

# MACROINVERTEBRATE INDICATORS: PRESENCE OR ABSENCE IN NATIONAL POLICY?

JOANNE CLAPCOTT, ANNIKA WAGENHOFF, KEVIN COLLIER, RUSSELL DEATH, JON HARDING, CHRISTOPH MATTHAEI, MARTIN NEALE, JOHN QUINN, BRIAN SMITH, RICHARD STOREY, ROGER YOUNG

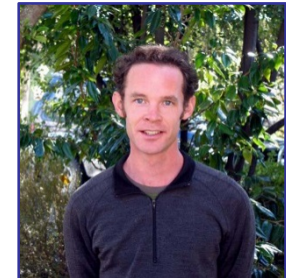
22 NOVEMBER 2017



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# MEET THE PLAYERS

*Ichthybotus* (mayfly)



*Stenoperla* (stonefly)



*Olinga* (caddisfly)



**E**phemeroptera +

**8**

+

**P**lecoptera +

**10**

+

**T**ricoptera = **EPT taxa**

**9**

= **MCI scores**

(**Macroinvertebrate Community Index**)

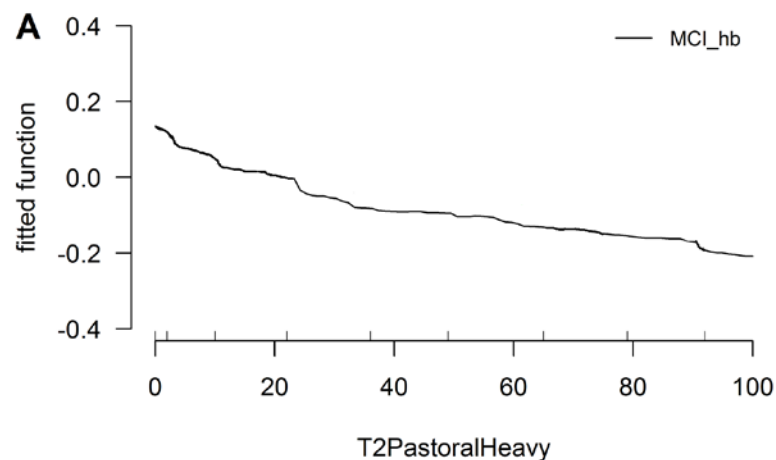
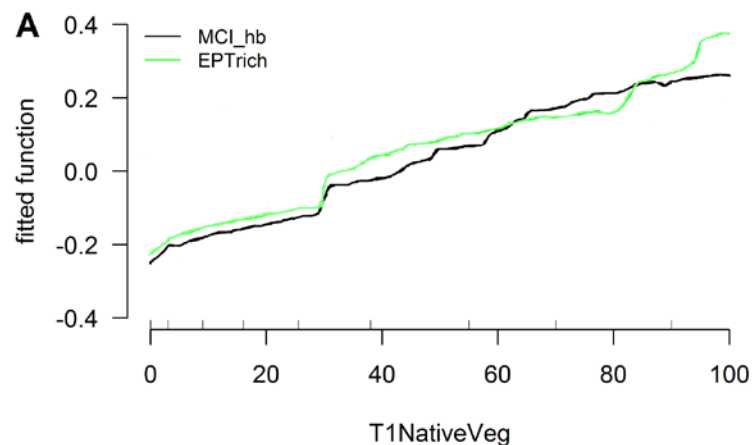
# MACROINVERTEBRATES ARE EXCELLENT INDICATORS OF STREAM HEALTH

Or are they?

