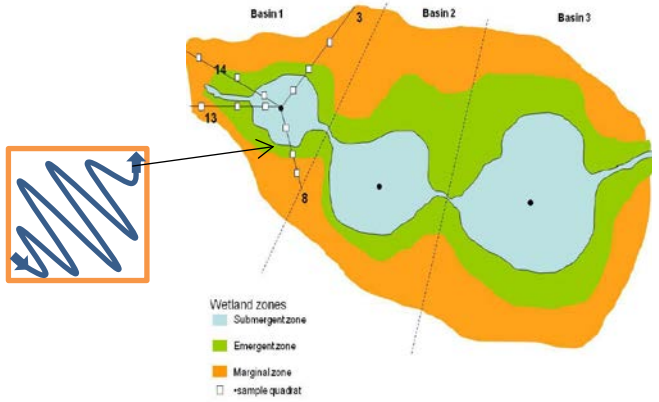


Figure modified from Bailey and Reynoldson (2009) & kick-net pattern from Emily McIvor (2014).

Data summary: rating of wetlands using Index of Biotic Integrity: (IBI)

Goals:

1. Develop an index to rate wetland health using invertebrate metrics

Methods from US EPA 2002

2. Use multivariate methods to analyze data.

Rooney and Bailey 2010 and other references

Index of Biotic Integrity: Step 1, Trends in physiochemistry

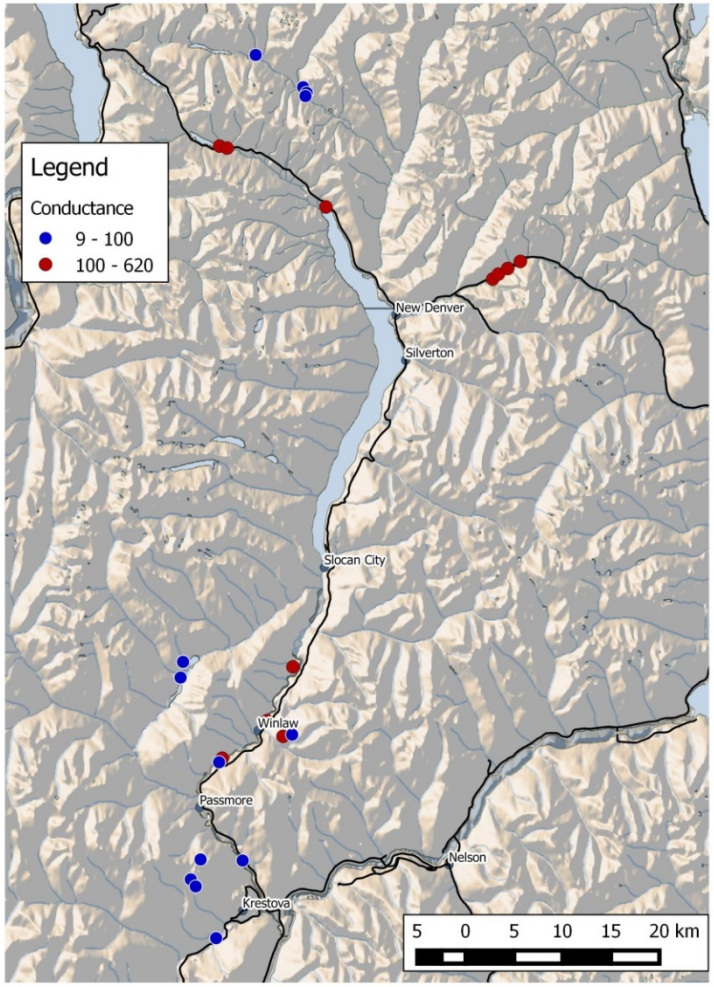
Step 1
- Look at trends in physiochemistry

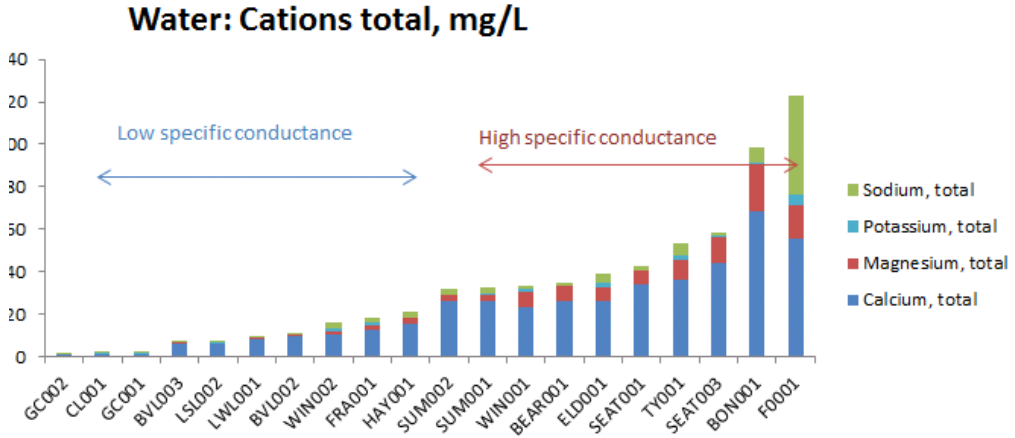
Step2
- Develop a Wetland Stress Gradient

