# The influence of forest harvest on watersheds.

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Forestry & Environmental Management



### Who am I?

Assessing non-point source pollution in agricultural regions of the upper Saint John River basin using the slimy sculpin (Cottus cognatus)

• effects-based assessment, environmental monitoring, basic ecology

- Hydro facilities MB Hydro
- Diamond mine Diavik Diamond Mines
- Traditional medicinal plants Atlantic First Nations Environmental Network
- Canadian Aquatic Biomonitoring Network (CABIN) ECCC
- Baseline condition characterization near shale gas development NB Energy Institute



### Who am I?

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#### **CURRENT PROJECTS**

- Landscape-level effects of intensive forest management on fish health NSERC and JDIrving
- Smallmouth bass and chain pickerel predation on smolts in NS with Bluenose Coastal **Action Foundation**
- Freshwater mussel rescue and relocation **NB DTI**
- Water quality management triggers for the Saint John River NB ETF & Atlantic Ecosystem Initiative (AEI)

### CRI's vision is to *make every river a healthy river*



## What is a healthy river?





**Brief Outline** 

Watersheds 101

**Forest harvest interactions** 

Some research findings

Take home thoughts..



### Watersheds 101

#### Concepts that dominate research and management

Watershed – management unit based on catchment area



River Continuum – management based on connectivity





### $\mathbf{1}^{\text{ST}}$ and $\mathbf{2}^{\text{ND}}$ order

- 'Steep'
  - shallow
    - less water at start
  - cold water
    - groundwater inputs, shade
  - clear water
    - slope and flow
  - larger rocks
    - smaller ones moved by flows
  - higher dissolved oxygen
    - colder, less biological oxygen demand
  - low organic matter
    - washed downstream, except logs



### **Terrestrial inputs**







#### FILTER FEEDERS...BLACKFLY





LEAF CUTTERS...CADDISFLY LARVAE





### Middle order waterways ... (3<sup>rd</sup> to 4<sup>th</sup> order)

Sediment accumulates

- Wider, less energy, slope reduced
  - deposition
  - emergent plants







BC2983 [RM] © www.visualphotos.com

### 5<sup>th</sup> and larger order rivers

- Large volumes
- Increased meanders in lower reaches\*
- Warmer (open and less shade)
- More turbid phyto/zooplankton
- Lower dissolved oxygen, higher biological demand









Richard Carignan, Université de Montréal



Nutrients, algae Mud – diverse benthic life Fish – scavengers and others, more diversity





### Let's recap... some 'predictable' or expected relationships



### ... #itscomplicated

## **Forest industry interactions in watersheds**



Comeau 2017 – Healthy Water, Healthy People

### Why are people concerned?

..40% of the province's population obtain their water supply from surface watersheds..



Comeau 2017 – Healthy Water, Healthy People



### Stressor effects are now subtle – not so in the past

... #itscomplicated



#### FIRE

While they play an important natural role in many ecosystems, climate change and human disturbances can make fires more damaging. High-intensity fires can **increase runoff**, **erosion and toxic sediment** 

#### IMPACTS:

 GREATER RISK OF WATER CONTAMINATION

MORE DROUGHTS
AND FLOODS

#### Converting land to agriculture or built areas, logging, disease and fire

DEFORESTATION AND DEGRADATION

expose soil and remove vegetation, reducing groundwater, changing rainfall patterns and increasing erosion, pollution and runoff

#### EROSION

Soil washes into waterways, increasing sediment and pollution, raising water treatment costs and sometimes causing landslides



### **Forest harvest**

## Forest management activities



## Sustainable forest management activities

Aims to conserve aquatic ecosystems & their water resources





## **Riparian areas**

- Unique ecotones
- Hydrologically-connected linkages
- Create diverse habitat conditions
  - Support rich biodiversity

Regulate aquatic, especially headwater, ecology

## Forest removal and ground disturbance



Potential risks to aquatic ecosystems, water resources and their biodiversity

### **Sediment sources**

- Road building
- Improper culvert placement or size
- Perched/raised culverts as fish barriers







### Limiting factors for fish

- warm(er) and warming water temperatures
  - pools are deeper and cooler

## *diggers logs as restoration technique*







## Management... buffer strips

new idea in the 1970s

to buffer the sediment and pollution between farms and water



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### RIPARIAN ZONE ≠ BUFFER ZONE...but it should...





