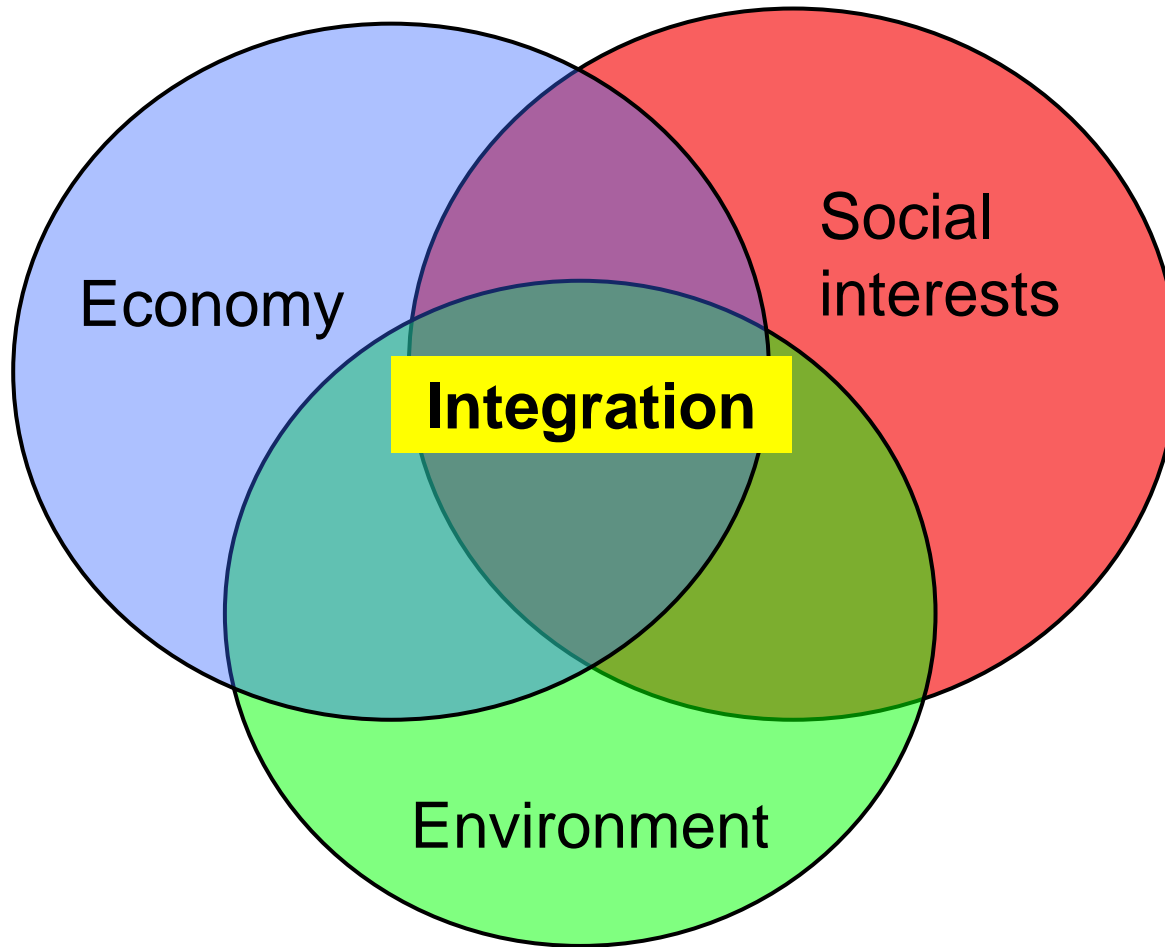


Sustainable development of hydropower – tools and methods

Atle Harby, CEDREN

Sustainable development



Dams

- Migration barrier
- Loss of connectivity
- Less access
- Loss of biodiversity





Degraded habitat in bypassed sections



Change in downstream flow regime



An aerial photograph of a landscape featuring a river and a dam. The river flows from the top center towards the bottom center, where it is impounded by a dam. The surrounding area is covered in dense forest, with some patches of yellow and orange, possibly indicating autumn foliage. The overall scene is a mix of natural and human-made elements.

Landscape effect Impacts on wildlife

Foto: NINA





The image shows a calm body of water, likely a lake or a wide river. In the foreground, three white, rectangular floats are floating on the surface. Each float is encased in a dark, inflatable ring. Green ropes are attached to the floats, extending towards the bottom of the frame. In the background, several pieces of weathered driftwood stand vertically in the water. The horizon is flat, with distant, hazy mountains visible under a cloudy sky. The overall tone is muted and naturalistic.

