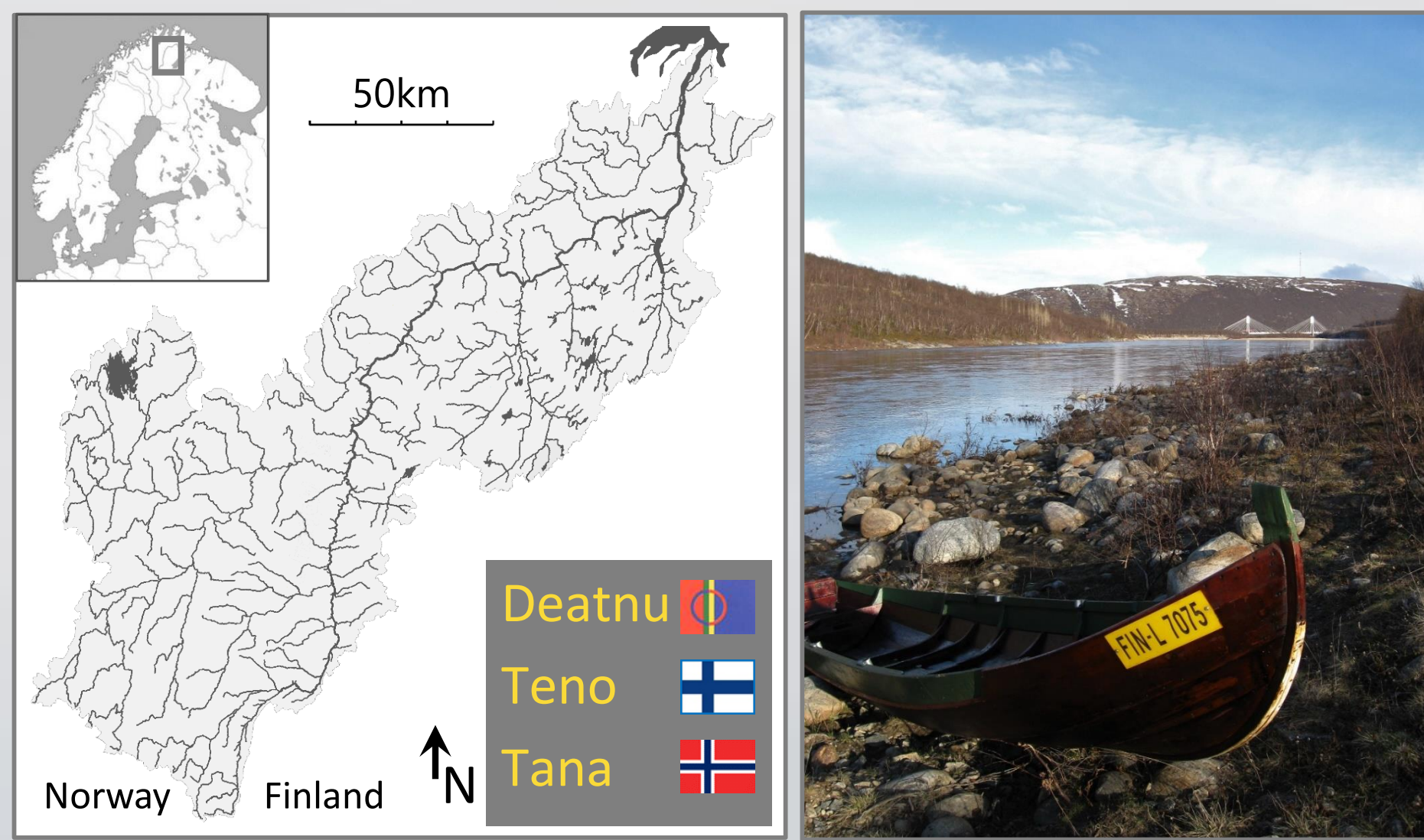


Adaptive Co-Management of Arctic Natural Resources: The Teno Salmon Experience

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Teno salmon: an important sub-Arctic fishery



