River restoration

A tool for solving RES and WFD incompatibilities

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20-20-20

- Increase energy mix in Norway 67,5% renewable energy
- 26.4 TWh new RE as part of a agreement with Sweden
- WFD = Sustainable use of water resources

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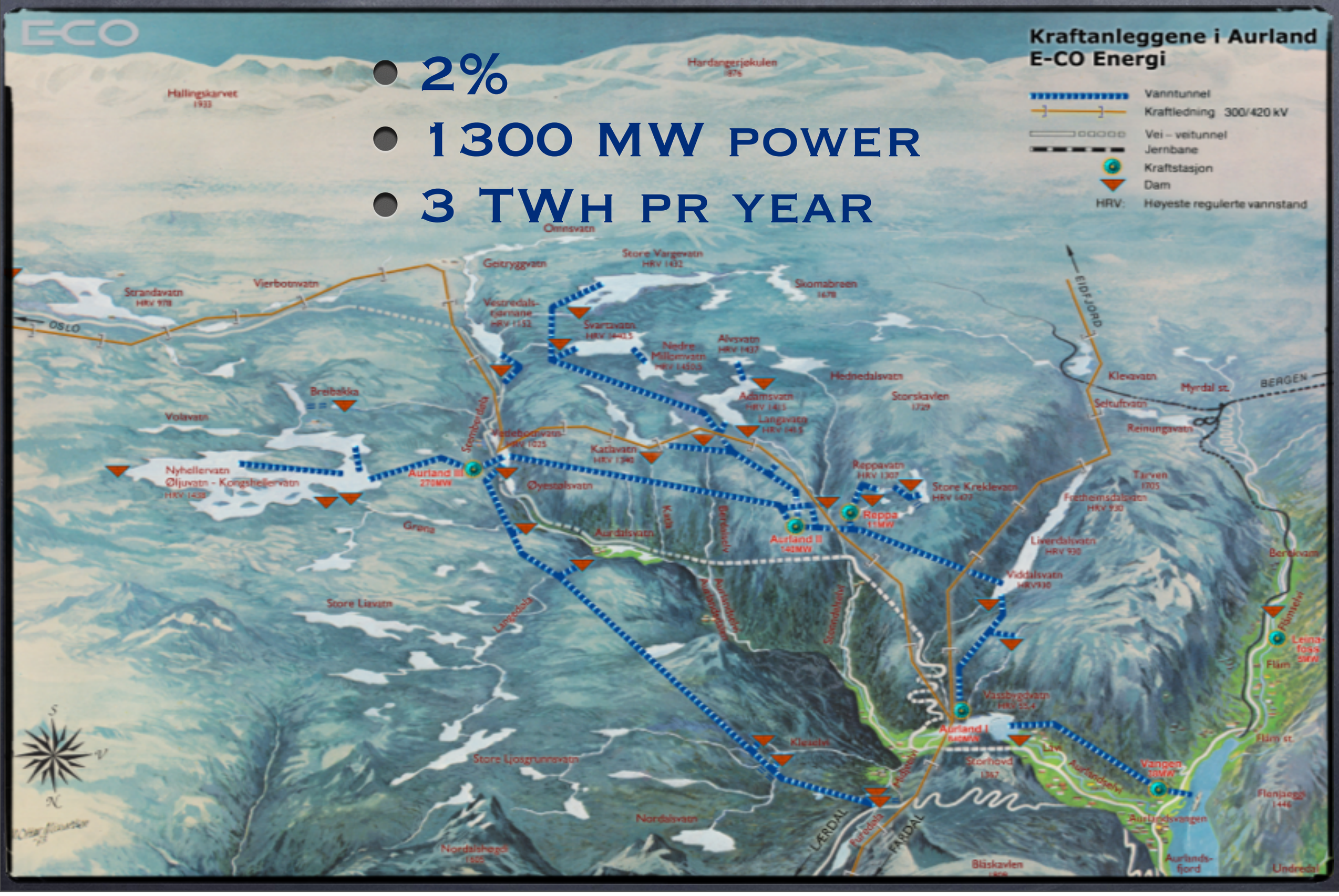
- increased percentage of renewable energy means more volatile and intermittent energy supplies (in Norway almost all new concessions have been small non regulated HP and wind-power)
- important to get the most out of our investments, and also
- to minimize environmental degradation