**Greenhouse gas
emission control**

Resettlement

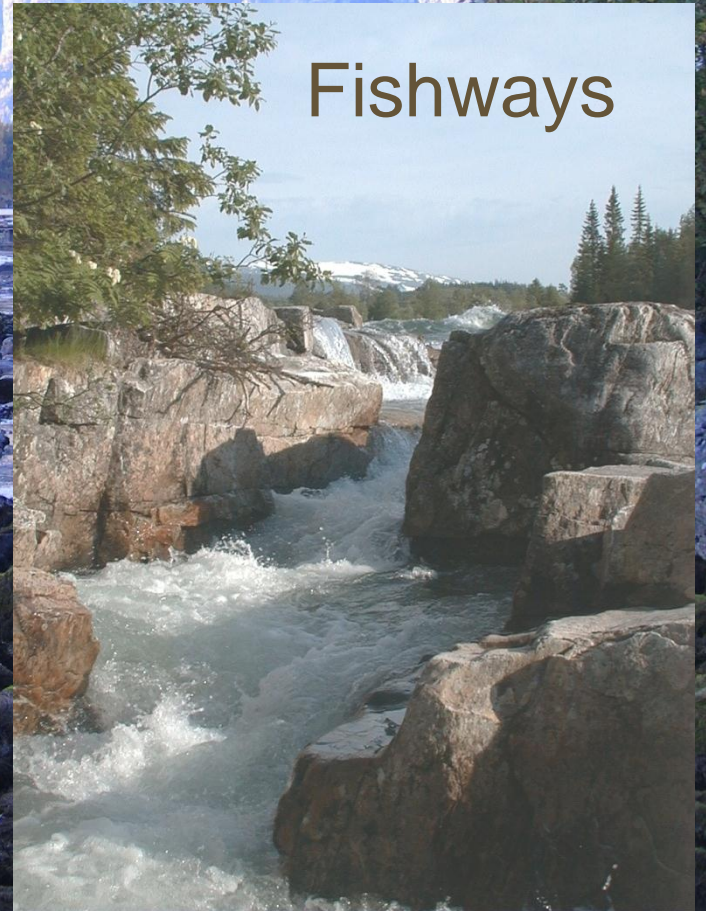


Fish stockings



Mitigation

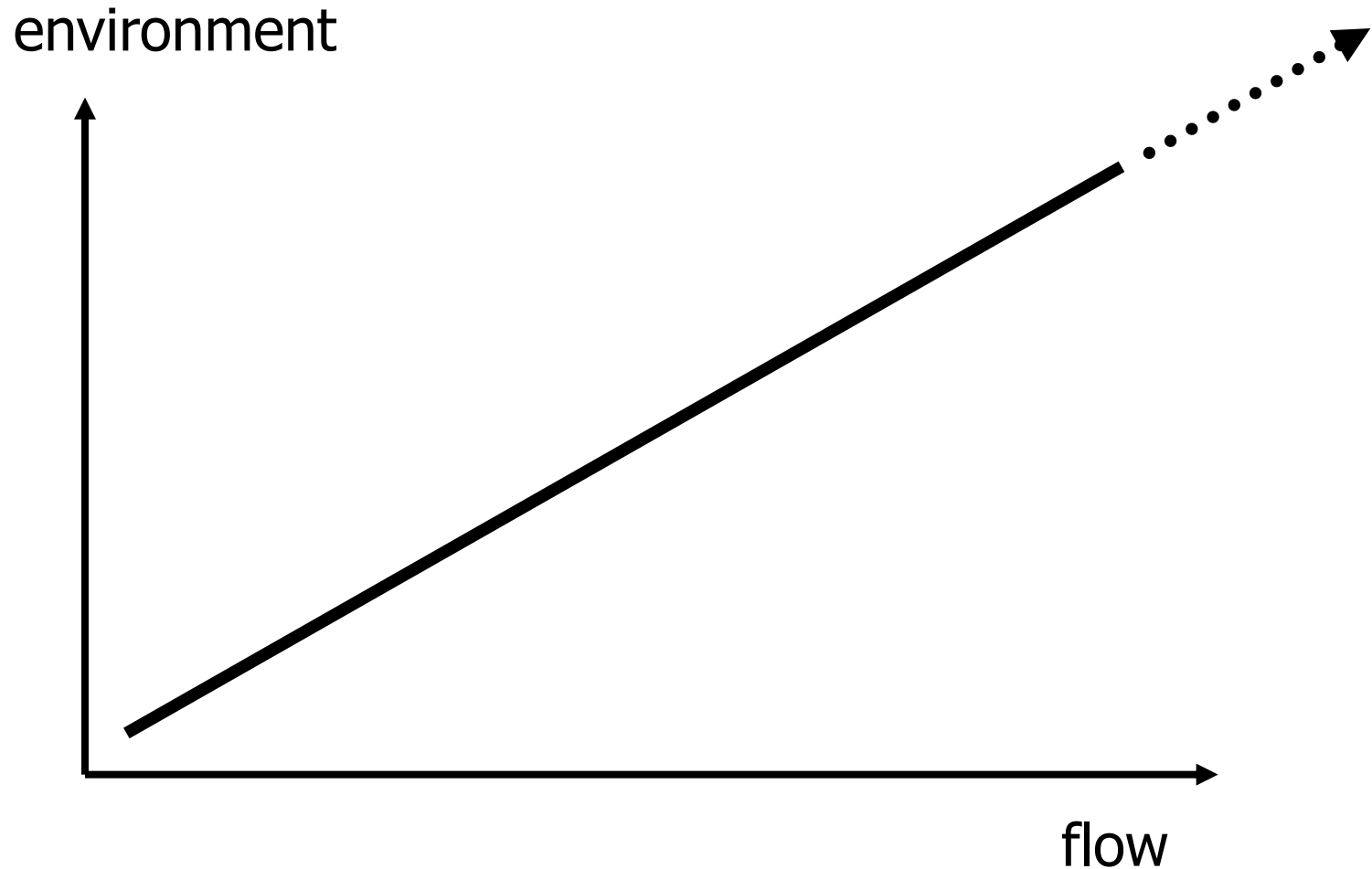
Fishways



