NSERC HydroNet
A national research network to promote sustainable hydropower in Canada

NSERC
HydroNet
CRSNG

General objective of NSERC HydroNet:

- Provide knowledge and tools that will permit the sustainable development of hydropower in Canada.

  -develop the strategies to assess, minimize, and mitigate the effects of hydropower on fish and their habitats,

  -facilitate the decision-making process associated with hydropower,

  -improve the interactions among stakeholders.

Regulatory framework

- **Canadian Environmental Assessment Act**

  «…to ensure that such projects do not cause significant adverse environmental effects…»

  (CEAA; Gov. of Canada, 1992)

- **Species At Risk Act**

  «...to classify the species as extinct, extirpated, endangered, threatened or of special concern...»

  «...to protect the species' habitat, including its critical habitat...»

  (SARA; Gov. of Canada, 2002)

- **Fisheries Act**

  -Policy for the management of fish habitat

  «...no net loss of the productive capacity of fish habitats...»

  (Habitat policy; DFO, 1986)

Central theme of NSERC HydroNet:

- **The productive capacity of fish habitats (PCFH).**

«…maximum production rate that may be observed in an ecosystem…»

(Minns 1995, Randall 2003)

Process to study PCFH:

- Define a conceptual model
- Select a study strategy
- Identify study sites
- Coordinate interactions
- Implement an adaptive management strategy

•Mechanistic study strategy:

-Advantages:	Understanding of the mechanisms of action of variables Representation of the interactions among variables
-Disadvantages:	Challenge of scaling up specific results Predictive tools require a quasi-complete picture

•Empirical study strategy:

-Advantages:	Predictive tools do not require all variables/processes The variable of interest is always part of the model
-Disadvantages:	No understanding of the mechanisms Interactions among variables is not defined

NSERC HydroNet's hybrid study strategy

Given that the advantages and the disadvantages of the empirical and the mechanistic approaches are complementary, NSERC HydroNet has adopted a hybrid research strategy:

-conduct mechanistic studies that focus on the effects of some stressors and processes on key attributes identified in the conceptual models,

-conduct empirical analyses using explanatory variables that, according to the conceptual models, appear to have the highest potential to directly or indirectly affect the productive capacity of fish habitats.

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2 consequences:

1) Strategic objectives of NSERC HydroNet

- Improve our ability to estimate metrics of productive capacity

- Improve our ability to predict metrics of productive capacity

- Better assess the relative influence of various key drivers of production rate

- Better quantify the interactions between physical and biological processes that determine production rate and focus on environmental conditions affected by hydroelectric developments

2) Requirements from scientists

Specific projects
(methodological,
mechanistic)

Networking project
(empirical)

Projects Leaders

STRATEGIC NETWORK GRANT (SNG)

1	Networking of NSERC HydroNet	D. Boisclair
2	Productive capacity of fish habitats in rivers	D. Boisclair
3	Chemical drivers of the productive capacity of fish habitats	J. Rasmussen
4	Flow regime of natural versus regulated rivers	M. Lapointe
5	Effects of dams on the thermal regime of rivers	A. Saint-Hilaire
6	Long-term physical transformation of regulated river	M. Lapointe
7	Winter stressors for fish in rivers	F. Hicks
8	Egg survival in response to river regulation	R. Cunjak
9	Thermal regime in regulated rivers and effects on fish growth	M. Power
10	Effect of biodiversity on fish production and trophic structure	J. Rasmussen
11	Hydraulic/biological evaluation of upstream sturgeon passage	S. Cooke

COLLABORATIVE RESEARCH AND DEVELOPMENT (CRD)

12	Hydroacoustic mapping of fish in the pelagic zone of reservoirs	G. Rose
13	Modelling of fish productive capacity in lakes and reservoirs	D. Boisclair
14	Hydraulic modelling of physical conditions in reservoirs	D. Zhu
15	Study of fish behaviour and thermal requirements in reservoirs	S. Cooke

