NSERC HydroNet:

Mesoscale modelling of the productive capacity of fish habitats in lakes and reservoirs.

Manitoba Hydro

Manitoba Water Stewardship

Pêches et Océans Canada | Fisheries and Oceans Canada

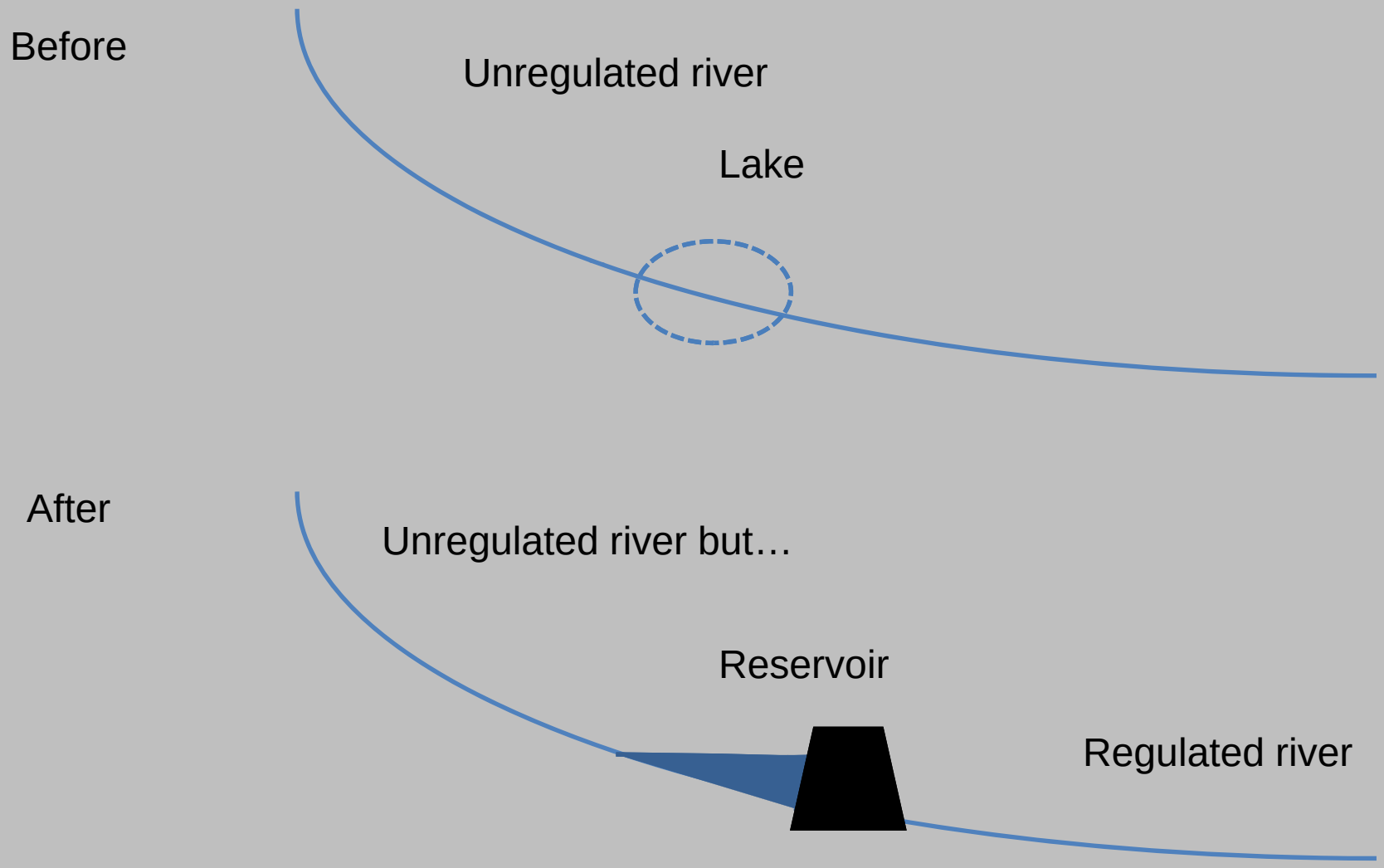
NSERC HydroNet CRSNG

Accounting of No Net Loss:

$$\frac{\text{Productive capacity}_{\text{after}} - \text{Productive capacity}_{\text{before}}}{\text{Impact of a perturbation}^{*}}$$

** Should be zero to achieve 'no net loss'*

Accounting of NNL:



Accounting of NNL:

1) Estimate the productive capacity of the unregulated river before (SNG)

2) Predict the productive capacity of the unregulated and regulated river after (SNG)

3) Estimate the productive capacity of a lake before (CRD)

4) Predict the productive capacity of a reservoir after (CRD)

Accounting of NNL:

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3) Estimate the productive capacity of a lake before (CRD)

4) Predict the productive capacity of a reservoir after (CRD)

Postulates:

- Ecosystems are mosaics of tiles of habitats (mesohabitat)

- Different types of mesohabitats may play different roles for different fish species and size-classes

- Different types of mesohabitats may play different roles at different times (day vs night; summer vs winter)

Consequences:

- Estimation of the productive capacity of a lake or a reservoir may require the partitioning of ecosystems in a mosaic of mesohabitats

- Prediction of the productive capacity of reservoirs may require a knowledge of;

    -which type of mesohabitat is lost or gained?
    -how much of any given type of mesohabitat is lost or gained?
    -what is the ecological role of these mesohabitats?

