Mesoscale modeling of the productive capacity of fish habitats in the littoral zone of reservoirs

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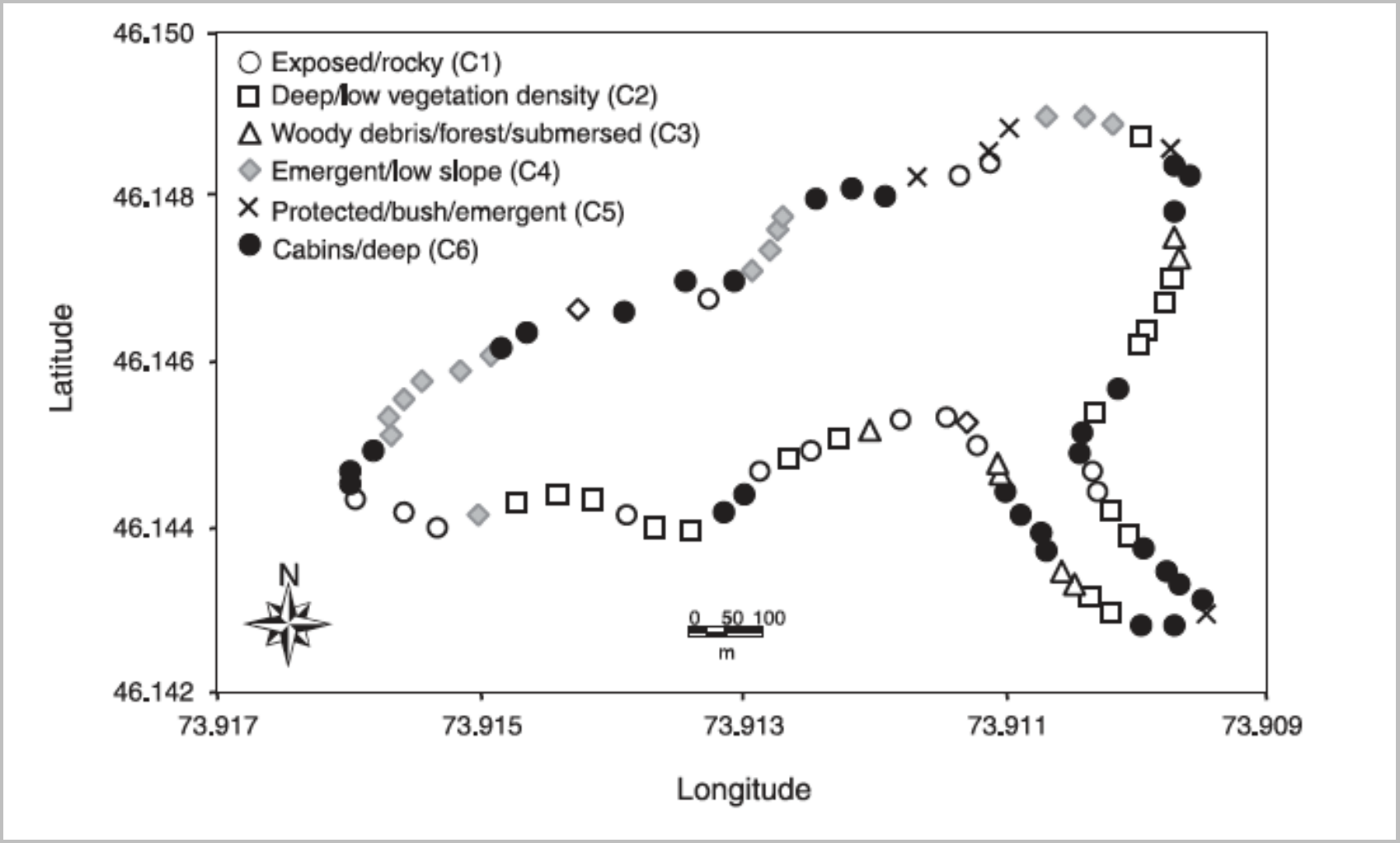
- General objective:

  Contribute to the development of knowledge and tools to improve our ability to estimate and predict metrics of the productive capacity of fish habitats in reservoirs.*

  *Abundance, Density, Biomass, CPUE

Context and rationale:

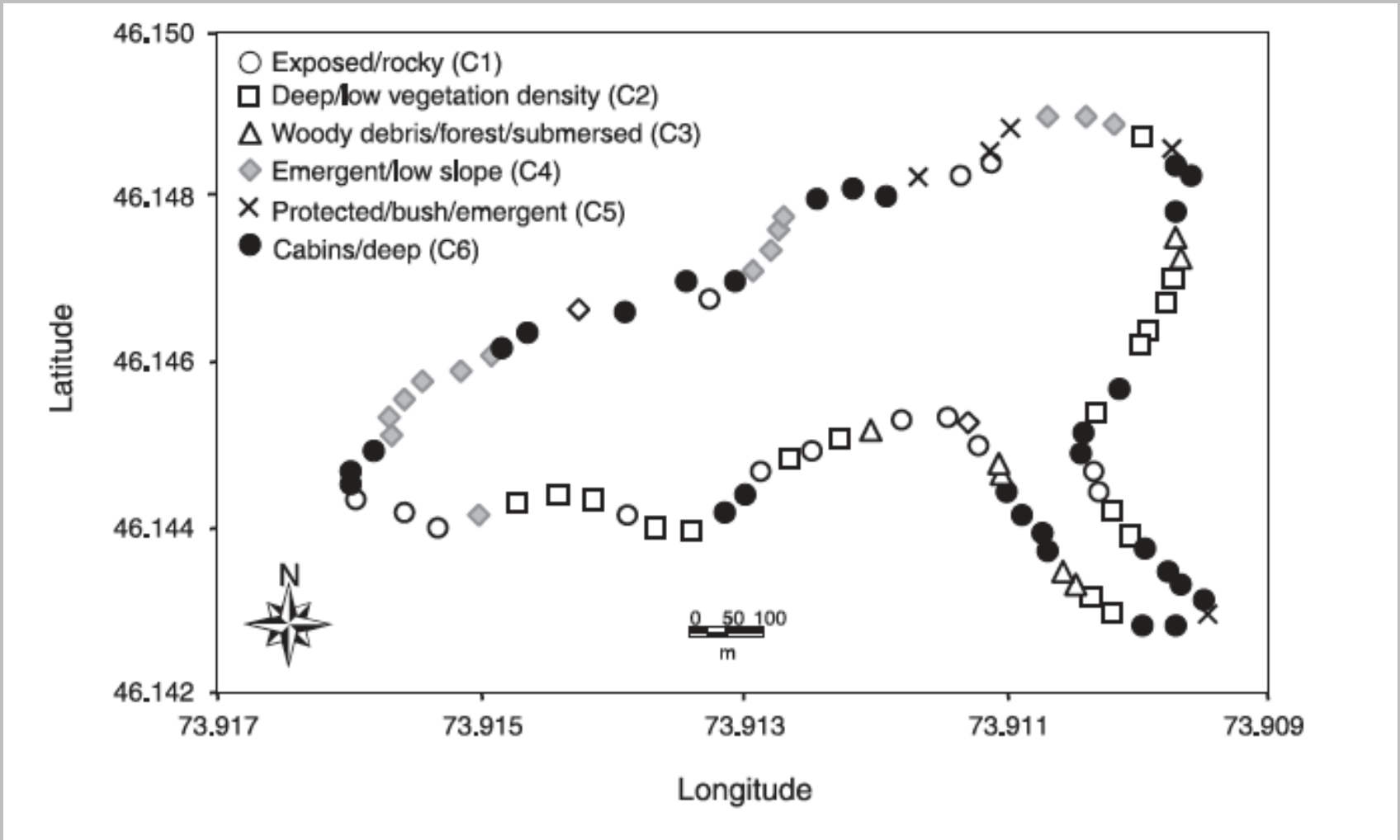
- Ecosystems are **mosaics of habitats patches (mesohabitats)** of **different types** that play **different roles** for fish;



Brind'Amour and Boisclair (2006)

Context and rationale:

- The **size** of habitat patches and the **spatial structure** of the mosaic of habitat patches may affect fish;



Brind'Amour and Boisclair (2006)

Context and rationale:

- Changing water levels in ecosystems may not only change the **wetted area** of rivers and reservoirs, but also the **size** of habitat patches, the **spatial structure** of the mosaic of habitat patches, and the **proportion** of different types of habitats;

- Estimating metrics of the productive capacity of fish habitats and;

- Predicting the effects of changes in water levels in ecosystems on fish,

  -may require models in which the type, the size, the spatial structure, and the proportion of habitat patches are explicitly considered.

Challenges to the development of mesoscale models:

1) Assign a metric of PCFH to a habitat patch: effects of the sampling method

2) Identify explanatory variables: local, lateral, and contextual variables

3) Assess temporal stability: day vs night

4) Define the biological unit: species, size-classes, guilds

Summer 2011

Pre-sampling summer to;

- Survey potential study ecosystems (Lac du Bonnet and Lake Manigotagan)

