Presentation available at: https://docs.google.com/presentation/d/1Kn-PzGTxcMRQXrJN1R2Apvh4KHevNUhgcjKMQVbCFW8/export/pdf

Impacts from climate change, hydropower and invasive species on freshwater ecosystems in Nordic waters

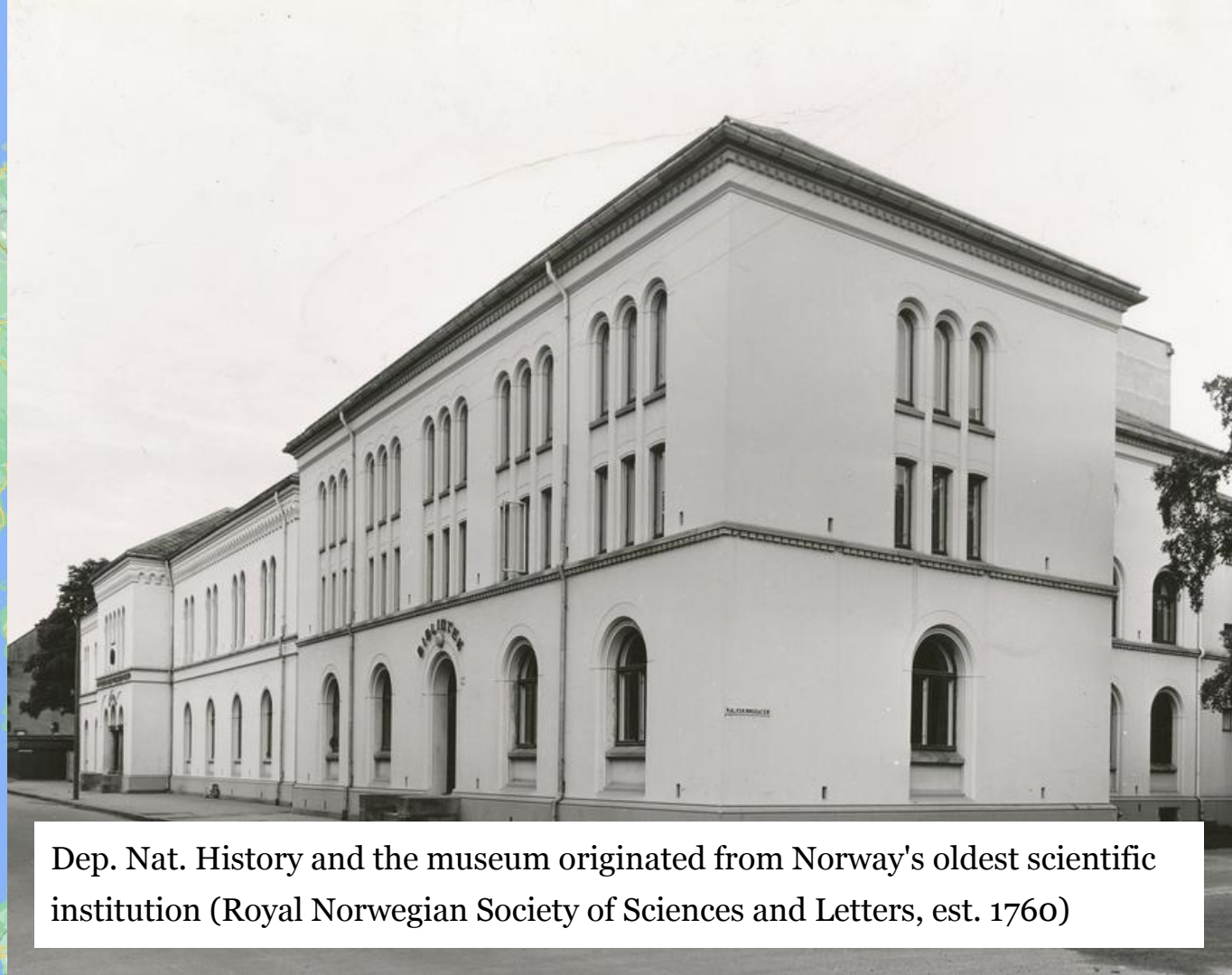
Anders Gravbrøt Finstad
Department of Natural History
Centre of Biodiversity Dynamics
Norwegian University of Science and Technology

CENTRE FOR BIODIVERSITY DYNAMICS

Norwegian Centre of Excellence

NTNU
Norwegian University of Science and Technology

NTNU
UNIVERSITY MUSEUM



Dep. Nat. History and the museum originated from Norway's oldest scientific institution (Royal Norwegian Society of Sciences and Letters, est. 1760)

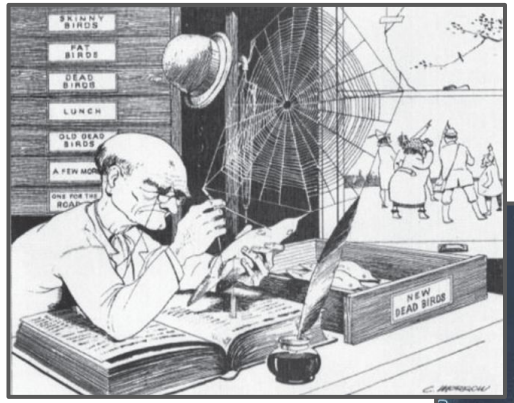
Datacurrator obligations

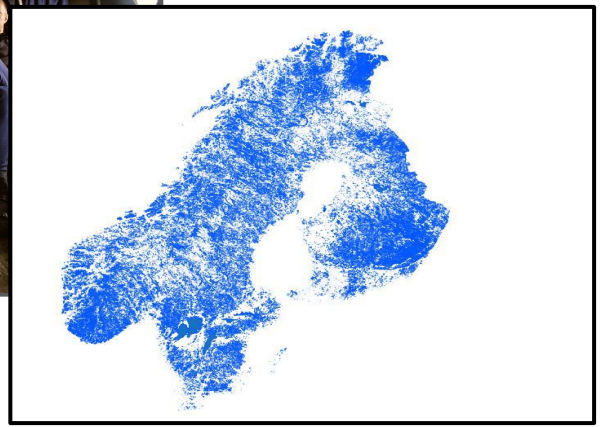
About

- Data curator and Open Science advocate
- Freshwater ecologist
- Field based studies, and ..
- Large scale data synthesis and ecological forecasts

