



Restoring degraded ecosystems in regulated river systems to conserve biodiversity in the face of climate change

Roland Jansson



Sustainable hydropower?

Sustainability of natural ecosystems

- (1) management will not degrade systems being utilized
- (2) Pass on resources to future generations

Ecological sustainability

“The maintenance or restoration of the composition, structure, and processes of ecosystems”

- Biodiversity
- Ecosystems
- Ecosystem functions



Status of regulated river systems in Sweden

Biodiversity

- Species richness of most taxa reduced
- Lake species replace running water species



Ecosystems:

- Riparian vegetation: 12 % remaining
- Rapids and water falls: 1% remaining
- Reaches with running water replaced by impoundments and reservoirs

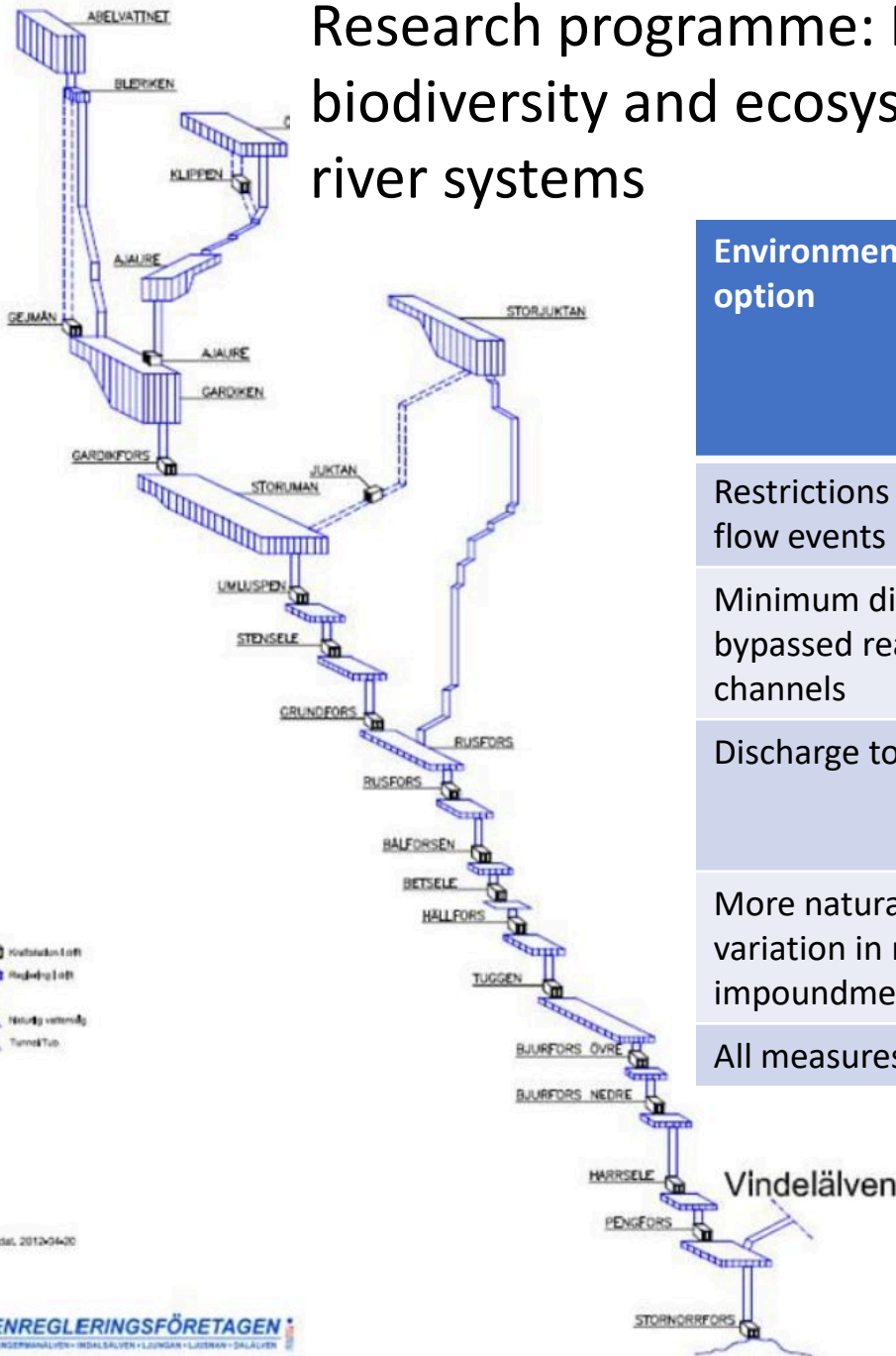


Ecosystem functions

- Connectivity of fish, aquatic insects and plants impaired
- Land/water interactions lost
- Yield from populations of native fish species reduced