- Map habitat patches in these ecosystems

- Identify the fish sampling methods that can be used

- Measure the sampling effort that can be deployed

Maps of habitat patches

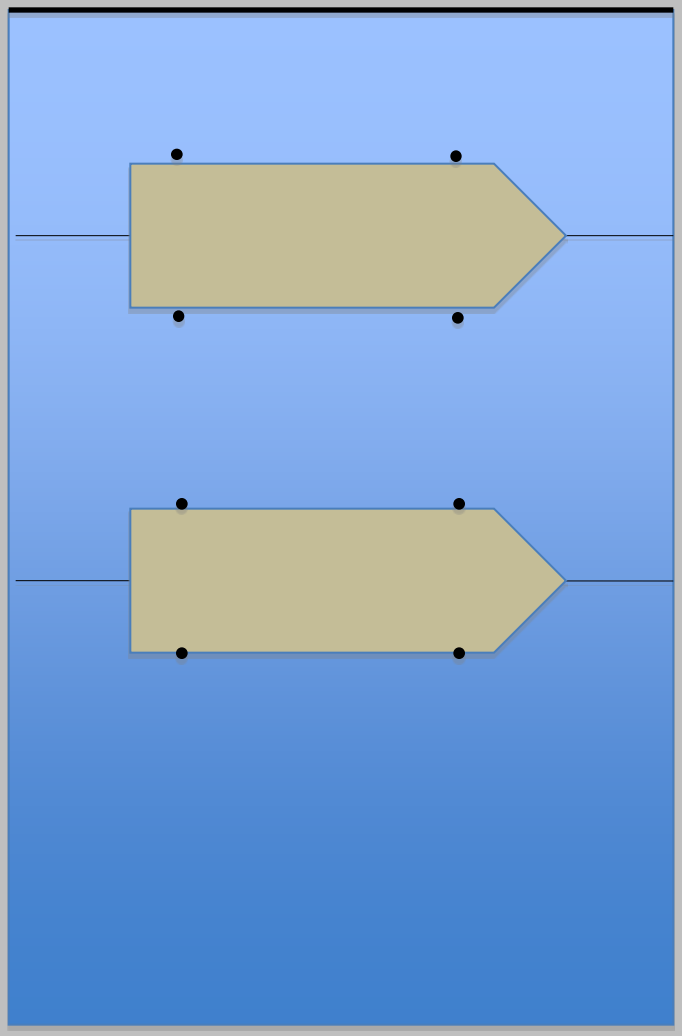
- **Challenges:**

  -Size of the study ecosystems
  -Water transparency

- **Solutions:**

  -Point sampling/’Metal rod’ method (Cooley et al. 1999)
  -Hydroacoustics

Point sampling



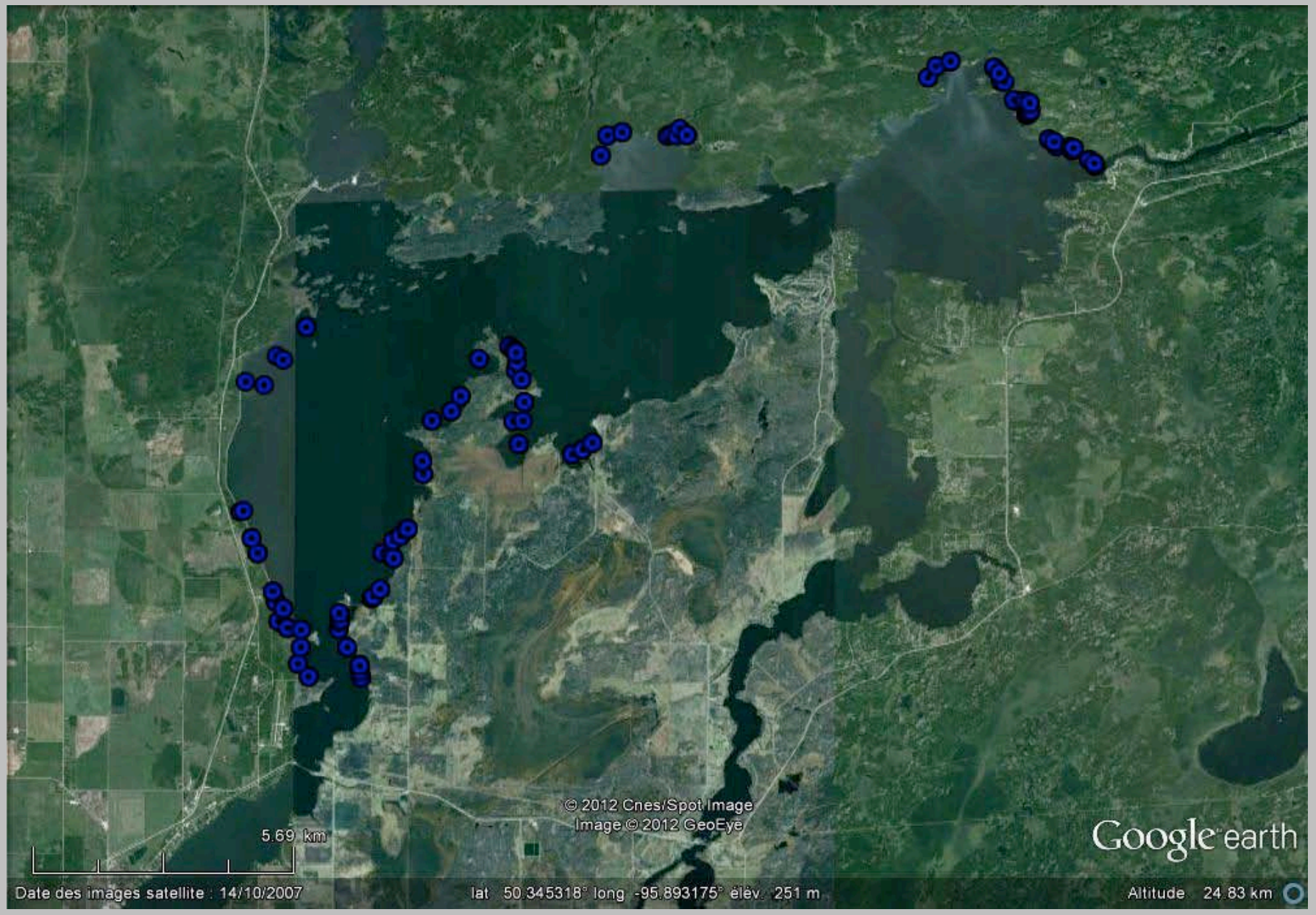
-% cover of silt, sand, gravel… boulder
-% cover of riparian vegetation
(within 20 m of shore)

-Number of emerging macrophytes
(0,25 m^2)