Today

- Thematic area
- Approaches
- Example studies

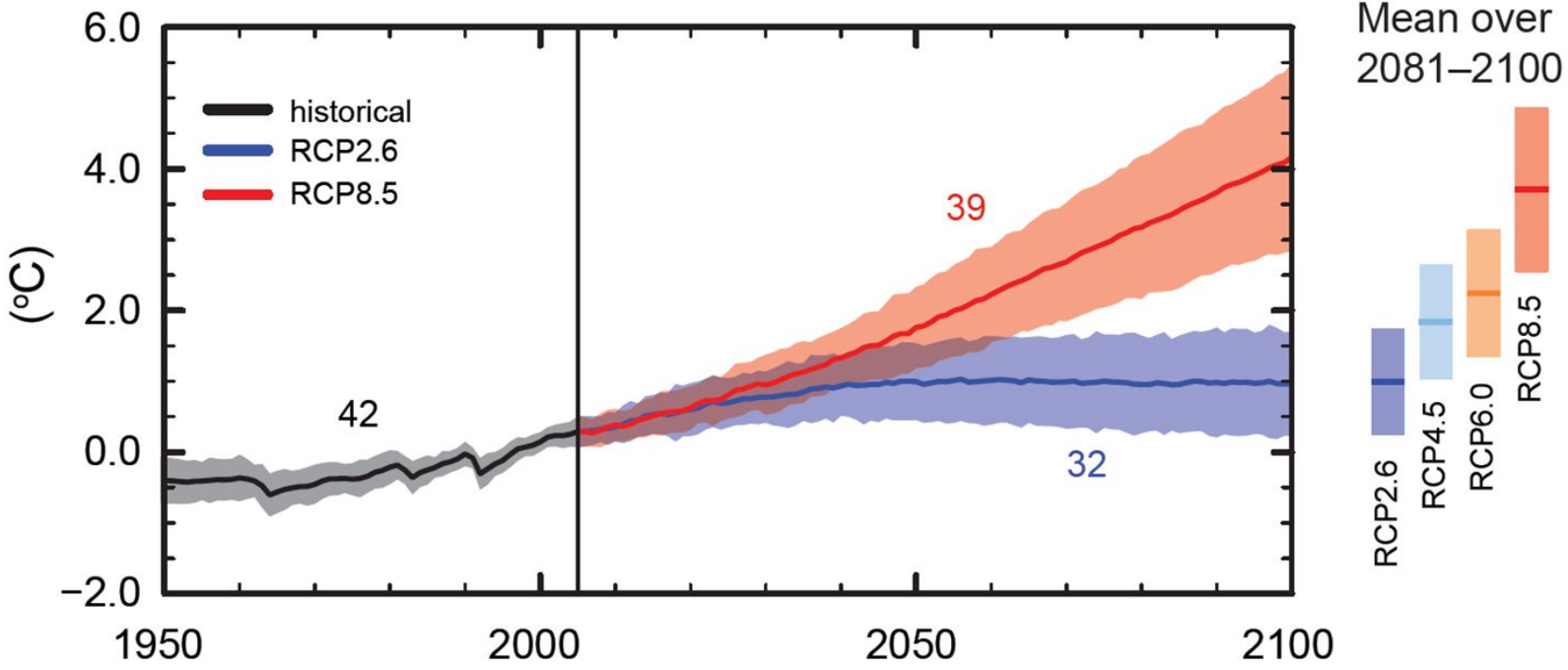




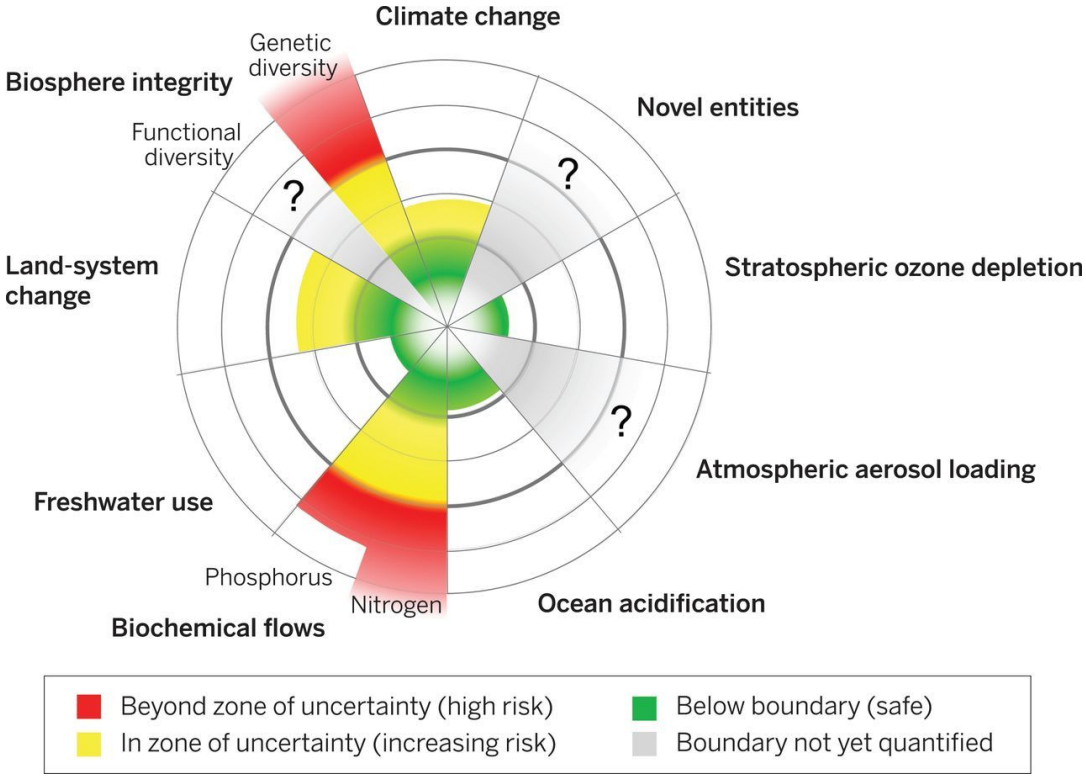
A window to the past

A mirror of the future

On the importance of Natural history collections

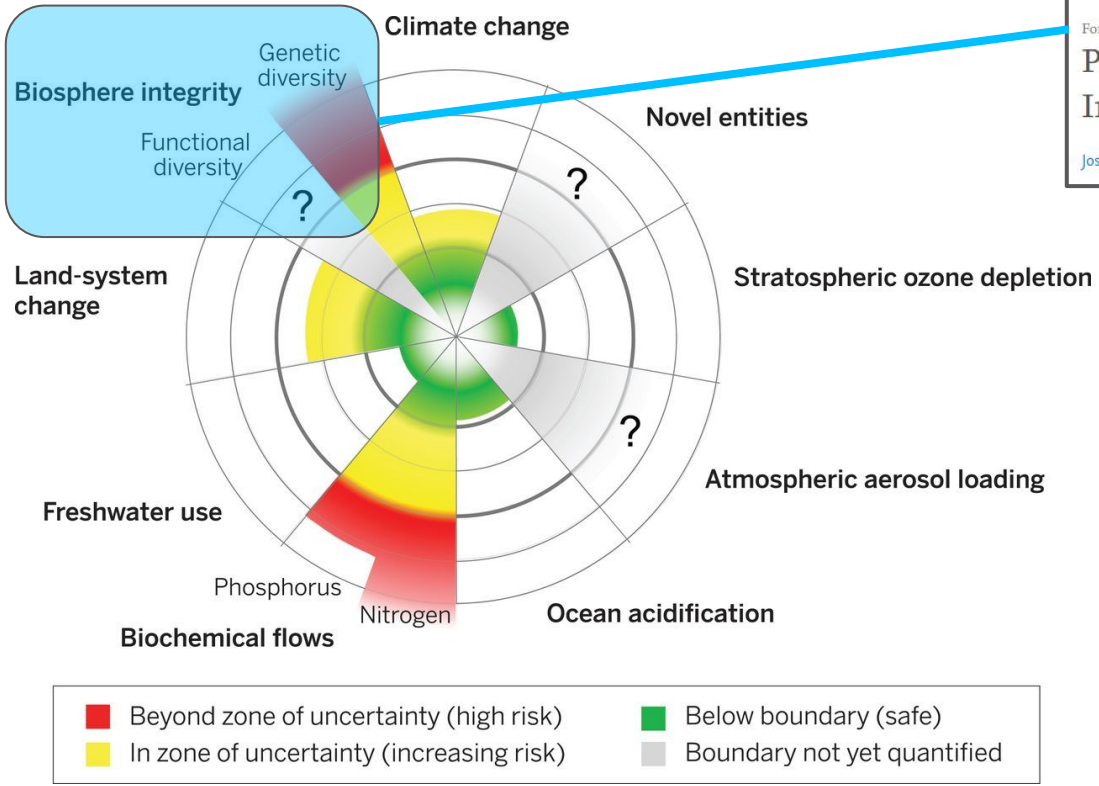

6.0
4.0
2.0
0.0
−2.0
(°C)
1950
2000
2050
2100
historical
RCP2.6
RCP8.5
42
39
32
Mean over
2081–2100
RCP2.6
RCP4.5
RCP6.0
RCP8.5

Planetary Boundaries



Steffen et al. (2015). DOI: 10.1126/science.1259855

Planetary Boundaries



Trends in Ecology & Evolution
Volume 33, Issue 2, February 2018, Pages 71-73
CellPress

Forum

Planetary Boundaries for Biodiversity: Implausible Science, Pernicious Policies

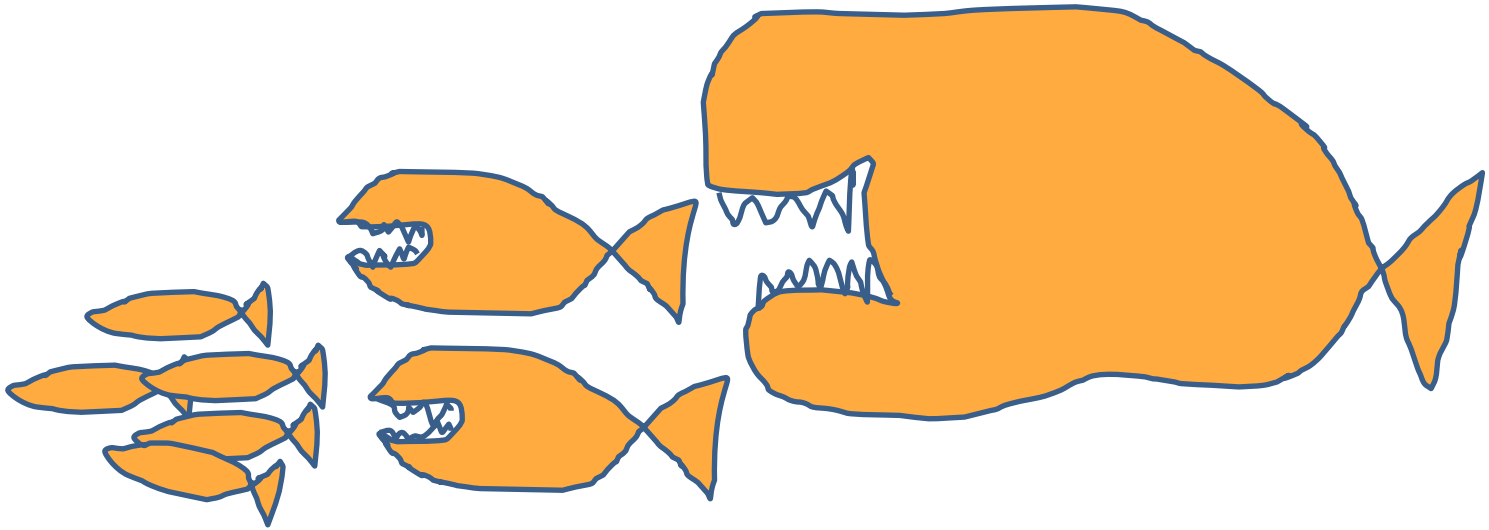
José M. Montoya [1], Ian Donohue [2], Stuart L. Pimm [3]