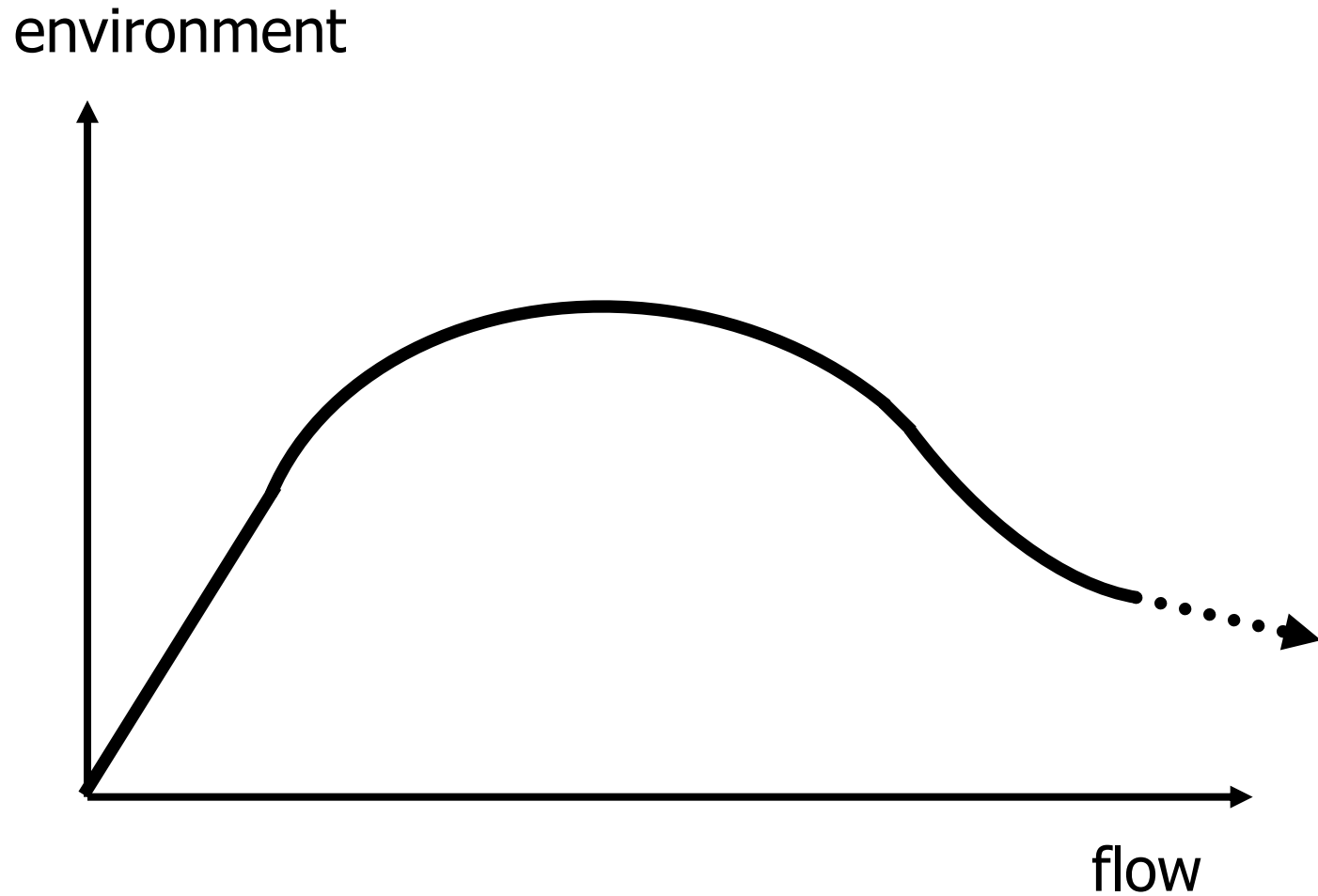
Physical constructions



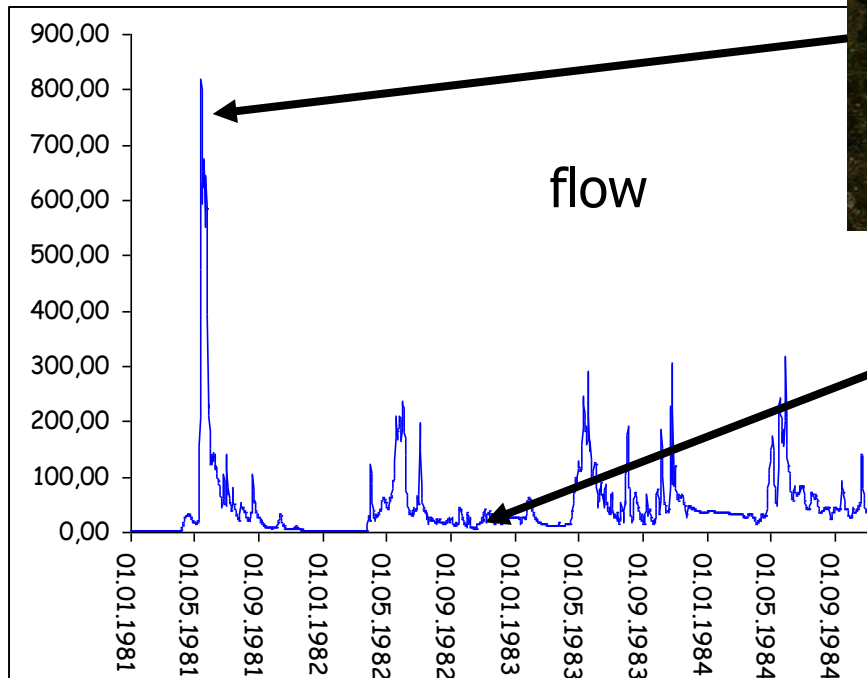
Flow and the environment



Flow and the environment



Variation important!



