



Diversity in life histories and genetic structure in a large population complex of wild Atlantic salmon in the River Teno, northernmost Europe

Jaakko Erkinaro

Finnish Game and Fisheries Research Institute, Oulu, Finland





Acknowledgements

Juha-Pekka Vähä

Morten Falkegård

Eero Niemelä

Panu Orell

Maija Länsman

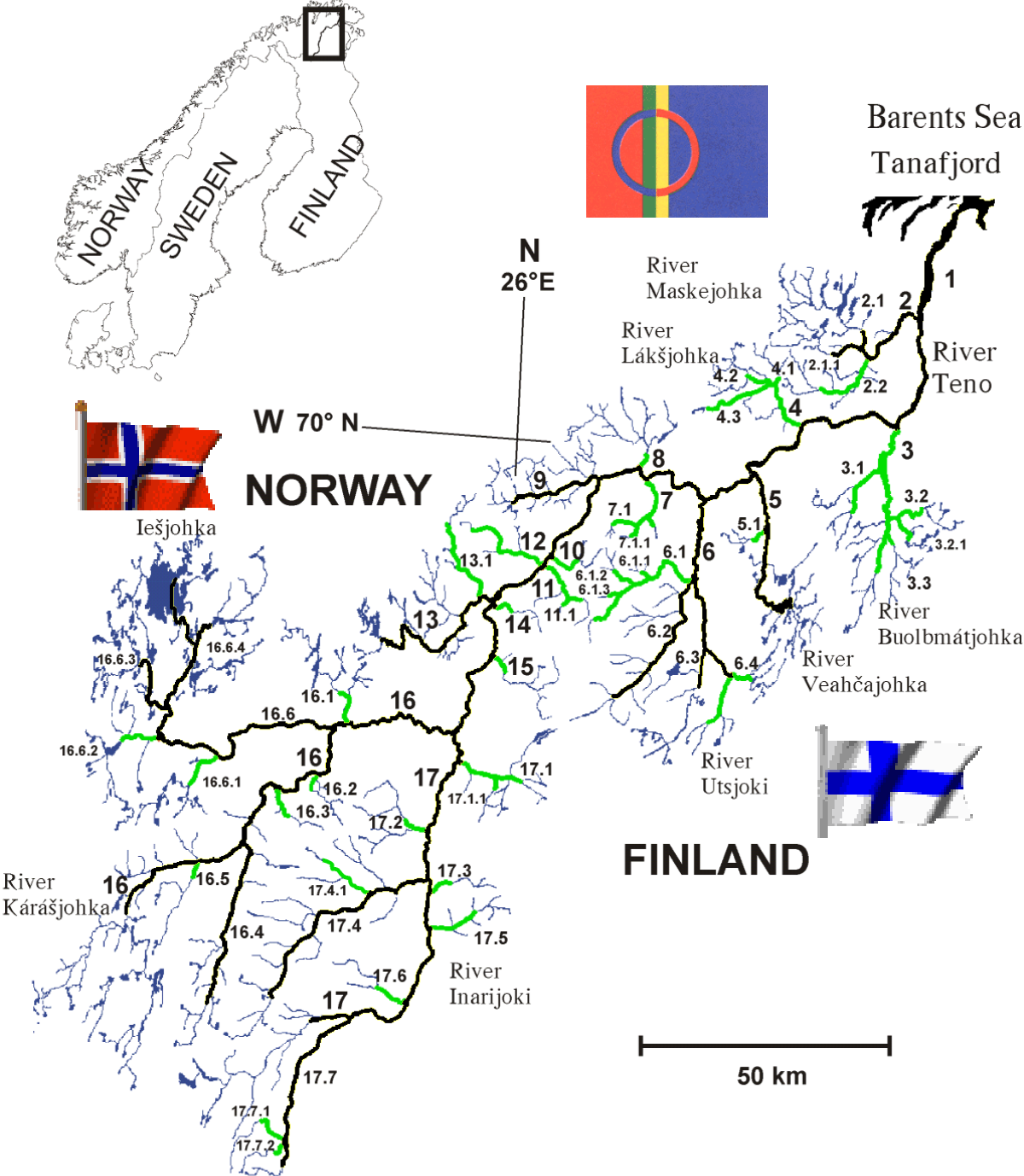
Jorma Kuusela

Matti Kylmäaho

Jari Haantie

Jorma Ollila

Kjell-Magne Johnsen



Teno/Tana/Deatnu

Catchment area 16 380 km²

Mean discharge 170 m³/s
(max. 3000 m³/s)