"The notion of a 'safe operating space for biodiversity' is vague and encourages harmful policies. Attempts to fix it strip it of all meaningful content. Ecology is rapidly gaining insights into the connections between biodiversity and ecosystem stability. We have no option but to understand ecological complexity and act accordingly"

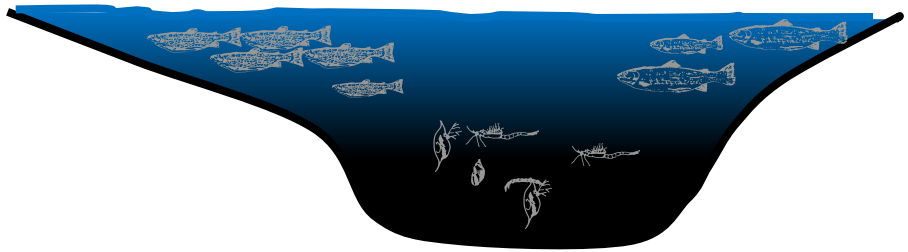
Steffen et al. (2015). DOI: 10.1126/science.1259855

Big fish eat small fish

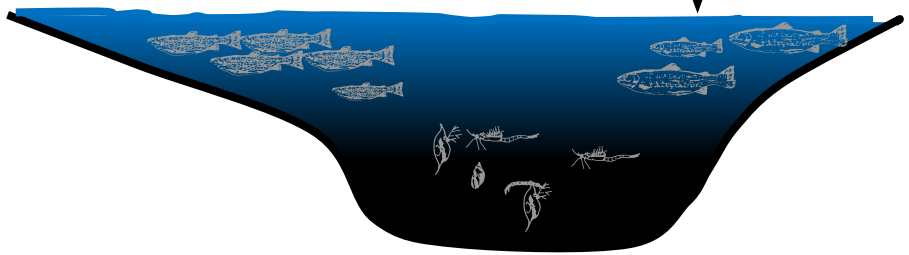
Shakespeare, Pericles, 1576



How the environmental drivers change biotic interactions and why it matters

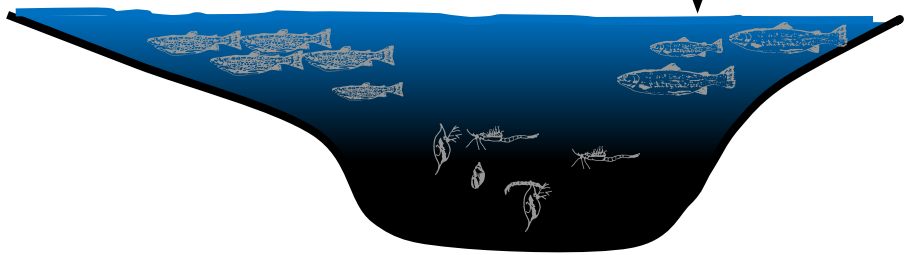


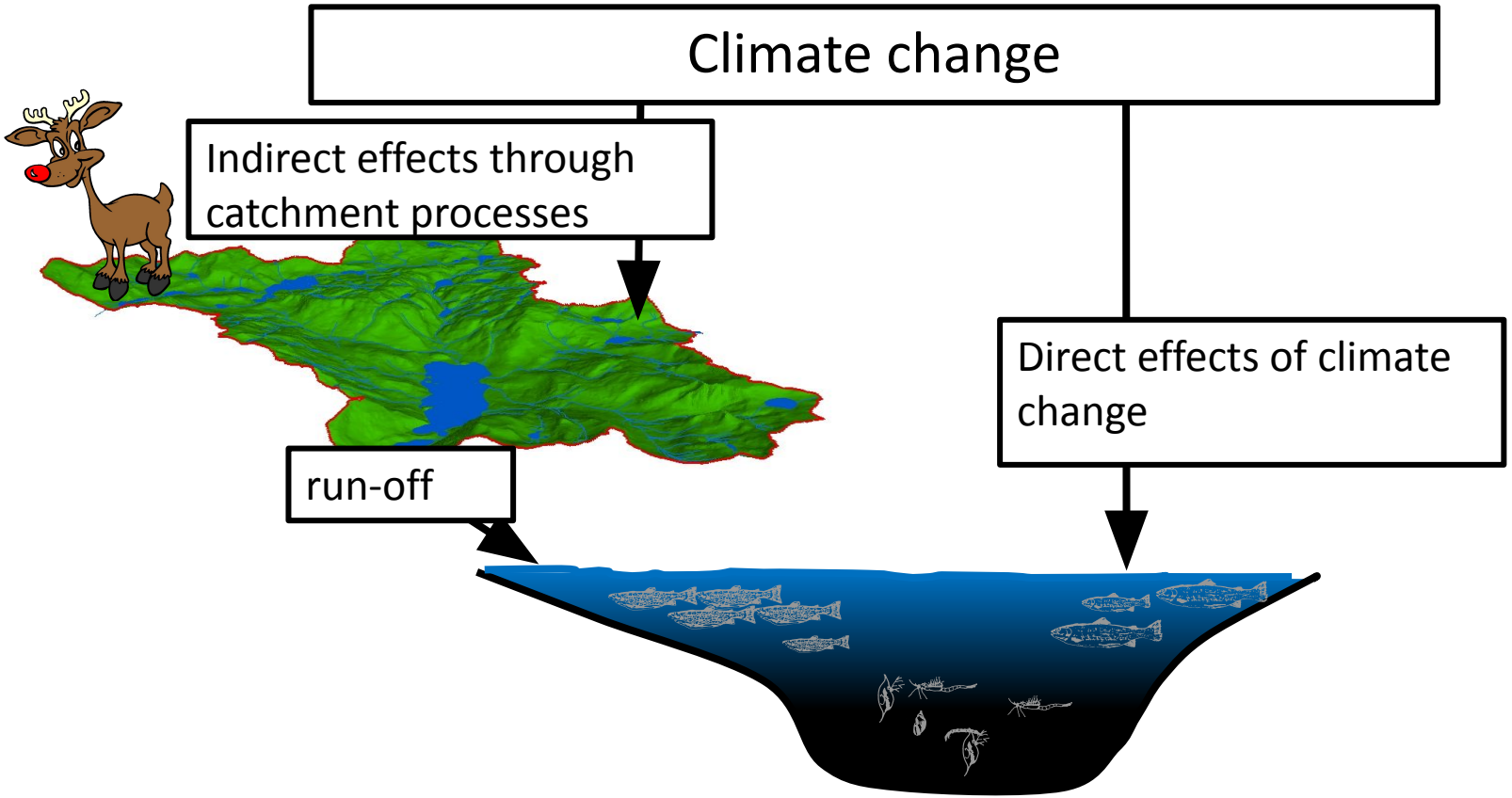
Climate change



Climate change

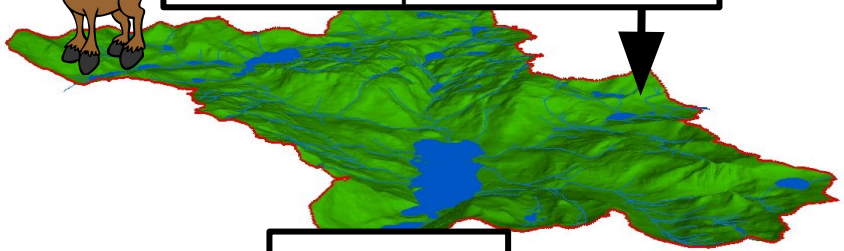
Direct effects of climate change




Climate change
Indirect effects through catchment processes
Direct effects of climate change
run-off

Climate change

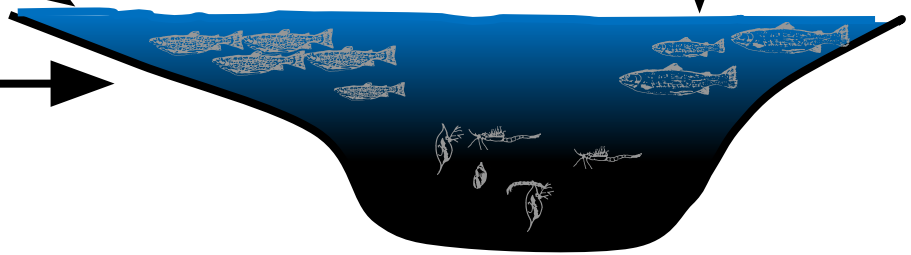
Indirect effects through catchment processes