Research programme: Restore and rehabilitate biodiversity and ecosystem functions of regulated river systems



Environmental flow option	Environmental benefit	Change in annual hydropower production (%)
Restrictions against zero flow events	355 ha of running water habitat (350% increase)	-0.5
Minimum discharge to bypassed reaches and side channels	162 ha of rapid ecosystems	-1.1
Discharge to fishways	276 ha running water habitat made available to trout and grayling	-0.9
More natural water-level variation in run-of-river impoundments	64 ha of riparian vegetation (66% increase)	-1.0
All measures	All above	-3.8

Widén et al. (2021) *Water Resources Research*

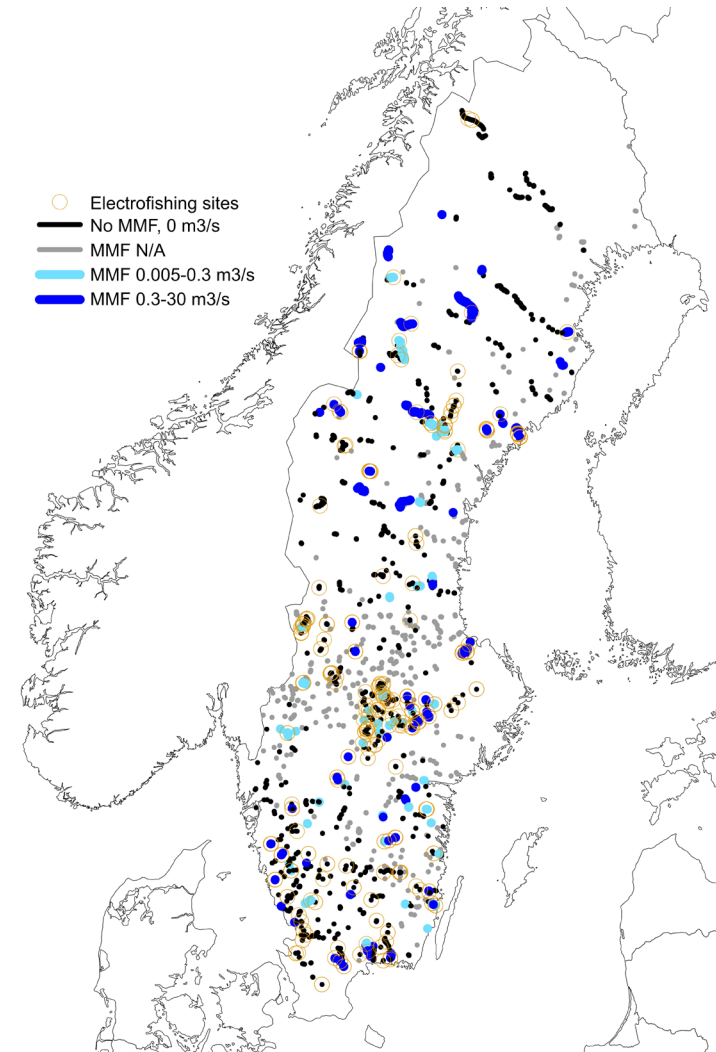
Restoration of rapids: Discharge and structural restoration of bypassed reaches



Rapid in free-flowing river

By-passed reach

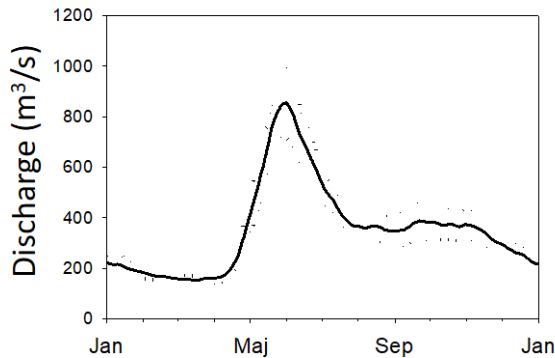
- 964 by-passed reaches in Sweden
- 800 of them former rapids
- 73% lacks minimum discharge
- Minimum discharge: on average 8.3% of mean annual discharge