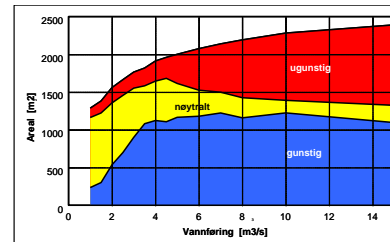
Alternatives



Compare to other rivers



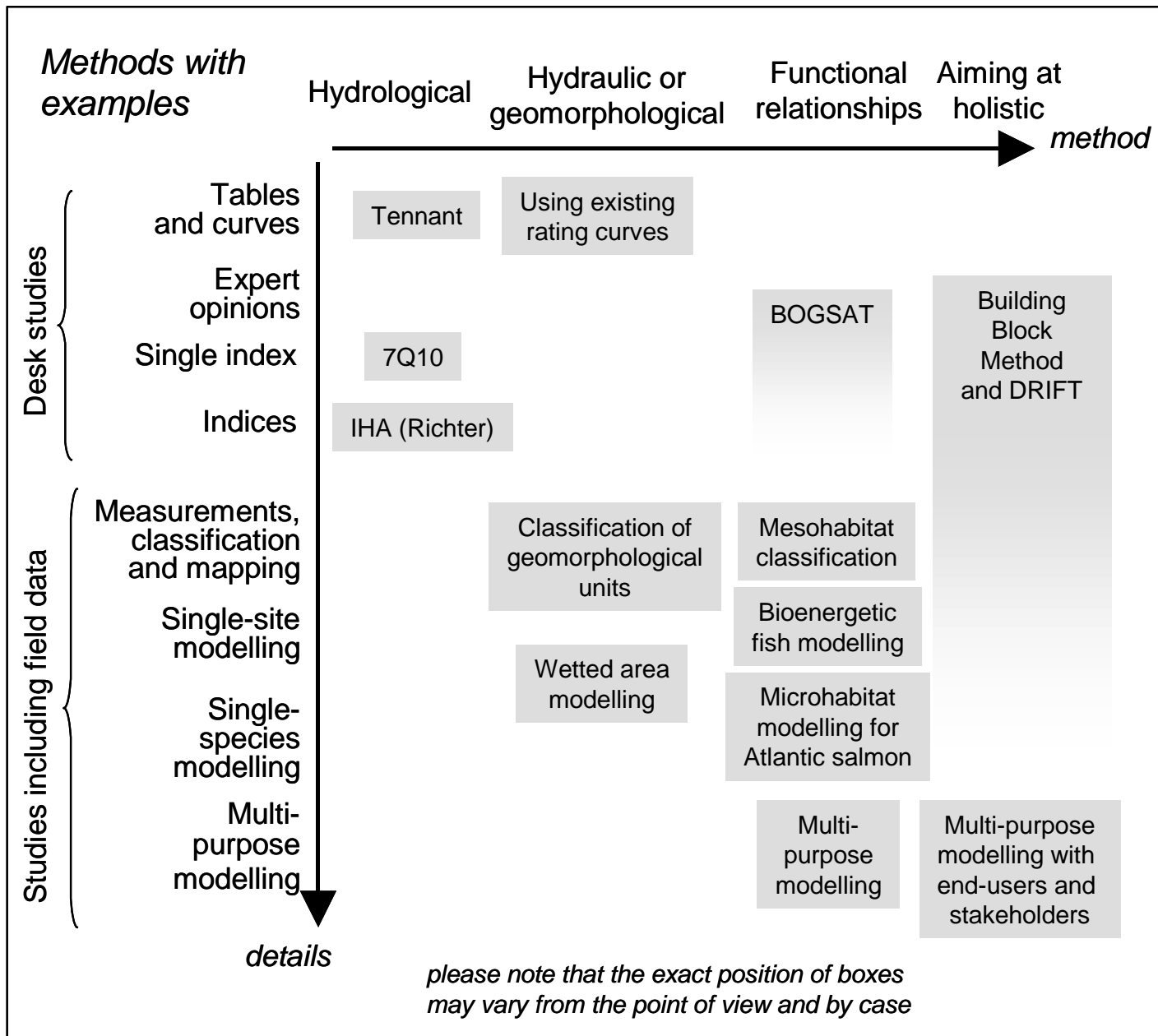
Guess