Direct effects of climate change

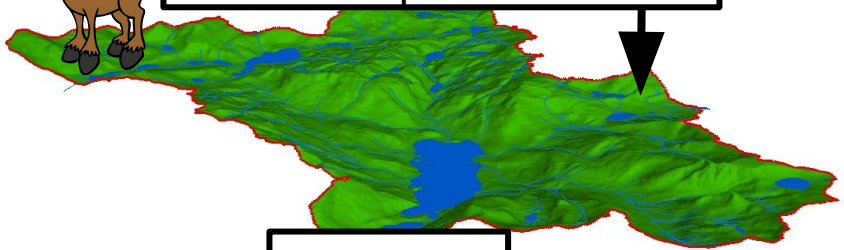
run-off

Invasive species



Climate change

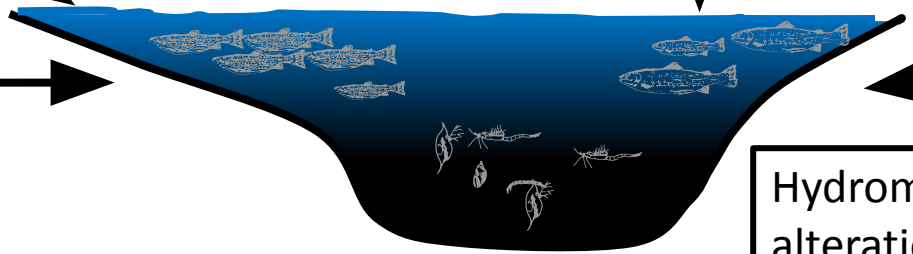
Indirect effects through catchment processes

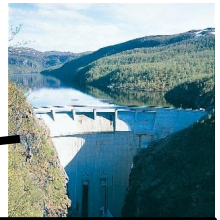


Direct effects of climate change

run-off

Invasive species

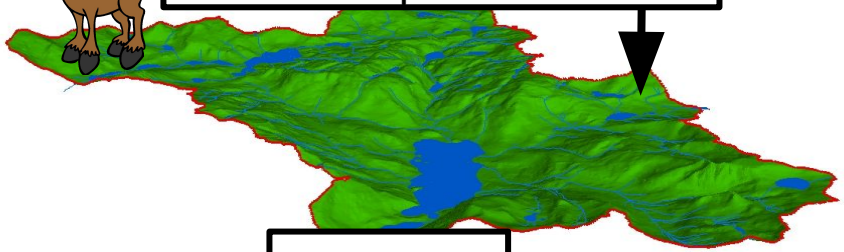




Hydromorphological alterations of habitat

Climate change

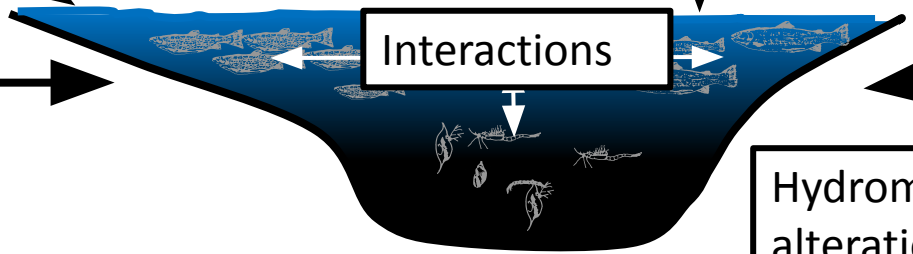
Indirect effects through catchment processes



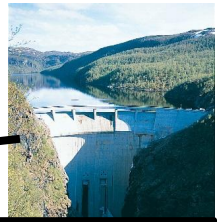
Direct effects of climate change

run-off

Invasive species

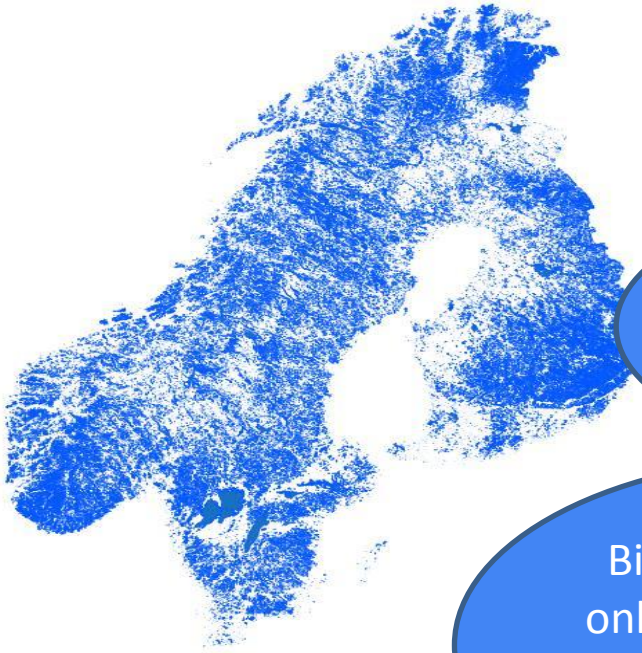


Interactions



Hydromorphological alterations of habitat

Data aggregation across national borders



Individual data: raw gillnet data

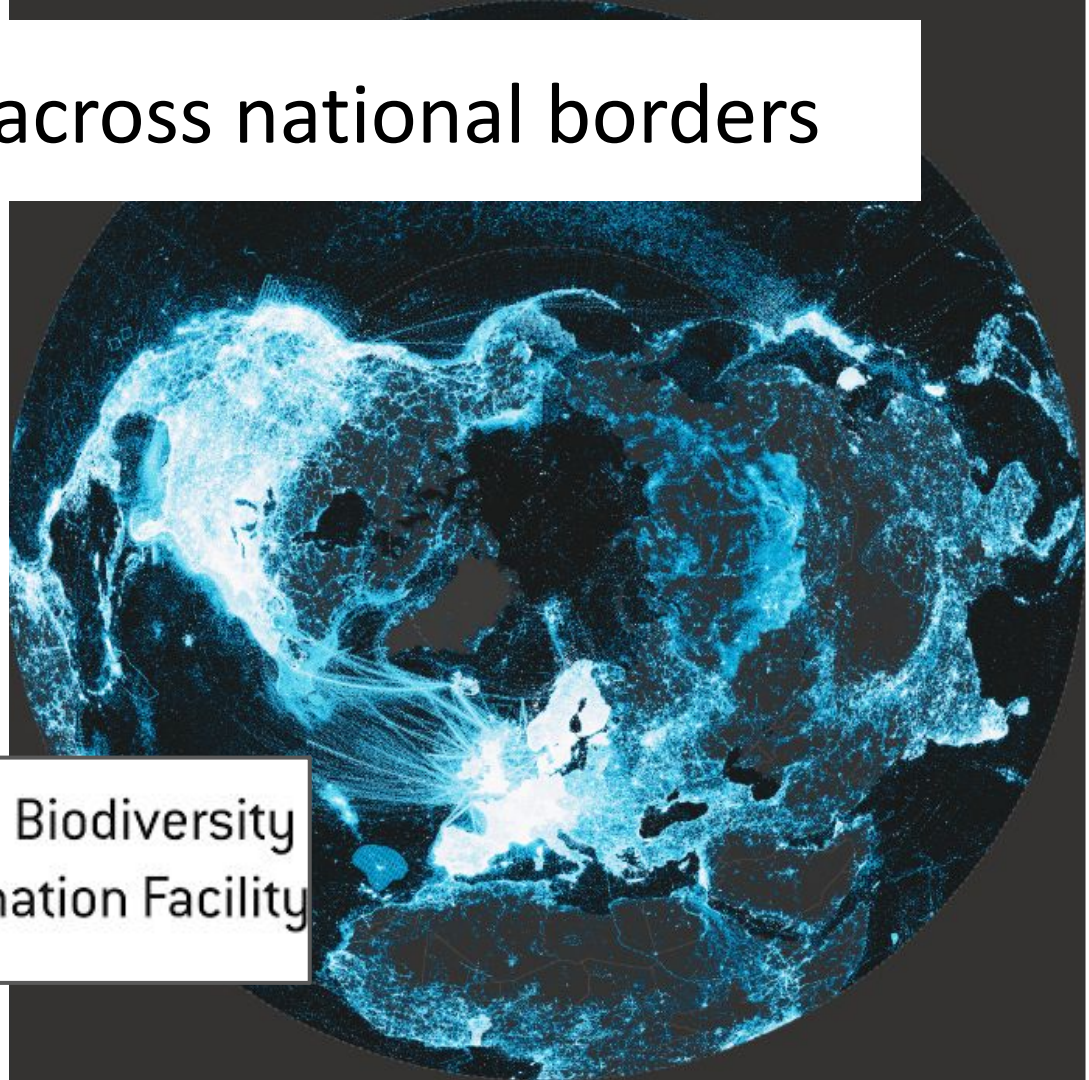
Aggregated quantitative data: CPUE from literature

Binary data: presence only, Presence-absence, introductions, extinctions

Environmental data:

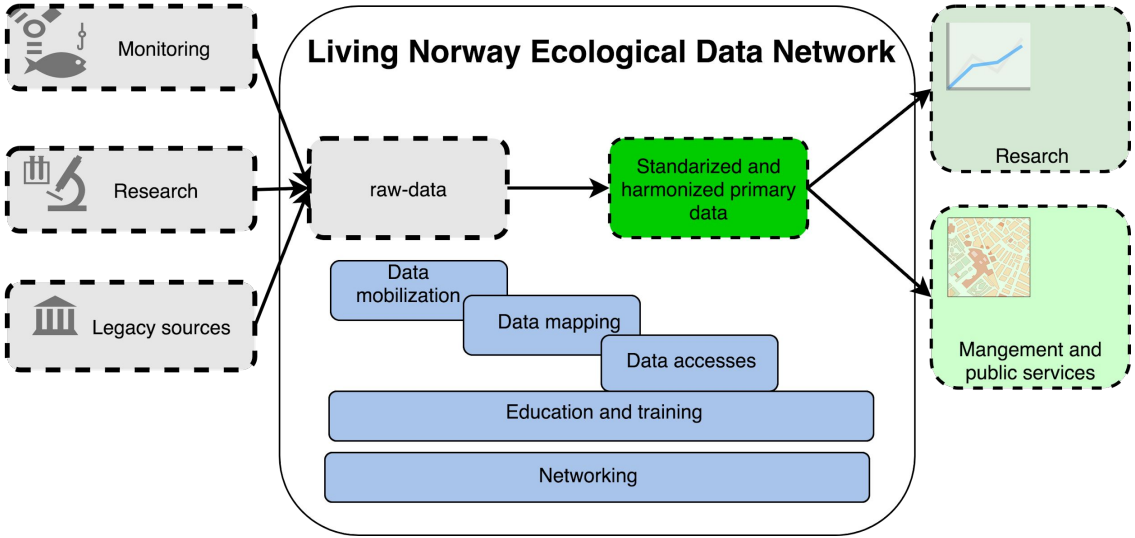
- climate
- topography
- catchment characteristics
- Connectivity matrix

Data aggregation across national borders



GBIF Global Biodiversity Information Facility

Living Norway
Ecological Data Network



Facilitating reproducible and transparent workflows

Case: forecasting introduction of invasives

DOI: 10.1111/1365-2664.13993

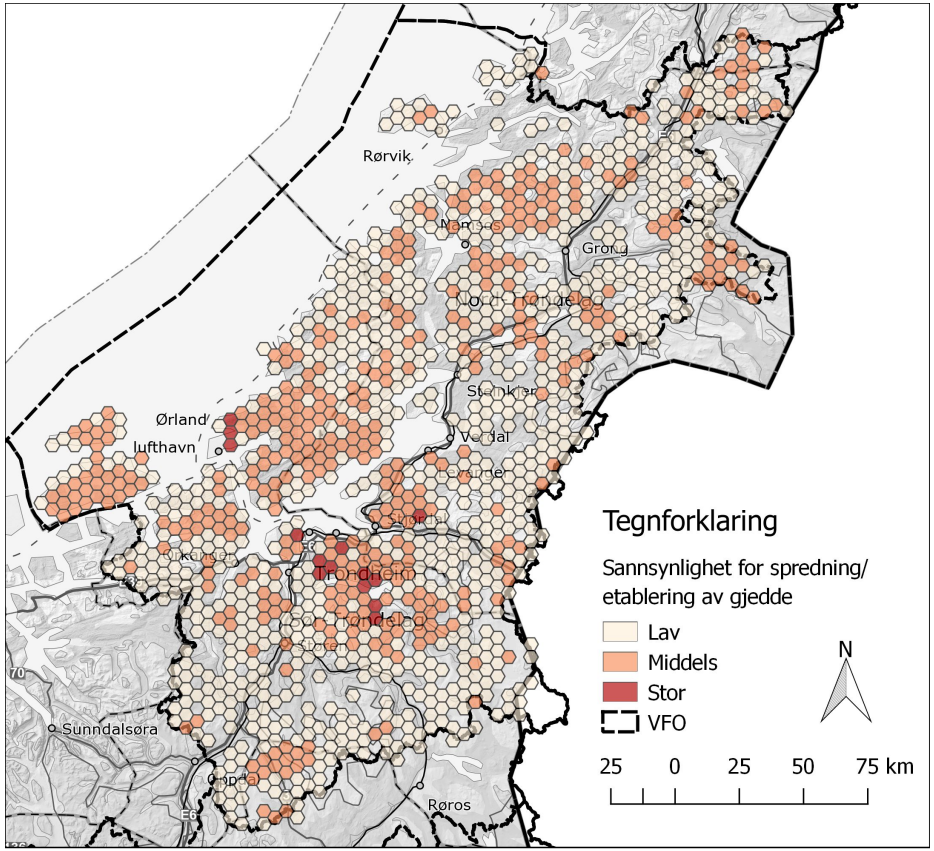
Journal of Applied Ecology

RESEARCH ARTICLE

Forecasting the future establishment of invasive alien freshwater fish species

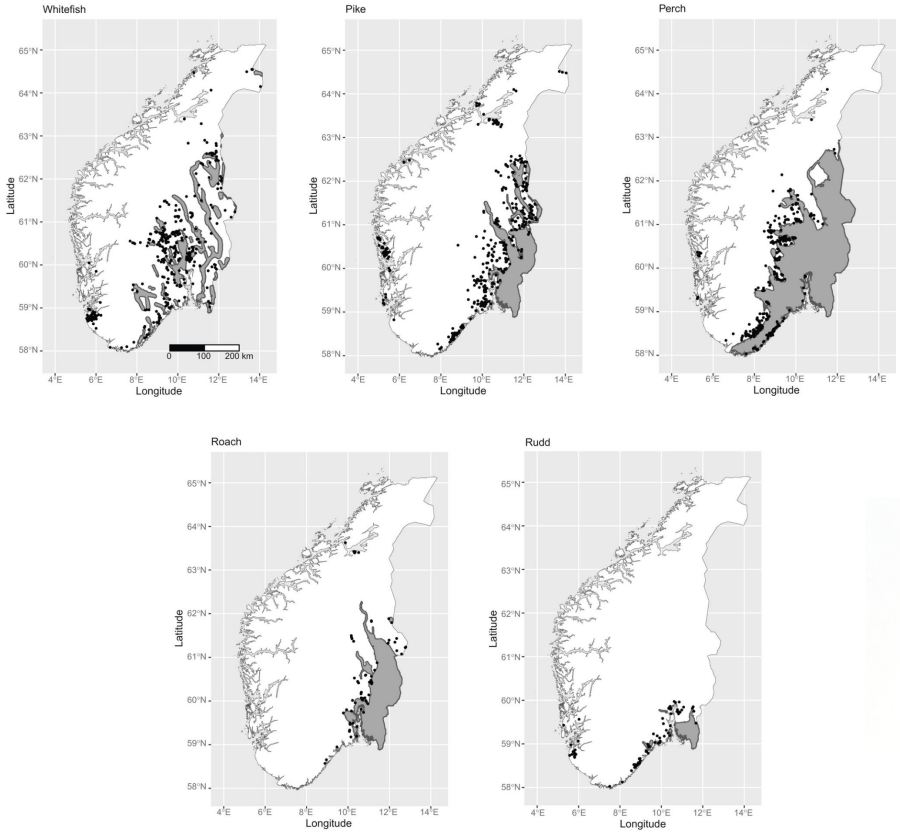
Sam Wenaas Perrin[1,2] | Kim Magnus Bærum[3] | Ingeborg Palm Helland[3] | Anders Gravbrøt Finstad[1,2]

Why forecasting?



- Stop of spreading and early intervention in terms of eradication often only measure practical possible
- Need for structured and cost-effective monitoring schemes
- Evaluation of spatial variation in risk of introductions

The native aliens

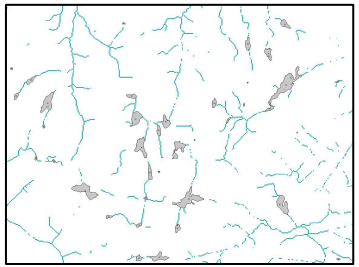


How?

$$P_{introduction} = f(P_{human\text{-}dispersal}, P_{establishment}, P_{natural\text{-}dispersal})$$

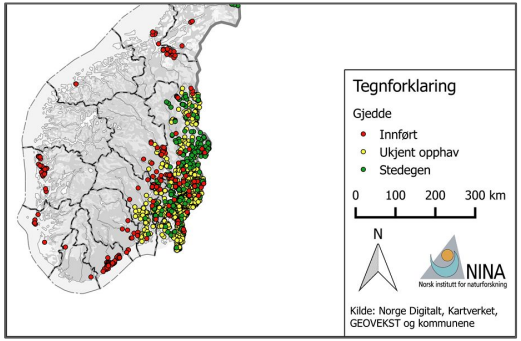
$$Risk = P_{introduction} \times P_{consequence}$$