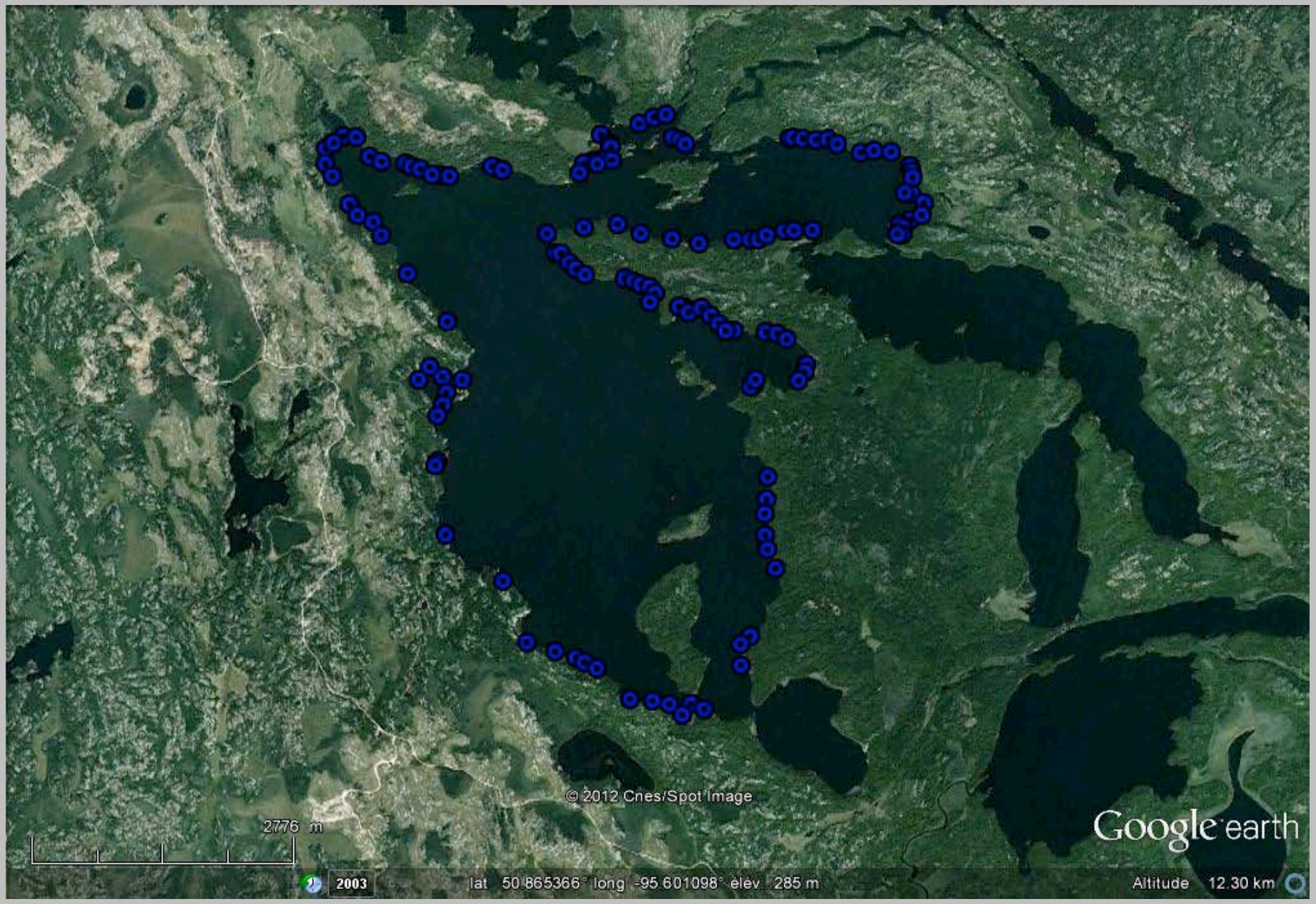
-Susbstrate softness (cm penetration)
-Horizontal axis of substrate (cm)
-Vertical axis of substrate (cm)

-Distance to shore at the 2,5 m depth isobath (m; slope in %)