YES! common and easily sampled, sensitive to stressors

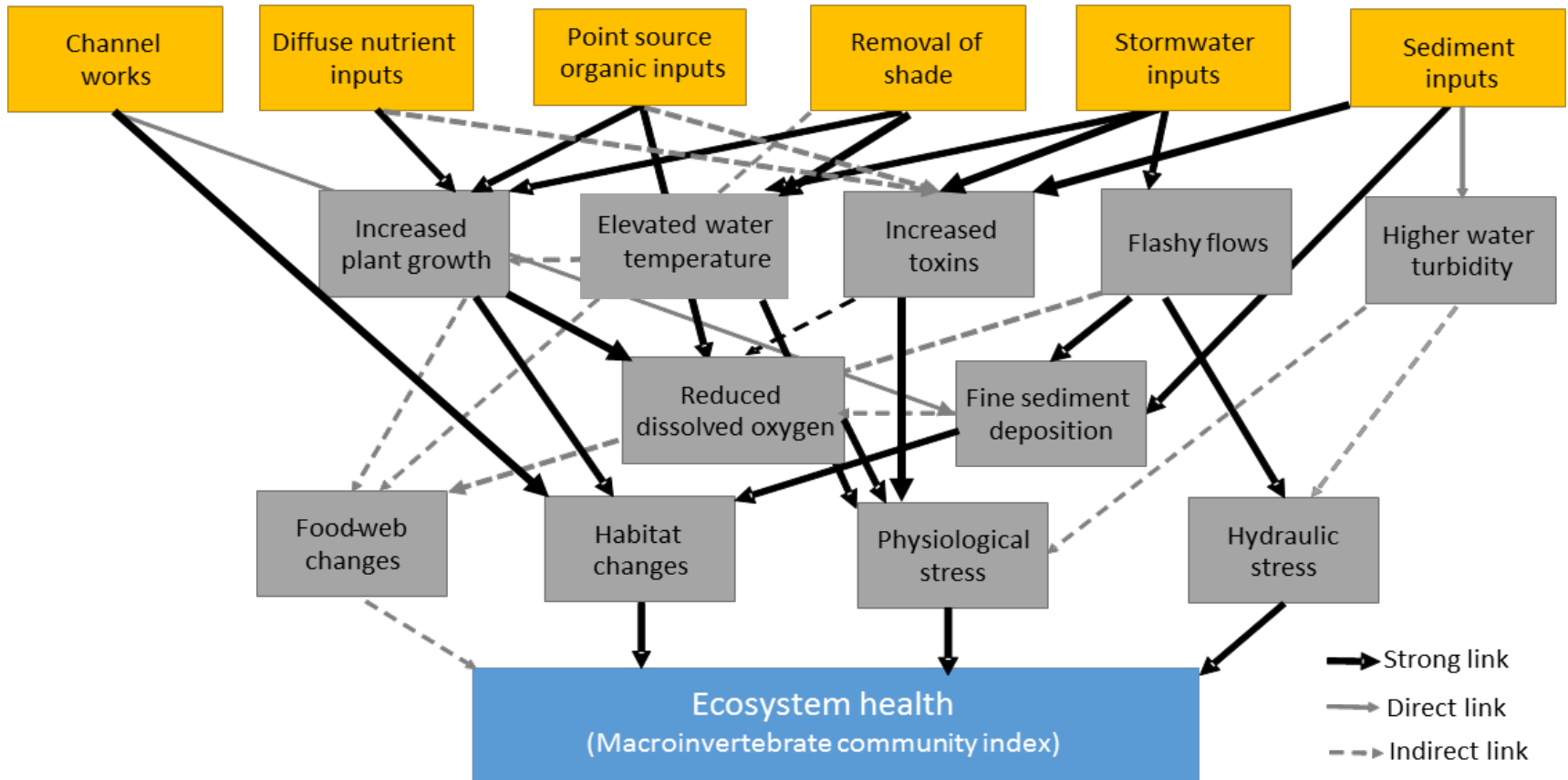
But which stressors?

## LAND USE



# MACROINVERTEBRATES ARE EXCELLENT INDICATORS OF STREAM HEALTH

Yes, but which stressors?!



# MACROINVERTEBRATES ARE EXCELLENT INDICATORS OF STREAM HEALTH

Yes, but which stressors?!

And, are taxa (and taxa traits) more sensitive than community metrics?

MCI added to the NPS-FM (August 2017). Under Policy Objective CB3 every regional council must be:

- a) using the Macroinvertebrate Community Index;
- b) establishing methods under Policy CB2 to respond to a Macroinvertebrate Community Index score below 80, or a declining trend; and
- c) ensuring that methods:
  - i. investigate the causes of declining trends or the Macroinvertebrate Community Index score below 80;
  - ii. seek to halt declining trends; and
  - iii. seek to improve on a Macroinvertebrate Community Index score if it is below 80, unless this is caused by naturally occurring processes, pest or unwanted organism, or by infrastructure listed

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## CURRENT PROJECT

1. Collation of data and calculation of existing metrics including traits (**Brian**)
2. Exploration of a multivariate approach (**Martin**)
3. Development of stressor specific metrics including workshop, ecological evidence, and gradient forest analyses (**Annika**)
4. Linking metrics with stressors
5. Development of a framework and multi-metric index



# 1. COLLATION OF DATA AND CALCULATION OF EXISTING METRICS INCLUDING TRAITS

Thank you!