- Implementation of the principle of «No Net Loss» may require the use of mesoscale habitat models

    1) Partition lakes/reservoirs in a series of mesohabitats
    2) Assign an index of productive capacity to each mesohabitat
    3) Integrate indices of productive capacity over the complete ecosystem

Mesoscale modelling of the productive capacity of fish habitats in lakes and reservoirs

General objective:

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

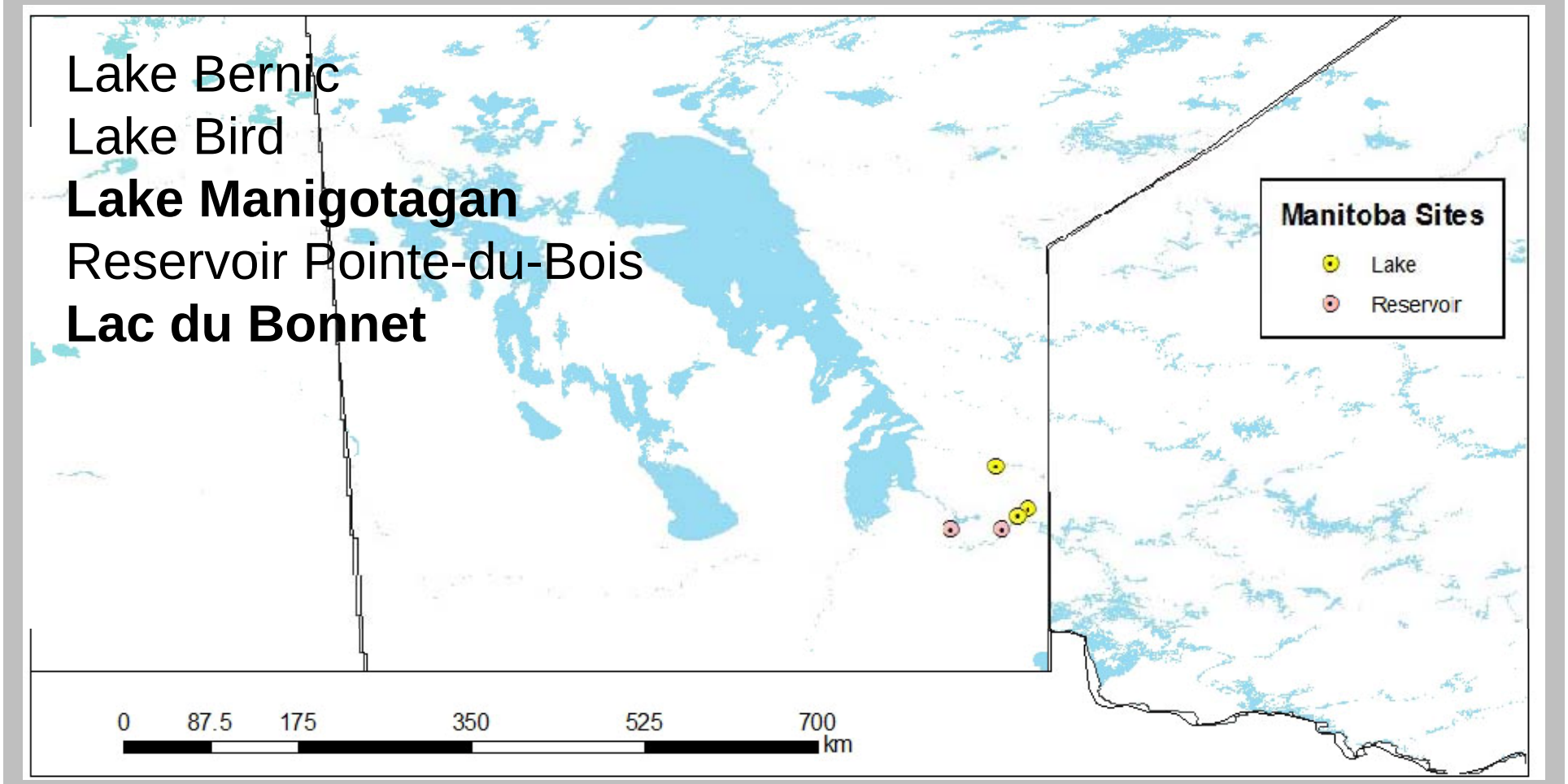
Specific objectives (What?):

1) Augment our understanding of the role played by different types of mesohabitats for a complete suite of fish species and size-classes;

2) Gain knowledge of the daily variation of habitat use in different types of mesohabitats;

3) Compare the relative performance of different sampling gears at achieving 1) and 2).

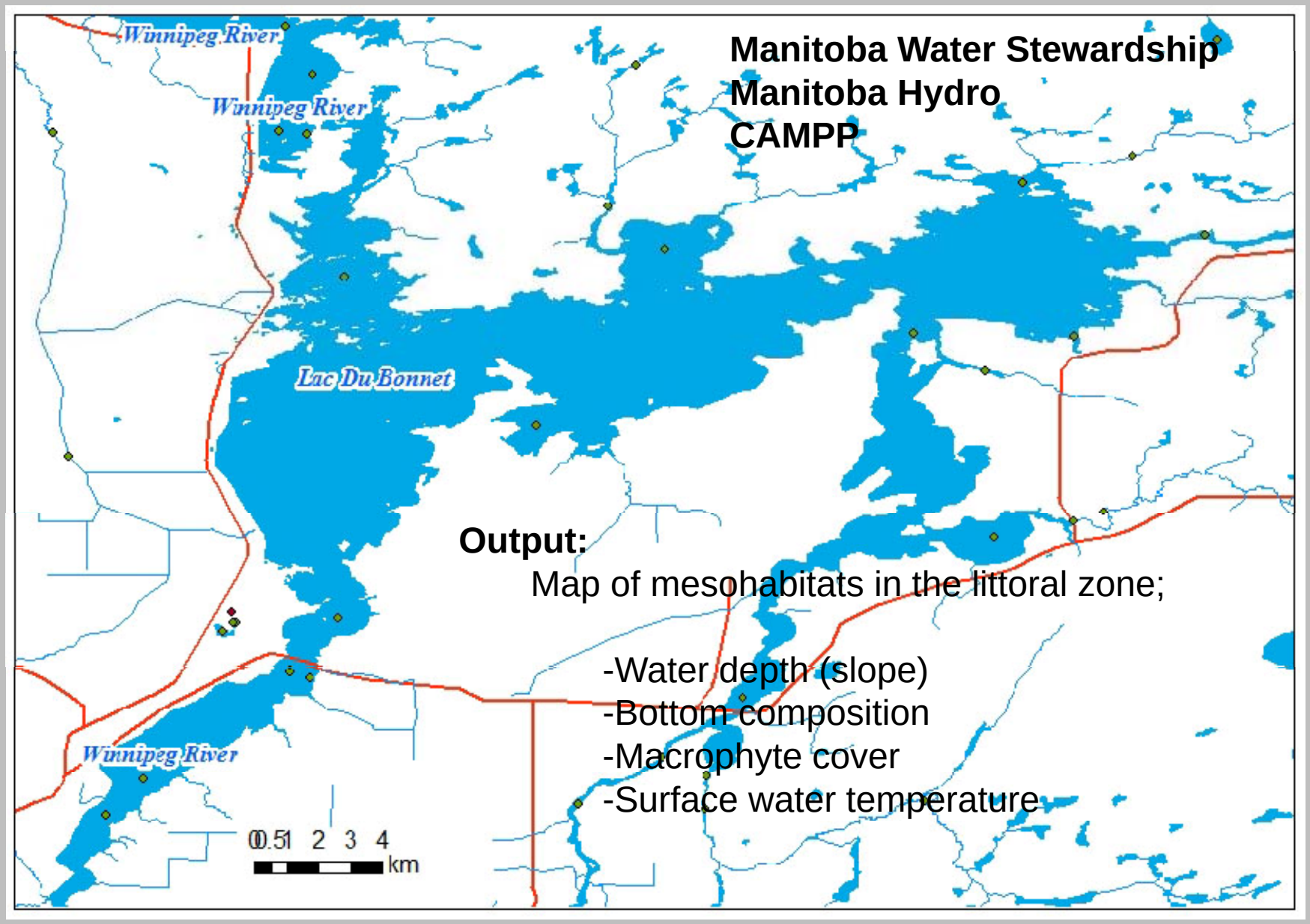
Where?