Modeling establishment probability

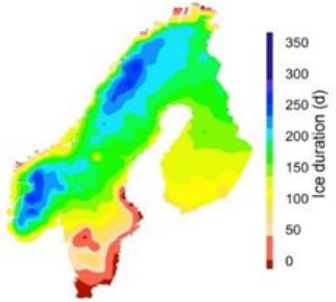


Connectivity matrix

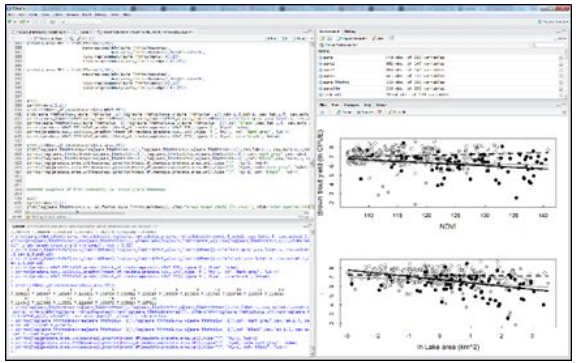
Known distribution



Known introductions

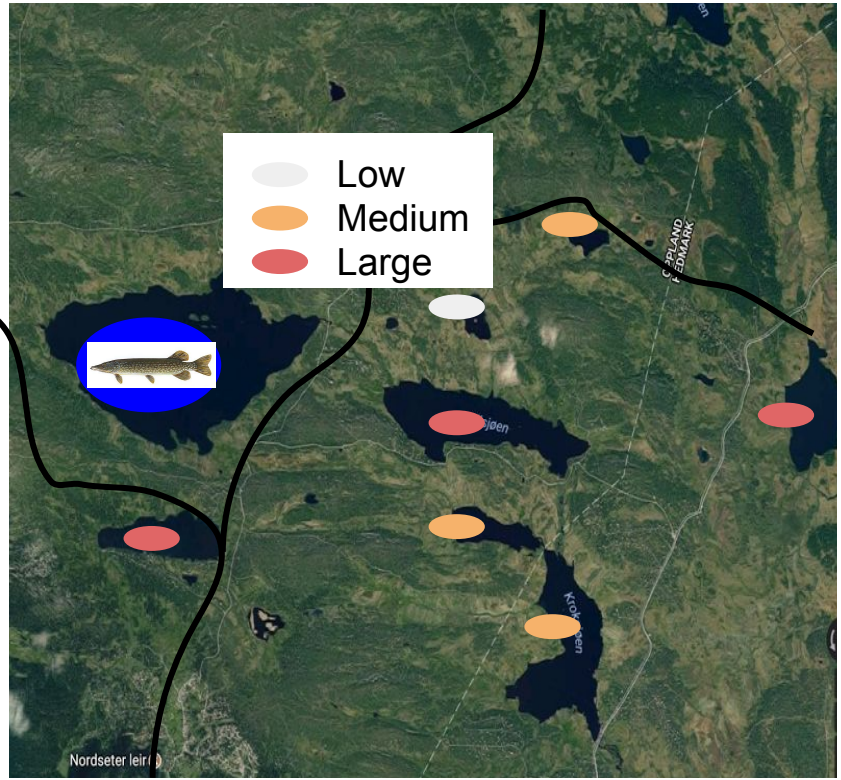


Climate data and forecasts



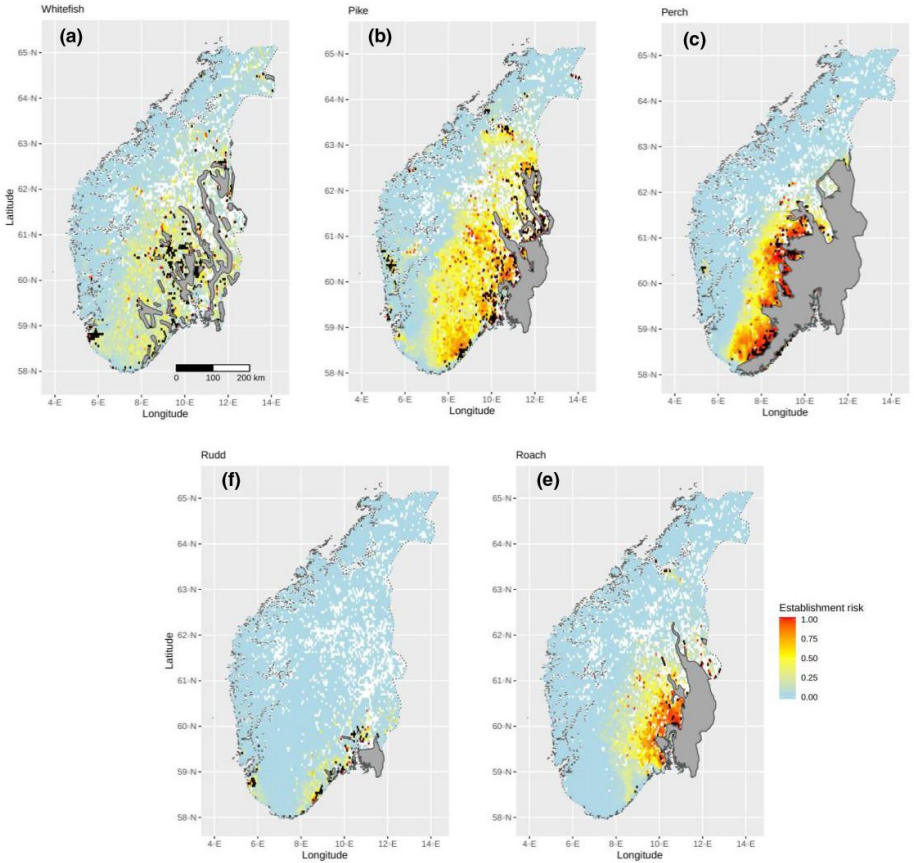
Environmental layers

Establishment probability influenced by several interacting factors



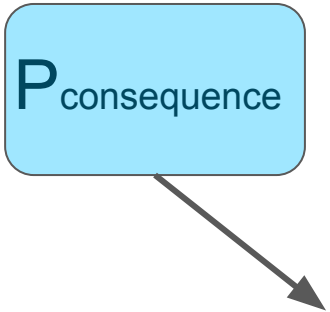
Probability largest in large lakes, close to road, close to existing populations

Probability of establishment



Consequences?

$$Risk = P_{introduction} \times P_{consequence}$$



Biotic interactions and extinction risk of native species

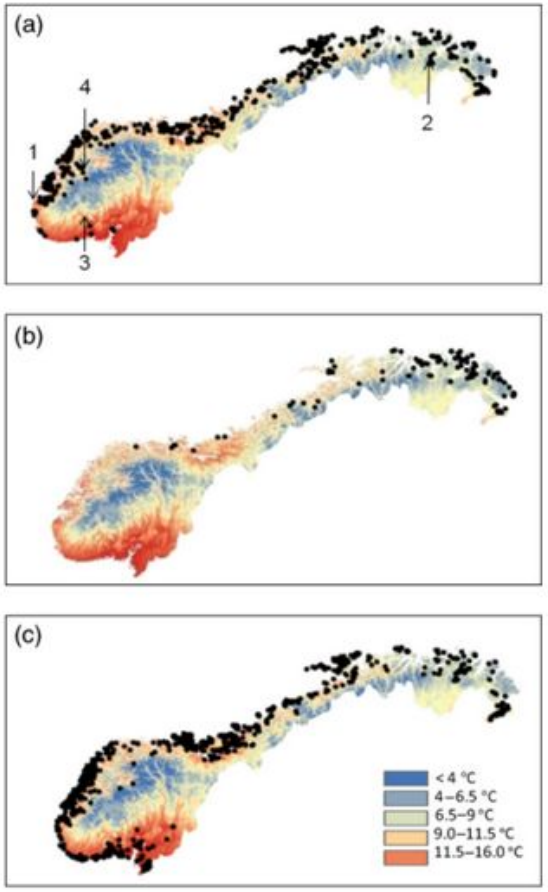


Fig. 1 Distribution plots for sympatric char and trout (a), allopatric char (b) and allopatric trout (c) in Norway (below historical marine limit) given along with July normal temperature isoclines plotted for the whole of Norway. Arrows in (a) indicates source of populations used in common environment experiments; (1) Lia-vatn and Fossbekk, (2) Hals, (3) Tunhovd and (4) Lærdal.

Global Change Biology

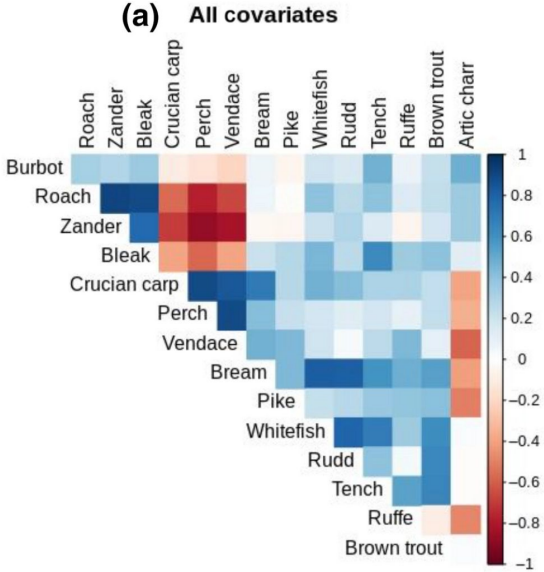
Global Change Biology (2011) **17**, 1703–1711, doi: 10.1111/j.1365-2486.2010.02335.x

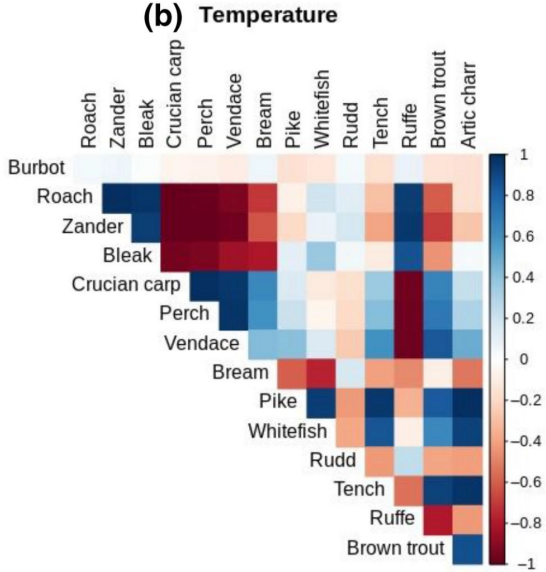
Competitive exclusion along climate gradients: energy efficiency influences the distribution of two salmonid fishes