26 existing macroinvertebrate metrics

*Ichthybotus*



*Stenoperla*



*Olinga*



➔ Update of freshwater macroinvertebrate traits database

- 20-40 mm max length
- 1 reproductive cycle
- 1000-3000 descendants
- oviposit at water surface
- burrowers
- deposit feeders
- low body flexibility
- adult or larvae aquatic stage

- 5-10 mm max length
- 1 reproductive cycle
- 100-1000 descendants
- oviposit at water surface
- crawlers
- scrapers
- low body flexibility
- adult or larvae aquatic stage

- 5-10 mm max length
- 1 reproductive cycle
- 100-1000 descendants
- oviposit at water surface
- crawlers
- scrapers
- no body flexibility
- larvae aquatic stage

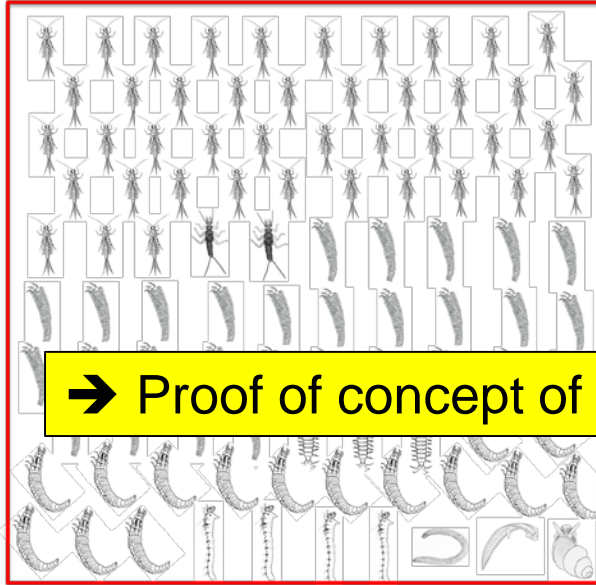


16 traits and 59 trait modalities and 13 trait diversity indices

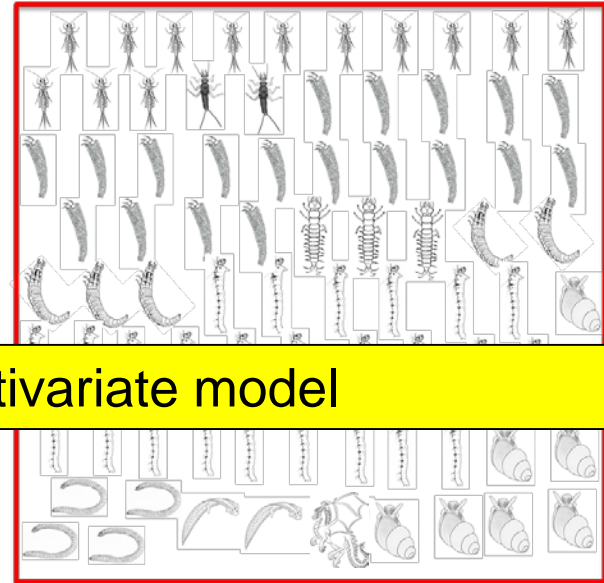
## 2. EXPLORATION OF A MULTIVARIATE APPROACH

Reference condition approach to quantifying community composition

Expected



Observed



→ Proof of concept of national multivariate model

Observed / Expected (O/E) metric, e.g. RIVPACS, AUSRIVAS

### 3. DEVELOPMENT OF STRESSOR SPECIFIC METRICS INCLUDING ECOLOGICAL EVIDENCE, WORKSHOP, AND GRADIENT FOREST ANALYSES

Systematic review of the sediment literature using EcoEvidence (Webb et al 2011)



Excellent tool for unbiased review of literature;

Lots of info for deposited sediment, less for other stressors

### 3. DEVELOPMENT OF STRESSOR SPECIFIC METRICS INCLUDING ECOLOGICAL EVIDENCE, **WORKSHOP**, AND GRADIENT FOREST ANALYSES



#### Taxa tolerance values

- A highly sensitive
- B moderately sensitive
- C moderately insensitive/tolerant
- D least sensitive/most tolerant