- this can in many (if not most) be achieved by not depreciate existing large scale HP using restoration measures

Aurland hydropower complex

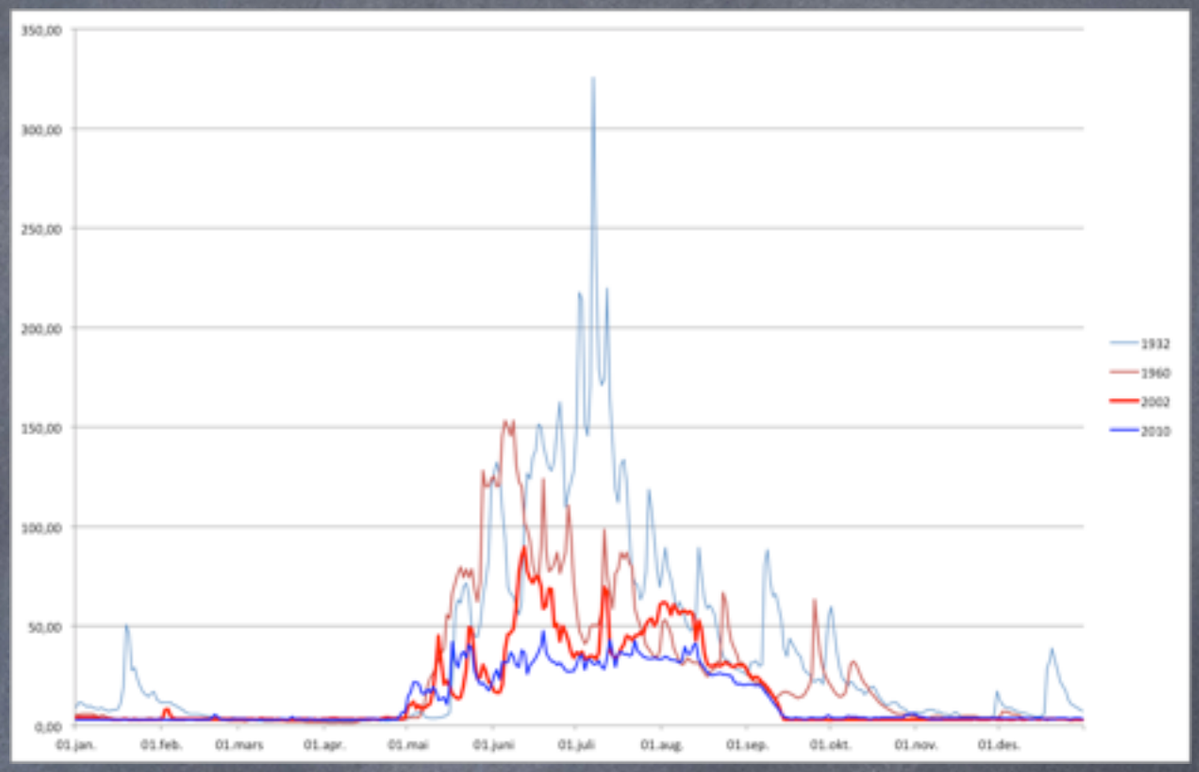
- 2%
- 1300 MW power
- 3 TWh pr year

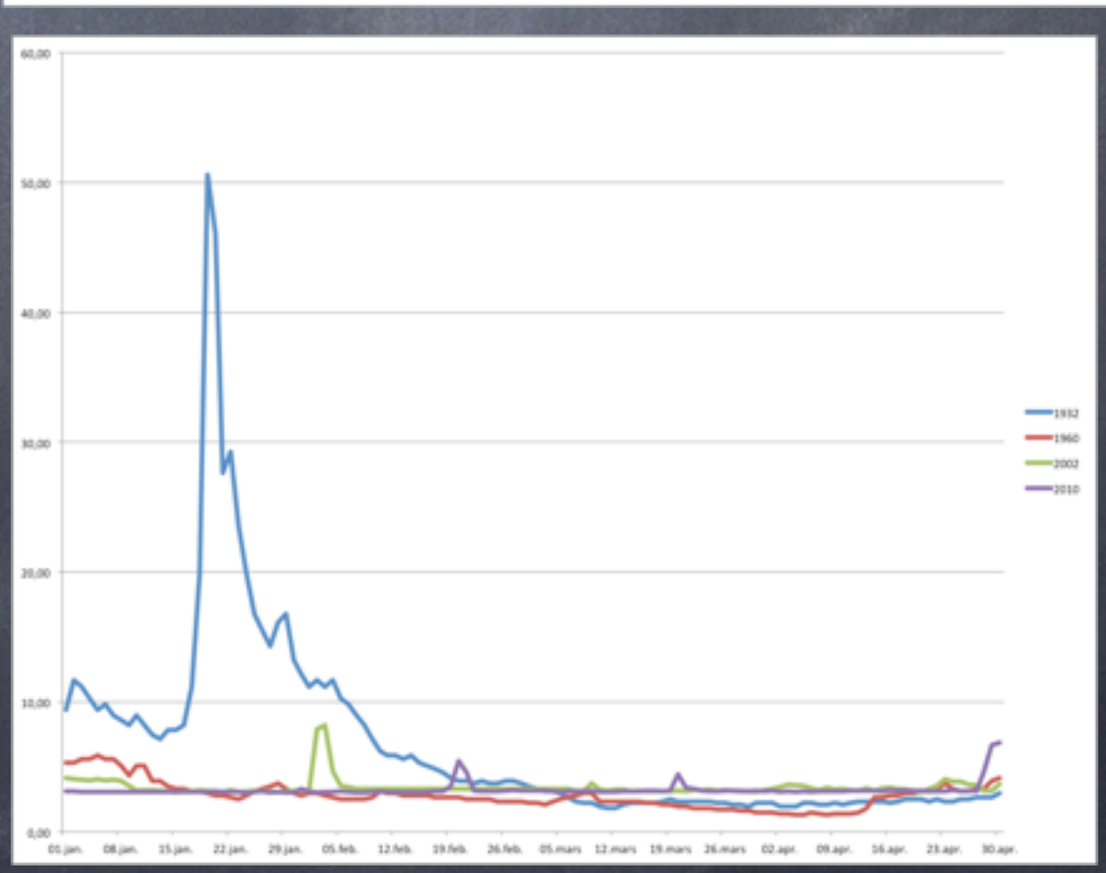


- Western Norway (municipality of Aurland)
- Very important power plant in the norwegian hydro-electric system.Provides stabilizing services (frequency and voltage stabilization.
- Well regulated with 6 P stations and 1 pump (capacity 56 m3/s, 400 metres head)
- HMWB designated to all rivers, reservoirs and small streams

Environmental flow

- Complex regime for Aurlandselva
  - variable according to season
  - smooth ramping curves
- 150 - 300l/s voluntary in upper parts in wintertime





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Minimum during winter: 3 m3/s
Minimum during summer: 28 m3/s

150 l/s for 3 months equalled in 2012 apprx. a loss of NOK 650 000,-

No effect of hydropeaking because the lake in the system (Vassbygdivann) acts as a buffer

What have we done?

- 11 Weirs in Vassbygdelva in 1997
- Reopening of side channels i 2003 - 2009
- Fishway, 2010
- Spawning gravel, 2009 - 2012
- Harrowing, 2011-2012

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Fishway

Built in 2009-2010, cost apprx NOK 10 million

Hydraulic fishway operates in synchrony with the water level in the lake (regulated max 1,5 metres during wintertime when the hydraulic gate at the lake outlet has been raised)

Improved access to upper part of system

Facilitated building and restoring a very important spawning site at the outlet of the lake (outlined in picture top-right)