> 1200 km and >30
tributaries available for
anadromous salmon

Green = tributaries with
predominantly 1-sea-winter
salmon

Black= stretches and
tributaries with high % of
multi-sea-winter salmon



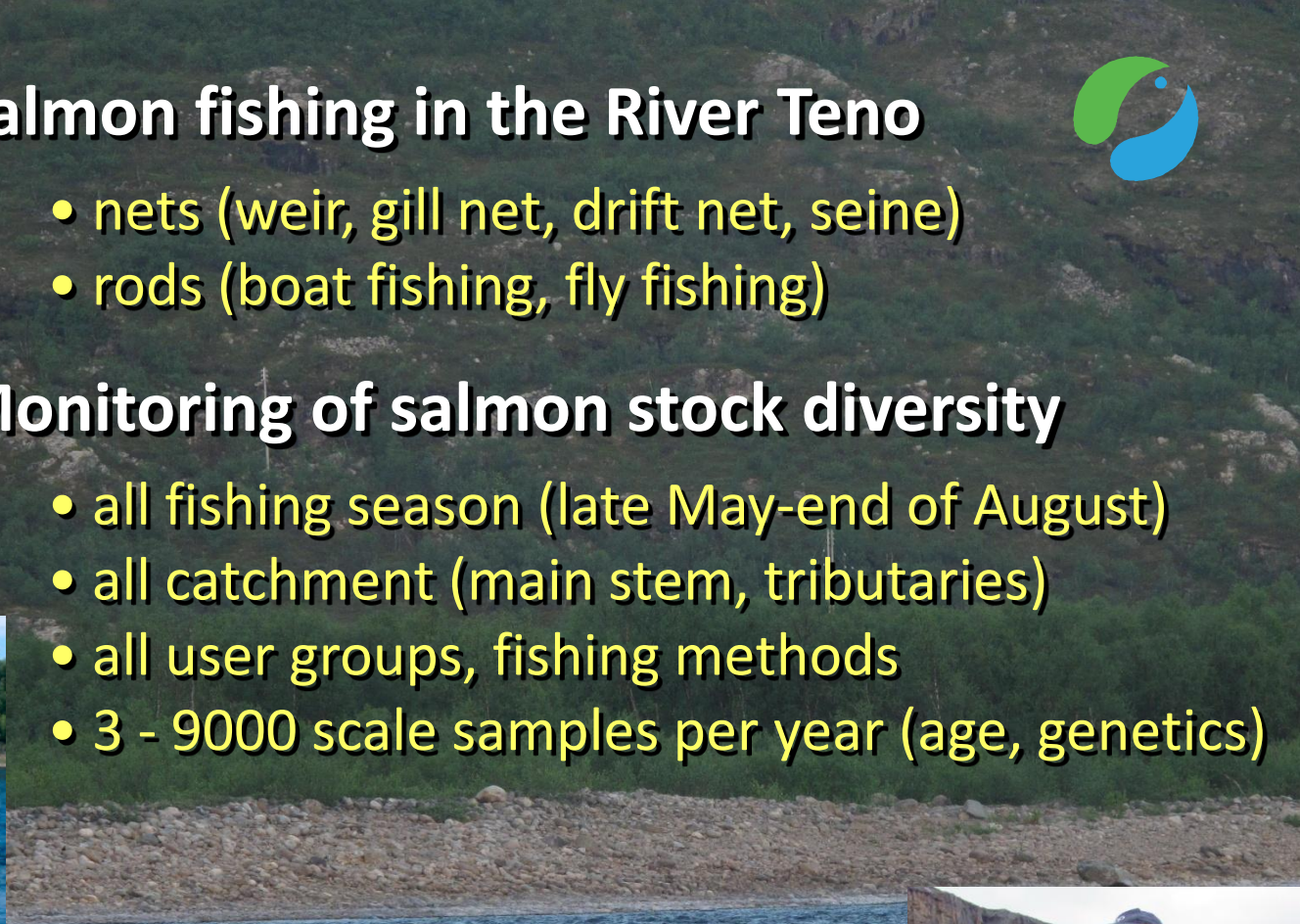


Salmon fishing in the River Teno

- nets (weir, gill net, drift net, seine)
- rods (boat fishing, fly fishing)