Lake Bernic
Lake Bird
Lake Manigotagan
Reservoir Pointe-du-Bois
Lac du Bonnet
Manitoba Sites
Lake
Reservoir
0
87.5
175
350
525
700
km

When?

- 2010 (Site visits/calibration; August to September)
- 2011-2013 (Sampling; June-August)
- 2014-15 Data analysis and writing up of reports

How?



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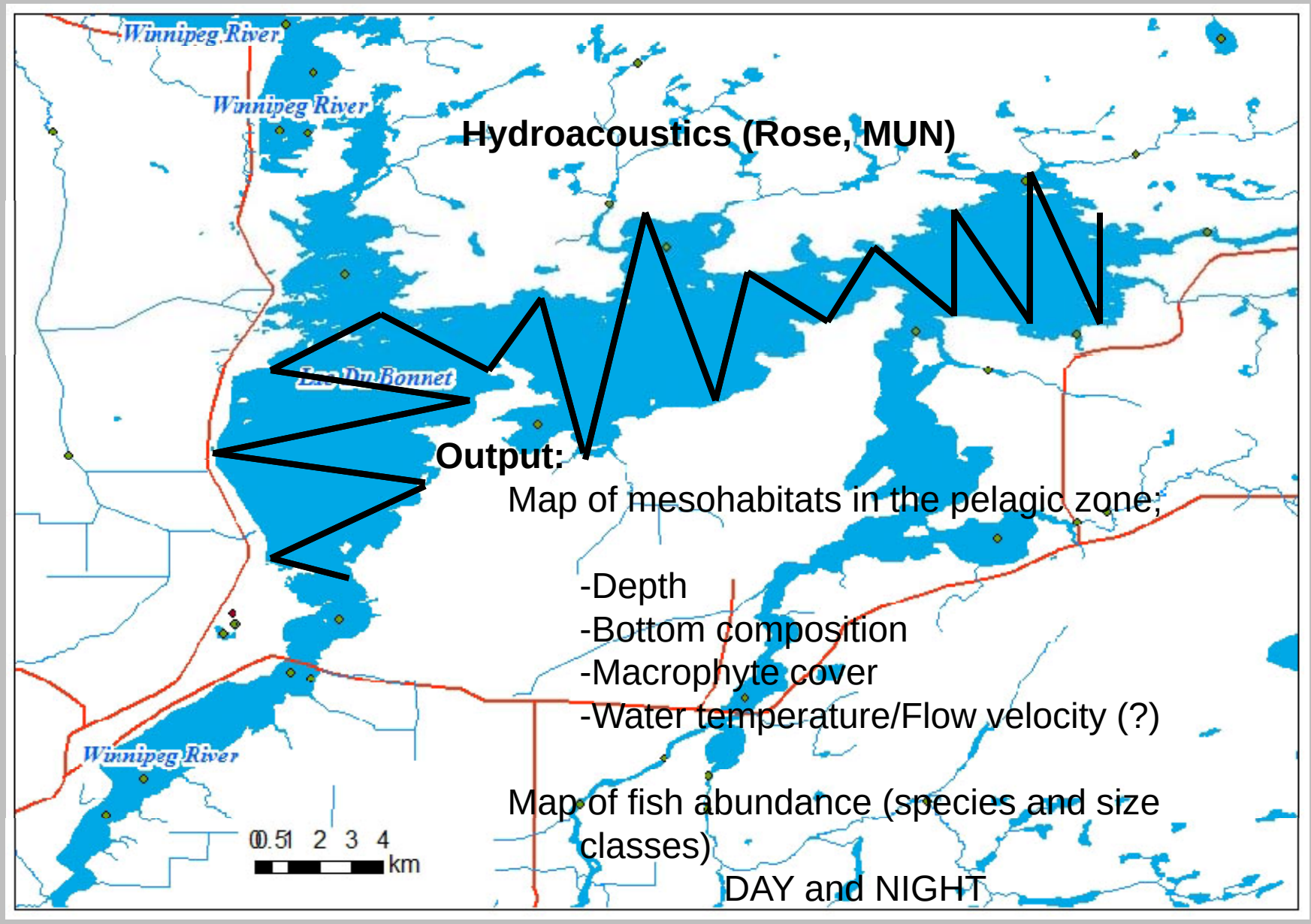
Output:

Map of mesohabitats in the littoral zone;

-Water depth (slope)
-Bottom composition
-Macrophyte cover
-Surface water temperature

How?