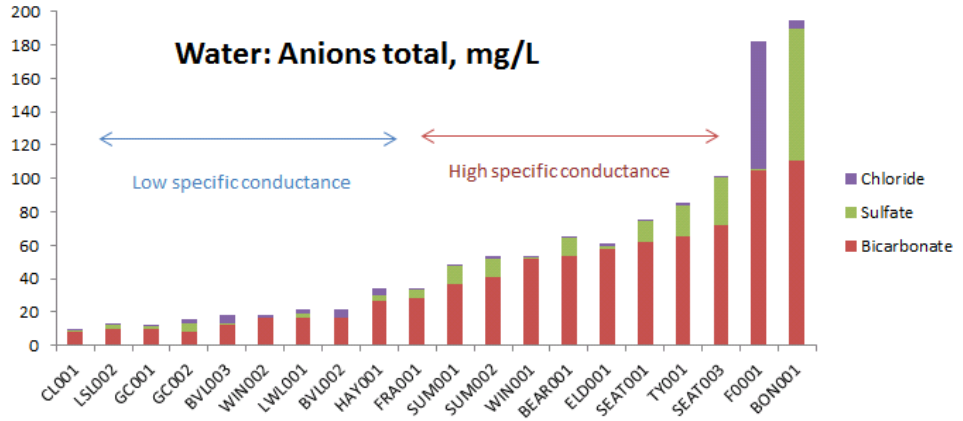
Step 3
- Combine invertebrate metrics into an IBI index