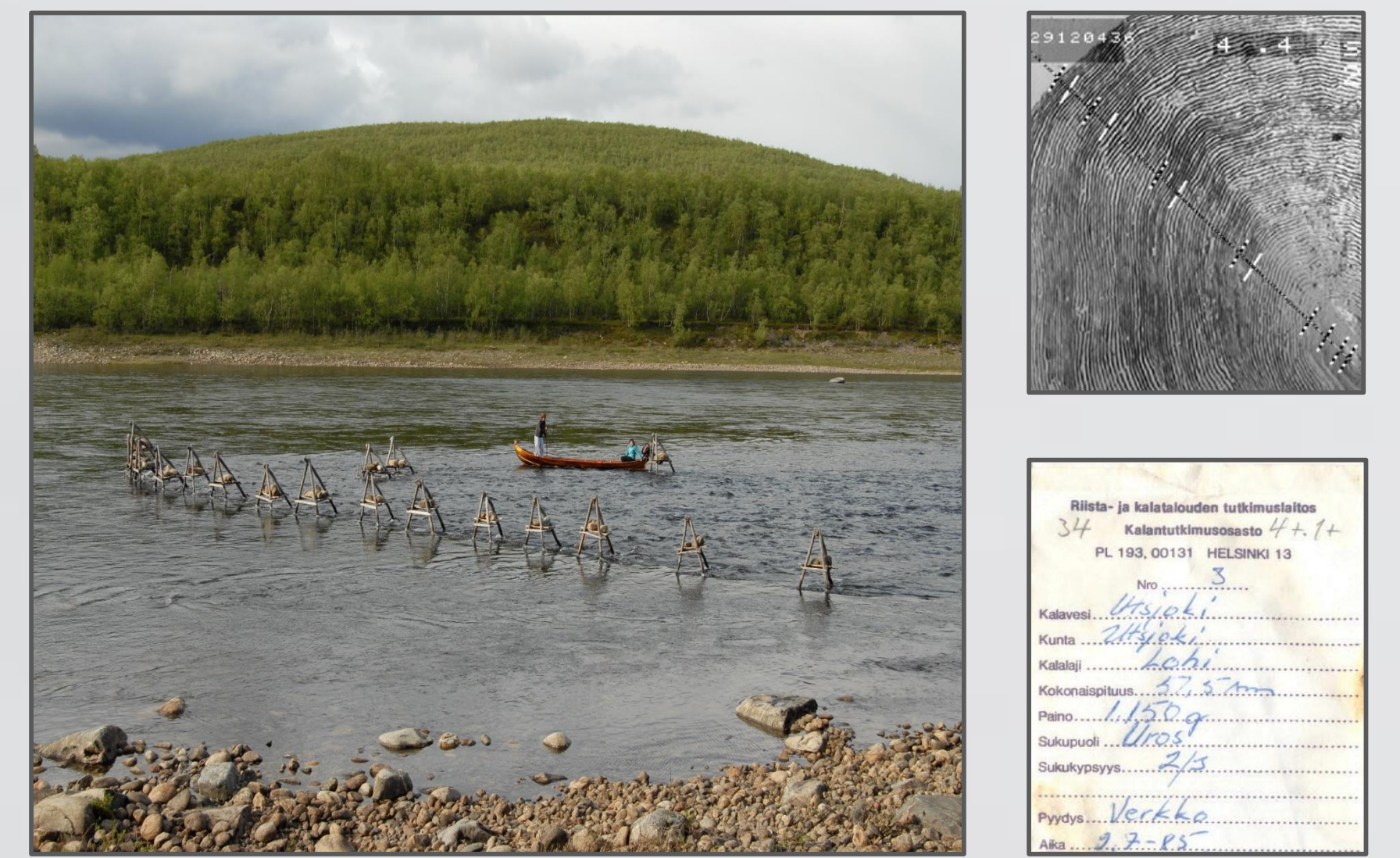
- One of the world's largest Atlantic salmon (*Salmo salar*) stocks: up to 100,000 spawners each year.
- Includes many genetically distinct populations with extraordinary life-history diversity.
- Half of the returning salmon are harvested: Sámi and other local fishers, fishing tourists.
- Culturally important to the Sámi; managed jointly by Finland and Norway.