### **Forested Watershed Research**

## Legacy impacts



- Literature shows older practices (~ pre-90's) often caused:
  - stream canopy cover reduction
  - ↑ light, temperature, algal production
  - $\uparrow$  fine sediment deposition on stream beds

  - $\downarrow$  particulate organic matter (POM) inputs
  - often large changes in aquatic invertebrates, sometimes fish (both  $\uparrow$  and  $\downarrow$ )

## **Impacts review**

#### Environmental Reviews 21(4) & Environmental Reviews 23(1)

- Recent, evolving Best Management Practices (BMPs) & regulations focus on water protection
- Contemporary forest management practices do apply BMPs and regs
  - most adverse effects greatly reduced or eliminated
- FMPs overall usually pose little significant or long-term risk
- Some uncertainties: changing harvest patterns
  - cumulative spatial/temporal impacts
  - harvesting for biofuels
  - new practices: e.g., emulation of natural disturbance

Maitane Erdozain PhD and Post-doctoral research

#### Research

Much focuses on short-term post-harvest effects, BUT!

• Effects are the result of multiple, interacting stressors

ightarrow potential for cumulative impacts

- Intensive vs. extensive forestry
- Predicted intensification of forestry



Much focuses only a few indicators, BUT!

- Each ecosystem component responds to disturbance differently
  - $\rightarrow$  holistic studies
- Very few studies looking at catchment scale and forestry-**stream food webs**

Maitane Erdozain PhD and Post-doctoral research



#### **RESPONSE VARIABLES**

Sediment deposition Water chemistry & DOM quality Temperature

Leaf decomposition

**Biofilm & algal biomass** 

Benthic macroinvertebrate community Food web structure

Maitane Erdozain PhD and Post-doctoral research

### **EXPLANATORY VARIABLES**

1. Forest management intensity

2. Forest structure & composition (catchment & riparian)

3. Landscape

4. Stream morphology

#### **RESPONSE VARIABLES**





Maitane Erdozain

PhD and Post-doctoral research

Shift in benthic invert community

Terrestrial contribution to food webs



Catamaran Brook study Dr. Rick Cunjak and others (DFO and UNB)

higher peak flows in tributary when > 20% of the watershed was harvested

#### Harvesting-related soil disturbances are primarily the result of roads

To target this delivery:

- **Stream crossings:** e.g. proper installation & maintenance of culverts, diversion swales...
- Over-land delivery: e.g. wider riparian buffer zones

Current best management practices do **not offer full protection** from catchment disturbance

• **But** effective overall at maintaining healthy stream communities





Optimize methods to **quantify harvesting** intensity by incorporating **distance to waterbody** 

Continuous monitoring of water flow

How are changes in headwater streams expressed in larger **downstream** rivers?





### **Seasonally Flooded Forest Wetlands**

The area is flooded for part of the year with water from rivers, lakes, spring runoff or groundwater.



### **Rivers** flood

#thatsnotascomplicated

### TAKE HOME MESSAGES...

- Water and watersheds are impacted by forestry, forests are impacted by water
- Waterways need to be managed as a connected unit
- Riparian buffer strips are valuable for erosion control not a one-size fits all
- Wetlands don't get top billing and are being lost some seen as unimportant
- Nature is best at sustaining biodiversity on landscape
- Managed forest landscapes more similar to natural forest landscapes arising from natural disturbance

### TAKE HOME MESSAGES...

### We need to be less myopic

Maggie Paul (St. Mary's FN)

- "We have to humble ourselves in the eyes of...
  - the grandmothers
  - the children
  - the swimmers
  - the crawlers
  - the winged ones
- We have to know what they know"



## Thank you...



1<sup>st</sup> question FOR the audience





















## Forest Cover GAIN **2001-2012**



Forest Cover GAIN **2001-2012** LOSS **2001-2012**