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

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

Some are tolerant to stress

Some are sensitive to stress
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
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
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 Reynolds, 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 Lamoureux, 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:

- 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 quadrat


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

Step 2
- 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

Water: Cations total, mg/L

Low specific conductance

High specific conductance

Sodium, total
Potassium, total
Magnesium, total
Calcium, total

Water: Anions total, mg/L

Low specific conductance

High specific conductance

Chloride
Sulfate
Bicarbonate
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

\[ m_i = \text{metal concentration, mg/kg} \]
\[ c_i = \text{criterion value} \]
\[ \text{CTU} = \frac{\sum m_i}{c_i} \]

Legacy mining impacts at
SEAT001
SEAT002
SEAT003

168-225 X
>Guidelines

>10 CTU significantly polluted
>2 CTU may affect community structure & cause mortality
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
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
Step 3: Relate macroinvertebrates to wetland stress & create IBI

- Step 1: Look at trends in physiochemistry
- Step 2: Develop a Wetland Stress Gradient
- Step 3: Combine invertebrate metrics into an IBI index
- Step 4: Test and Validate Index
Step 3: Retain metrics that show strong response to Wetland Stress

Select metrics with high dose-response to stress

<table>
<thead>
<tr>
<th>Candidate Metric</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Genus</td>
<td>Declined with stress</td>
</tr>
<tr>
<td>Number of Clitellata taxa</td>
<td>Decreased with stress</td>
</tr>
<tr>
<td>% Dominant taxa</td>
<td>Increased with stress</td>
</tr>
<tr>
<td>% Top 3 dominant taxa</td>
<td>Increased with stress</td>
</tr>
<tr>
<td>% Top 5 dominant taxa</td>
<td>Increased with stress</td>
</tr>
<tr>
<td>% Abundance Callibaetis</td>
<td>Increased with metals and conductivity</td>
</tr>
<tr>
<td>% Abundance of Mayflies, caddisflies &amp; dragonflies</td>
<td>Related to above</td>
</tr>
<tr>
<td>% non-insect</td>
<td>Increased with stress</td>
</tr>
<tr>
<td>% Diversity of bivalves, amphipods &amp; gastropods</td>
<td>Decreased with stress</td>
</tr>
<tr>
<td>% Abundance collector-gatherers</td>
<td>Increased with stress (oligochaetes)</td>
</tr>
<tr>
<td>Number of intolerant taxa</td>
<td>Increased with stress</td>
</tr>
<tr>
<td>% Diversity of amphipods to (amphipods + bivalves + gastropods)</td>
<td>Declined with stress</td>
</tr>
<tr>
<td>% Diversity of Collector filterers + Collector Gatherer</td>
<td>Declined with stress</td>
</tr>
</tbody>
</table>
Data summary: Metric analyses

% Dominant genus

R² = 0.724

Y axis transformed with Arcsin(sqrt()) transformation
Eliminate redundant metrics

Step 3:
6 uncorrelated metrics were retained

<table>
<thead>
<tr>
<th>Metrics used to calculate IBI</th>
</tr>
</thead>
<tbody>
<tr>
<td># of taxa (Genus level)</td>
</tr>
<tr>
<td>Number of Clitellata taxa</td>
</tr>
<tr>
<td>% Abundance Callibaetis</td>
</tr>
<tr>
<td>% Abundance collector-gatherers</td>
</tr>
</tbody>
</table>

| 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

Individual metrics were scaled, corrected for direction of response and summed
### Independent, quantitative scores for each site of interest

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

Note: There is error associated with these index categories
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

![Graph showing the relationship between Macroinvertebrate IBI and Wetland Stress Gradient.]

- High wetland stress
- Low biological integrity

- Candidate reference sites

- Floodplain
- Lacustrine
- Palustrine
- Riverine
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
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.
Partners and supporters

Reports produced: 11 reports/updates as of March 31, 2016

Funding from FWCP for a wetland restoration site

Education

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 to, Slocan Streamkeepers and Slocan Solutions Society, Slocan Lake Stewardship Society and BC Wildlife Federation.
References


- Archer, R.W., Christopher, P., Lorenz, J. and Jones, K.E. Monitoring and assessing marsh habitat health in the Niagara River area of concern. Prep. for Environment Canada-Great Lakes Sustainability Fund.


- www.waterontheweb.org photos of invertebrates