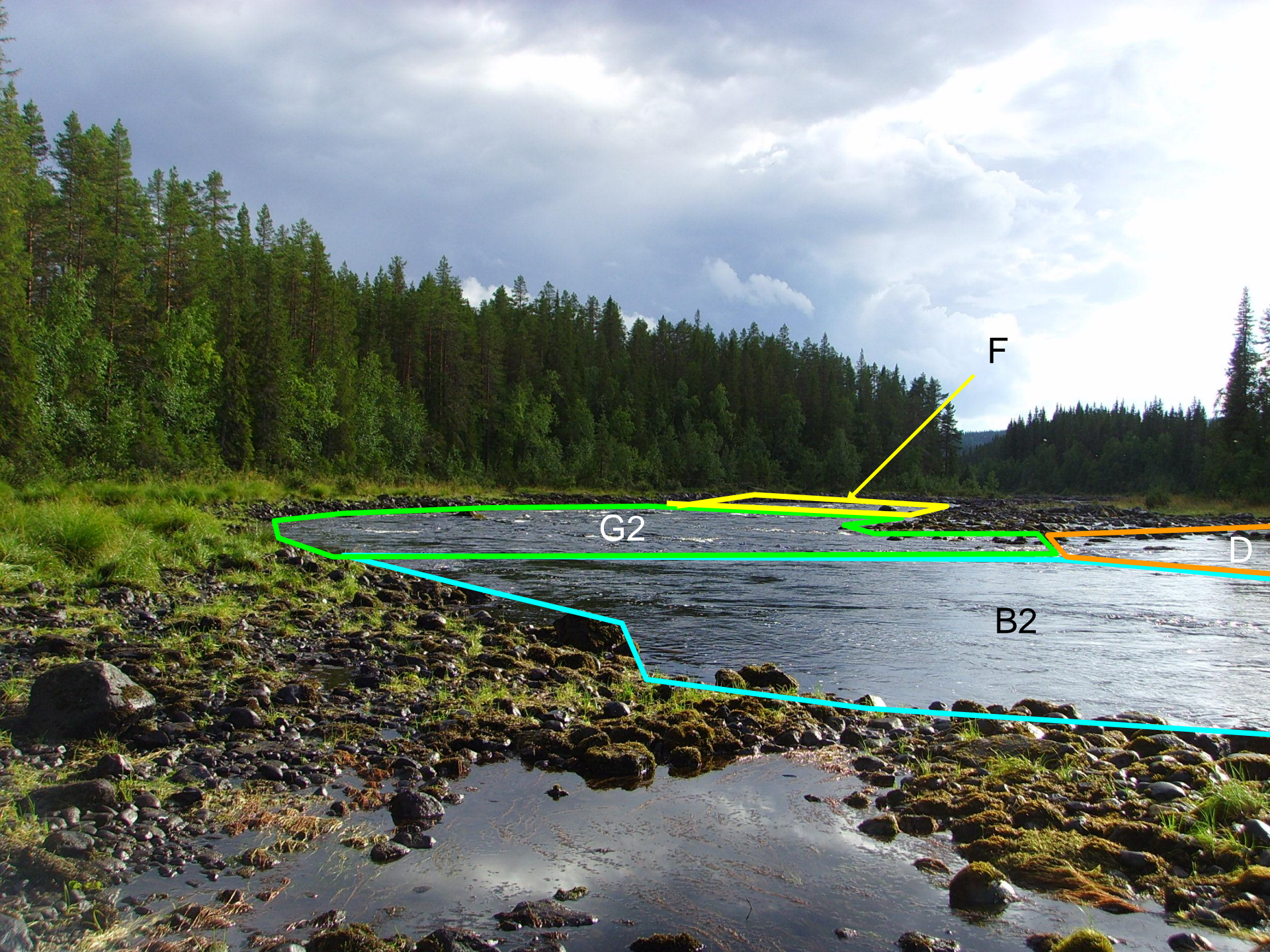


Model



Methods and models





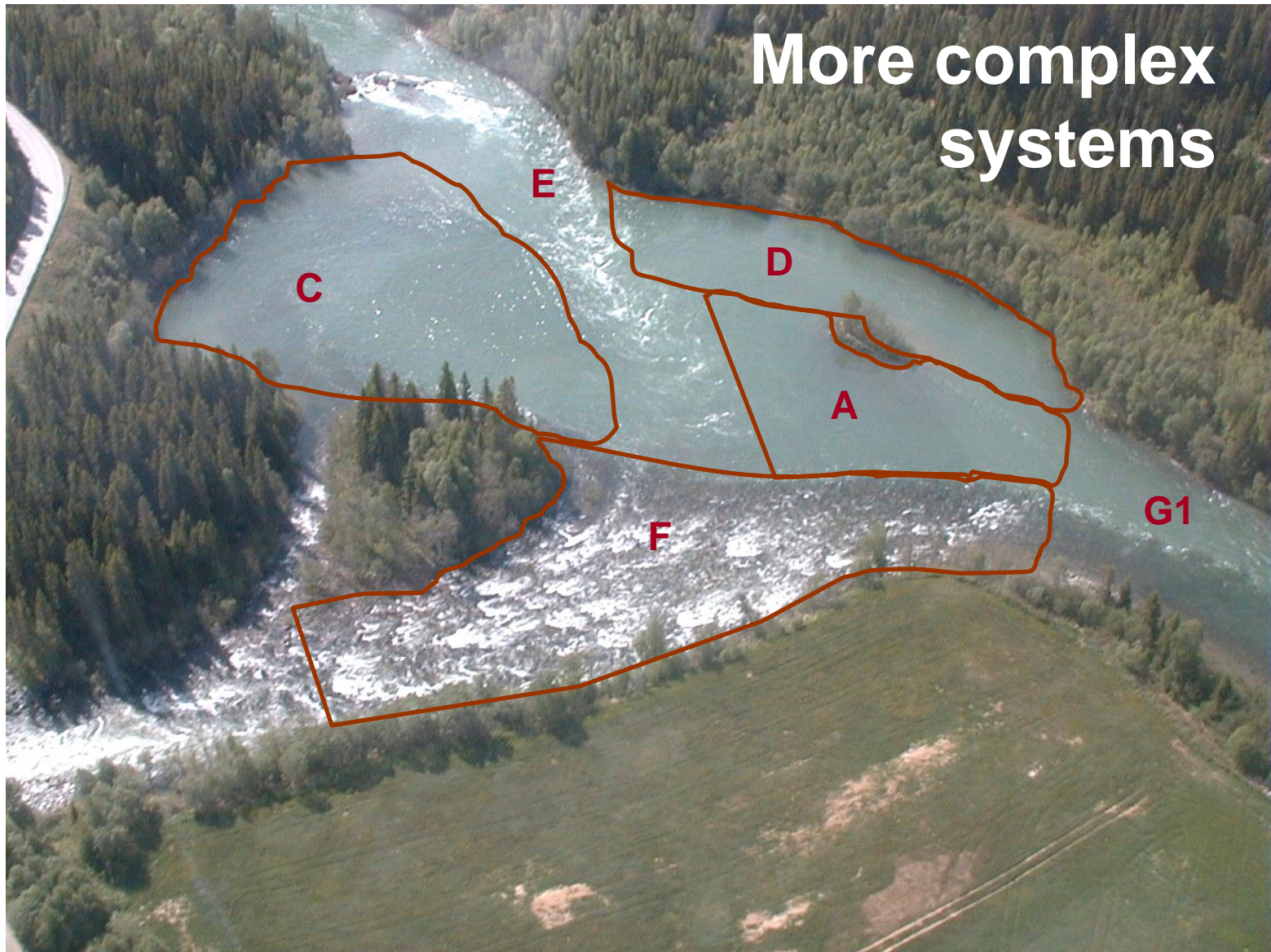
F

G2

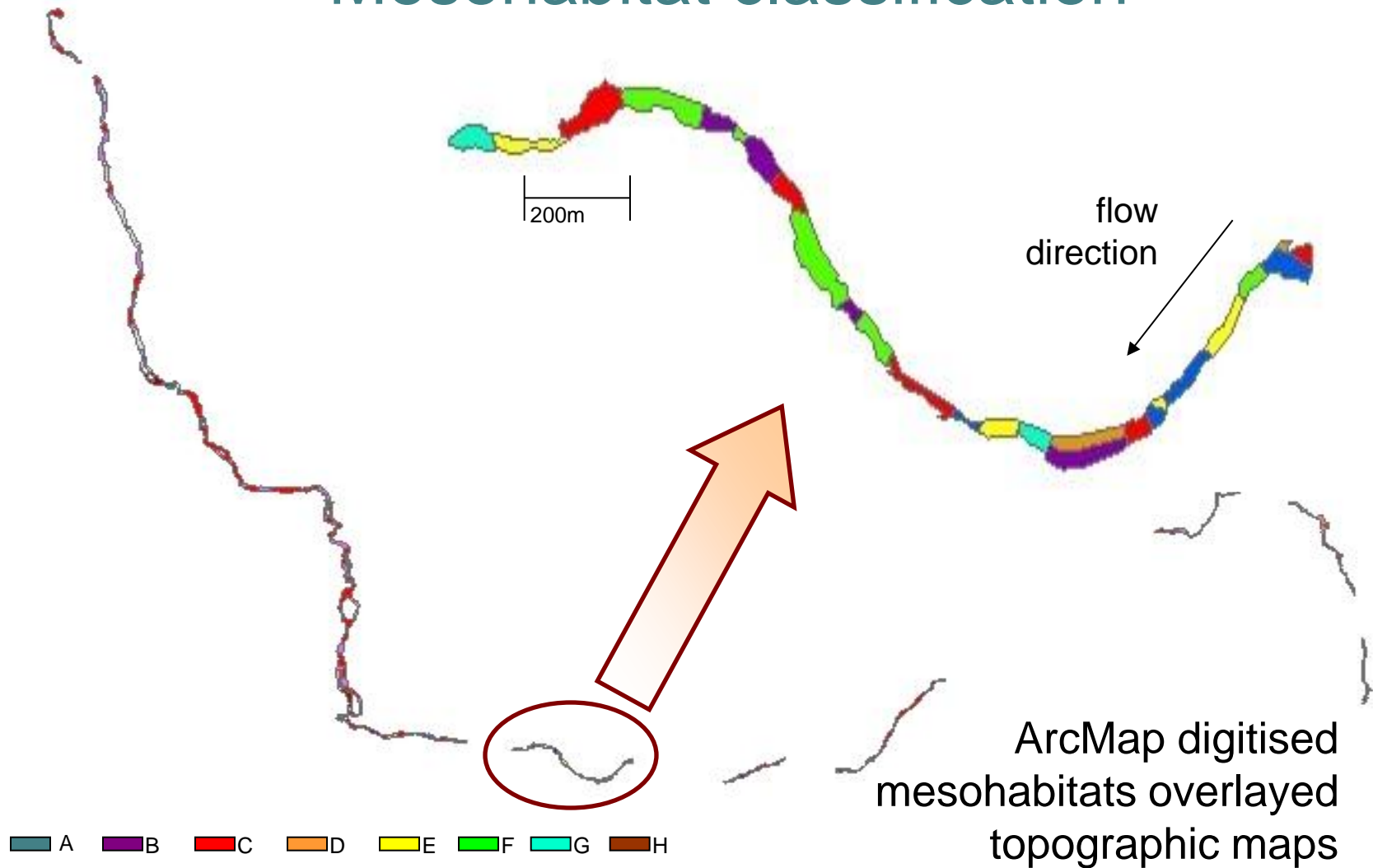
D