Step 4
- Test and Validate Index

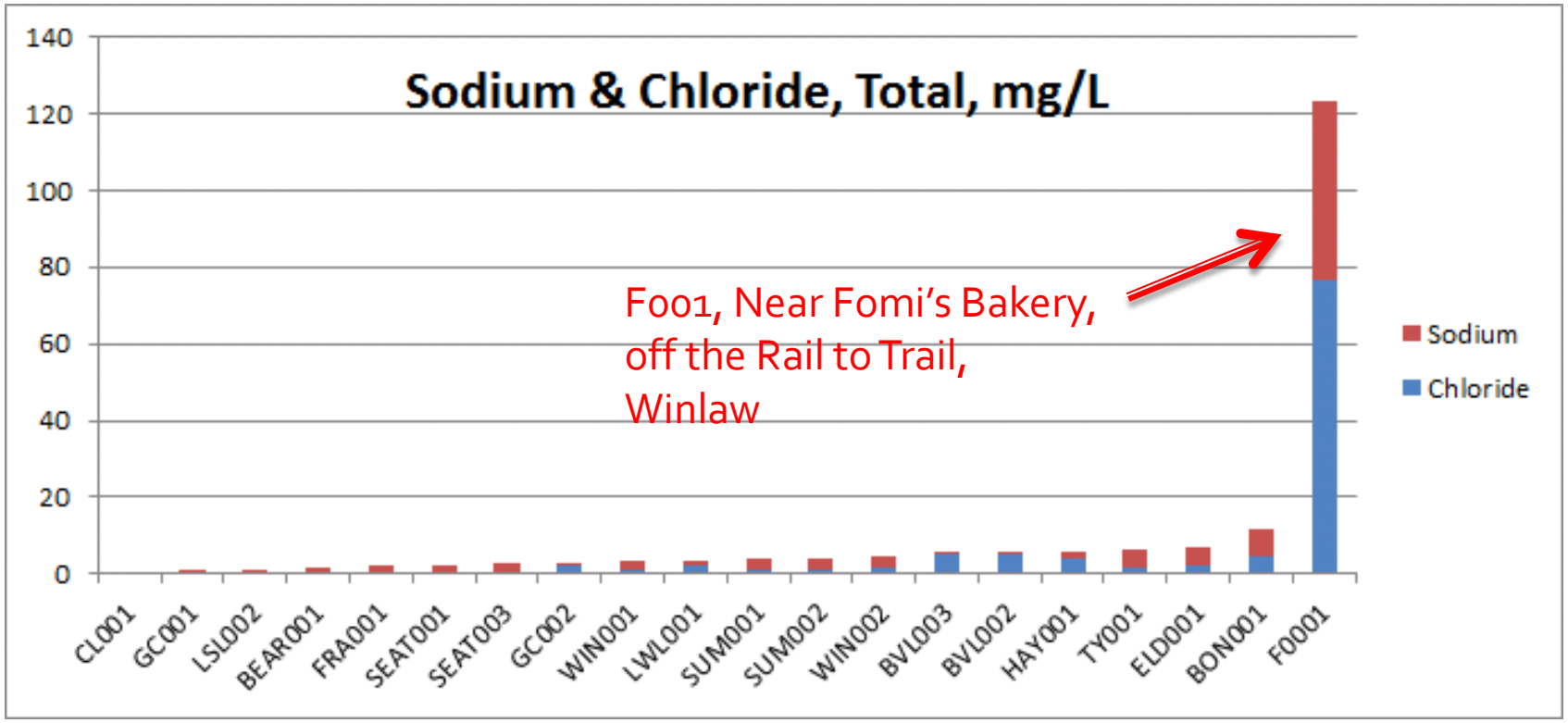
Step 1: Geology affects water quality





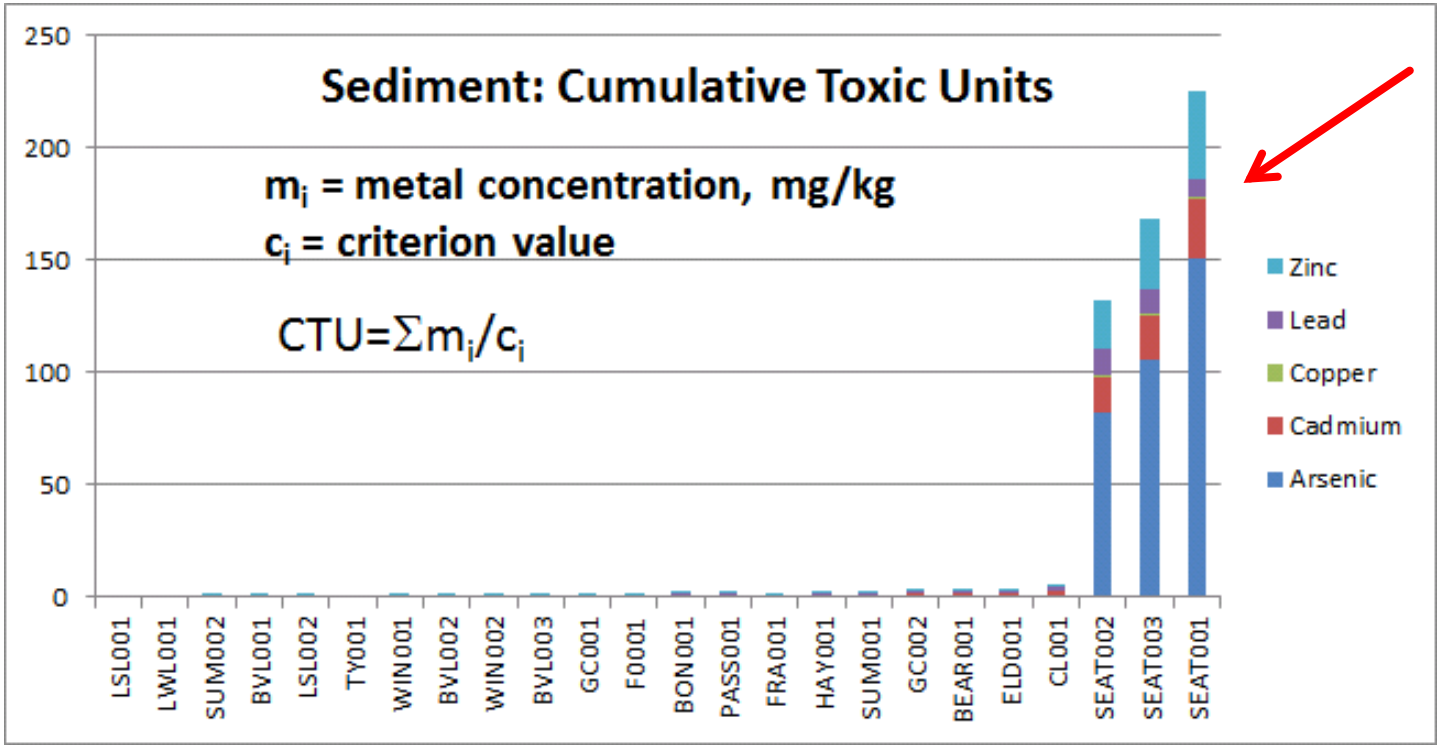


Altered water chemistry



Chloride:
Guidelines for aquatic life: 150 mg/L 30-day average, 600 mg/L Max
Significant effect on amphibians: 200 mg/L , (Sadowski 2005)
Natural waters normally <40 mg/L (NPTA 1999)

