vann fra fjell til fjord

A simple and robust index for assessing the status of fish communities

Steinar Sandøy and Trygve Hesthagen

Background

- (ii) Norway (and the Nordic countries) have a very large number of lakes with fish.

- (iii) Most lakes have no or insufficiant biological data. Fish is the QE for which we have the most extensive datasets, and also a substantial amount of local experience and knowledge.

- (iv) We were in need of a simple and robust index, based on abundance categories and changes in population status, which not necessarily need quantitative datasets to be calculated.

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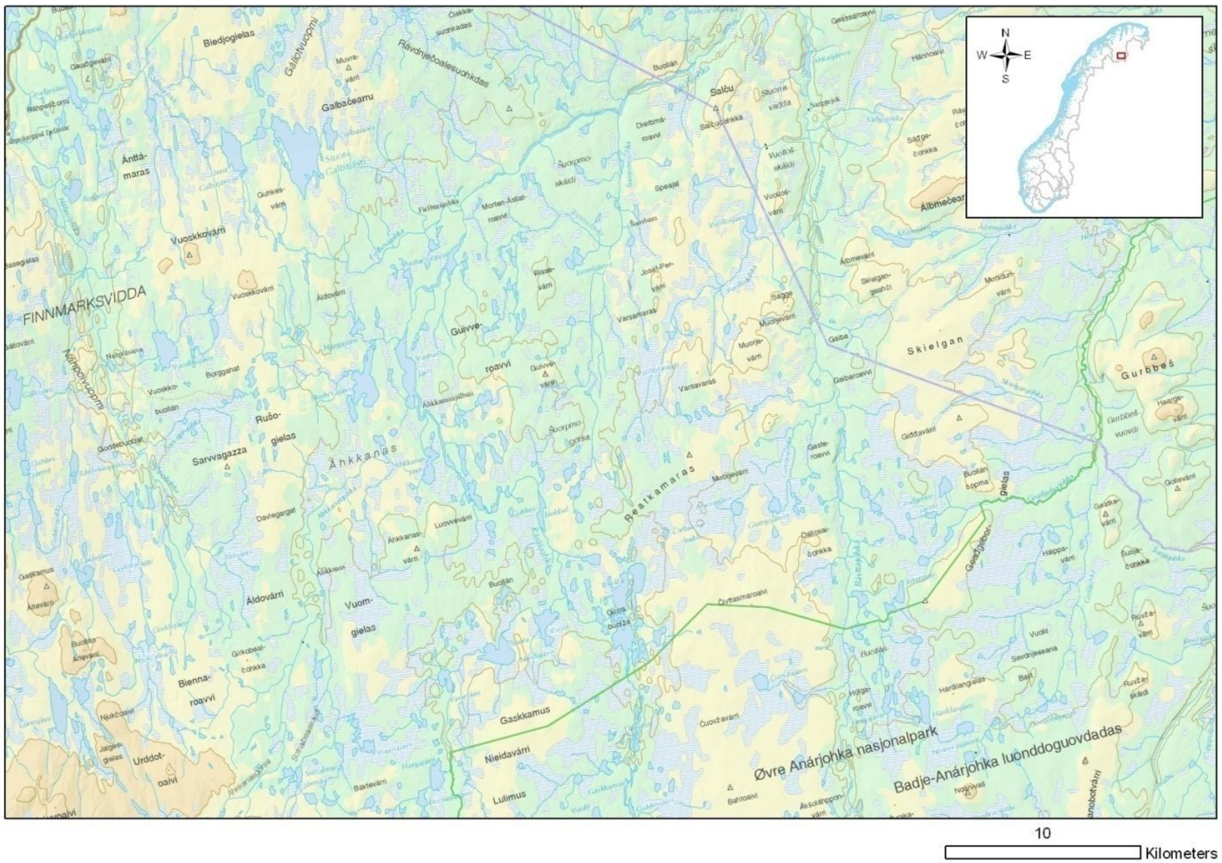
