Brown trout and hydro-morphological changes

Standardized gill net catches as tool for classifying effects of hydropower regulation in lakes

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Background

- Fish is a quality element in WFD when classifying ecological status of lakes
- Hydro-morphological changes an important external factor
- Effect of water level changes on fish populations least developed in implementation of WFD in Norway
- Need for identification of relevant parameters (biological and abiotic)
- Start with already available datasets

  → Brown trout database


Photo: I.P. Helland


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Photo: E.B. Thorstad

Aims

Overall:

- Identify easy parameters for evaluation of hydro-morphological changes in lakes

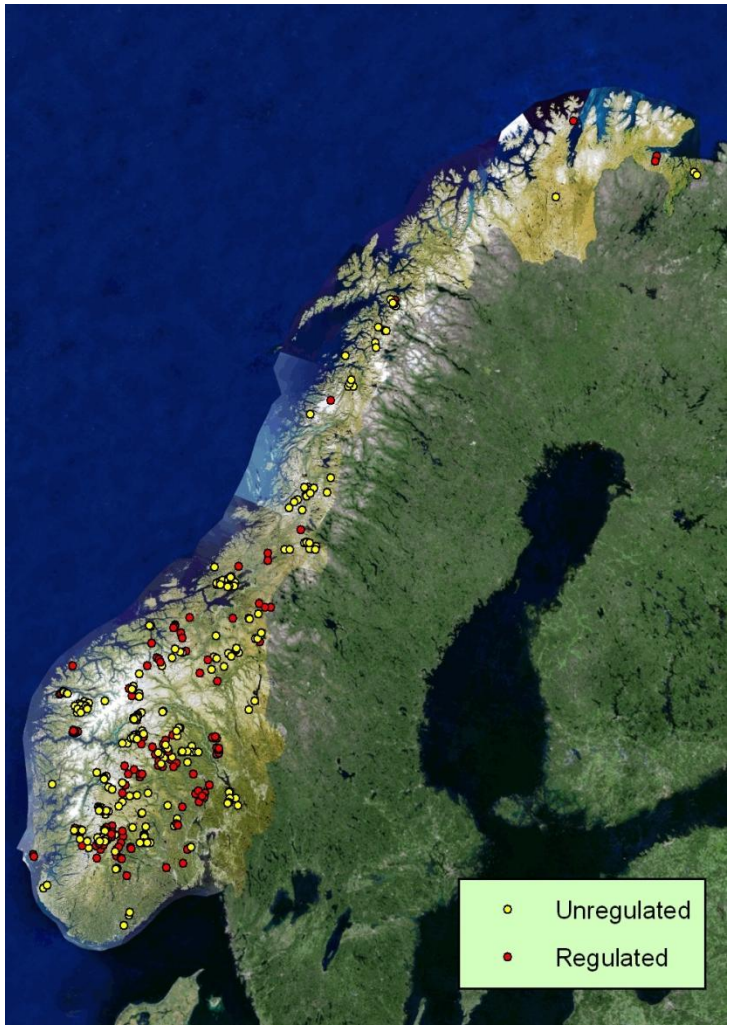
Specifically:

- Test whether standardized catches from gillnet surveys can be used as indicator of ecological effects of hydropower production


Photo: I.P. Helland

Brown trout database

- Standard survey nets in 410 lakes
- Collected 1972-1997
- 365 included, cover most of Norway
  - 238 unregulated
  - 127 regulated



Survey nets

- Standardized gill net series: Jensen series
  - 8 nets: 52, 45, 39, 35, 29, 26, 2 x 21 mm
  - Representative sampling of trout between 19 – 45 cm

- Weight per unit effort (CPUEW) as proxy for population size


Photo: I.P. Helland


Photo: A.G. Finstad

Questions

- Are there differences in brown trout populations between hydropower reservoirs an unregulated lakes?
- Can the differences be correlated to extent of water level regulations?