Life history diversity in Atlantic salmon



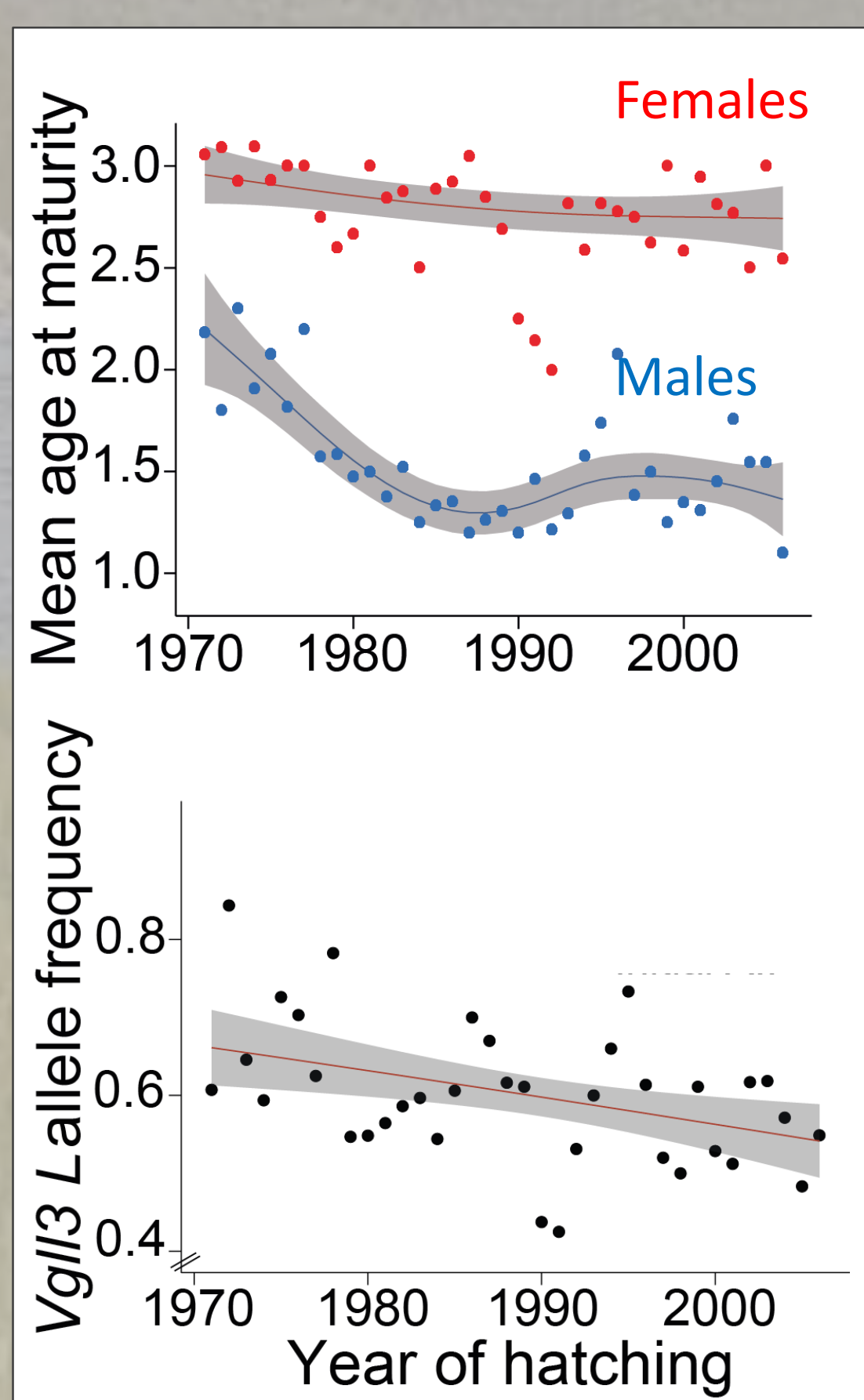
- Salmon spend their early life in the river, then migrate to the ocean, before returning to spawn.
- 'One sea-winter' (1SW) salmon spend one year growing in the ocean before maturing and returning to the river; 'multi sea-winter' (MSW) salmon spend longer and return at a larger size.
- The gene *vgll3* influences when a salmon matures. One version of the gene makes it mature early (1SW), the other makes it mature later (MSW).
- The Teno has both 1SW and MSW salmon - large fish in particular attract many tourist anglers.