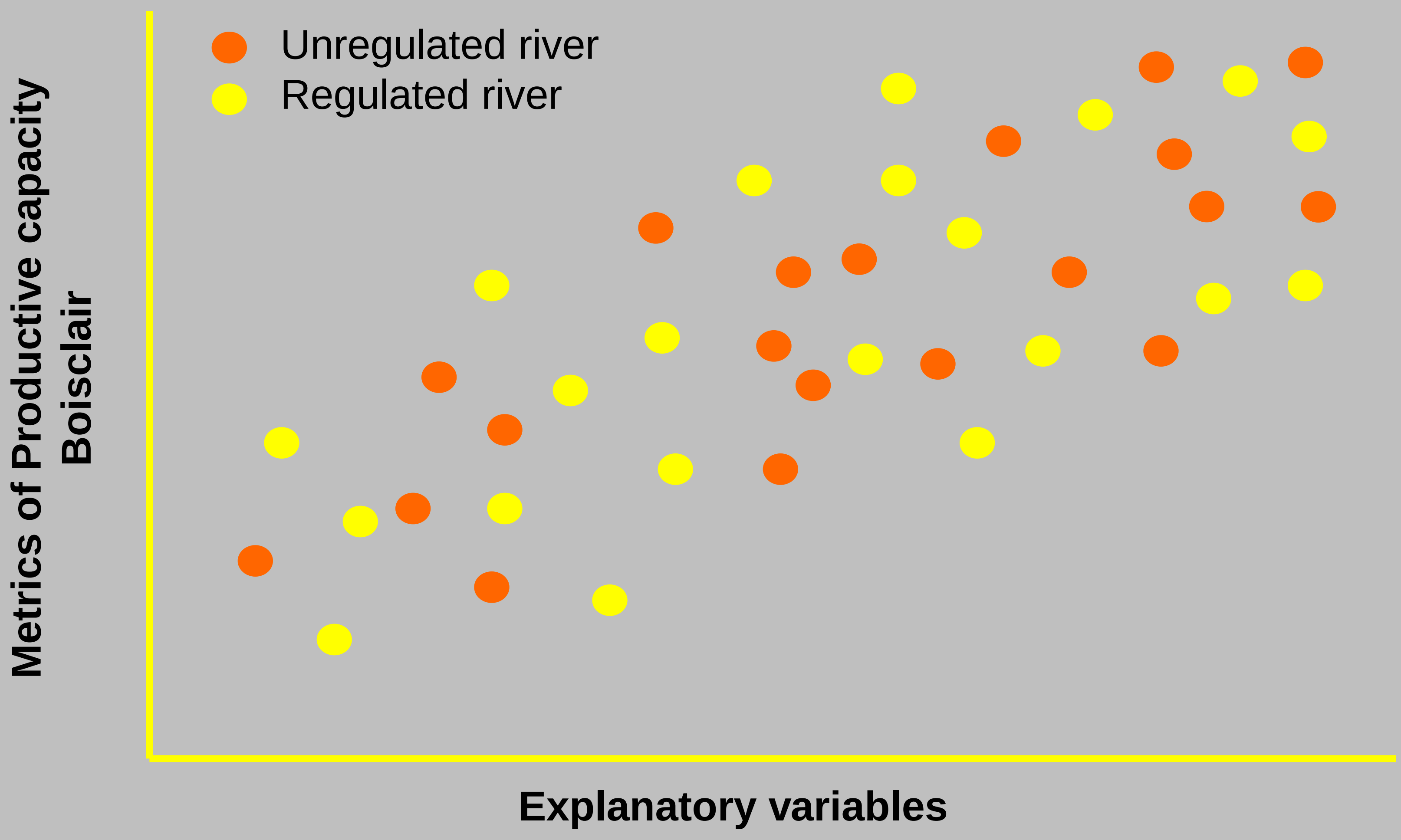
CENTER OF EXPERTISE OF HYDROPOWER IMPACTS ON FISH AND FISH HABITATS (DFO-CHIF)