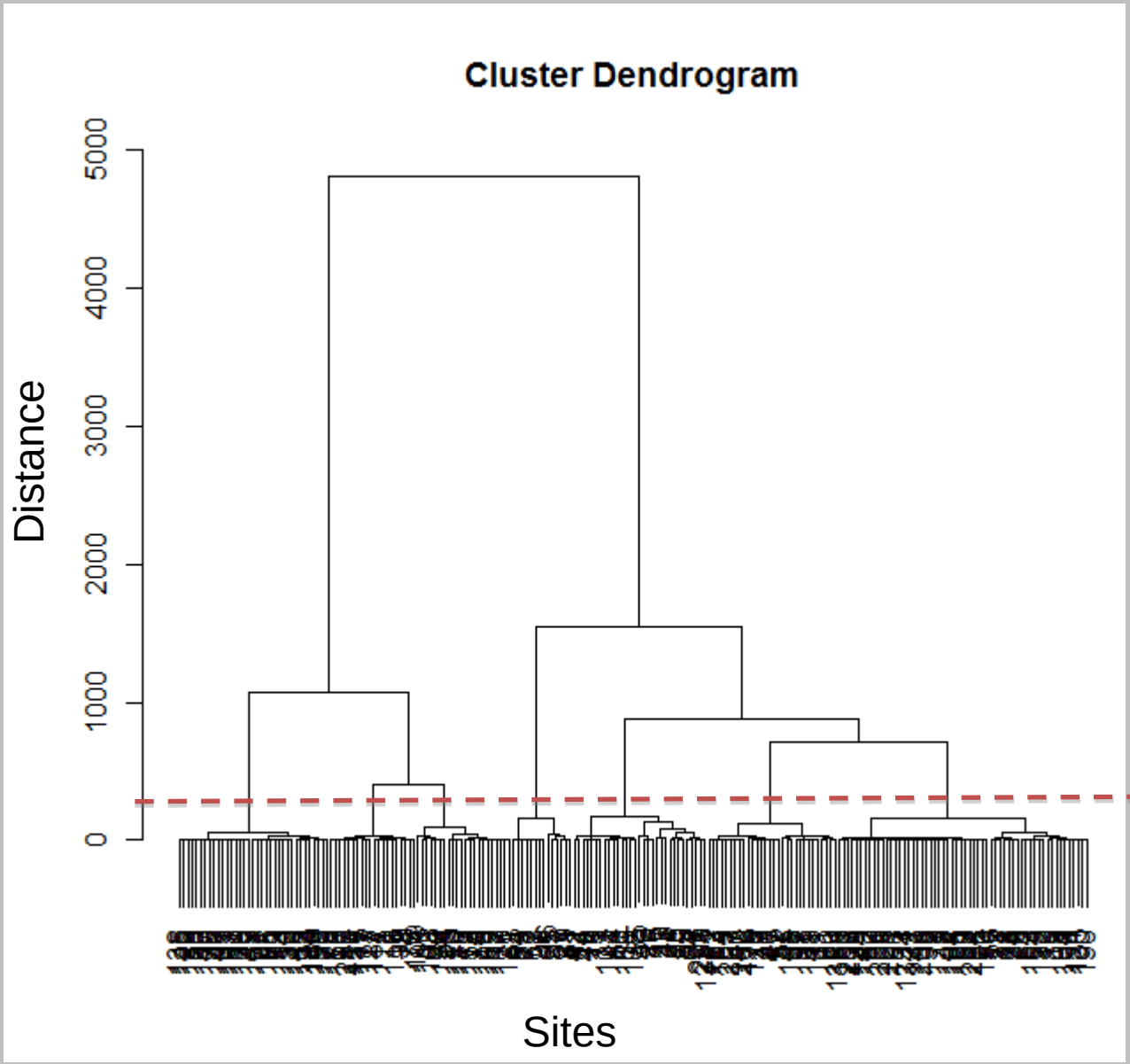
Lac du Bonnet; 78 points



Lake Manigotagan; 132 points



Two ecosystems: seven habitat types



Attributes of habitat types

Habitat type	Slope	Macrophyte density	Bottom softness	Stem density	Substrate size	Lake Manigotagan	Lac Du Bonnet
1	gentle slope	very high macro	soft bottom	high stem	silt/sand	13	22
2	gentle slope	high macro	soft bottom	medium stem	sand/gravel	12	8
3	medium slope	no macrophyte	soft bottom	medium stem	sand/gravel	25	33
4	medium slope	low macro	soft bottom	high stem	sand/cobble	20	10
5	medium slope	medium macro	soft bottom	low stem	sand/cobble	19	3
6	high slope	no macrophyte	med softness	no stem	cobble/boulder	27	2
7	steep slope	no macrophyte	hard bottom	no stem	cobble/boulder	16	0
						132	78

Maps of habitat patches

-no more than 6 habitat types in Lac du Bonnet

-7 habitats types in Lake Manigotagan

Next steps

- Compare ‘point sampling data’ with hydroacoustic signals.
- Combine ‘point sampling data’ and hydroacoustic signals to produce a map of habitat patches over the complete perimeter of the littoral zone.
- Use such maps to structure summer 2012 littoral sampling.
- Validate the maps.

Sampling methods

- **Questions:**

  What methods can be used efficiently to capture fish in the study ecosystems?

  What is the minimum time that gears can be left fishing?
  (minimize fish mortality, minimize negative perceptions, maximize the possibility of comparing days to nights)