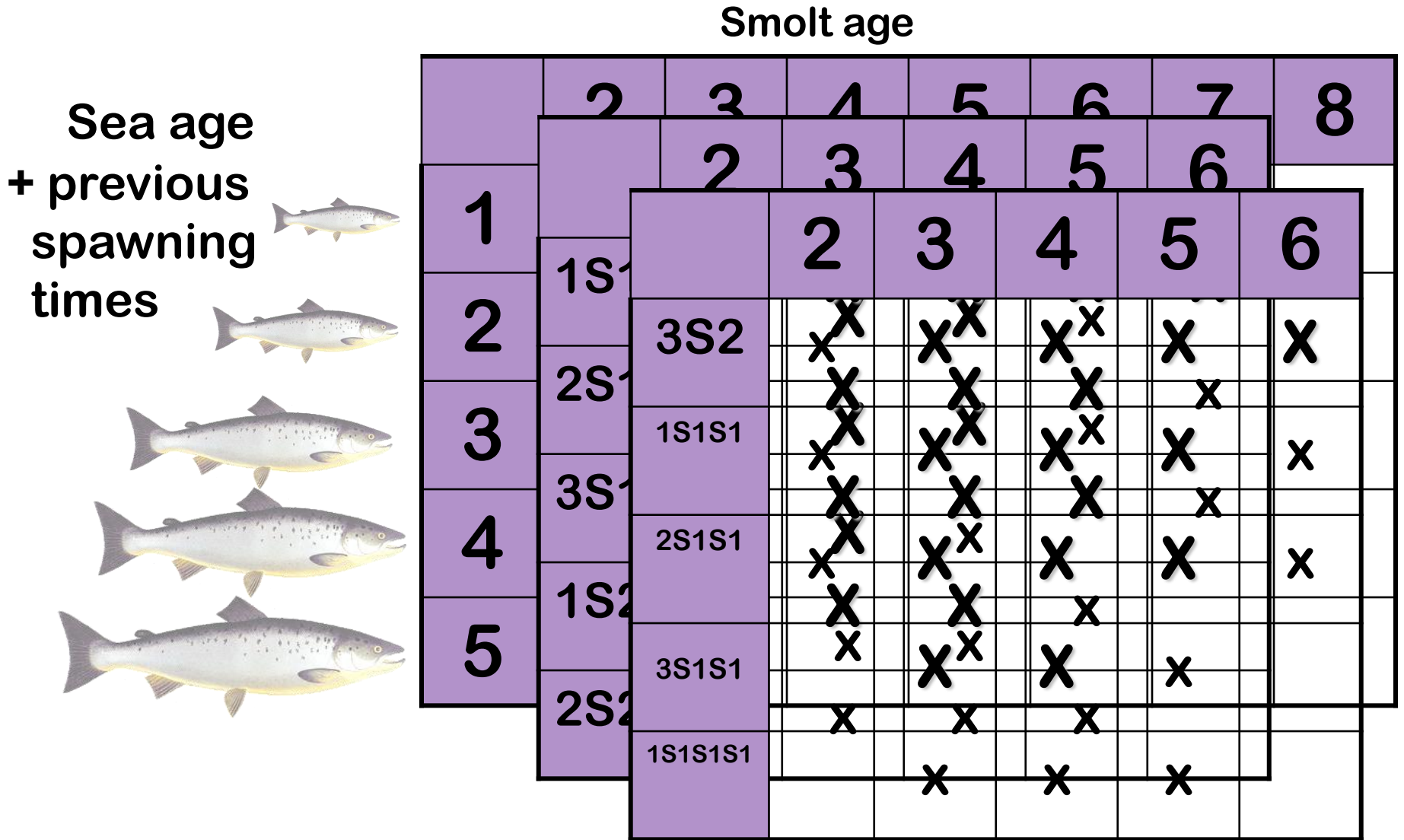
Monitoring of salmon stock diversity

- all fishing season (late May-end of August)
- all catchment (main stem, tributaries)
- all user groups, fishing methods