16	Thermal aspects of fish entrainment risk in reservoir	M. Patterson
17	Longitudinal and lateral responses in communities to altered flow regimes	K. Clarke
18	Fish behaviour in relation to trash racks	E. Enders
19	Numerical investigation of turbulent flows through trash racks	H. Ghamry
20	Changes in productive capacity of mountain streams	M. Bradford
21	Experimental determination of ramping rate effects on downstream biota	K. Smokorowski

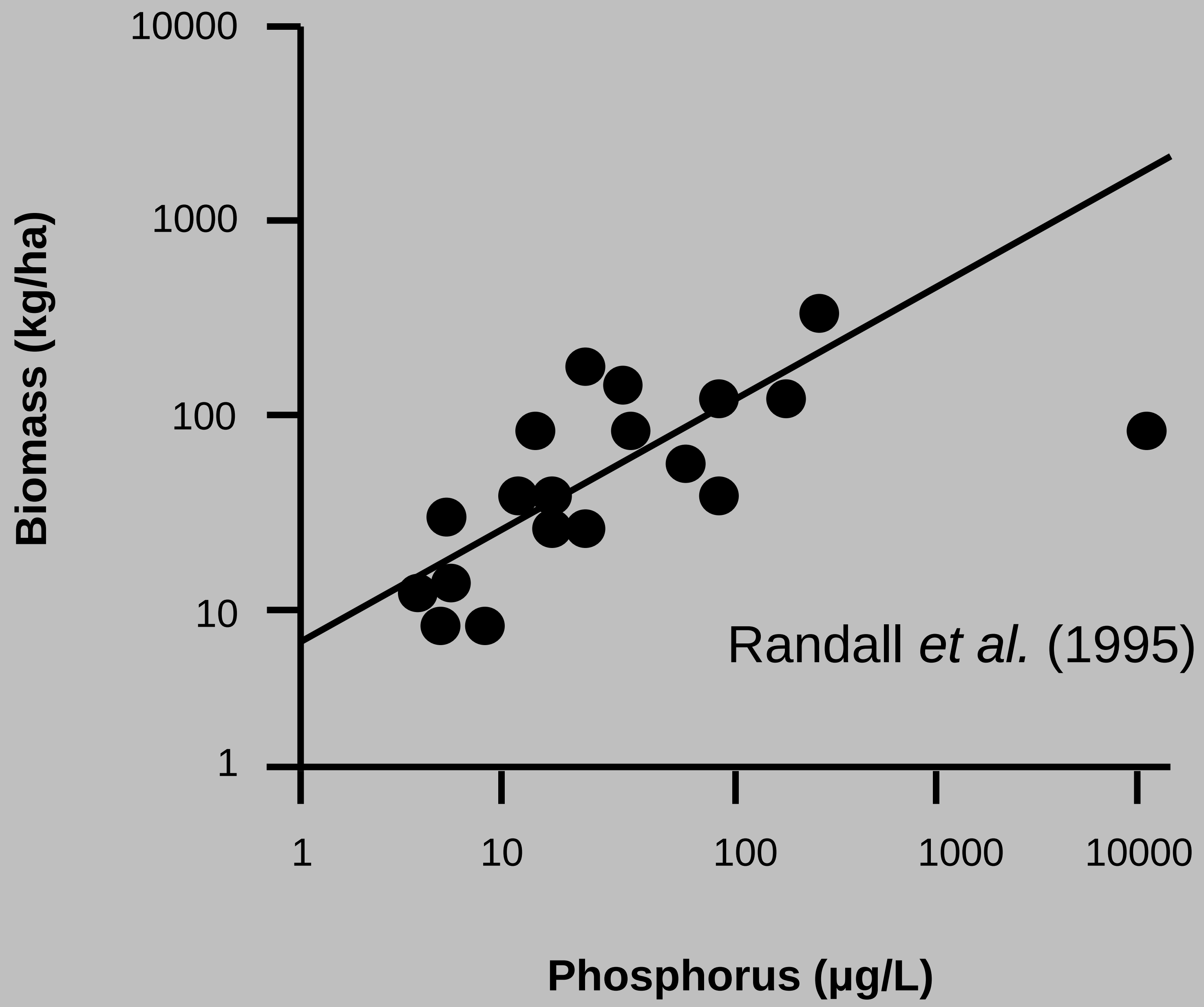
Research team

- 16 university professors (12 universities)
- 30 graduate students and PDF
- 14 research professionals
- 8 industry collaborators
  (BC Hydro, Manitoba Hydro, Nalcor, Brookfield Power)
- 9 scientists from federal agencies (DFO)
- 4 scientists from provincial agencies
  (MWS, OMNR, MRNFQ)
- 1 scientist from NGO (SLI)