*Ichthybotus*



*Stenoperla*



*Olinga*



Expert scores

Sediment	D	A	A
Nutrients	B	A	B
Oxygen	B	A	A
Temperature	A	A	A
Metals	A	C	B

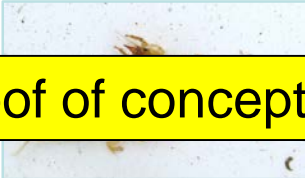
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*Ichthyobotus*



*Stenoperla*



*Olinga*



→ Proof of concept of 20 new stressor-specific metrics

Expert scores

	<i>Ichthyobotus</i>	<i>Stenoperla</i>	<i>Olinga</i>
Sediment	D	A	A
Nutrients	B	A	B
Oxygen	B	A	A
Temperature	A	A	A
Metals	A	C	B

GF scores

Sediment	-	10	10
Nutrients	10	-	5

## 4. LINKING METRICS WITH STRESSORS

Statistical approaches to quantifying relationship between metrics and stressors

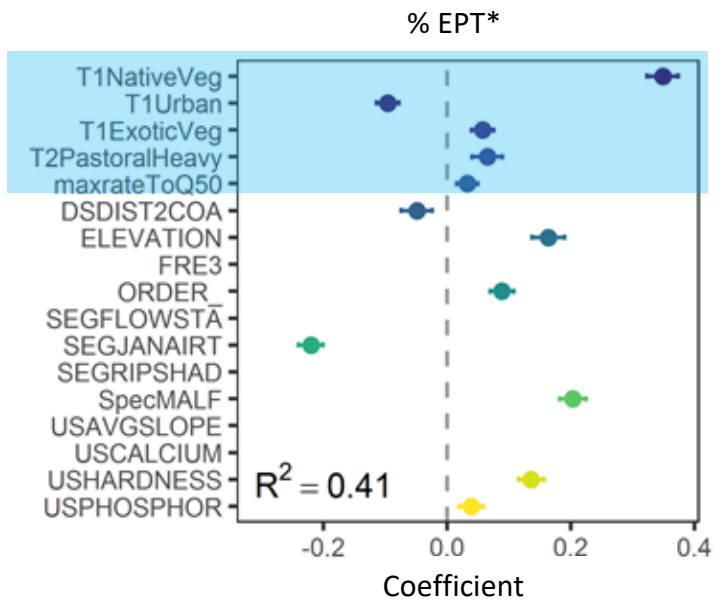
- Gradient forest analysis
- Random forest
- **General linear models**
- Variance partitioning

Two scales of stressors

- Catchment-scale land use: native vegetation, pasture, urban, exotic vegetation, flow modification
- Reach-scale instream state: deposited sediment, periphyton (nutrient pathway effect), flow modification