- 3 - 9000 scale samples per year (age, genetics)





Life histories of the River Teno Atlantic salmon



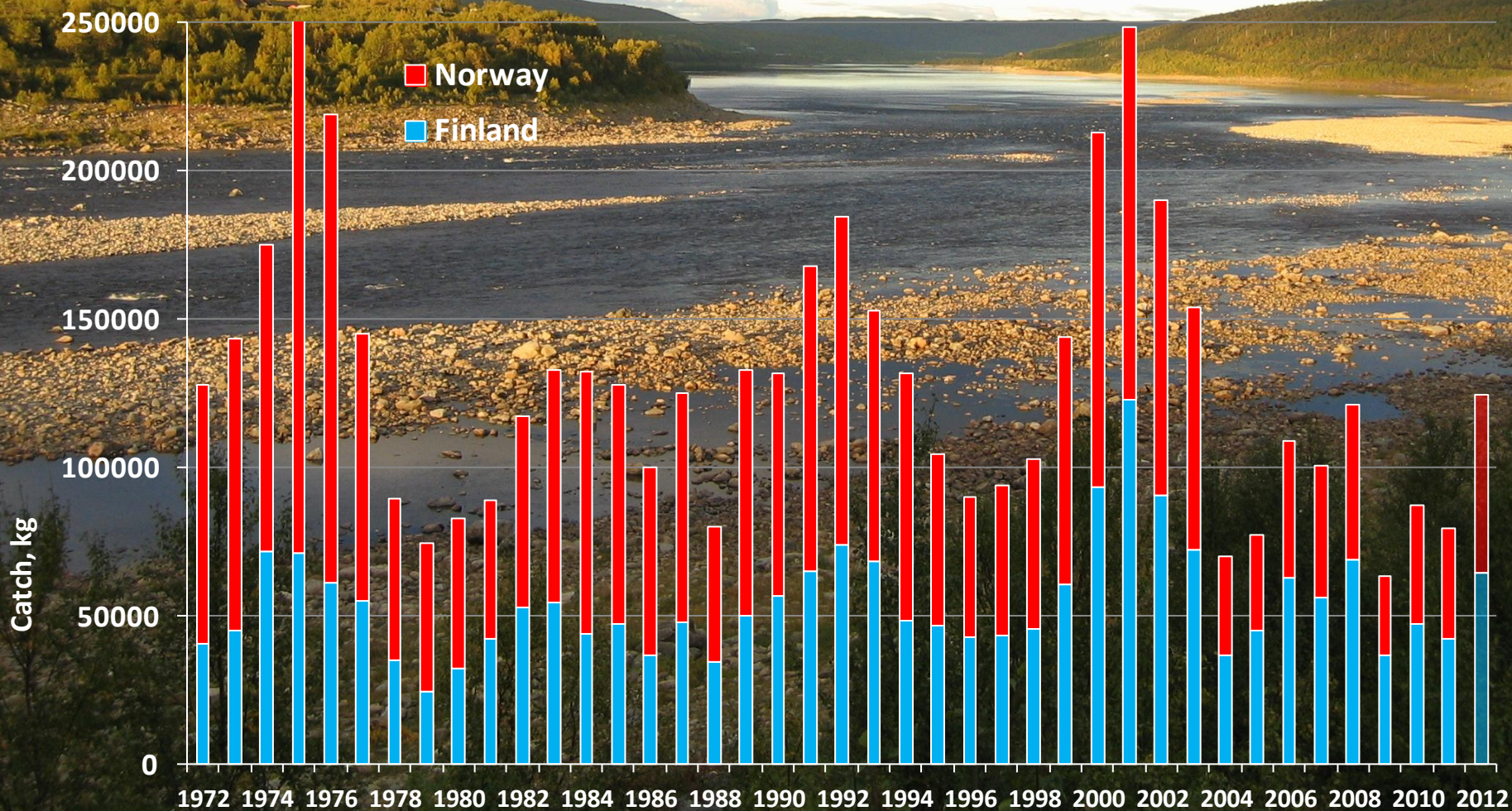
96 combinations !