Teno fishers as 'citizen scientists'



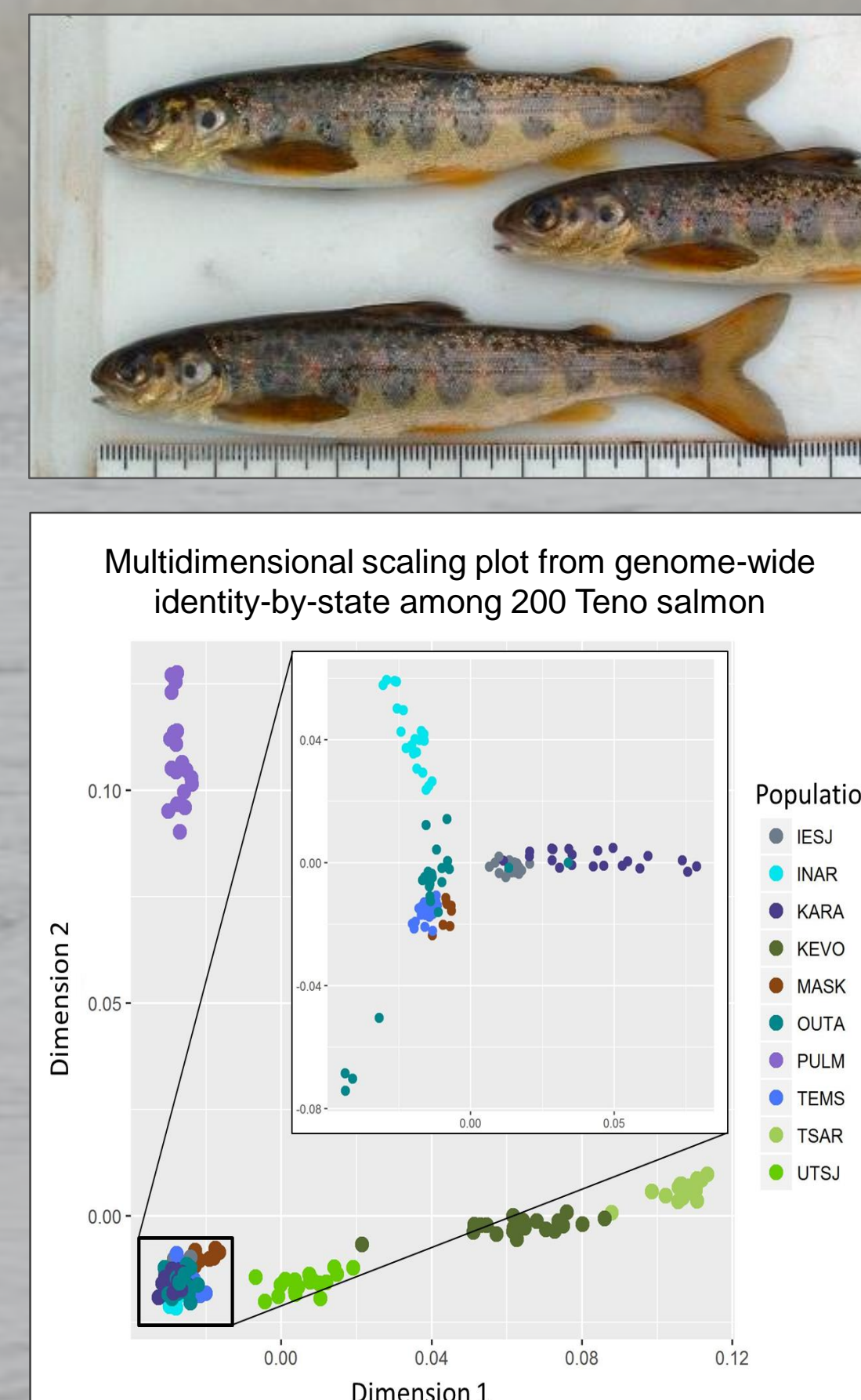
- Teno salmon research relies on local fishers, who collect scales from their catches and record length, weight, sex and location.
- LUKE now has scales from >150,000 salmon, collected throughout the Teno since the 1970s.
- Scale growth rings show how many years a salmon has spent in the river and at sea.
- Scales yield DNA for genetic analyses.

What is driving the decline in larger Teno salmon?