NETWORKING PROJECT (RIVER)



TN, TP, DIC (Rasmussen)
Flow characteristics (Lapointe, Boisclair)
Thermal regime (Saint-Hilaire, Bergeron)
Habitat heterogeneity (Boisclair)
Geomorphological setting (Lapointe, Eaton)
Ice conditions (Hicks, Loewen)
Trophic structure (Rasmussen)



10000
1000
100
10
1
Biomass (kg/ha)
1
10
100
1000
10000
Phosphorus (µg/L)
Randall *et al.* (1995)

Identify study rivers

-an average flow of 5 to 100 cms;

-quasi wade-able (less than 2 m in maximum depth);

-the regulated rivers must be affected by a dam for more than 15 years;

-the rivers must be heterogeneous (within and among ecosystems variations);

-the sites must be in pairs (regulated and reference sites);

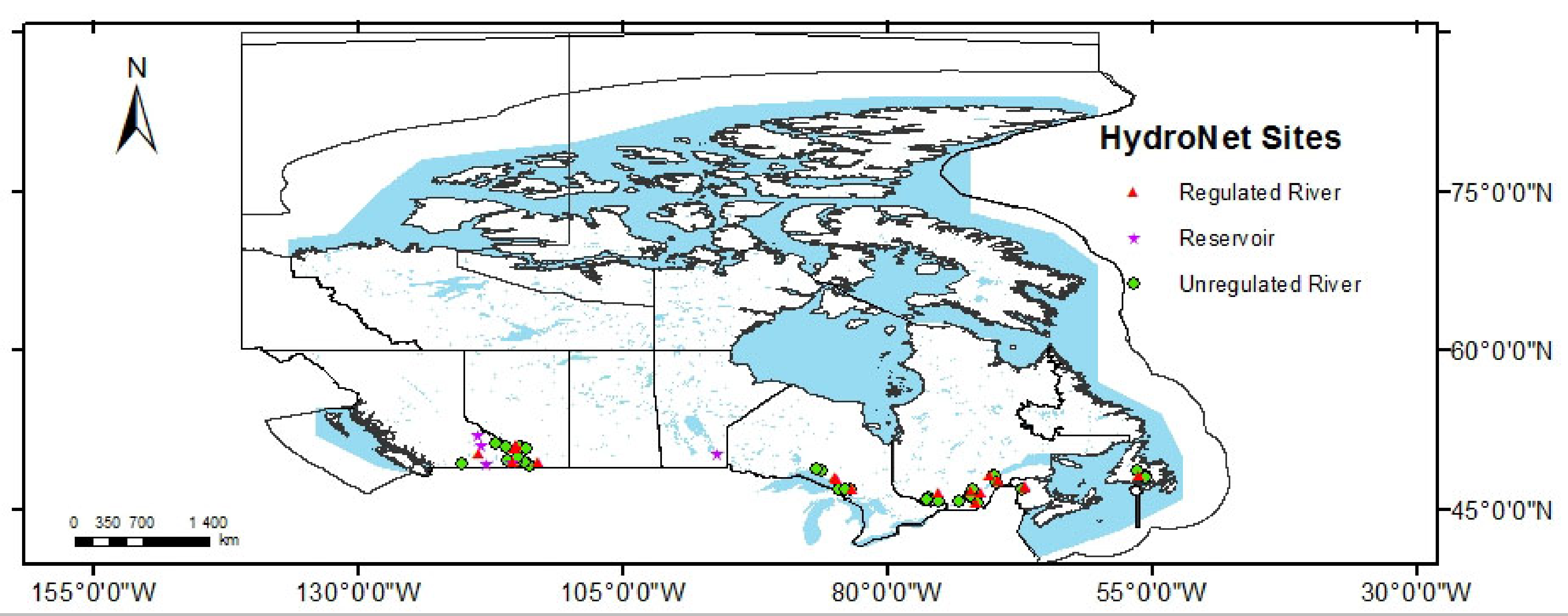
-each segment is at least 5 to 10 km long;