B2

More complex systems

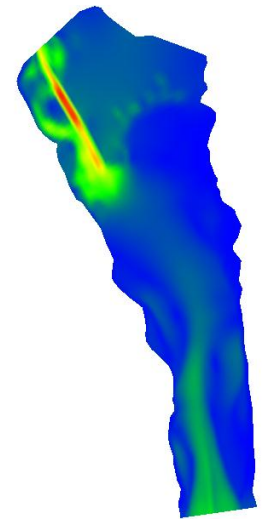
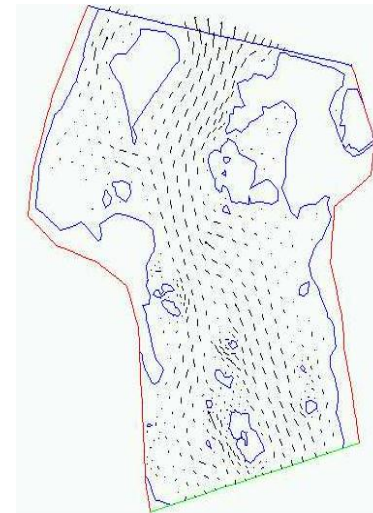
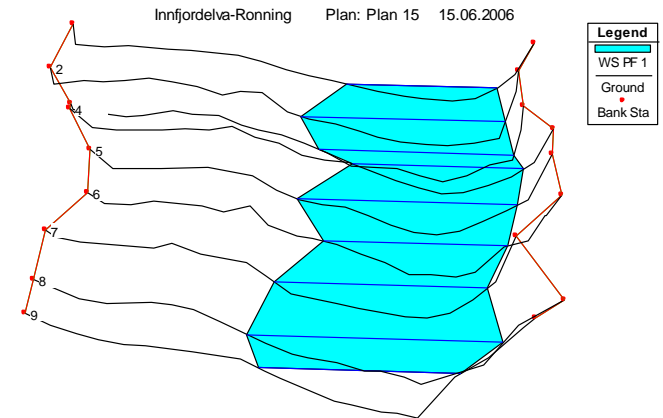