Size difference within male individuals reproducing at the same time & place up to 10 000 –fold ! (3g vs. 30 000g)

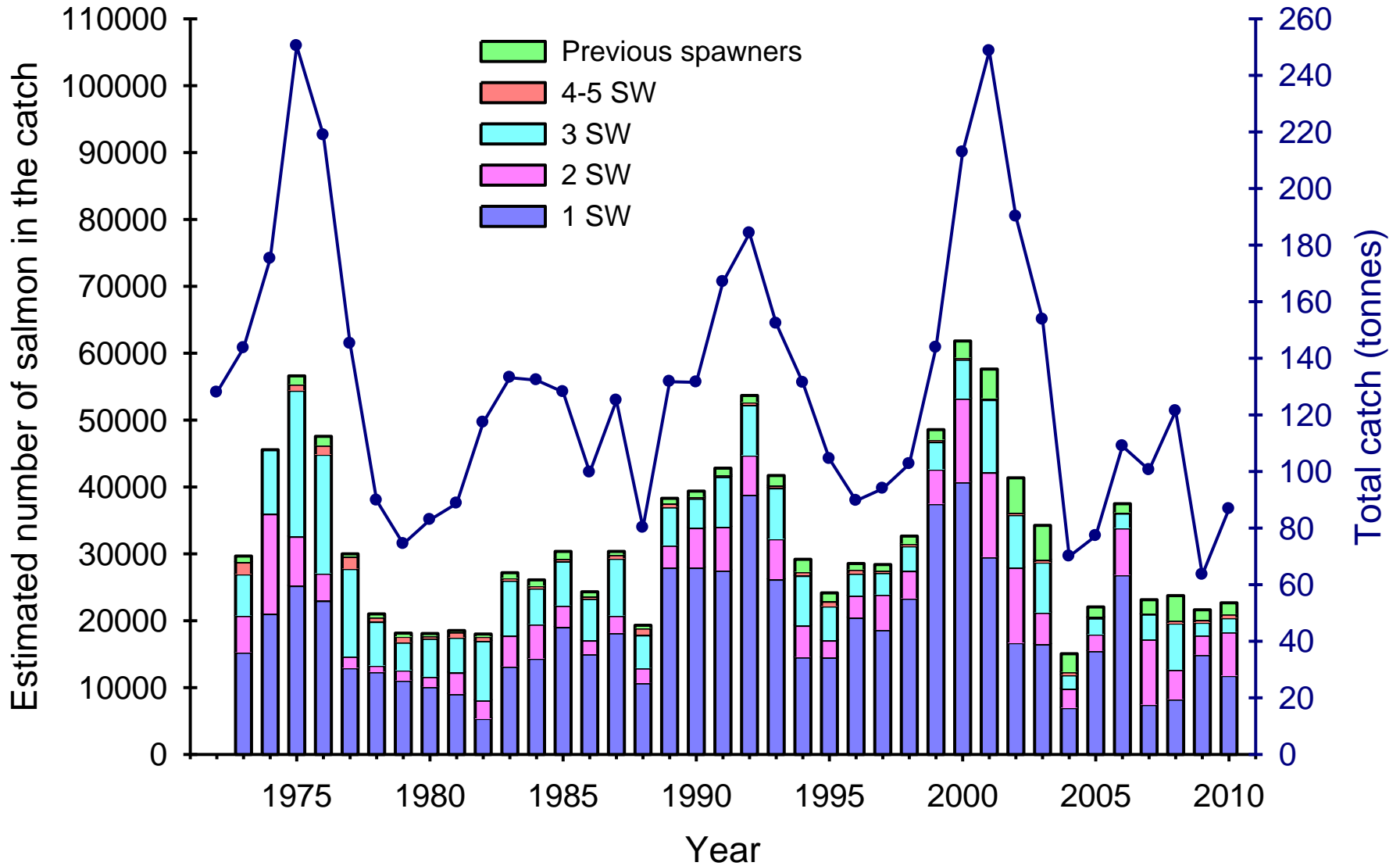


Atlantic salmon catch in the River Teno





Salmon catch of the River Teno



Distribution (%) of salmon from 1990 year class across later spawning years

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Maiden salmon	0.05	11.6	39.7	29.4	15.1	3.8	0.4	0.01	0.01			
Previous spawners			0.1	8.3	33.4	32.6	17.9	5.8	1.7	0.3	0.1	0.05

- ▶ A single year class may contribute to reproduction over 12 years
- ▶ So...what if there wasn't this diversity?
 - Less buffer/resilience against environmental/human disturbances, less adaptation to various habitats
- ▶ Portfolio effect?
 - Diversity is stabilizing ecosystems and the services they provide – analogy: asset diversity & stability of financial portfolios