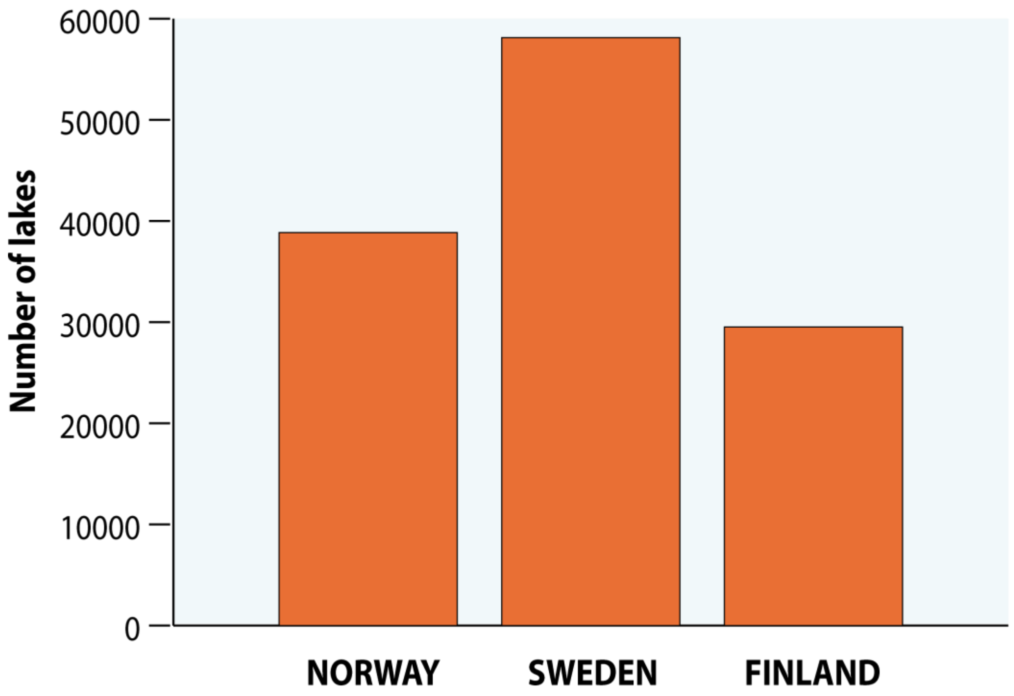
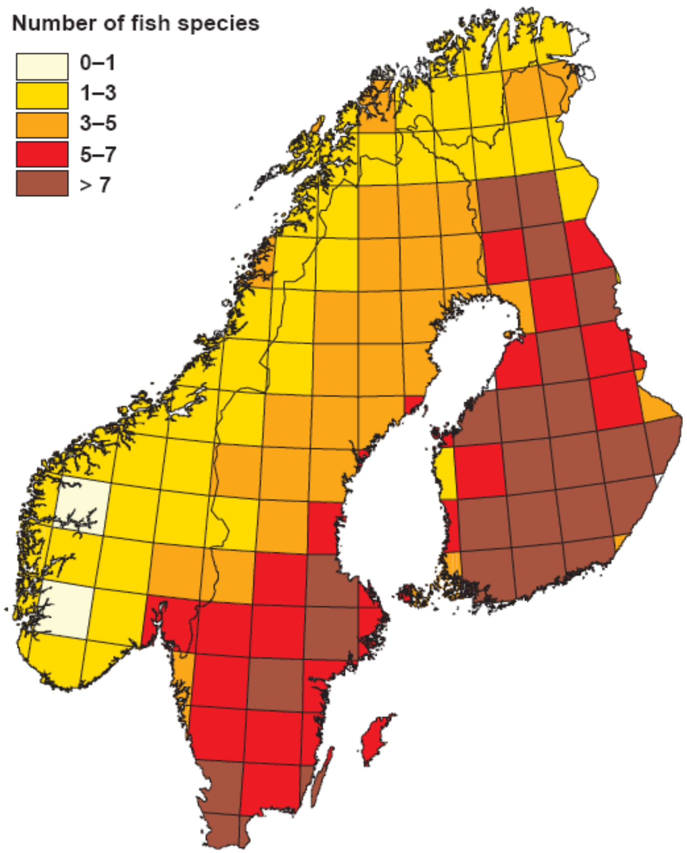
There are lots of lakes in Norway!!



Number of lakes > 4 ha



Regional distribution of the mean number of fish species in lakes



The Fish index

- We need a method which can compare status in sites with different numbers of fish-species
- We use abundance/dominance categories as the quantitative indicator in the index
- All fish species in a waterbody need to be categorized as dominant, subdominant or rare
- To calculate the index you need to know if there have been changes in fish populations compared to reference condition.