Hydroacoustics (Rose, MUN)

Output:

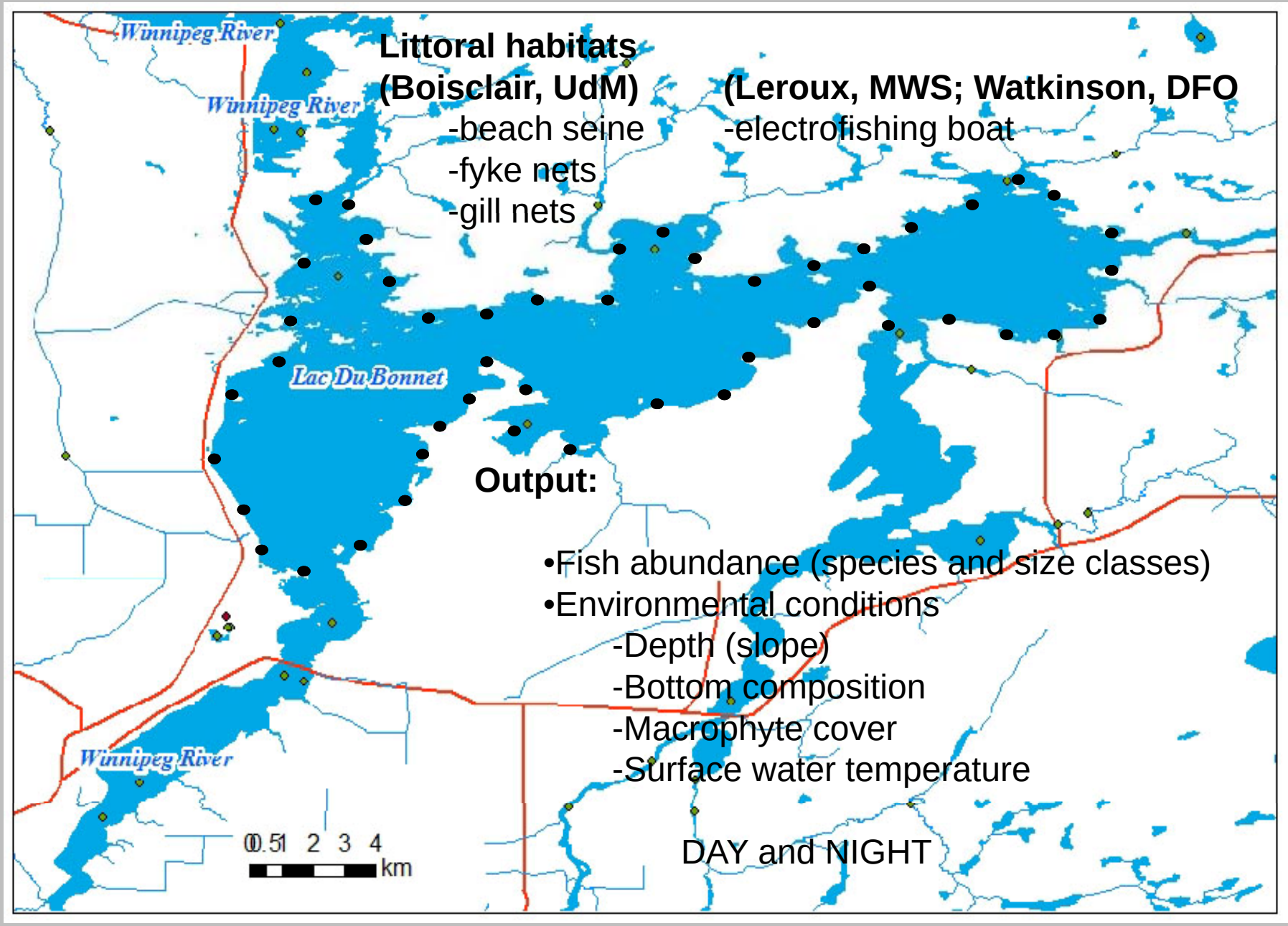
Map of mesohabitats in the pelagic zone;

-Depth
-Bottom composition
-Macrophyte cover
-Water temperature/Flow velocity (?)

Map of fish abundance (species and size classes)

DAY and NIGHT

How?