-the lakes and/or reservoirs must be at least 10 km downstream;

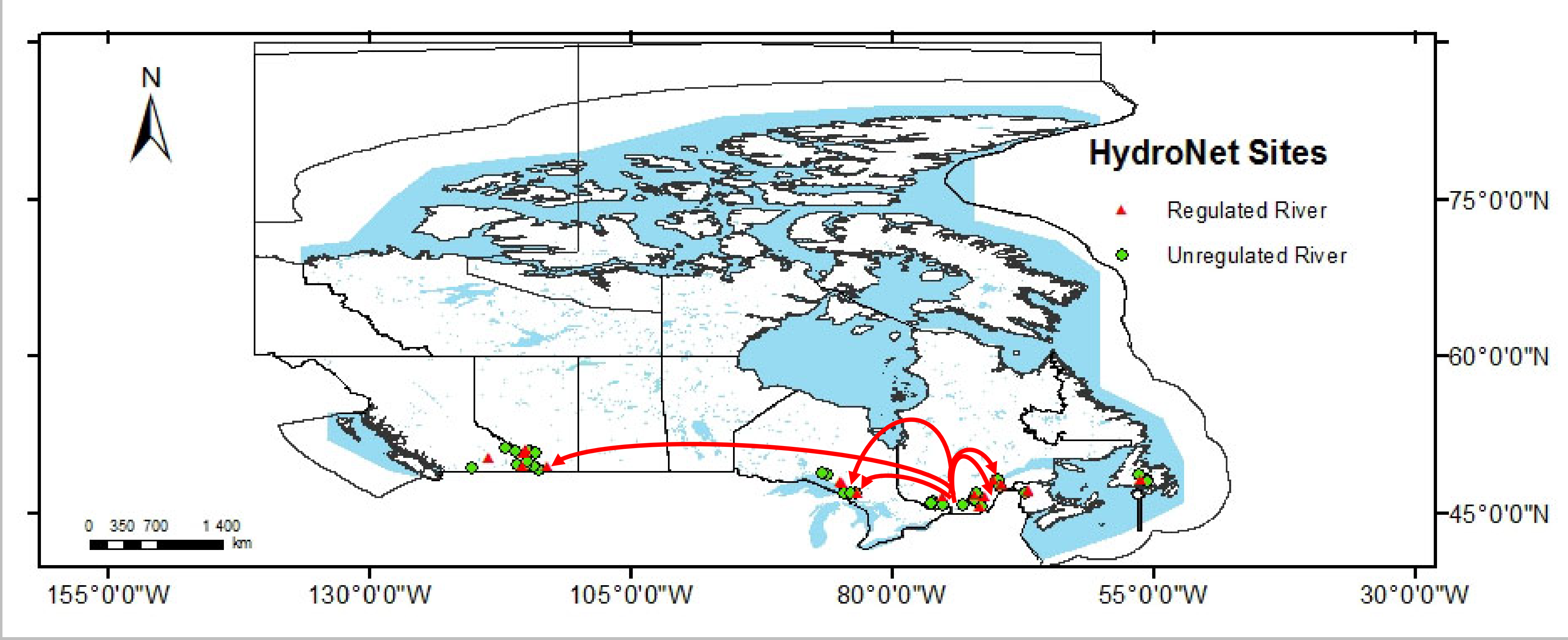
-sites must be accessible (within a one hour drive from lodging for 10 to 15 people; access at every 2 km of the river segment).