Photo: O. Ugedal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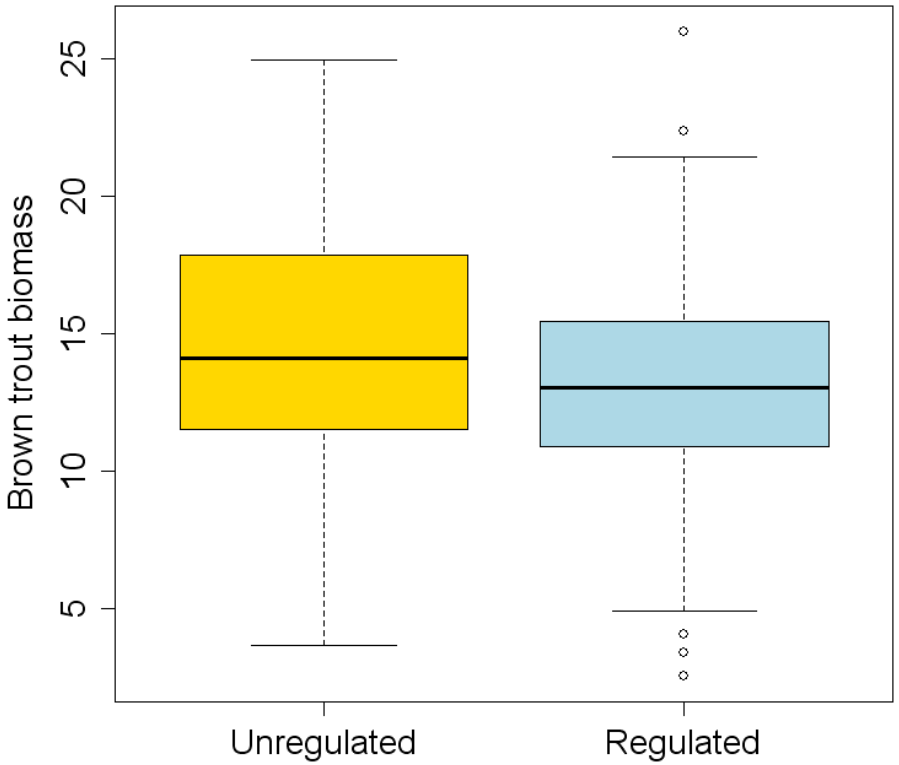
Difference? Yes, but...



$F_{1,363}$=10.54, t=-3.24, p=0.001

Challenge

- Separate effect of water level regulations from other biotic and abiotic factors known to influence population size of brown trout

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More explanatory variables

Factors

- Regulation (unregulated vs. regulated)
- Presence of other species (allopatry vs. sympatry)
- Compensatory stocking of brown trout

Continuous variables

- HRWL-LRWL
- Lake area
- Proportion littoral zone (perimeter:area ratio)
- Summer temperature (mean temp. July)
- Winter length (number of days with snow cover)

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Photo: I.P. Helland

Lake morphology

- Hydropower reservoirs usually large lakes, effect of hydropower production disappear when lake size is corrected for
- Trout biomass decreases with increasing lake area and increases with larger proportion of littoral zone
  → Brown trout prefer littoral habitat

Competition

- Allopatric trout has significantly larger biomass than trout in lakes with other competing fish species
- Competition has stronger effect than hydropower production
- Yet difference between regulated and unregulated lakes remains statistically significant when presence of other fish species is corrected for

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Photo: I.P. Helland

Climate

- Warm summers negative effect, long winters positive
- Apparent positive with cold climate, BUT probably indirect effect of interspecific competition
  - Allopatric lakes in dataset have cold summers and long winters
- When sympatry is controlled for, the effect of climate is reduced