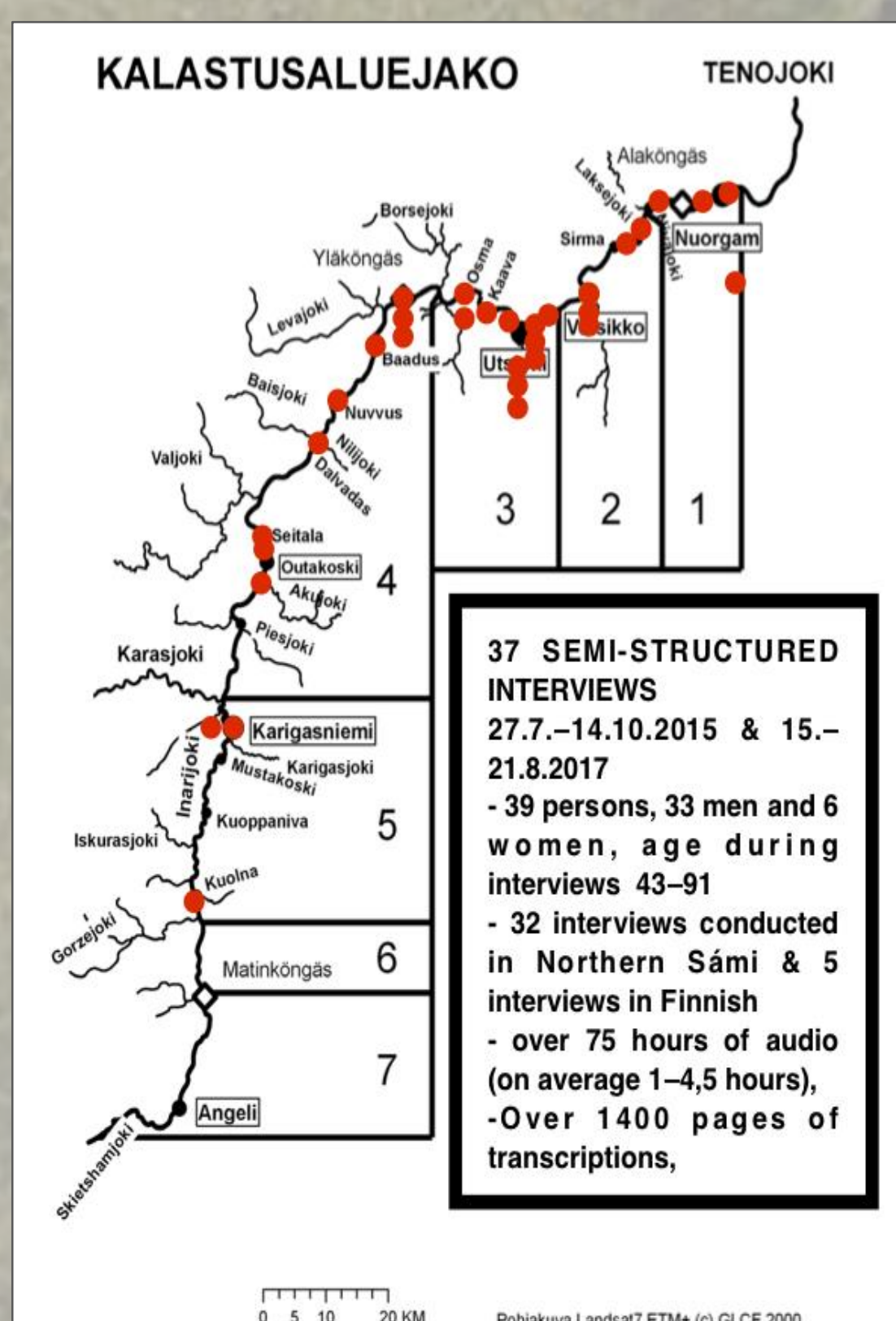
- Since 1972, large (MSW) salmon have become rarer in the Teno.*
- We found that the 'late maturing' *vgll3* version has also declined.
- This shows that loss of MSW salmon is due to genetic changes.†
- We examined factors that could drive this change (fishing, sea temperature, prey populations).
- We found that capelin fishing was a strong driver of *vgll3* variation.
- This suggests that fishing for prey species can indirectly drive evolutionary change in salmon.

Are the different Teno populations locally adapted?