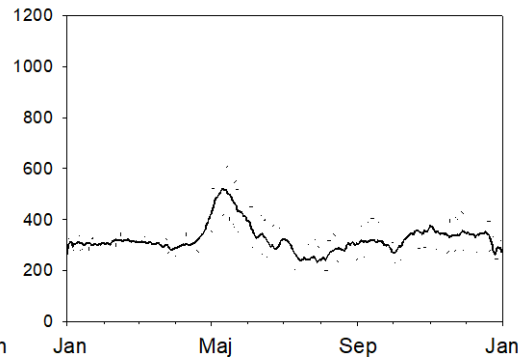
FLORIP: Reintroducing flood pulses to restore riparian ecosystems

Fäggeby, Dalälven

before regulation
(1852-1882)

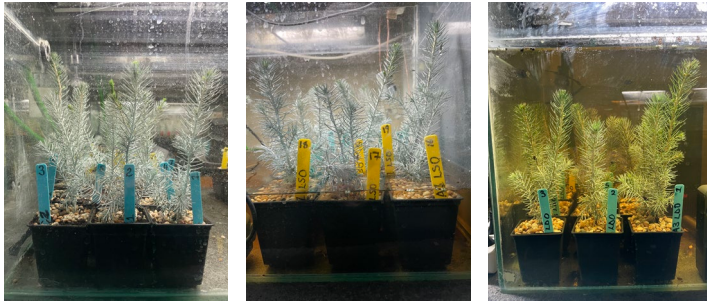


after regulation
(1978-2008)



Aim: Assess the magnitude and duration of riparian inundation needed to maintain and rejuvenate riparian deciduous forests along lower Dalälven