Evaluation (video monitoring and radio tracking) shows it works as planned

Gravel and cover

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Side channels

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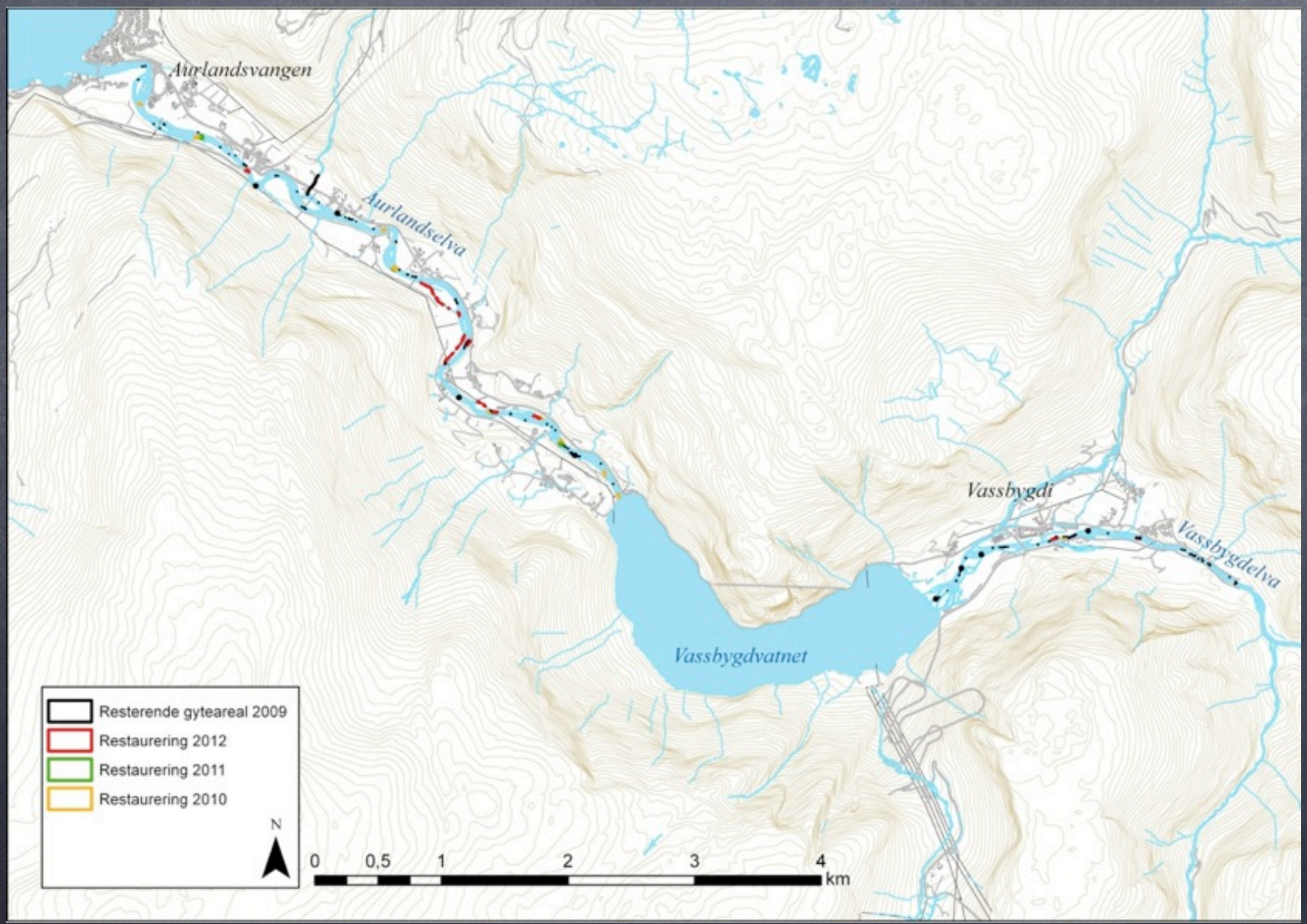
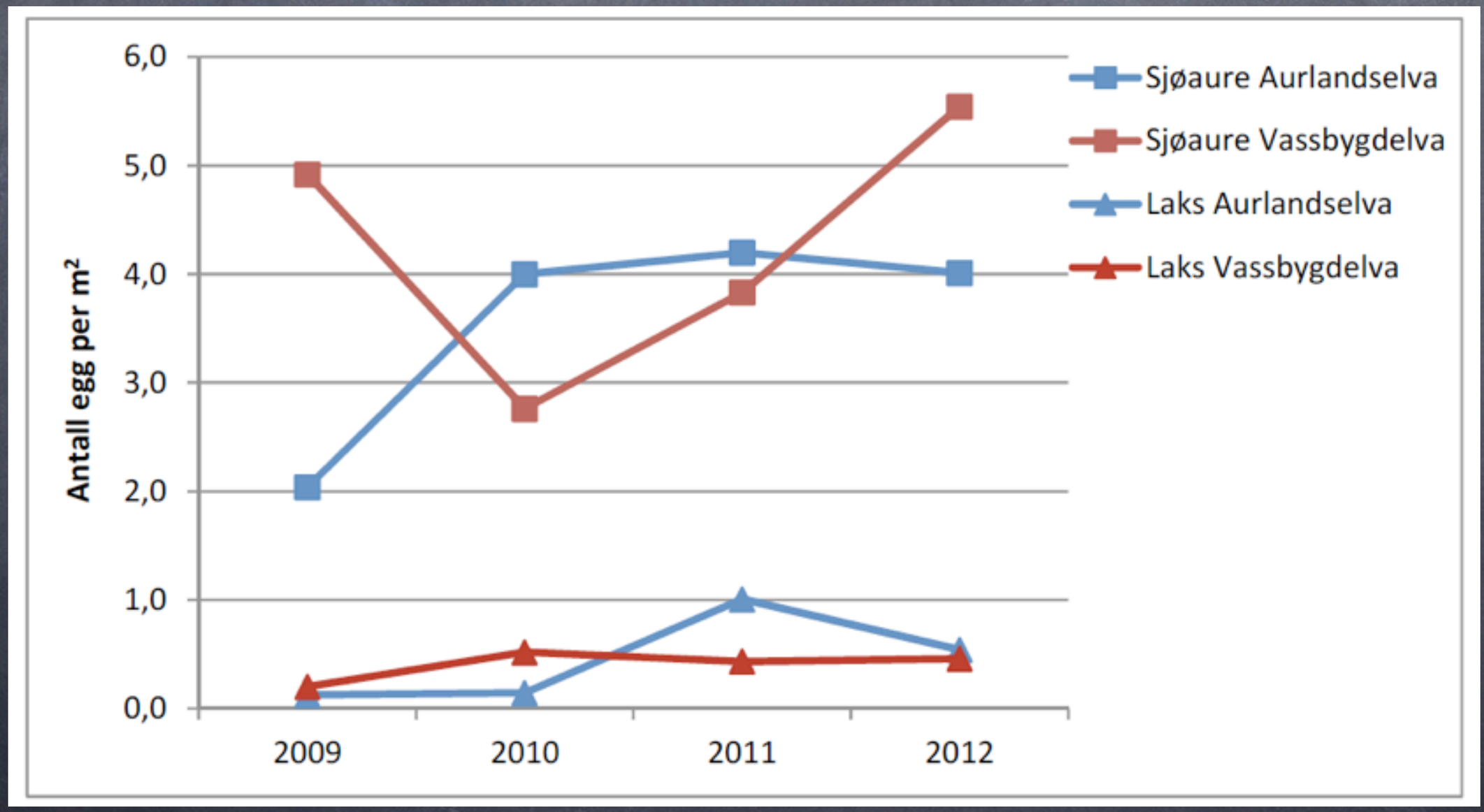
Rebuliding side channels that were created in 2002. Too much slow flowing water.