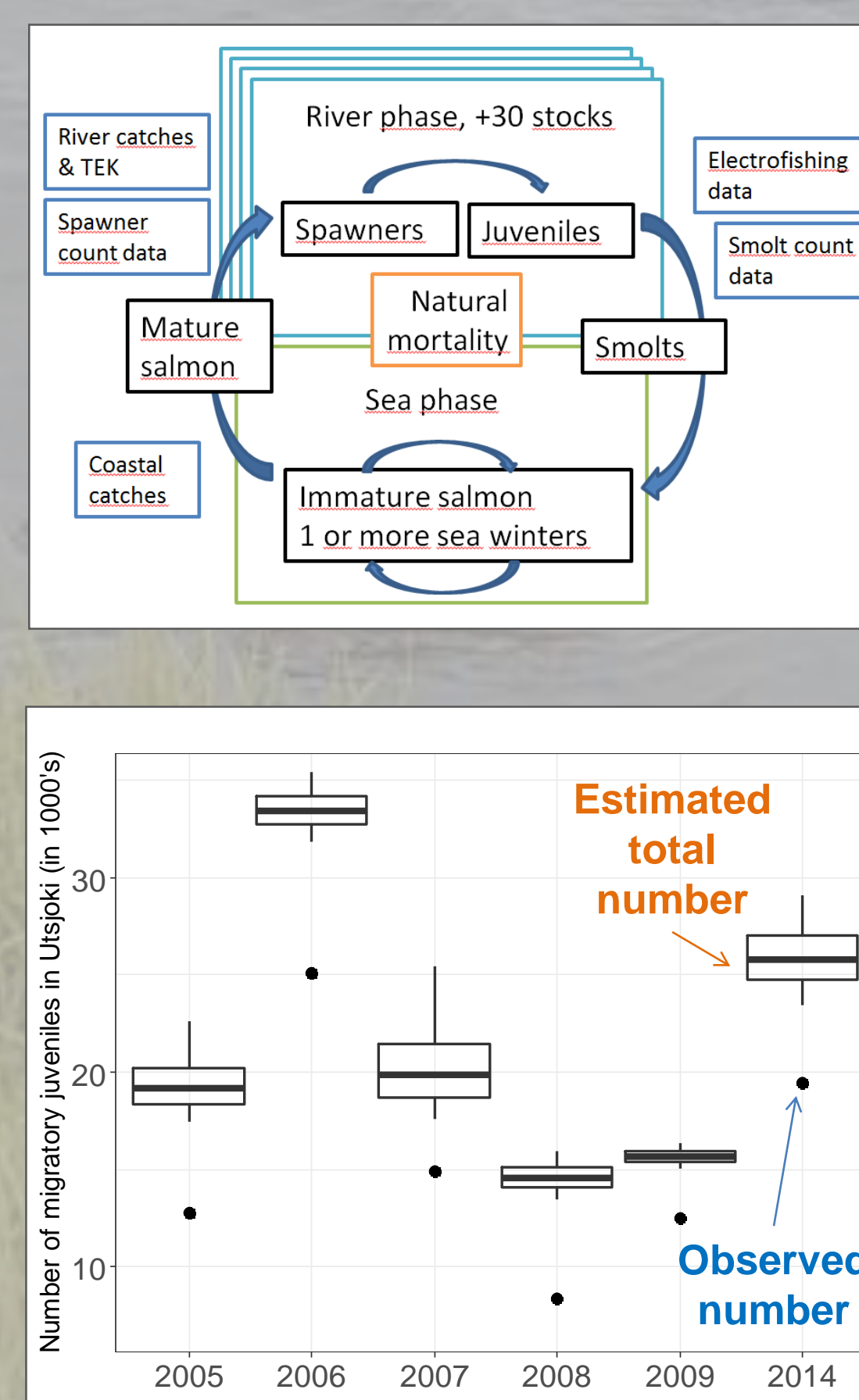
- Because salmon return to their exact birthplace to spawn, different populations in the Teno do not mix much. These populations may have genetically adapted to their local part of the river.
- We examined variation over the genome and found statistical signatures of this adaptation around genes involved in immune response, energy balance, and maturation (including *vgll3*).‡
- This local adaptation means that salmon lost from one part of the Teno may not easily be replaced by salmon from another part.

Sámi Traditional Ecological Knowledge (TEK)



- Sámi TEK about Teno salmon is passed down by older generations teaching younger ones traditional fishing methods.
- Opportunities for this have decreased as younger people have become less interested in fishing, economic value has declined, and traditional fishing methods have been restricted.
- Because of this, there is a danger that TEK will be lost.
- We documented Teno salmon TEK by interviewing Sámi fishers.

Bayesian population model of Teno salmon



- We are developing a modelling framework[§] that uses all the available data to estimate how many salmon of various life stages are in the Teno populations.
- Results from other parts of the project, including *vgll3* variation and TEK, feed into this model.
- We have different amounts of information from different Teno populations (e.g. number of juveniles) – the model enables us to use data-rich parts of the system to make predictions about the data-poor parts.