Littoral habitats

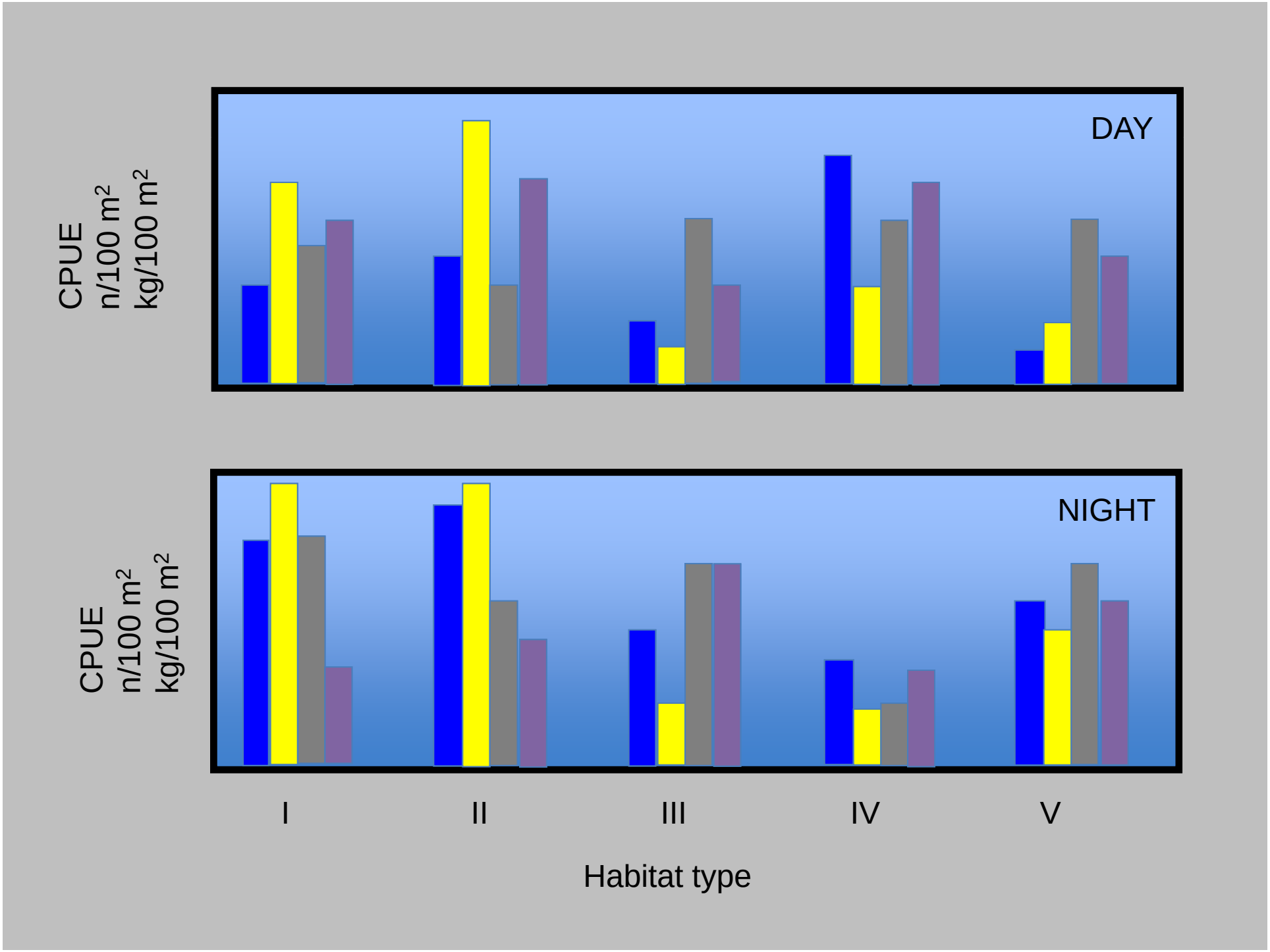
(Boisclair, UdM)
-beach seine
-fyke nets
-gill nets

(Leroux, MWS; Watkinson, DFO
-electrofishing boat

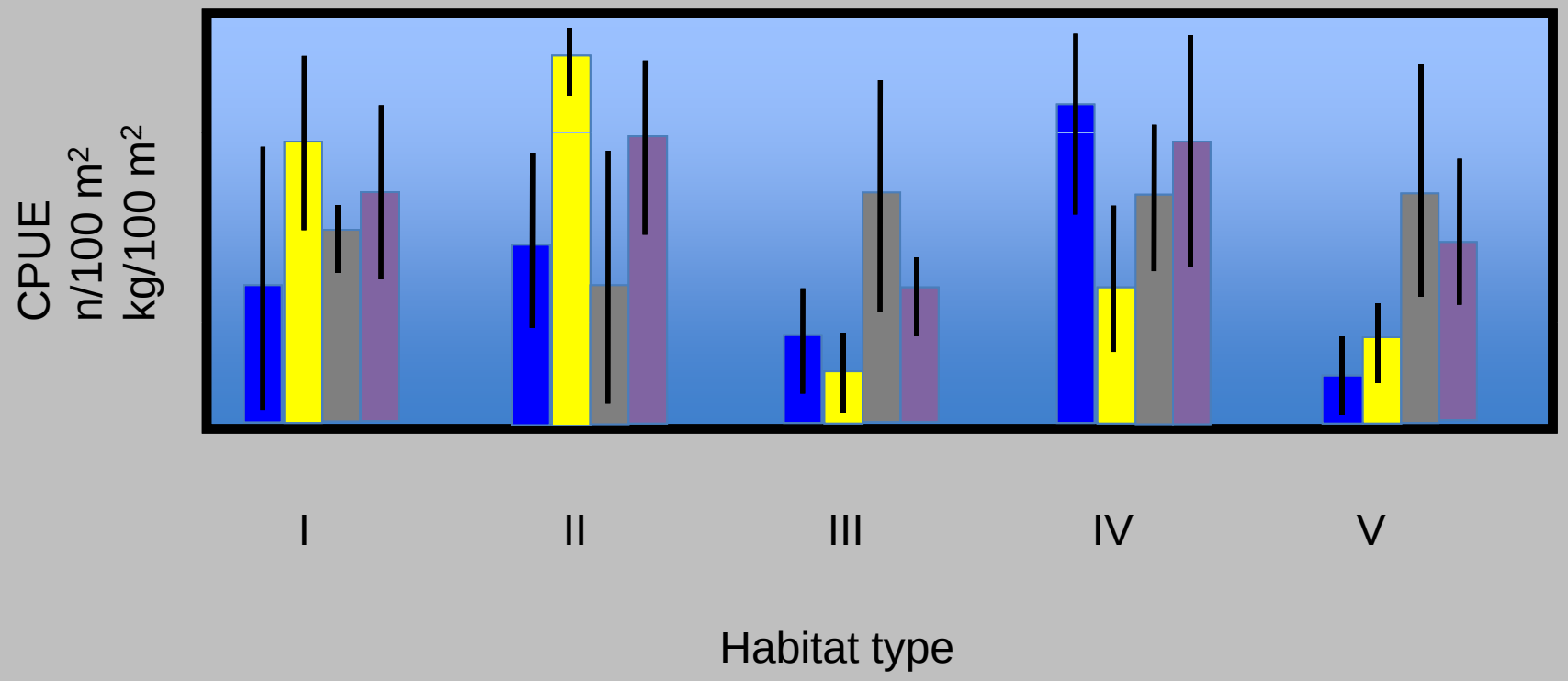
Output:

- Fish abundance (species and size classes)
- Environmental conditions
  - -Depth (slope)
  - -Bottom composition
  - -Macrophyte cover
  - -Surface water temperature