Mesohabitat classification



Hydraulic models for rivers

- HEC-RAS
 - Well known and widely used
 - 1-D suitable also for long reaches
- MIKE 11
 - Well known and widely used
 - 1-D and 2-D suitable also for long reaches
 - Expensive
- RIVER 2D
 - Robust, but not as well known or widely used as HEC-RAS or MIKE 11
- SSIIM
 - 3D including sediment transport
 - Widely in research use

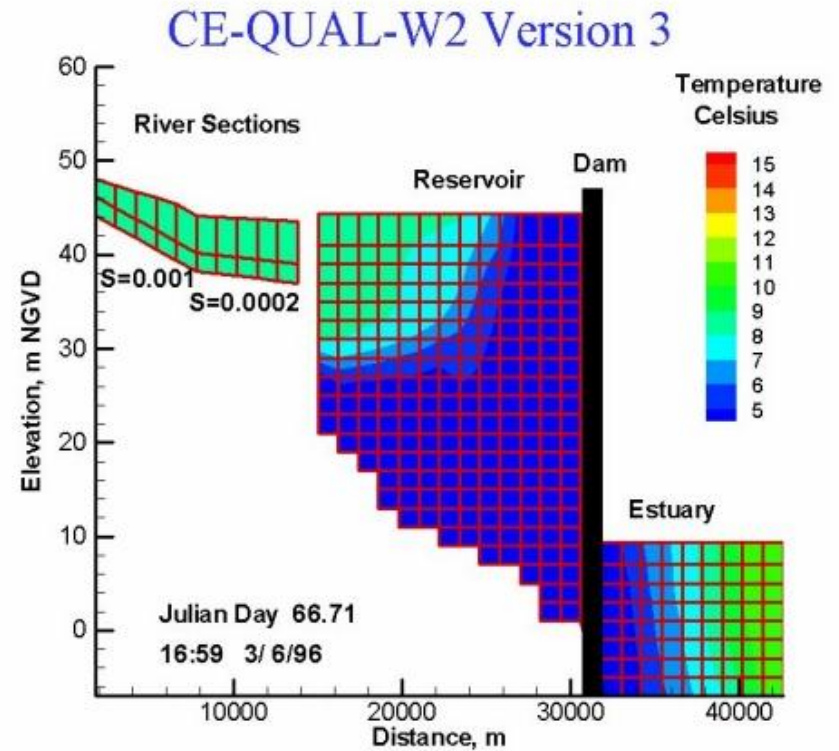


Rapid changes in flow → stranding risk



Lake and reservoir models

- CE-QUAL-W2 calculates physical and ecological variables as a function of climate, flow and load
- Results: Current velocity, temperature, ice, oxygen content, particle concentrations, chemistry, bacteria, sediments, algal growth, etc.
- 2-D model with user defined time steps
- CE-QUAL-W2 is well suited for simulations in long and narrow lakes and reservoirs, as well as rivers, estuaries and fjords.



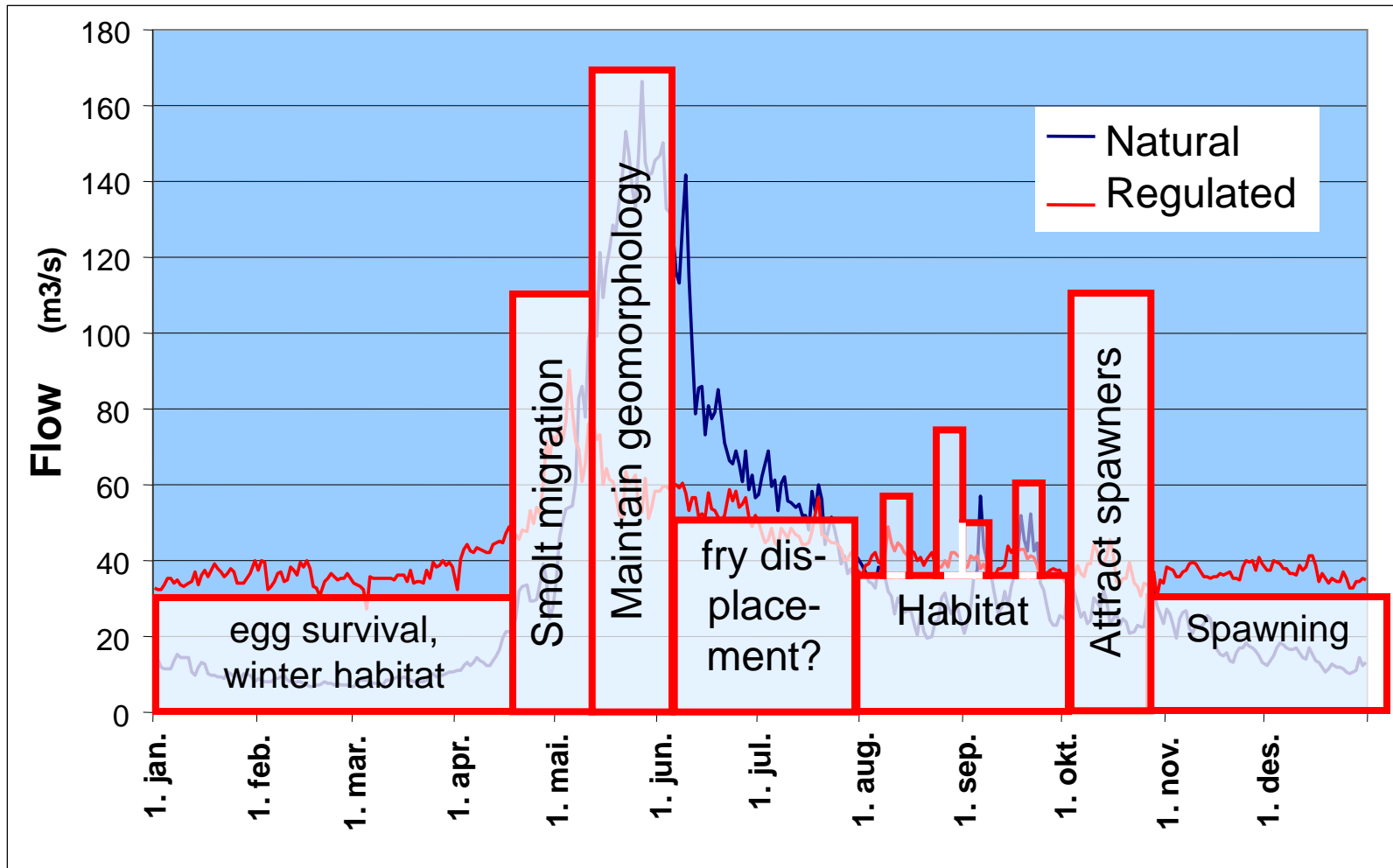
Freeware from EPA
Widely applied in Norway