Altered sediment chemistry: metals



Legacy mining impacts at SEAT001 SEAT002 SEAT003

168-225 X >Guidelines

>10 CTU significantly polluted

>2 CTU may affect community structure & cause mortality

Back to the big picture

Step 1
- Look at trends in physiochemistry

Step2
- Develop a Wetland Stress Gradient

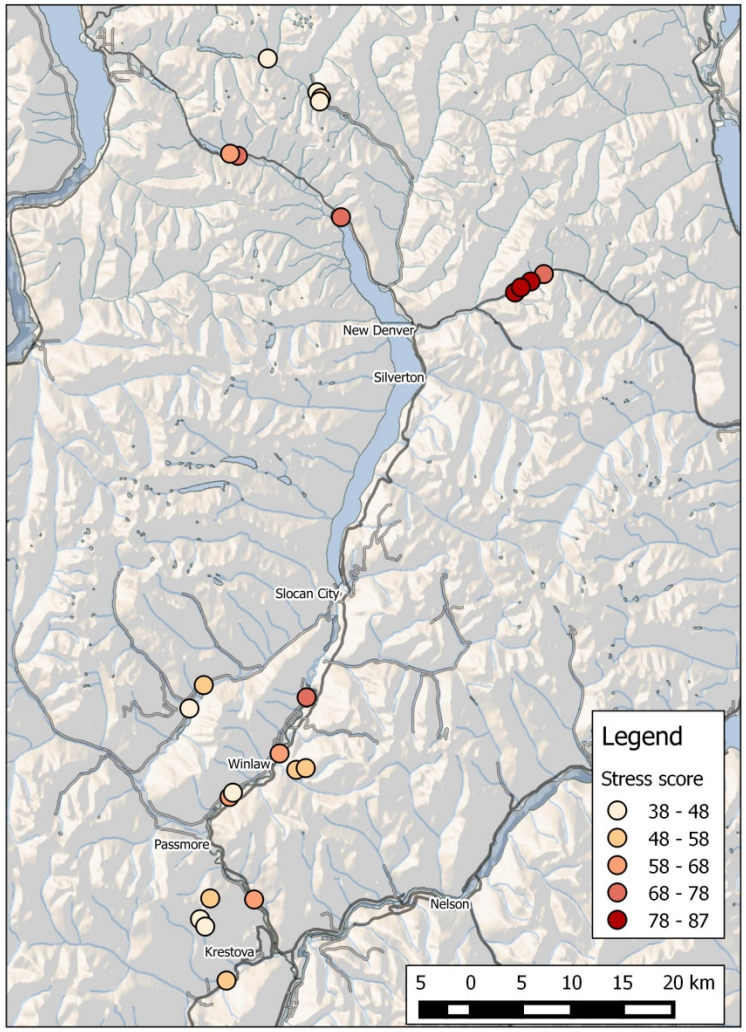
Step 3
- Combine invertebrate metrics into an IBI index

Step 4
- Test and Validate Index

http://thenelsondaily.com

Develop a Macroinvertebrate IBI to rate wetland health for restoration and conservation

Step 2: Wetland Stress Gradient



Quantitative Stress Gradient

Based on 4 Categories:

- Water: Calcium
- Sediment: Phosphorus
- Contaminants: Arsenic
- Physical: Human disturbance (GIS)

Used PCA methods to reduce # of parameters

Indicator variables were weighted, scaled and summed

Wetland Stress Gradient: testing

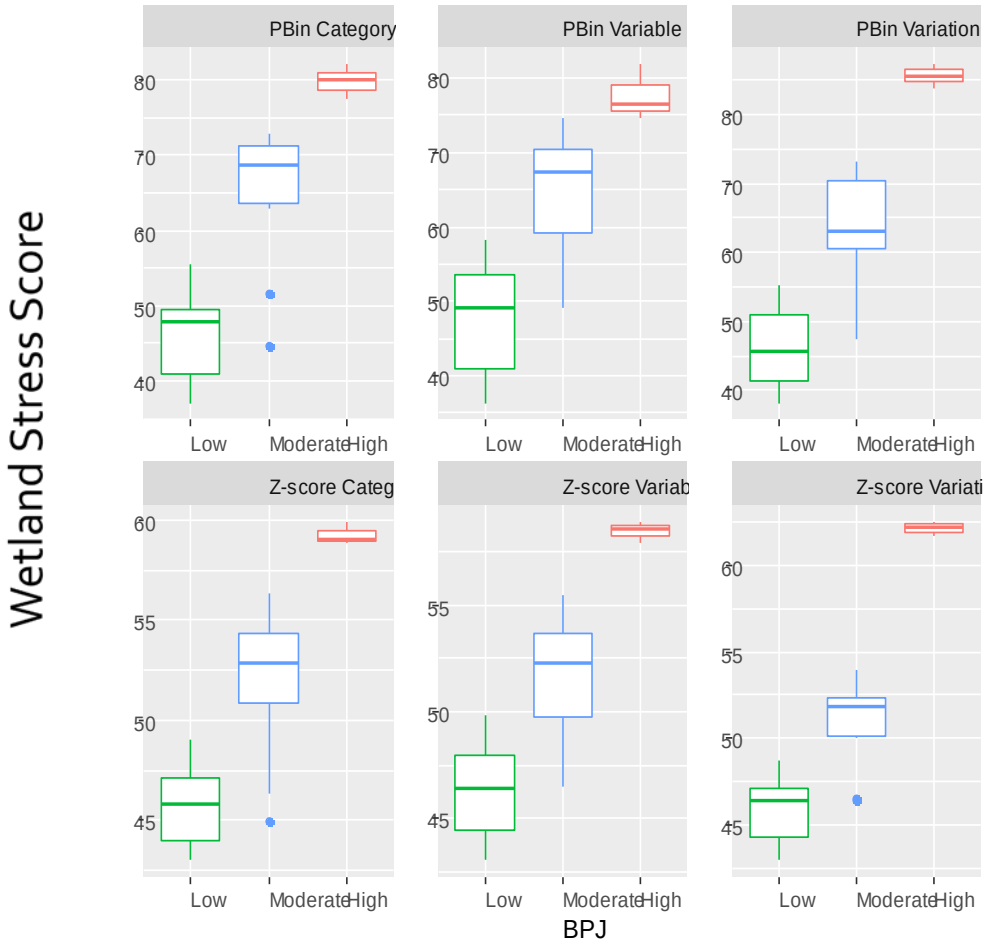
Quantitative Stress Gradient:

Tested 6 weighting and scoring schemes

All schemes correlated with each other and Best Professional Judgement (BPJ)

Pbin=percentile binning
Z-score= (X - μ) / σ

With weighting by either category, variable, or % variance from principal component axis



Best Professional Judgement (BPJ)

Step 3: Relate macroinvertebrates to wetland stress & create IBI

- **Step 1**
  - Look at trends in physiochemistry
- **Step2**
  - Develop a Wetland Stress Gradient
- **Step 3**
  - Combine invertebrate metrics into an IBI index
- **Step 4**
  - Test and Validate Index

Step 3: Invertebrate metrics vs. wetland stress gradient

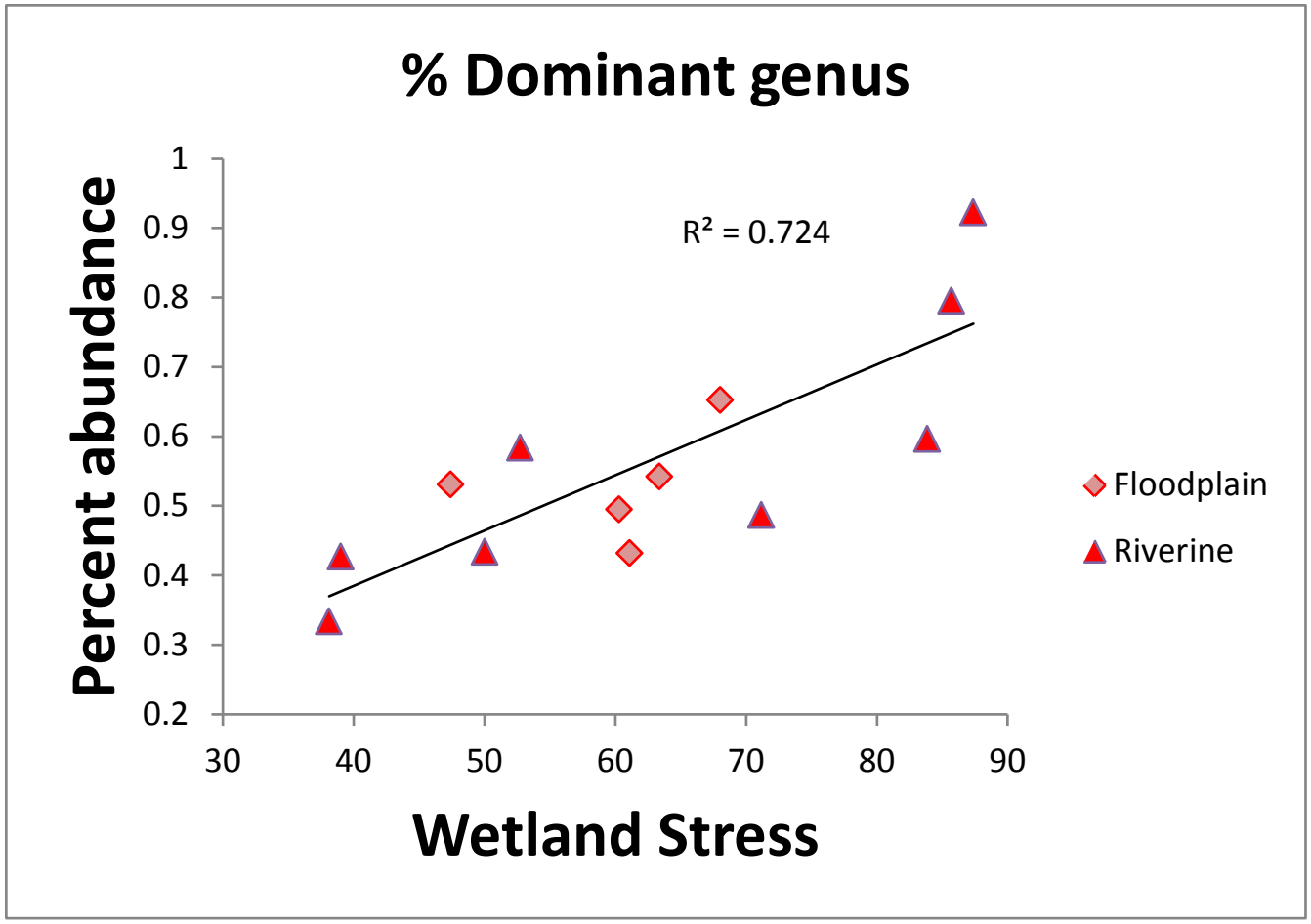
Step 3: Retain metrics that show strong response to Wetland Stress