DAY and NIGHT


DAY
CPUE
n/100 m²
kg/100 m²
NIGHT
CPUE
n/100 m²
kg/100 m²
I
II
III
IV
V
Habitat type

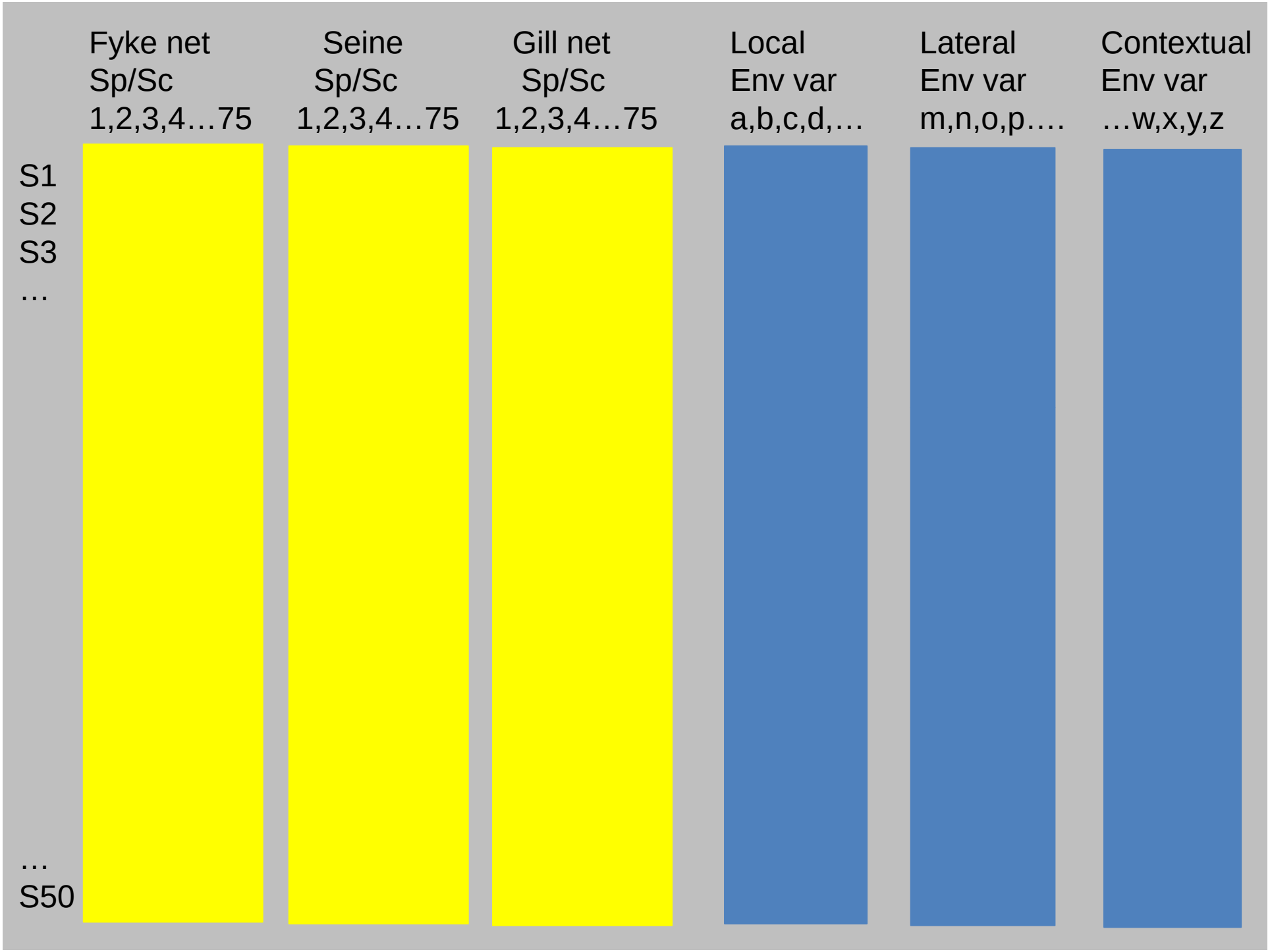
•50 = 10 replicates per combinations of method and 5 habitat types



- Habitat use modelling

CPUE
n/100 m^2
kg/100 m^2
} = f (local, lateral, contextual)