This lead to a reduction in area, but a much better habitat. This is a clear example of why the parametre «wetted area» is not a very good descriptor in models of how well a river functions!

Results, spawning gravel



Results, spawning



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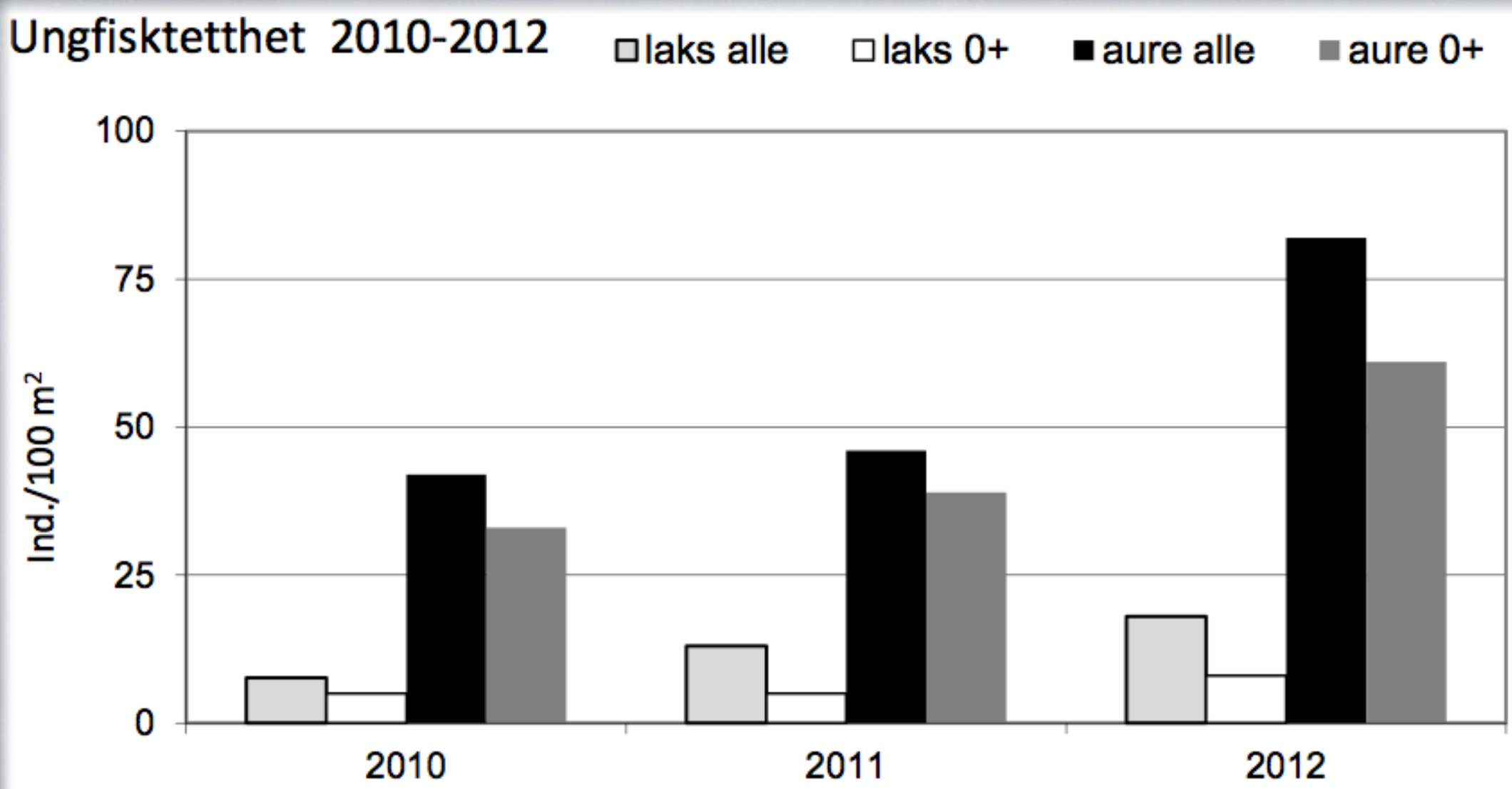
The number of returning spawners have been on the rise, and the expectation for this autumn is high! But, the number of returing fish also reflects the survival in the sea, and the pressures there (mainly salmon farming) is beyond our control.

Results, juveniles



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Measured in the vicinity of the restored spawning-gravel areas

the journey ahead...

- Gravel management
- Large woody debris
- Cover for juveniles
- Embankments and rip-rap modification
- Modification of «Fishermens» flow deflectors
- «rebulding» tributaries

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A program of measures and a research program (in cooperation with UNI Research in Norway and BOKU in Austria) will operate to 2019.

This program will address all the different impacts (hydropower, roads, flood control)

Restoration

- is often the most cost effective solution
- will improve ecological conditions in a HMWB - eventually GES?
- will enable continued power production

An effective tool for combining WFD and RES

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Take home message: restoration measures can be used to mitigate the effects of hydropower in a Heavily Modified Water Body and at the same time preserve a valuable energy and power resource with qualities that other RE do not have.