Select metrics with high dose-response to stress

Candidate Metric	Rationale
# of Genus	Declined with stress
Number of Clitellata taxa	Decreased with stress
% Dominant taxa	Increasesd with stress
% Top 3 dominant taxa	Increasesdwith stress
% Top 5 dominant taxa	Increasesd with stress
% Abundance Callibaetis	Increased with metals and conductivity
% Abundance of Mayflies, caddisflies & dragonflies	Related to above
% non-insect	Increasesd with stress
% Diversity of bivalves, amphipods & gastropods	Decreasesd with stress
% Abundance collector-gatherers	Increased with stress (oligochaetes)
Number of intolerant taxa	Increased with stress
% Diversity of amphipods to (amphipods + bivalves + gastropods)	Declined with stress
% Diversity of Collector filterers + Collector Gatherer	Declined with stress

Metrics that show no response to stress are discarded

Data summary: Metric analyses



Y axis transformed with Arcsin(sqrt()) transformation

Eliminate redundant metrics

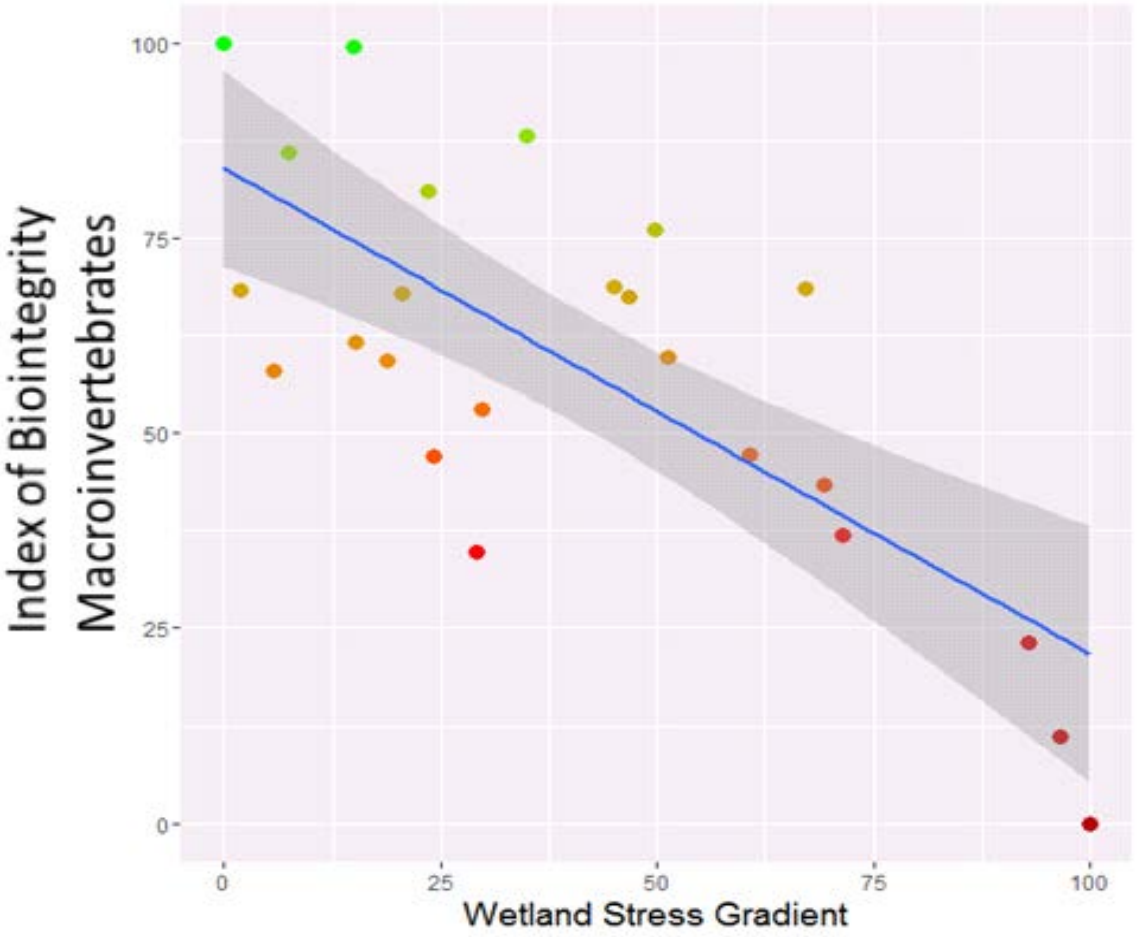
Step 3:
6 uncorrelated metrics were retained

Metrics were eliminated if there was a high correlation between metrics

Metrics used to calculate IBI
of taxa (Genus level)
Number of Clitellata taxa
% Abundance Callibaetis
% Abundance collector-gatherers
Number of intolerant taxa
% Diversity of amphipods/(amphipods + bivalves + gastropods)

Candidate metrics only, statistics will be rerun in 2016/17

Step 4: 6 metrics combined into overall IBI and rating system



Good

Fair

Poor

Individual metrics were scaled, corrected for direction of response and summed

Independent, quantitative scores for each site of interest

Site	*Possible restoration site or site of interest*	*Restoration or Conservation potential*	*Wetland stress score*	*IBI score*
FRA001	Side channel, residual Oxbow	Restoration	60.2	68.8
SEAT003	Seaton Creek/Three forks wetlands	Impacted by legacy mining.	87.4	0
BON001	Bonanza Creek wetland	Conservation	73.3	59.7