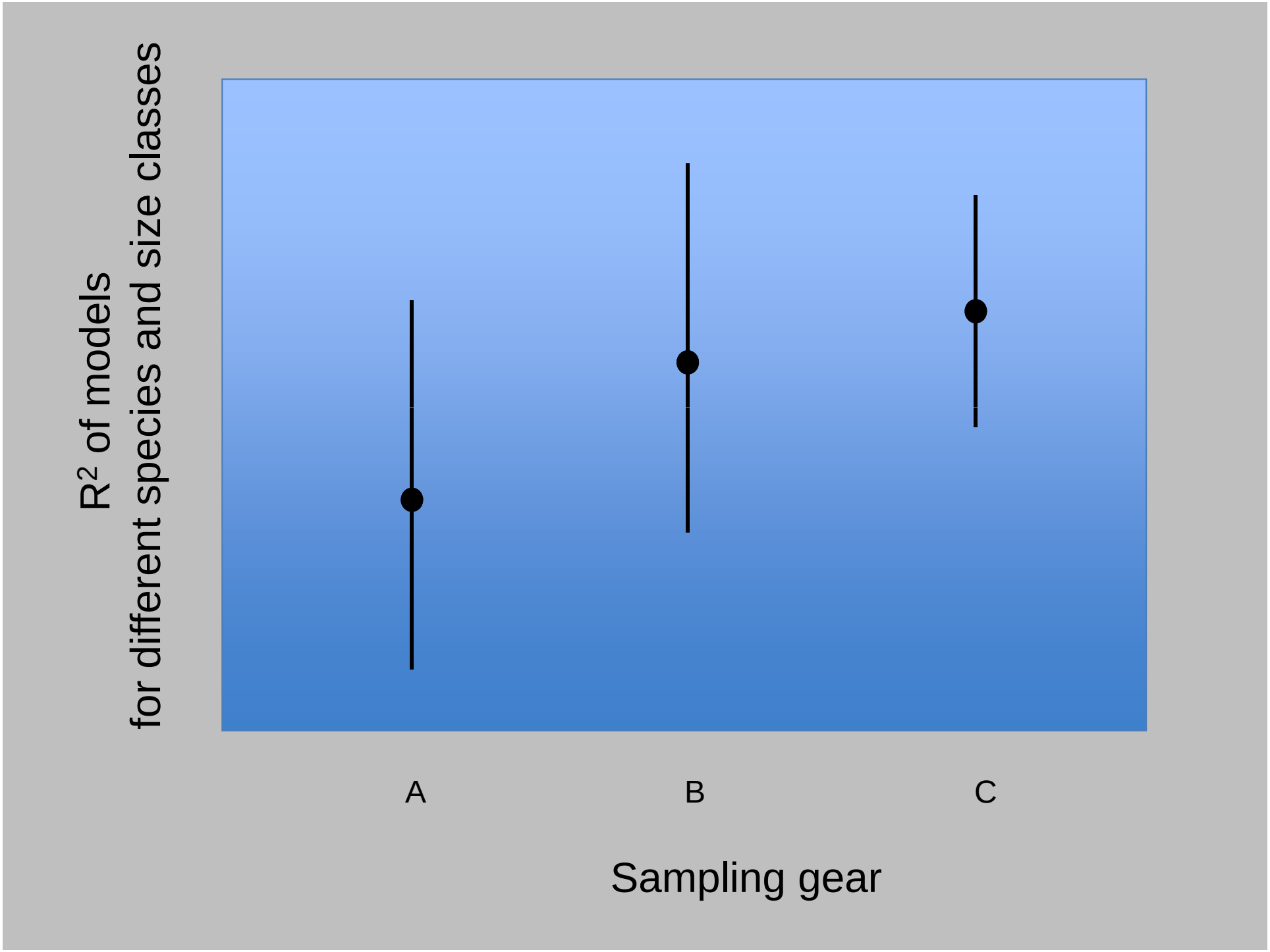
Local : depth, substrate composition, macrophyte cover, woody debris
Lateral : riparian vegetation, presence/absence cottages
Contextual : distance to tributary, distance to temperature anomalies, fetch, distance to deep sections of the lake

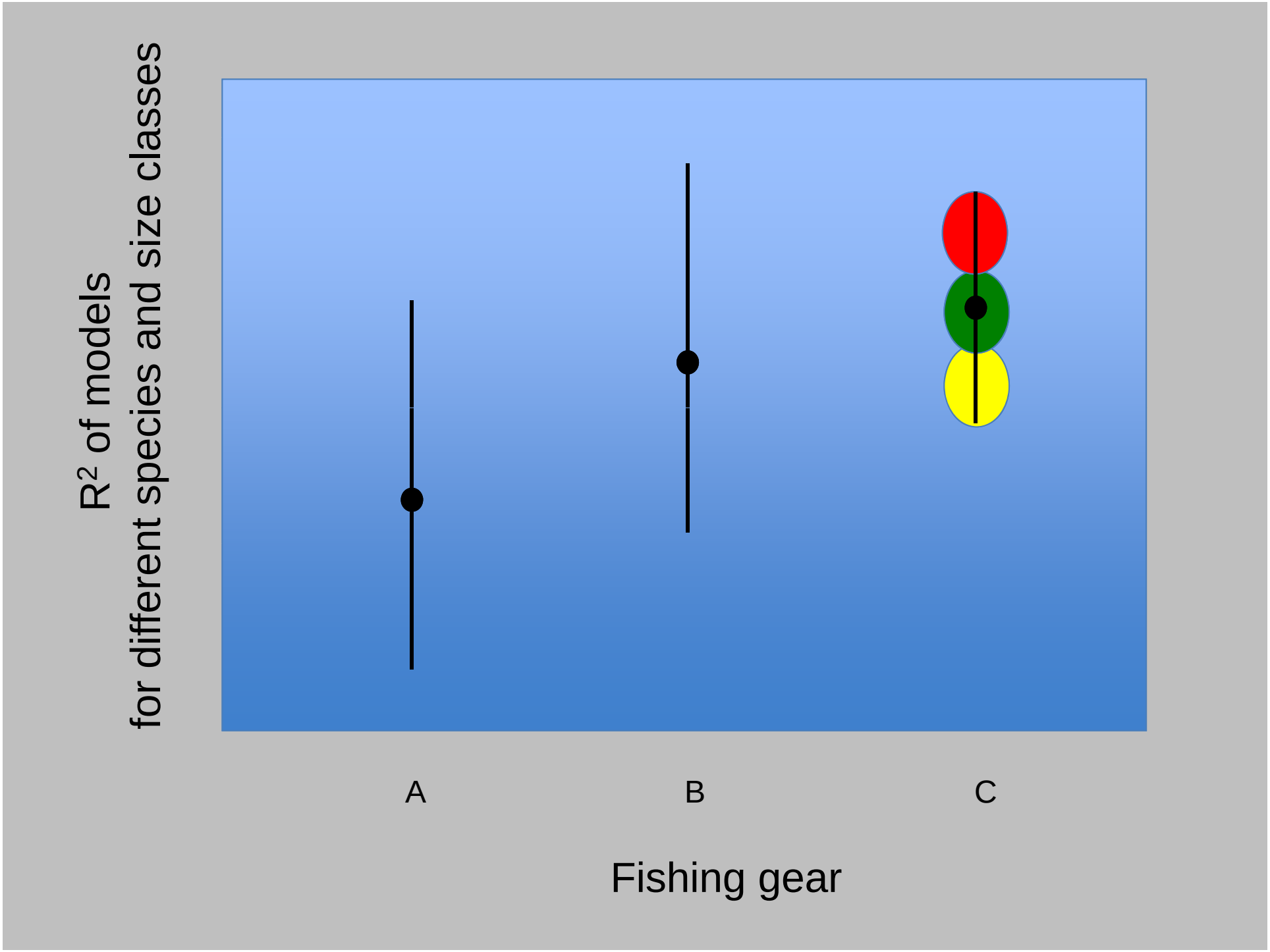

Fyke net
Sp/Sc
1,2,3,4…75
Seine
Sp/Sc
1,2,3,4…75
Gill net
Sp/Sc
1,2,3,4…75
Local
Env var
a,b,c,d,…
Lateral
Env var
m,n,o,p….
Contextual
Env var
…w,x,y,z
S1
S2
S3
…
…
S50