- **Assumption:**

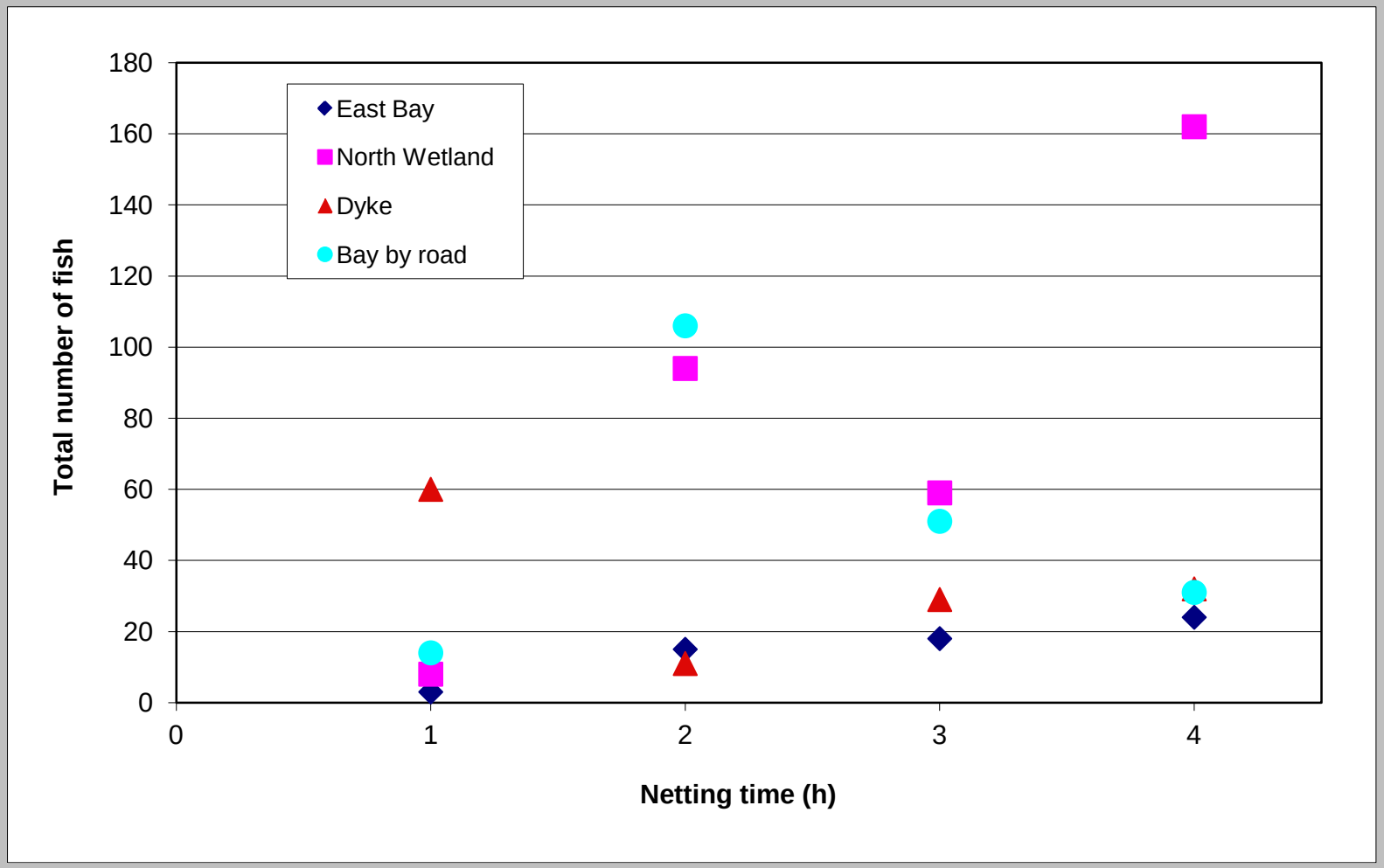
  The limiting factor would be fish captures during the day.

- **Consequence:**

  Fishing experiments done during the day.

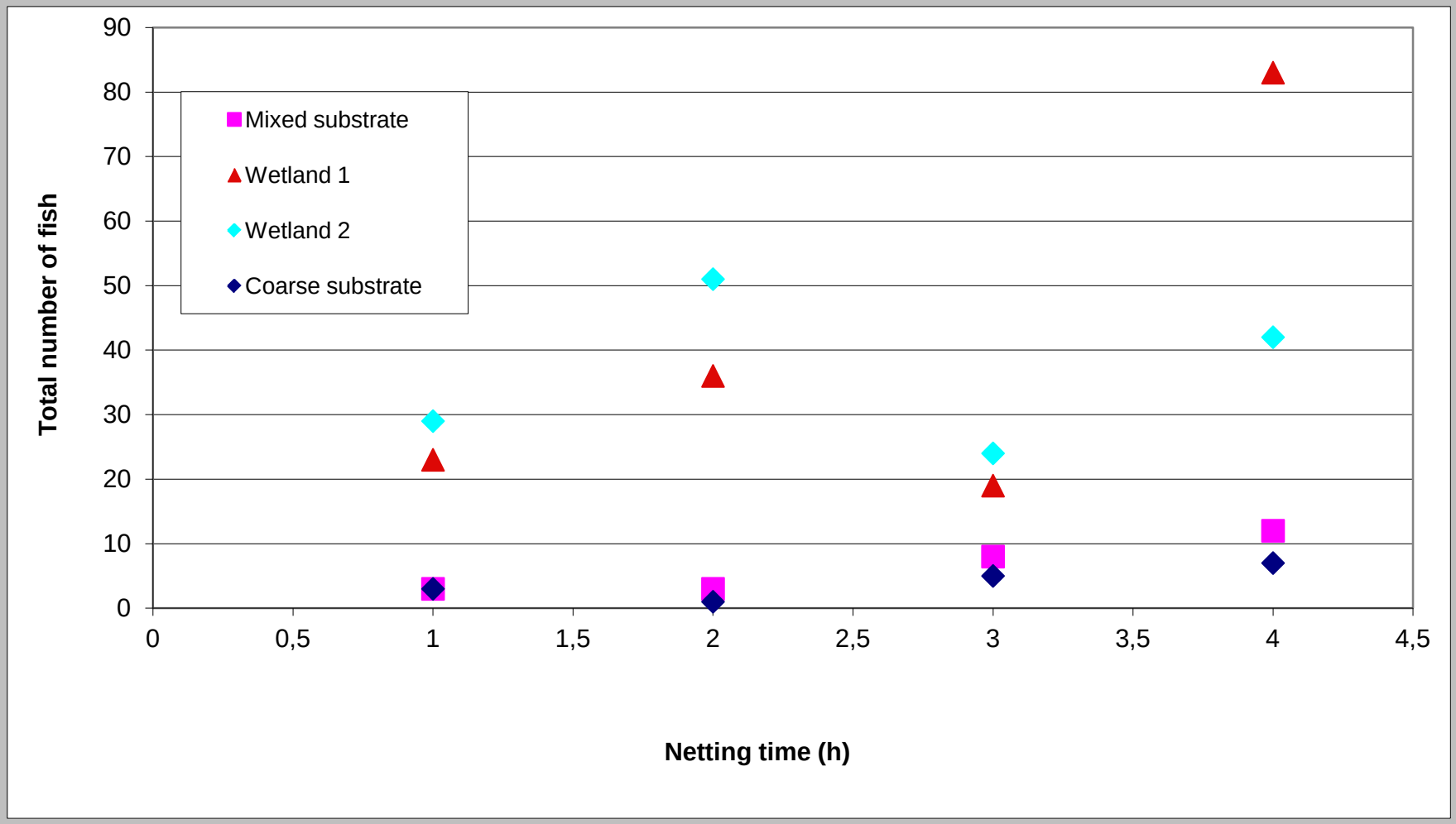
Relationship between the total number of fish captured and fishing time
Gill-nets (half-gang)