Note: There is error associated with these index categories

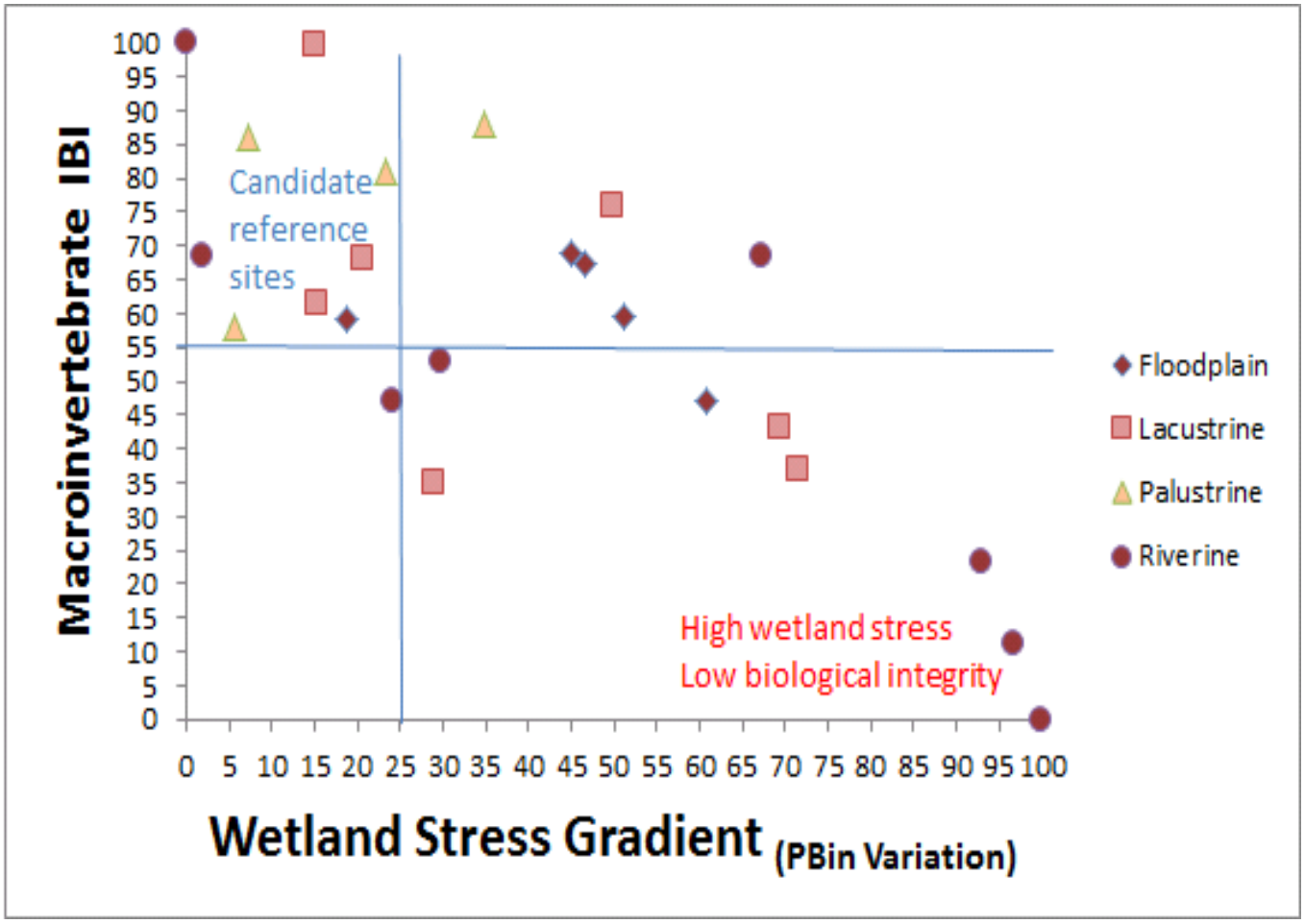
Validation and testing

In 2016/2017:

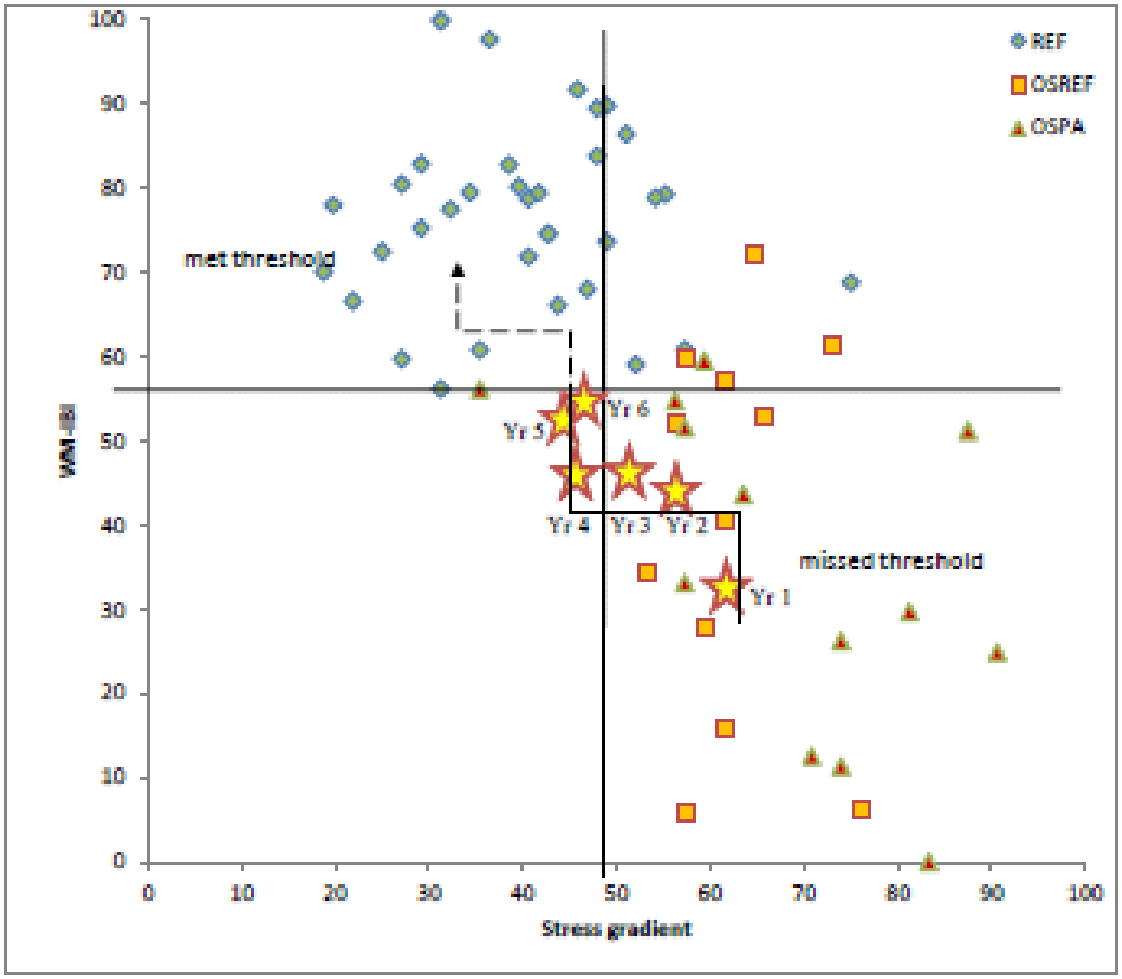
Cross-validation and correct classification rates using a "*hold-out or validation sample*" will be used to answer the question:

How well will this equation perform to predict wetland health?

IBI identifies reference sites for restoration targets



Criterion and thresholds can be used to assess restoration goals



Example of monitoring changes in condition over time

The trajectory (shown by the arrow) of the hypothetical marsh (the star)

From Bayley et al. 2014

Challenges & future work

- Use index of biotic integrity to prioritize wetlands for restoration
- Increase site number to provide coverage over a range of habitat types
  - Funding from FWCP for evaluation Halleran restoration sites 2016
  - CBT funding for 2016
- Peer review of protocols & methods
  - Feedback from Environment Canada, recent draft protocol received ver 1.0. SWAMP is beta testing these protocols.
  - Skype planned with University of Waterloo

Restoration and stewardship

- Continue stewardship and education to encourage private landowner restoration based on sites identified in IBI results.
- Use Spankie restoration site to gain credibility and buy-in: Meadow Creek example where farmers are now seeking restoration works based on information provided through public meetings, signage and tours.
- Continue to hold Wetland Educational Meetings: Similar to super successful February 2016 format held in New Denver with attendance by Richard Cannings.

http://thenelsondaily.com

http://slocanswamp.org/wetland-days

SWAMP: Accomplishments

- **Partners and supporters**
  - BC Hydro Fish & Wildlife Compensation Program, Columbia Basin Trust, BC Wildlife Federation, Central Kootenay Invasive Plant Committee, Regional District of Central Kootenay, Selkirk College, Environment Canada's National Wetland Conservation Fund and Canadian Biomonitoring Network, the Royal BC Museum and the Ministry of Forest Lands and Natural Resource Operations.
- **Reports produced :** 11 reports/updates as of March 31, 2016
- **Funding from FWCP for a wetland restoration site**
- **Education**
  - Wetland/Bug Days (4), Representation at Rivers Day, Wild Days (4), Media Day, School and private landowner outreach.

- **Participation:**

  SWAMP Technical committee (2 per year), SWAMP Executive meetings, Member AGMs Numerous board meetings, administration and volunteer hours,Col. Basin Watershed Network workshops (3), CBT Board meetings (2), Society for Freshwater Science, Selkirk College Drone workshop

Thank you

- Thank you to Rhia MacKenzie, Ryan Durand, Richard Johnson, Tyson Ehlers, Gregoire Lamoureaux, Verena Shaw , Mechelle Babic and Jennifer Yeow.

- Thank you to, Slocan Streamkeepers and Slocan Solutions Society, Slocan Lake Stewardship Society and BC Wildlife Federation

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