Study rivers

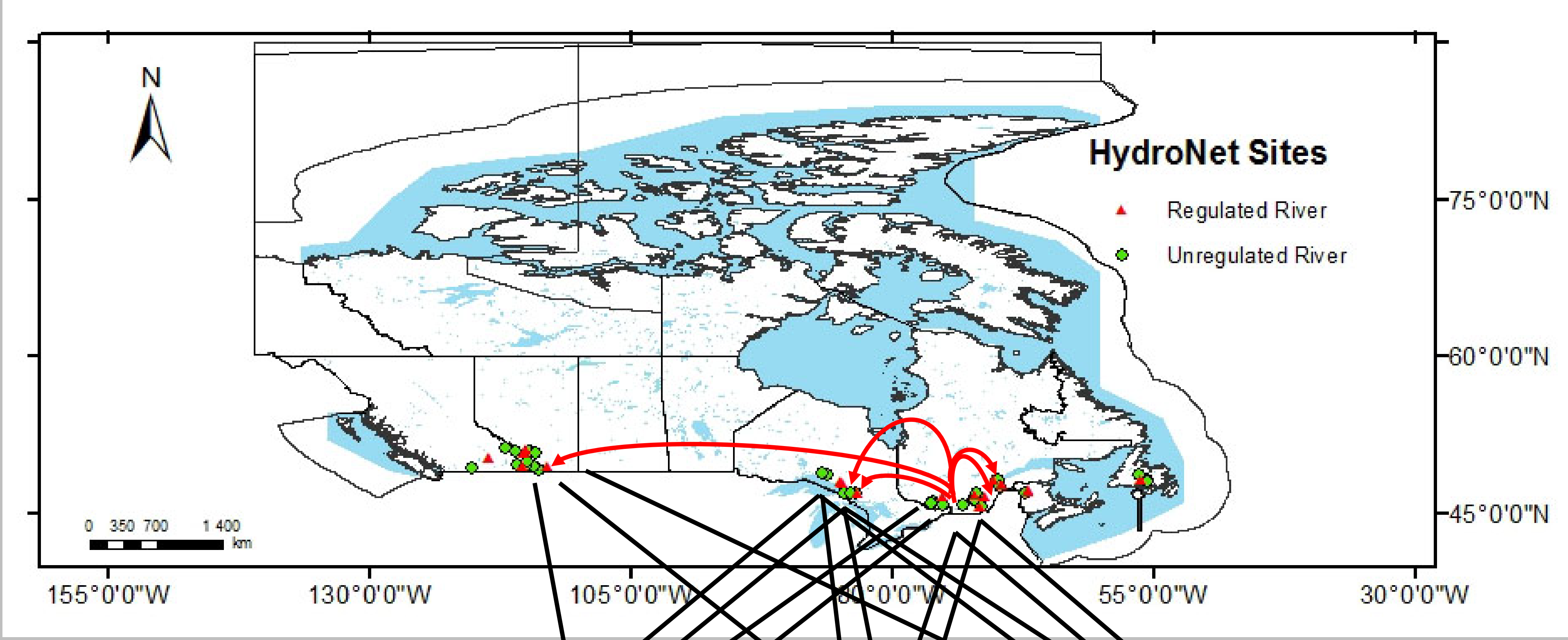
- 44 rivers: **16 regulated** [6 peaking+2 infrequently peaking]
  28 unregulated