Lac du Bonnet



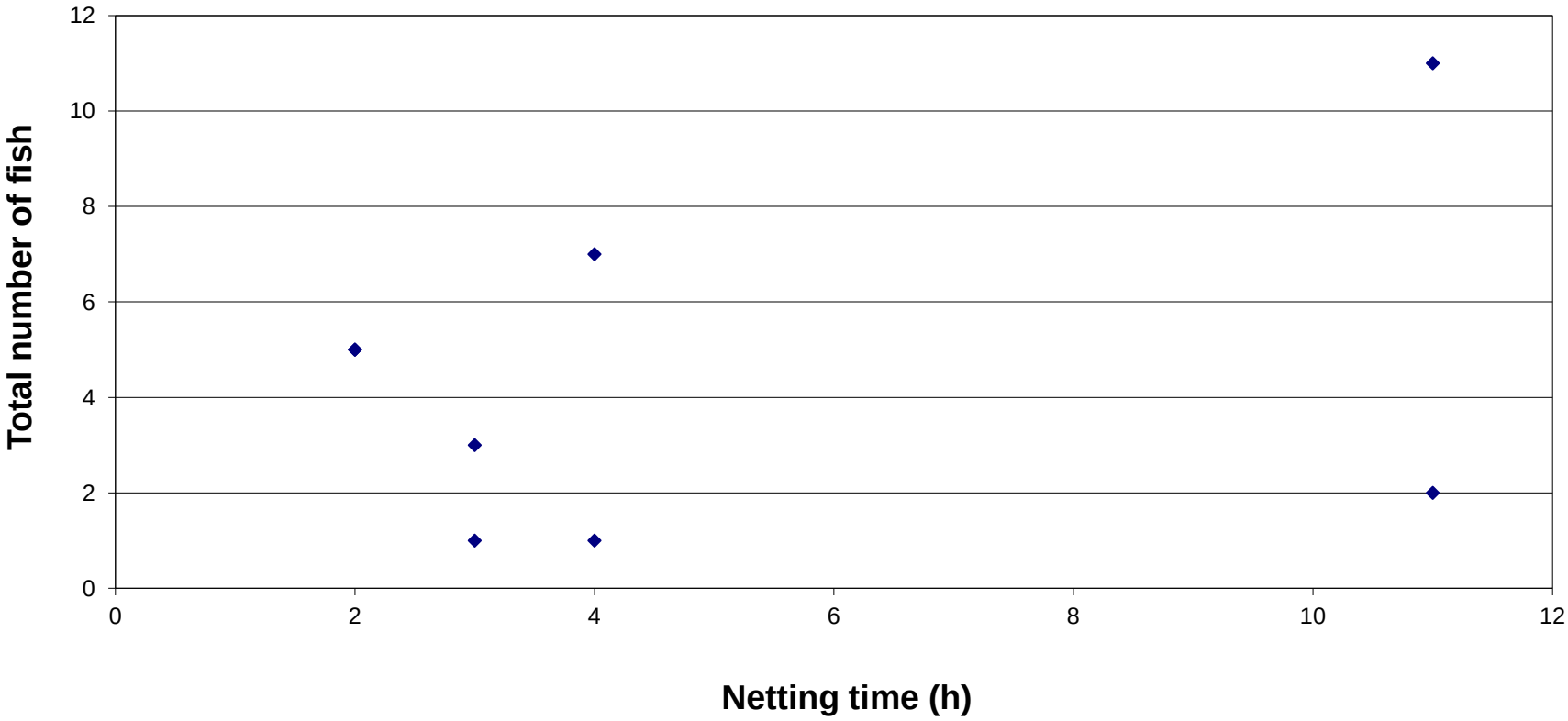
Relationship between the total number of fish captured and fishing time
Gill-nets (half-gang)

Lake Manigotagan



Relationship between the total number of fish captured and fishing time
Fyke-nets

Lake Manigotagan



Sampling methods

•**Questions:**

-What methods can be used efficiently to capture fish in the study ecosystems?

Gill nets
Not Fyke nets

-What is the minimum time that gears can be left fishing?

3 hours would be adequate for gill nets
>12 h for Fyke nets (not functional)

Sampling effort

- **Question:**

Given, -the size of the ecosystems (travel),
-the environmental conditions (wind, waves, weather),
-the size of the boats (quantity of equipment),
-the time needed to process fish (id, length),
-and the availability of 2 boats and 4 persons,

how many sets of gill nets and sets of seines can be done per summer in each ecosystem?