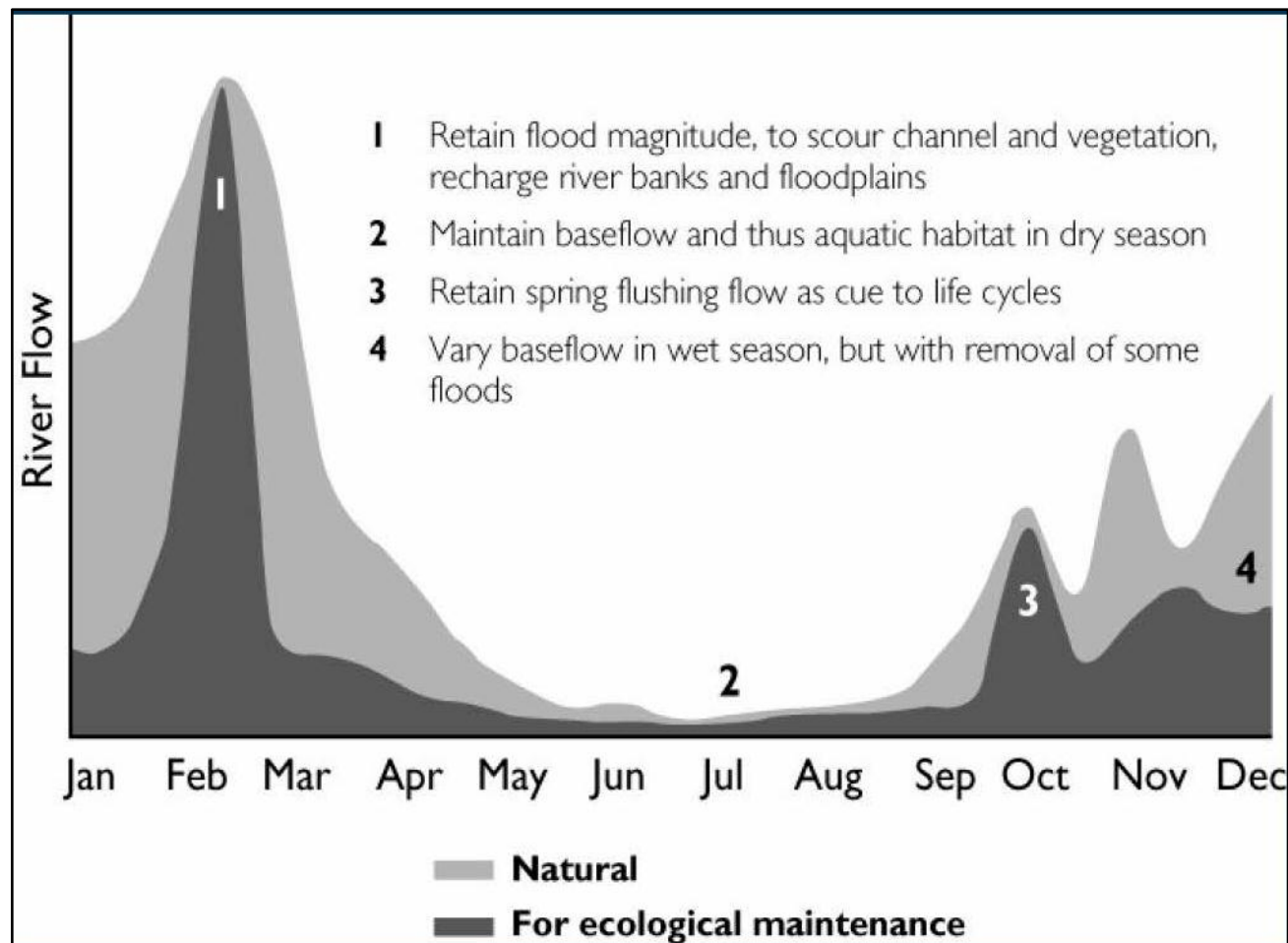
Biological and ecological models in running waters

- Functional relationships
- Correlations
- Habitat models
- Population models




Seasonal requirements





from Richter, adapted from Tharme & King



....thank you for your attention!