# 4. LINKING METRICS WITH STRESSORS – LINEAR REGRESSION

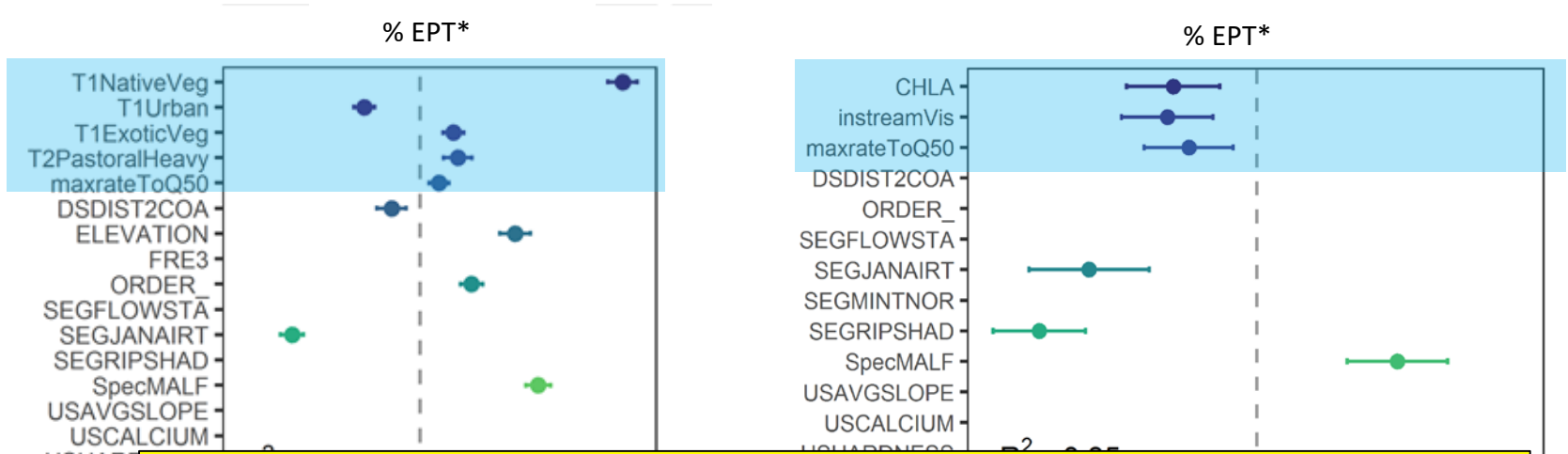
Catchment-scale land use



# 4. LINKING METRICS WITH STRESSORS – LINEAR REGRESSION

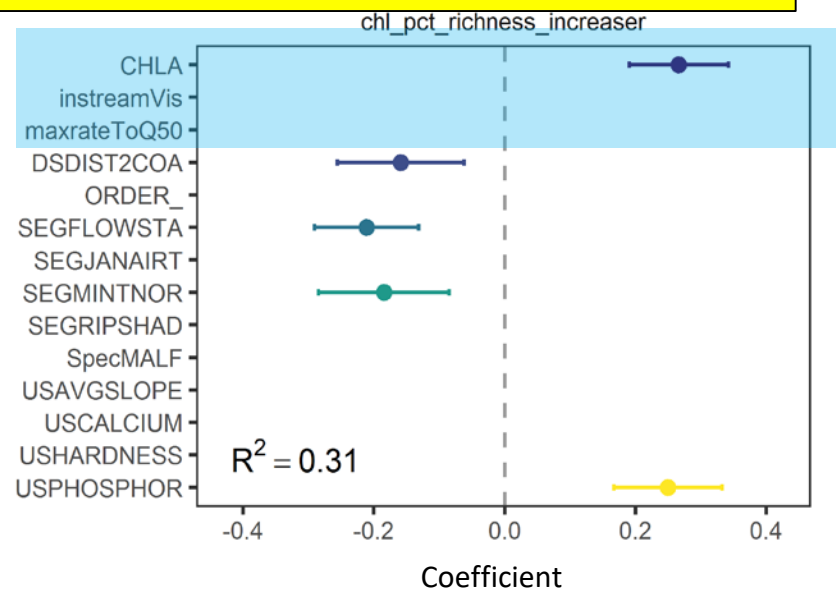
Catchment-scale land use

Reach-scale stressors



→ Quantified relative importance of stressors on metrics

Coefficient





## 5. DEVELOPMENT OF A FRAMEWORK AND MULTI-METRIC INDEX

“In a **healthy** freshwater ecosystem **ecological processes are maintained**, there is a **range and diversity of indigenous flora and fauna**, and there is **resilience to change**” MFE 2014

Functional aspects ( <b>processes</b> )	Organisation /composition ( <b>range</b> )	<b>Diversity</b> /richness	Tolerance ( <b>resilience</b> )
<ul style="list-style-type: none"> <li>• One repro. cycle</li> <li>• Adult or larvae</li> </ul>	<ul style="list-style-type: none"> <li>• % EPT richness*</li> </ul>	<ul style="list-style-type: none"> <li>• EPT richness*</li> </ul>	<ul style="list-style-type: none"> <li>• MCI_hb</li> <li>• Sed MCI</li> </ul>
<ul style="list-style-type: none"> <li>• → MMI based on the average of 4 metrics to indicate the state and trends in stream ecosystem health (based on macroinvertebrates)</li> <li>• → Use new stressor-specific metrics and traits to diagnose the causes of degradation and track restoration</li> </ul>			

- Rescaled metrics 0-1
- Logistic regression to determine which selection of component metrics best separated reference from non-reference sites

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1. Collation of data and calculation of existing metrics including traits (Brian)

→ Update of freshwater macroinvertebrate traits database

2. Exploration of a multivariate approach (Martin)

→ Proof of concept of national multivariate model

3. Development of stressor specific metrics including workshop, ecological evidence, and gradient forest analyses (Annika)

→ Proof of concept of 20 new stressor-specific metrics

4. Linking metrics with stressors

→ Quantified relative importance of stressors on metrics

5. Development of a framework and multi-metric index

→ MMI based on the average of 4 metrics

→ New stressor-specific metrics and traits to diagnose the causes of degradation and track restoration