Sampling effort

- **Answer(s)**

Option 1		Lac du Bonnet	Lake Manigotagan
Day	Gill net sets	19	19
	Seine hauls	19	19
Night	Gill net sets	19	19
	Seine hauls	19	19

Sampling effort

•Answer(s)

Option 1		Lac du Bonnet	Lake Manigotagan
Day	Gill net sets	19	19
	Seine hauls	19	19
Night	Gill net sets	19	19
	Seine hauls	19	19
Option 2 (day in 2012, night in 2013)			
Day	Gill net sets	38	38
	Seine hauls	38	38

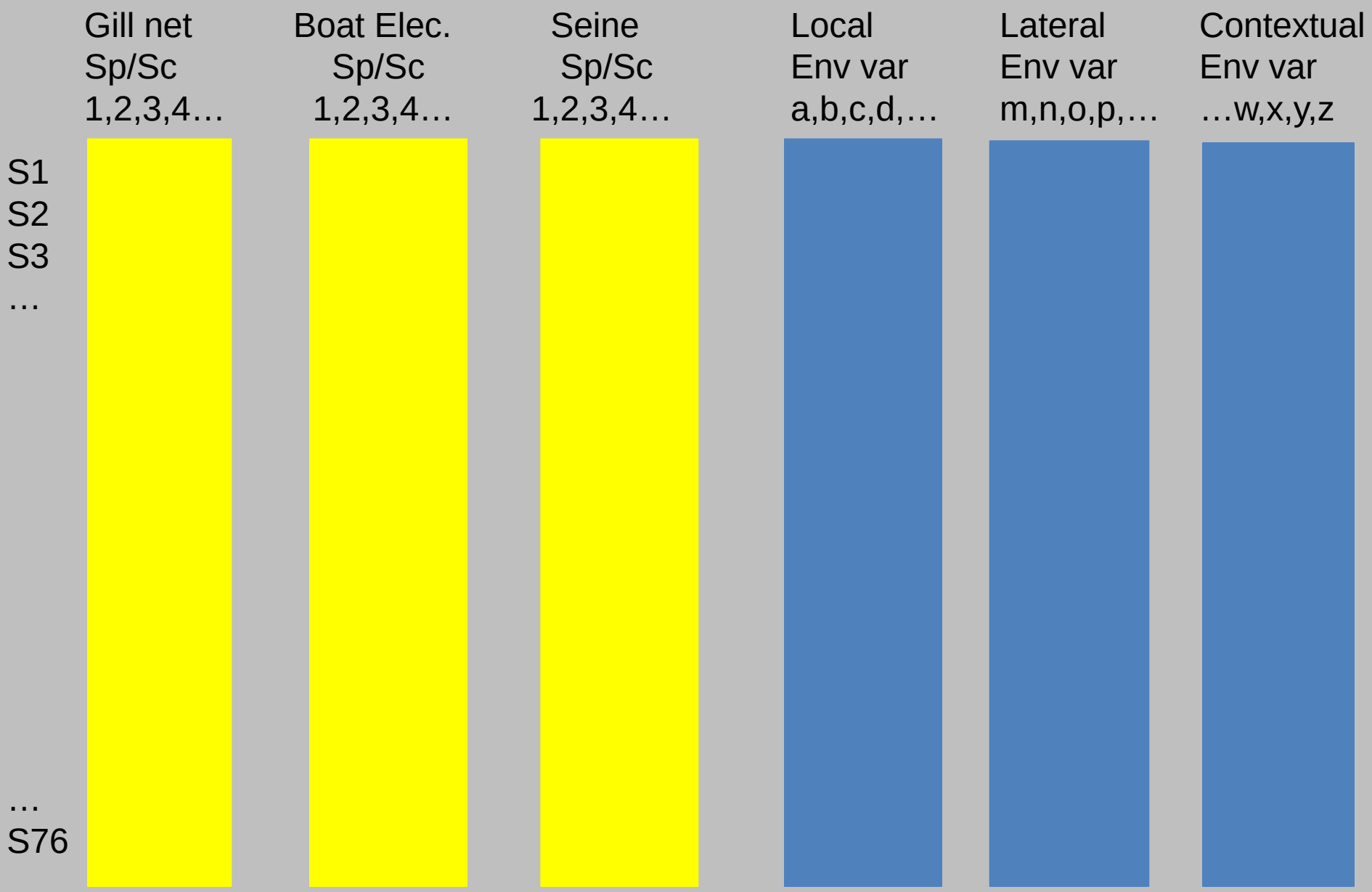
Sampling effort

•Answer(s)

Option 1		Lac du Bonnet		Lake Manigotagan
Day	Gill net sets	19		19
	Seine hauls	19		19
Night	Gill net sets	19		19
	Seine hauls	19		19
Option 2 (day in 2012, night in 2013)				
Day	Gill net sets	38		38
	Seine hauls	38		38
Option 3 (day in 2012, night in 2013)				
Day	Gill net sets	76	or	76
	Seine hauls	76		76

Pros and cons	Lac du Bonnet	Lake Manigotagan
Km of littoral that can be sampled	56	24
Number of testable sampling methods	3	2
Feasibility to test ‘guild’ hypothesis	higher (20 sp)	lower (10 sp)

Structure of data



Summary:

-Focus on gill netting (3 h), seining, and boat electrofishing

-Focus only on Lac du Bonnet
(daytime modeling in 2012; nightime modeling in 2013)

-Target an ‘n’ of at least 76 per sampling method

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