Weights used for reference condition, losses and changes (reduced or increased) for species in the different abundance categories

Species abundance category	Weights for reference condition	Weights for lost stocks	Weights for reduced stocks
Dominant species (*D*)	1.00	1.00	0.75
Subdominant species (*S*)	0,75	0.75	0.50
Rare species (R)	0,50	0.50	0.25

How to calculate the fish index
Step I

Reference value ***(RE)*** *is* defined as*:*

- Categories: Dominant (***D***), subdominant (***S***) and rare species (***R***)

$$RE = n_D \times w_{D,RE} + n_S \times w_{S,RE} + n_R \times w_{R,RE}$$
$$= \sum_{i=(D,S,R)} n_i \times w_{i,RE}$$

where n_i is the number of species from category *i* and $w_{i,RE}$ the corresponding weights.

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How to estimate the fish index
Step II

Then we estimate changes in fish status *(S_C)*

$$S_c = \left[n_{D,C} \times w_{D,C} + n_{S,C} \times w_{S,C} + n_{R,C} \times w_{R,C} \right] + \left[n_{D,L} \times w_{D,L} + n_{S,L} \times w_{S,L} + n_{R,L} \times w_{R,L} \right] = \sum_{i=(D,S,R)} n_{i,C} \times w_{i,C} + \sum_{i=(D,S,R)} n_{i,L} \times w_{i,L}$$

where $n_{i,C/L}$ is the number of species from category *i*, assigned to either changed (*C, i.e.* reduced or increased) or lost *(L),* and $w_{i,C/L}$ are their corresponding weights.

How to estimate the fish index
Step III

Finally, we estimate the fish index (*FI*), based on reference condition (*RE*) and changes in status (S_C)

$$FI = \frac{RE - S_C}{RE}$$

This means that the fish index *FI* will range from 1.0 (no change) to 0 (all stocks lost)

Classes for ecological status and their boundaries

Ecological status	Symbol	Class boundaries
High		1.0-0.95
Good		0.95-0.75
Moderate		0.75-0.50
Poor		0.50-0.25
Bad		<0.25

Two examples

Example 1: Two fish species in the lake

1. One dominant and one subdominant species under reference condition

$$\Rightarrow RE = 1 \times 1.0 + 1 \times 0.75 = 1.75$$

2. The dominant species is unaltered while the subdominant species has been reduced

$$\Rightarrow S_C = 1 \times 0.50 = 0.50$$

3. Fish index

$$\Rightarrow FI = \frac{1.75 - 0.50}{1.75} = \underline{\underline{0.71}}$$

Example 2: Three fish species in the lake

1. One dominant, one subdominant and one rare species under reference condition
2. The dominant species is reduced, the subdominant species is lost and the rare species is reduced
3. Fish index

$$\Rightarrow RE = 1 \times 1.0 + 1 \times 0.75 + 1 \times 0.50 = 2.25$$

$$\Rightarrow S_C = 1 \times 0.75 + 1 \times 0.75 + 1 \times 0.25 = 1.75$$

$$\Rightarrow FI = \frac{2.25 - 1.75}{2.25} = \underline{\underline{0.22}}$$

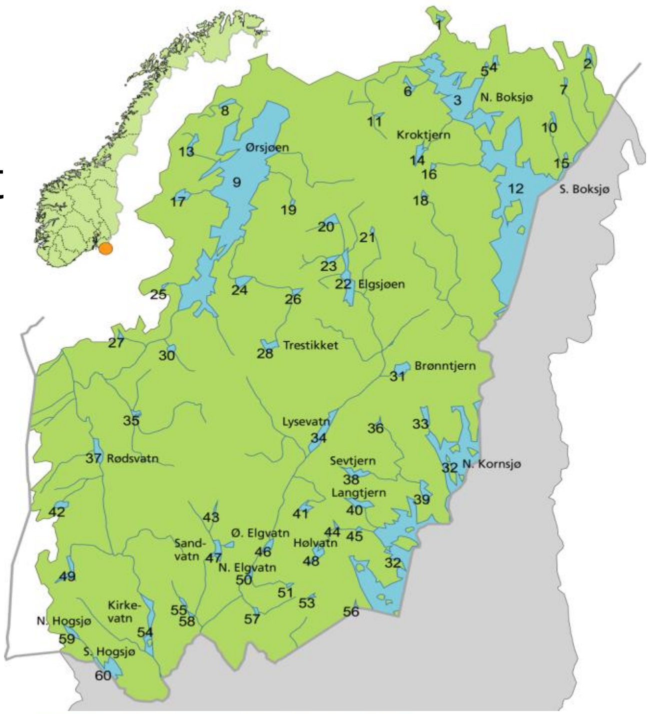
Classes for ecological status and their boundaries