ANDERS G. FINSTAD*, TORBJØRN FORSETH*, BROR JONSSON†, EDWIGE BELLIER*, TRYGVE HESTHAGEN*, ARNE J. JENSEN*, DAG O. HESSEN‡ and ANDERS FOLDVIK*

Early work based upon regression approaches: typically addressing species-pairs

Joint species distribution modelling of the fennoscandian fish community





DOI: 10.1111/gcb.15888

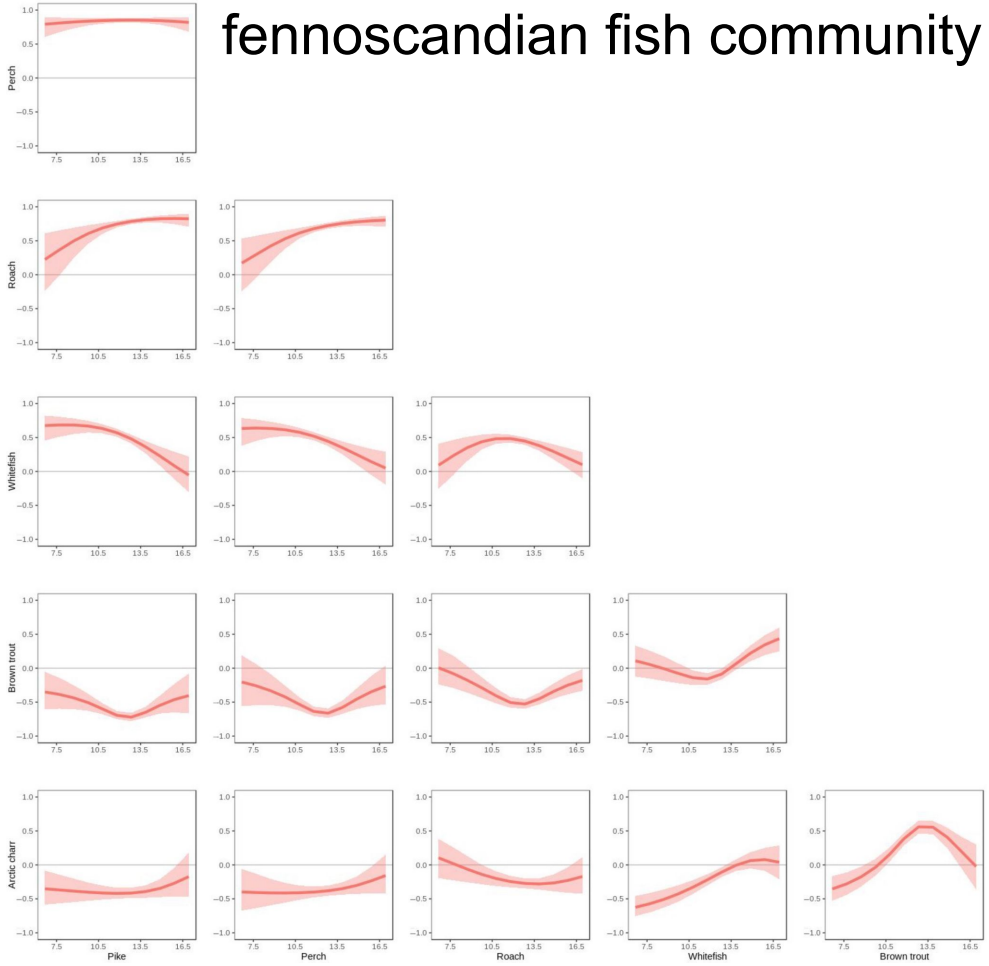
PRIMARY RESEARCH ARTICLE

Global Change Biology WILEY

Modelling temperature-driven changes in species associations across freshwater communities

Sam Wenaas Perrin[1] | Bert van der Veen[2,3] | Nick Golding[4,5,6] | Anders Gravbrøt Finstad[1]

Joint species distribution modelling of the fennoscandian fish community



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Modelling temperature-driven changes in species associations across freshwater communities

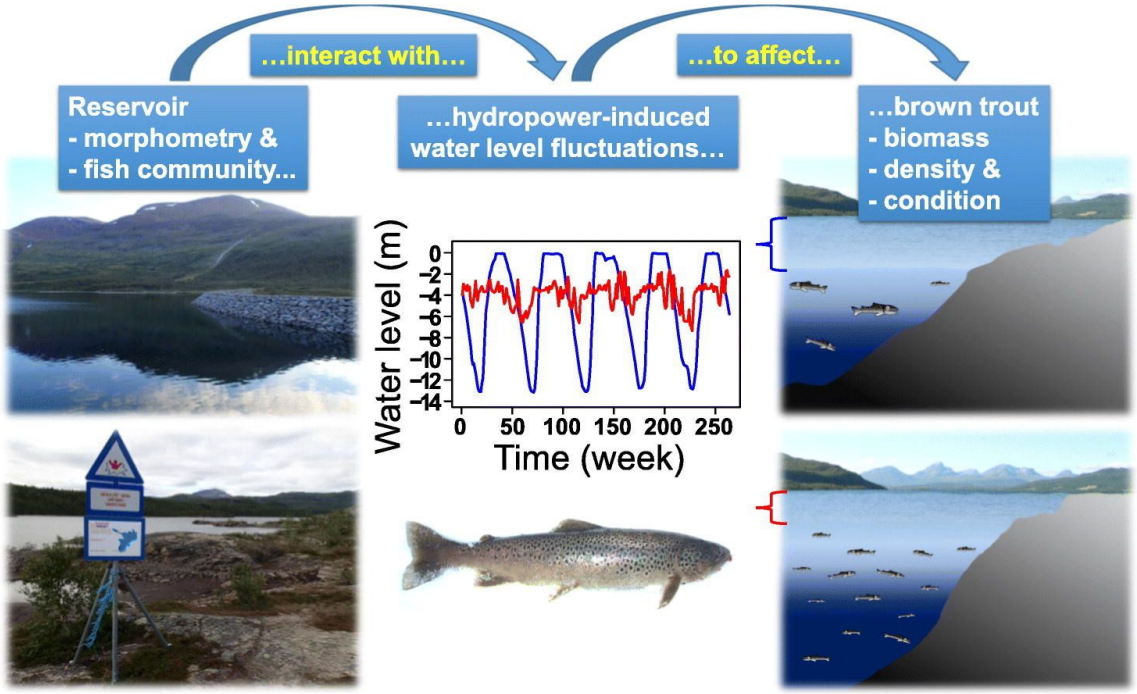
Sam Wenaas Perrin[1] | Bert van der Veen[2,3] | Nick Golding[4,5,6] | Anders Gravbrøt Finstad[1]

Biotic interactions modifies impacts of water-level fluctuations in reservoirs

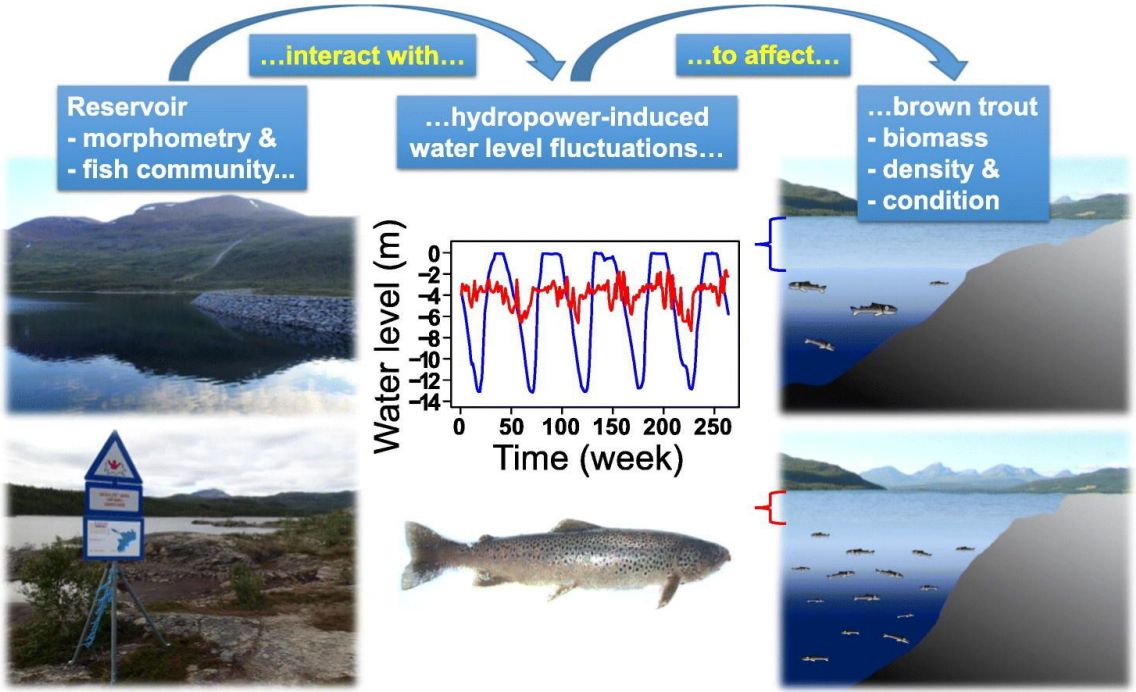
Science of The Total Environment
Volume 618, 15 March 2018, Pages 313-322