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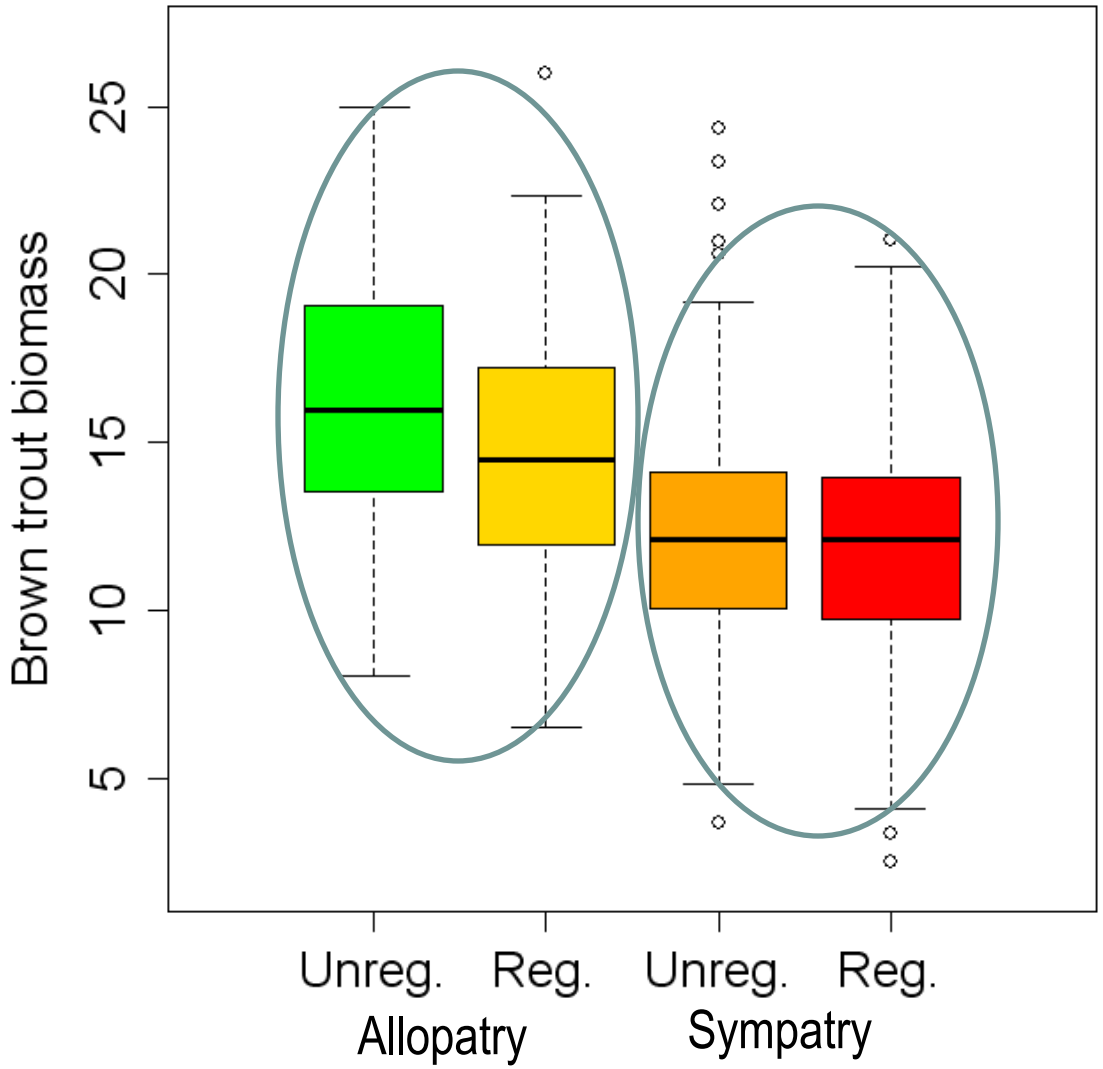
Brown trout biomass
5
10
15
20
25
Unreg.
Reg.
Unreg.
Reg.
Allopatry
Sympatry