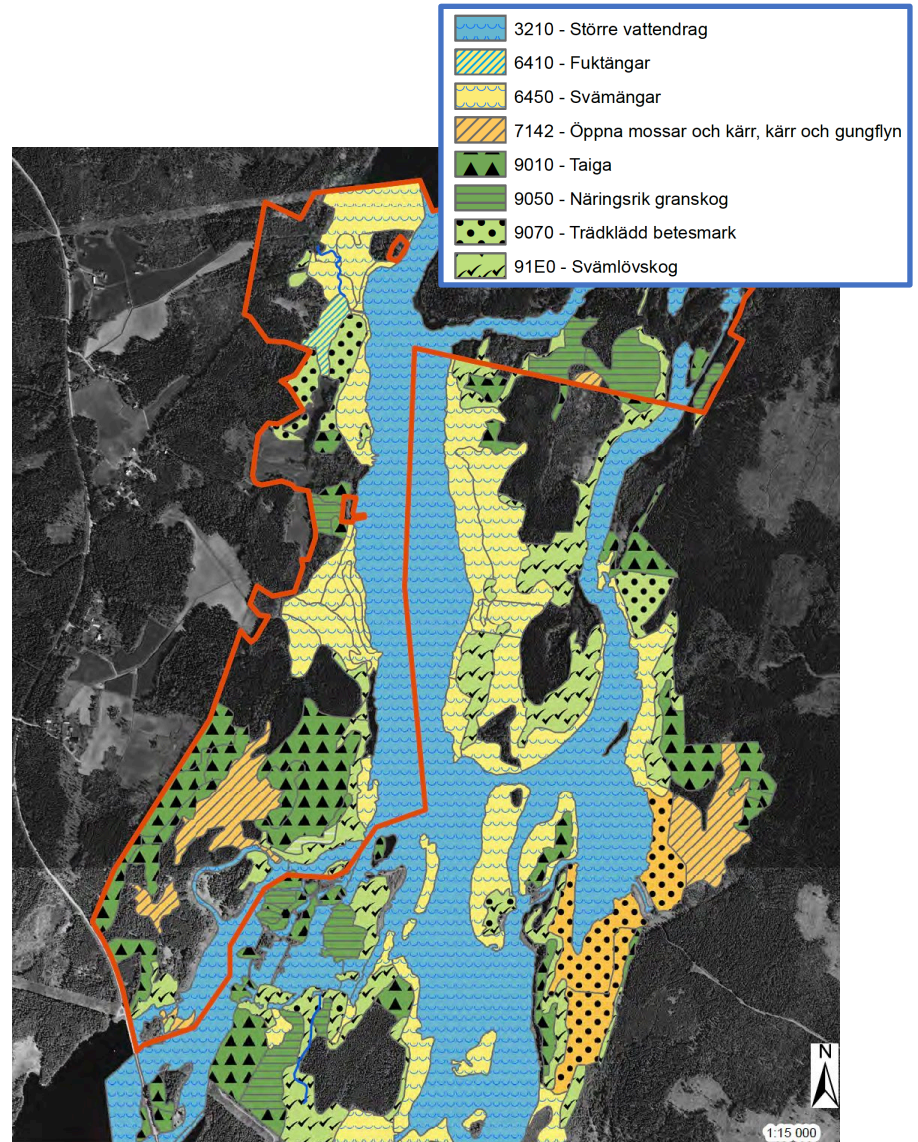


WP1 Lab experiment

WP2 Field transplant experiment

WP3 Natural occurrence of tree seedlings in riparian zones

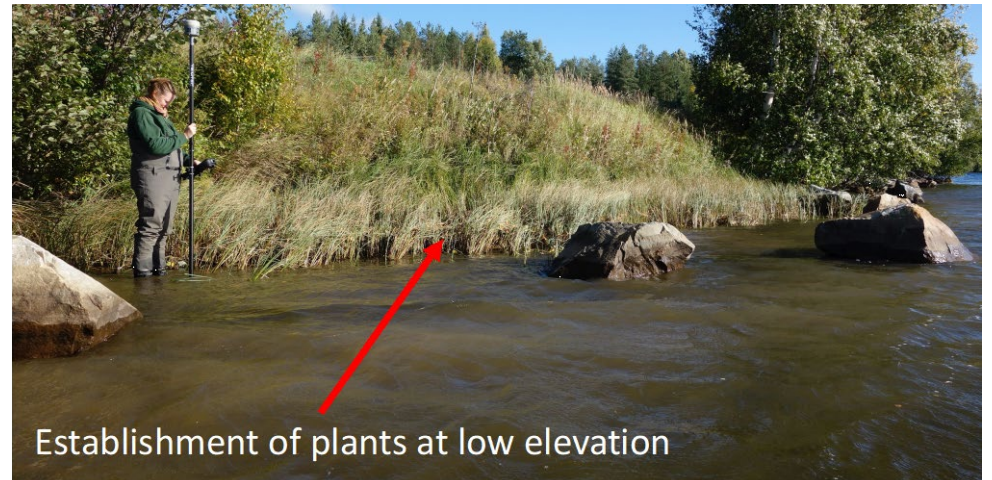
WP4 Projections of the geographic distribution of riparian deciduous forests along Dalälven under different environmental flow scenarios



Flows needed to maintain riparian meadows – "northern boreal alluvial meadows"



Reduce impacts of hydropeaking on riparian zones along run-of-river impoundments



Establishment of plants at low elevation

Environmental flows in a future climate – projections of future runoff in the Ume River

Environmental flow option	Environmental benefit	Change in hydropower production (%): Present	Change in hydropower production (%): 2030
All measures	All above	-3.5	-3.4

Projected increases in runoff →

Change in hydropower production (%): 2030
+2.2



Future challenges

- Need for restoration of rapids, riparian zones, deltas and other ecosystem types
- Enhance connectivity of organisms other than anadromous fish
- Climate change transforms riverine ecosystems also in free-flowing river systems – increased need for ecosystem restoration of regulated systems
- Environmental flows and restoration measures that are implemented need to be “future safe”
- Large potential for environmental rehabilitation of ecosystems in regulated river systems



UNITED NATIONS DECADE ON
**ECOSYSTEM
RESTORATION**
2021-2030



Birgitta Malm-Renöfält
Umeå University



Åsa Widén
Umeå University, SLU



Sofi Lundbäck
*Umeå University,
County admin. Västernorrland*



Erik Degerman
SLU, Norconsult



Joel Segersten
SLU



Serena Donadi
SLU



Dag Wisaeus
ÅF



Marcus Bryntesson
Anders Berglund
*County admin.
Västernorrland*

Jani Ahonen
Andreas Karlsson Tiselius
Umeå University



Länstyrelsen
Västernorrland



Norconsult