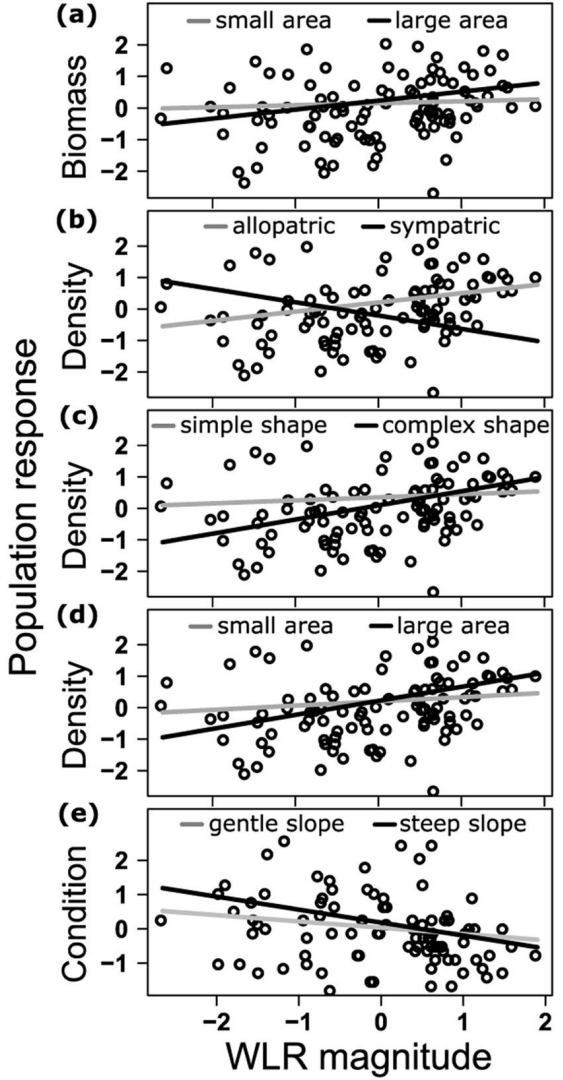
Hydropower impacts on reservoir fish populations are modified by environmental variation

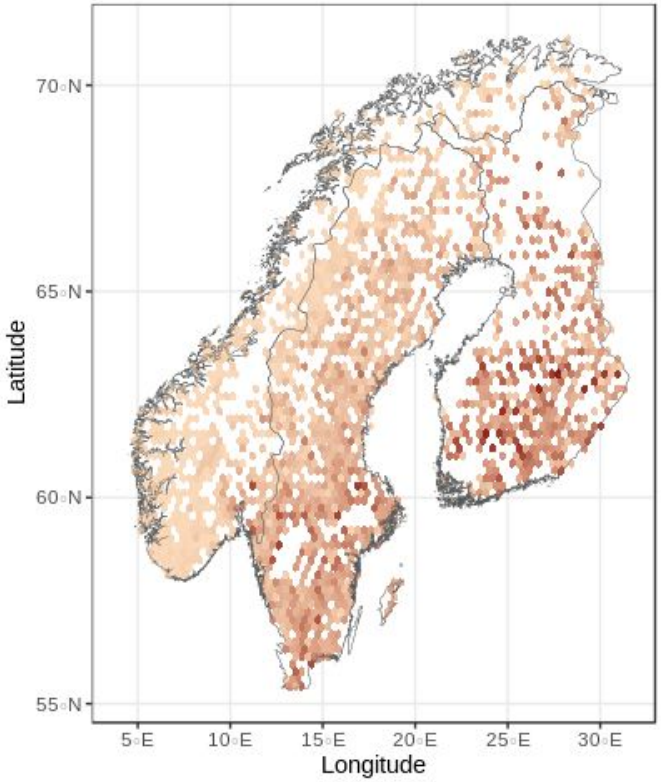
Antti P. Eloranta [a], Anders G. Finstad [a, b], Ingeborg P. Helland [a], Ola Ugedal [a], Michael Power [c]

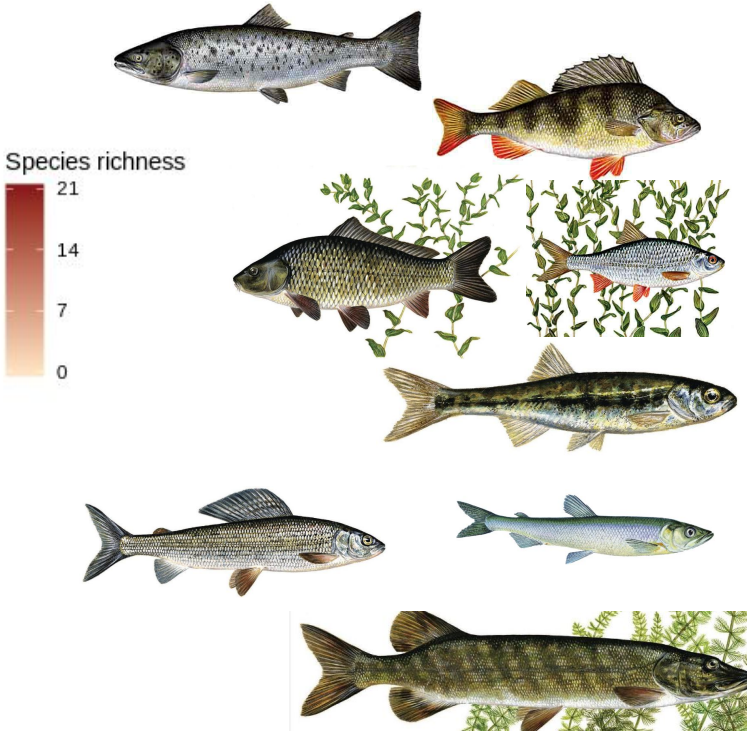


Biotic interactions modifies impacts of water-level fluctuations in reservoirs





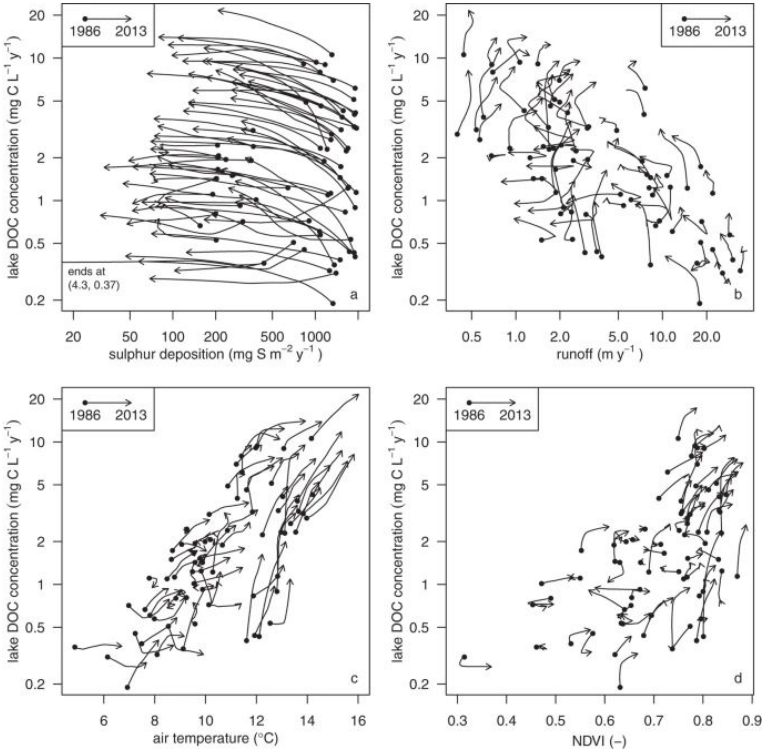




How will effects of hydromorphological changes vary across biogeogrphical gradients (?)

Data fra Northern European Lake Survey, 1995

Climate change and increased DOC load of boreal lakes



SCIENTIFIC REPORTS

OPEN

Received: 10 February 2016
Accepted: 27 July 2016
Published: 24 August 2016

From greening to browning: Catchment vegetation development and reduced S-deposition promote organic carbon load on decadal time scales in Nordic lakes

Anders G. Finstad[1,2], Tom Andersen[3], Søren Larsen[3], Koji Tominaga[3], Stefan Blumentrath[2], Heleen A. de Wit[4], Hans Tømmervik[2] & Dag Olav Hessen[3]

Summary

- Establishment probability of invasives depend upon environmental factors in a predictable fashion
- Species associations depend upon environmental variables, and can be predicted on a large scale
- Climate change will not only affect biology per ce, but through effects of species associations also affect how the environment respond to other perturbations