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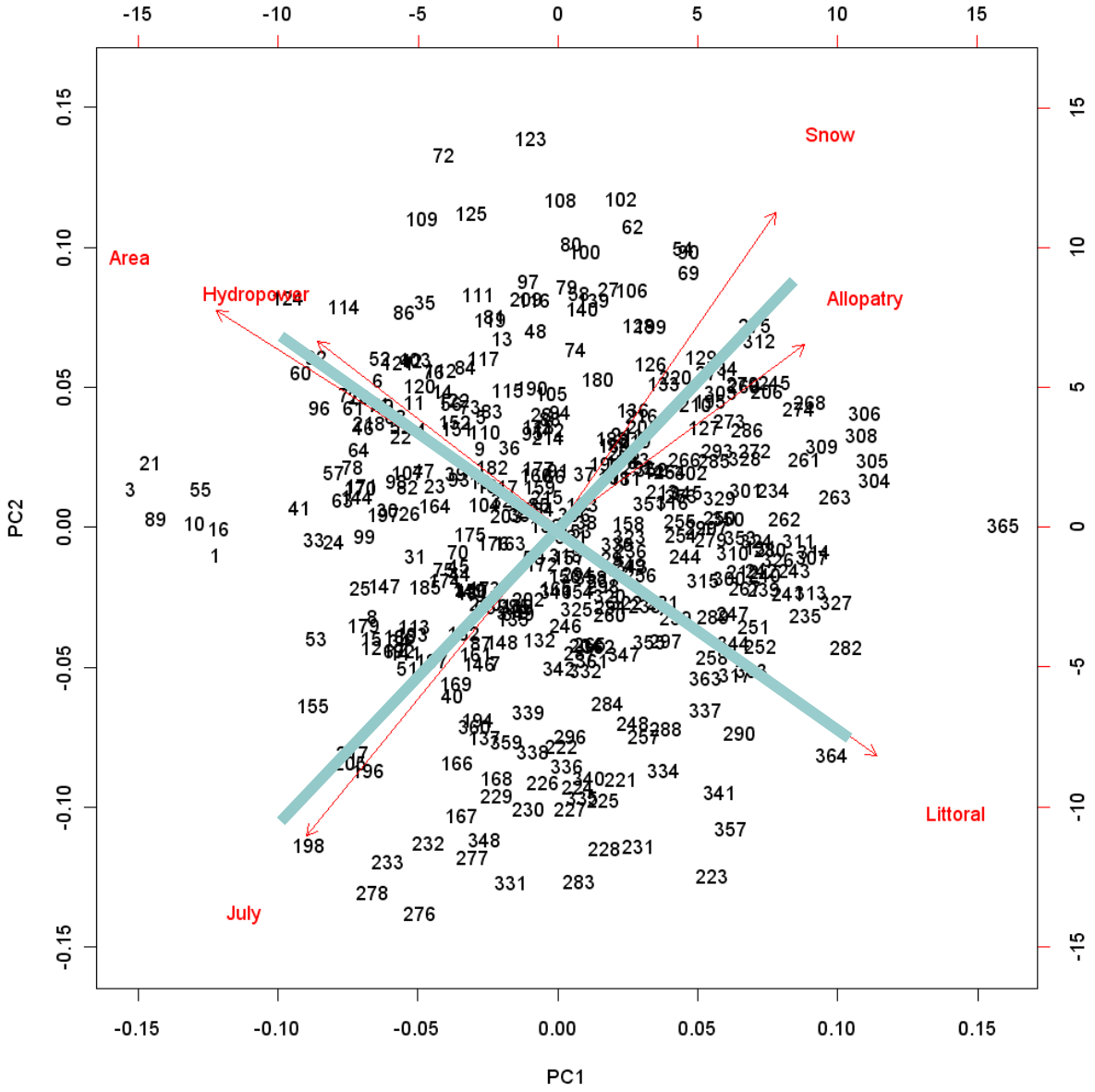
PCA


Snow
Area
Hydropower
Allopatry
Littoral
July
PC1
PC2
-15
-10
-5
0
5
10
15
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15

Stepwise model and parameter reduction

- Start model: All explanatory variables included interactions between each variable and hydropower production (no stocking included, N=268)
- Best model (R^2 = 0.2362):

  Trout biomass = sympatry + summer temp.+ area + winter length

- Strongest explanatory variables
  - Sympatry ($F_{1,263}$=68.30,p<0.001)
  - Lake area ($F_{1,263}$=8.03,p=0.004)
- Hydropower production was excluded in stepwise procedure and did not explain brown trout biomass

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Photo: E.B. Thorstad

Summary

- In spite of apparent differences in trout populations between hydropower reservoirs and unregulated lakes, regulation is not the explanation
- Presence of other fish species (interspecific competition) and lake morphology are the most influential factors on brown trout biomass


Photo: I.P. Helland


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Conclusions

- Brown trout biomass cannot alone be used as indicator of ecological effects of hydropower production
- The effect of water level regulations is probably dependent on lake morphology and competition (and productivity?)
- Complexity makes interpretations difficult

Conclusions contd.

- Necessary with more detailed information on extent and frequency of water level changes in the reservoirs
  - Regulated vs. unregulated too simple
  - Impact vary strongly depending on the extent of water level modifications
- HRWL – LRWL not informative enough
  - Need information of actual water level changes
- Ecological effects of water level changes are context dependent
- Can only be evaluated when looking at water level changes in combination with other measures

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Photo: I.P. Helland

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