Ecological status	Symbol	Class boundaries
High		1.0-0.95
Good		0.95-0.75
Moderate		0.75-0.50
Poor		0.50-0.25
Bad		<0.25

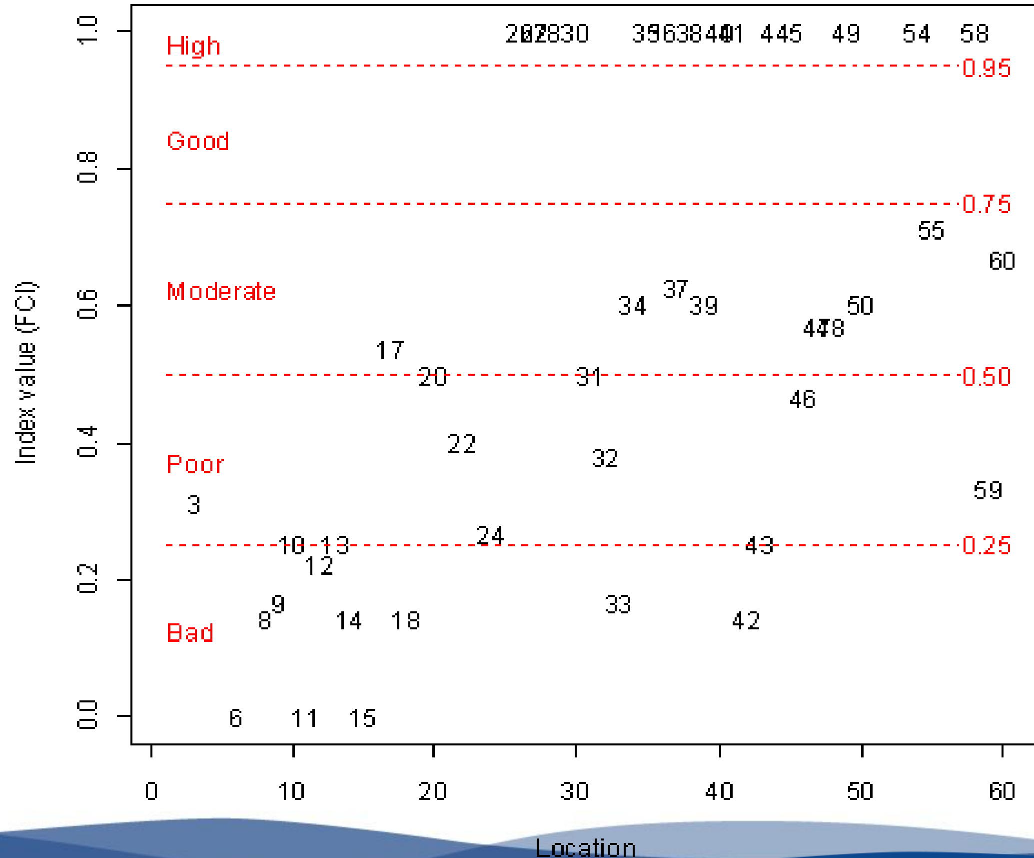
Calculating fish index values (*FI*) from a real data set

- Data from 44 lakes in Enningdal watershed in southeastern Norway
- Lakes above the marine limit are highly affected by acidification
- Many fish stocks have suffered damage and losses
- Number of fish species range from 1 to 6.

Enningdal catchment area



FI-values for fish from 44 lakes in Enningdal catchment



Additional comments

- If one species is lost, this should give *Moderate* status, regardless of the *FI* –value

- Effects of introductions/alien species may also be taken into account by the index.

Conclusions

- The boundaries between different classes may not be optimal, and can be adjusted along with new data and more experience using the index .
- The index might also be calculated based on non-scientific data on fish stocks, which will increase the number of lakes which can be classified.
- The *FI* may be less suitable in describing changes in fish communites with many species.

Further work

- We need to develop new or
- improve existing quantitative fish evaluation methods
- Should we do that in a Nordic cooperation?
  - Common types, comparable climate
  - Comparable pressures
  - Common fish species