Coordinate interactions



Coordinate interactions



J Rasmussen
Nutrients

M Lapointe
Channel geometry
D Boisclair
Metrics of PCFH

A St-Hilaire
Thermographs

Interactions among projects

Projects

No	Title	1.1.1	1.2.1	1.3.1	1.3.2	1.3.3	1.3.4	1.4.1	1.4.2	1.4.3	1.4.4	2.1.1	2.1.2	2.2.1	2.2.2
1.1.1	Productive capacity of fish habitats in rivers.		X	X	X	X	X			X					
1.2.1	Chemical drivers of the productive capacity of fish habitats.	X		X	X	X	X			X					
1.3.1	Flow regime of natural versus regulated rivers.	X	X		X	X	X			X					
1.3.2	Effects of dams on the thermal regime of rivers.	X	X	X		X	X	X	X	X			X		
1.3.3	Long term physical transformations of regulated riverine habitats.	X	X	X	X		X			X					
1.3.4	Winter stressors for fish in rivers: The effects of flow regulation.	X	X	X	X	X		X		X					
1.4.1	Egg survival in response to river regulation.				X		X								
1.4.2	Implications of thermal habitat stability for growth.				X										
1.4.3	Effect of fish biodiversity on fish production and trophic structure.	X	X	X	X	X	X								
1.4.4	Upstream sturgeon passage at the Vianney-Legendre Fishway.														
2.1.1	Hydroacoustic mapping at the scale of habitat patches.												X		
2.1.2	Productive capacity in shallow areas of lakes and reservoirs.				X							X			
2.2.1	Entrainment risk based on hydraulic conditions.														X
2.2.2	Reduction of entrainment risk based on the behaviour of fish.													X	

Environmental conditions

	# Rivers
Nutrients (DIC, N, P)	28
Geomorphology (watershed/channel slopes, morpho., sediments)	22-38
Thermal regime (water ° C; 3 min intervals; 4 months +)	28
Flow conditions (hourly flow rate 1995-)	35
Ice conditions (ice duration and timing)	41

Fish data

- **Fish abundance and biomass by species and size classes for;**

  -10 river segments (n=25-50 habitat patches of 300 m^2)

  -30 river segments (n=4-26 habitat patches of 300 m^2)

- **Length-weight relationships by fish species**
- **Interannual variations in fish density**

  10 rivers sampled in 2010 and 2011

- **Sampling efficiency**

  -3 passes electrofishing for 32 patches of 300 m^2

Implement an adaptive management strategy

- **Partners have come, partners have left, and more may be coming**

  … changes in study questions, strategy, sites, and scientists

- **The feasibility to sample sites has been, and continues to be, assessed**

  … eliminates sites in NL, BC, Alb but adds sites in NB

- **Adapt to a new regulatory framework**

  …potential changes about the CEAA and the FA (Habitat Policy)
  …potential new regulation about environmental flows

- **Communicate**

  …e-mails, telephone conferences, meetings, joint-samplings, and Annual Symposium

The objectives of the 2nd Symposium of NSERC HydroNet are:

1) To communicate results about projects conducted during 2011;

2) To present plans for 2012;

3) To describe how projects will be integrated and will contribute to the sustainable development of hydropower in Canada

4) To receive comments/suggestions from collaborators, partners, attendees, and members of the Science Advisory Committee and Board of Directors;

5) To develop new projects, or identify new research avenues, with existing or future collaborators/partners.

Interships to graduate students 2012

- **$3K to Paula Thoms (Rick Cunjak)**

Internship to the Freshwater Fisheries Laboratory (Pitlochry, Scotland) with Drs. Iain Malcolm and Chris Soulsby (University of Aberdeen) to quantify how flow regulation in rivers affects water quality parameters, especially in complex hyporheic environments and its implications to salmon population Dynamics.

- **$3K to Eduardo Martins (Steven Cooke)**

Internship to Dr. Ian Jonsen's lab at Dalhousie University (Halifax, Nova Scotia) to be trained in the efficient use of state-space models for the analysis of bull trout and burbot fine-scale movement data.

Strategic Network Enhancement Initiative

-Fellowships for students to visit laboratories outside Canada

-Workshop ‘Hydropower, Policies and Science’

-Joint HydroNet-CEDREN workshop

NSERC CRSNG

Université de Montréal

McGill

Canadian Rivers Institute

BC hydro
FOR GENERATIONS

Canadian Hydropower Association
Association canadienne de l'hydroélectricité

Ontario

University of Waterloo

Manitoba
Water Stewardship

Manitoba Hydro

Canadian Electricity Association
Association canadienne de l'électricité

Ressources naturelles et Faune
Québec

Memorial University

University of Lethbridge
FIAT LUX

Carleton University

Brookfield
Renewable Power

INRS
Université d'avant-garde

UBC

UNB
University of New Brunswick

University of Alberta

NSERC HydroNet CRSNG

Pêches et Océans Canada

Fisheries and Oceans Canada