Two challenges:

-The number of combinations of species and size classes

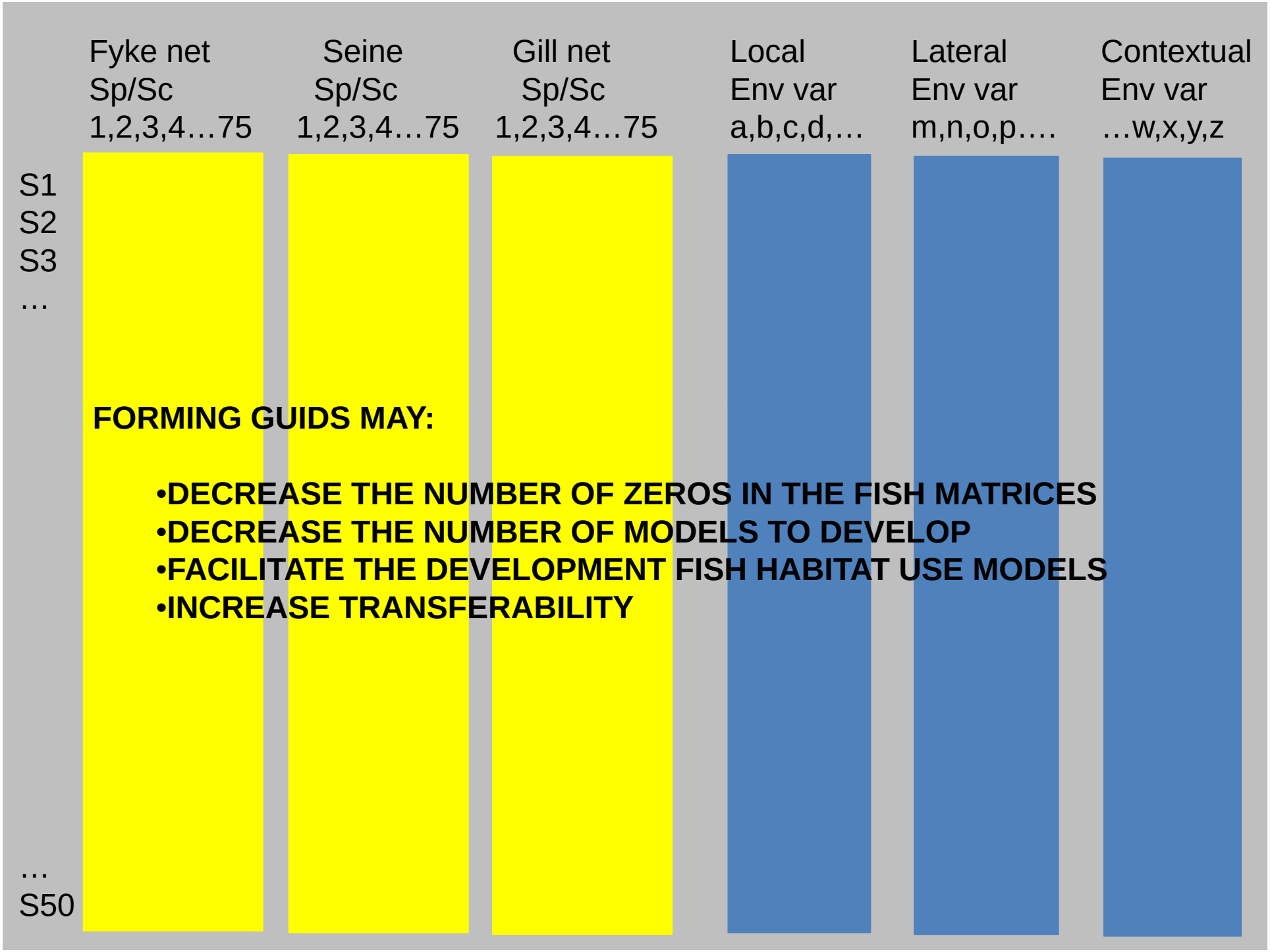
-The number of zeros per fish matrix


R2 of models
for different species and size classes
A
B
C
Sampling gear


R2 of models
for different species and size classes
A
B
C
Fishing gear

Criteria to form groups of fish species and size classes («guilds»)

-morphological traits
-anatomic traits
-life-history traits
-size
-diet


Fyke net
Sp/Sc
1,2,3,4…75
Seine
Sp/Sc
1,2,3,4…75
Gill net
Sp/Sc
1,2,3,4…75
Local
Env var
a,b,c,d,…
Lateral
Env var
m,n,o,p….
Contextual
Env var
…w,x,y,z
S1
S2
S3
…
…
S50
FORMING GUIDS MAY:
•DECREASE THE NUMBER OF ZEROS IN THE FISH MATRICES
•DECREASE THE NUMBER OF MODELS TO DEVELOP
•FACILITATE THE DEVELOPMENT FISH HABITAT USE MODELS
•INCREASE TRANSFERABILITY

Contributions:

- **Compare the relative performance of different sampling gears at estimating fish habitat use (CPUE, n/100 m^2, kg/100 m^2)**
- **Describe patterns of habitat use for species and size classes day and night**
- **Identify the sampling gear that allows to develop models having the highest explanatory power**
- **Assess the relative effects of local, lateral, contextual environmental conditions on fish habitat use**
- **Define criteria to form guilds that will facilitate the development of habitat use models**
- **Improve our ability to estimate and predict metrics of productive capacity (CPUE, n/100 m^2, kg/100 m^2)**

Potential improvements:

-3D map of flow velocity fields

-3D map of water temperature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