Vol 465|3 June 2010|doi:10.1038/nature09060

nature



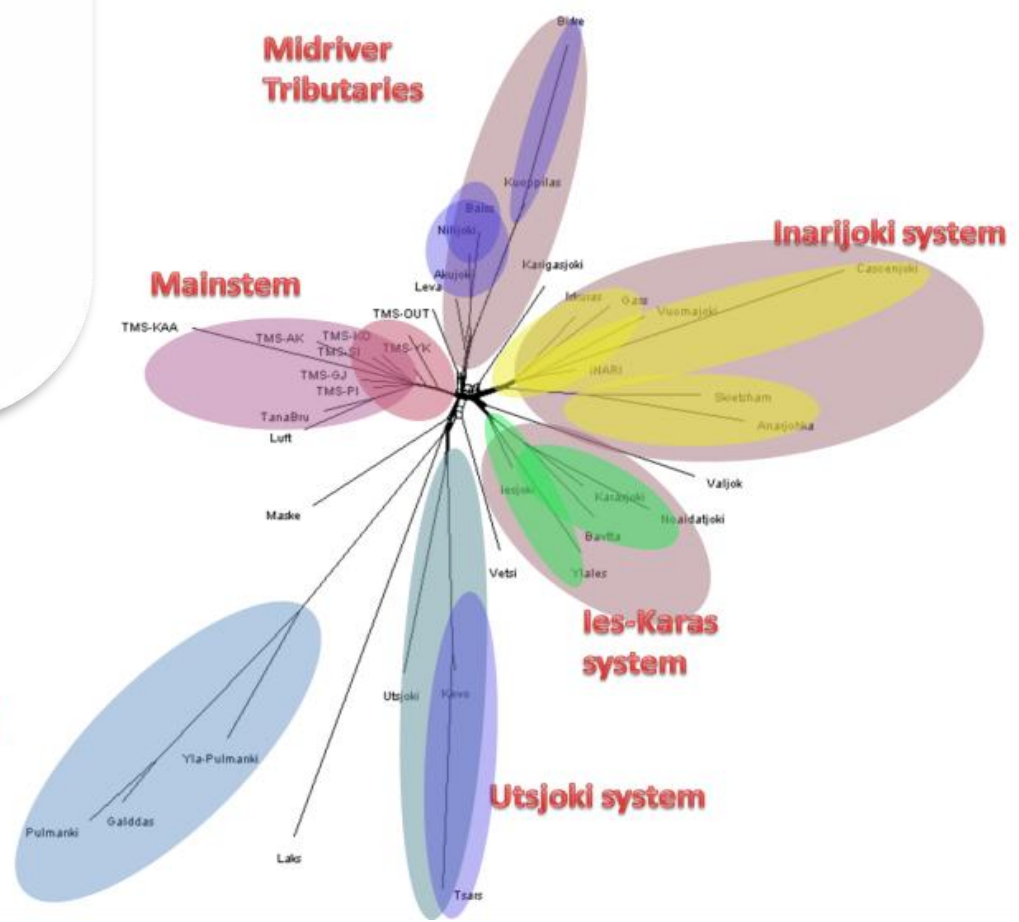
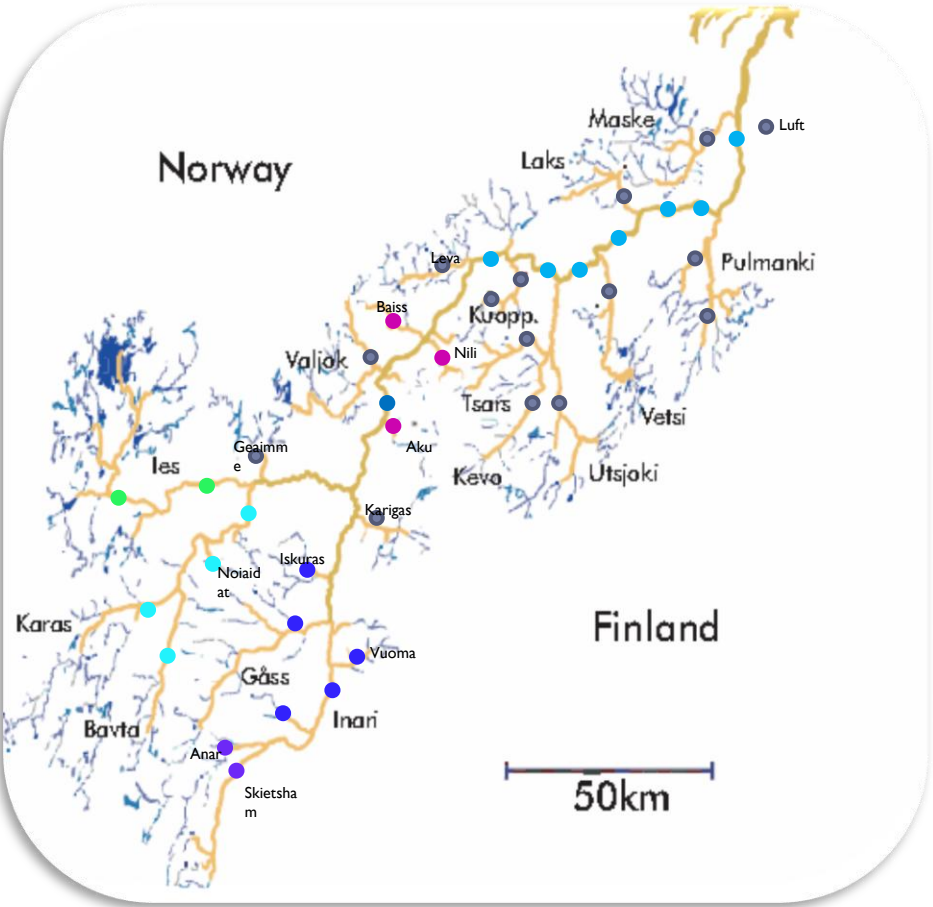
LETTERS

Population diversity and the portfolio effect in an exploited species

Daniel E. Schindler¹, Ray Hilborn¹, Brandon Chasco¹, Christopher P. Boatright¹, Thomas P. Quinn¹, Lauren A. Rogers¹ & Michael S. Webster²

Genetic structure of the River Teno salmon stock complex

- 30+ baseline populations



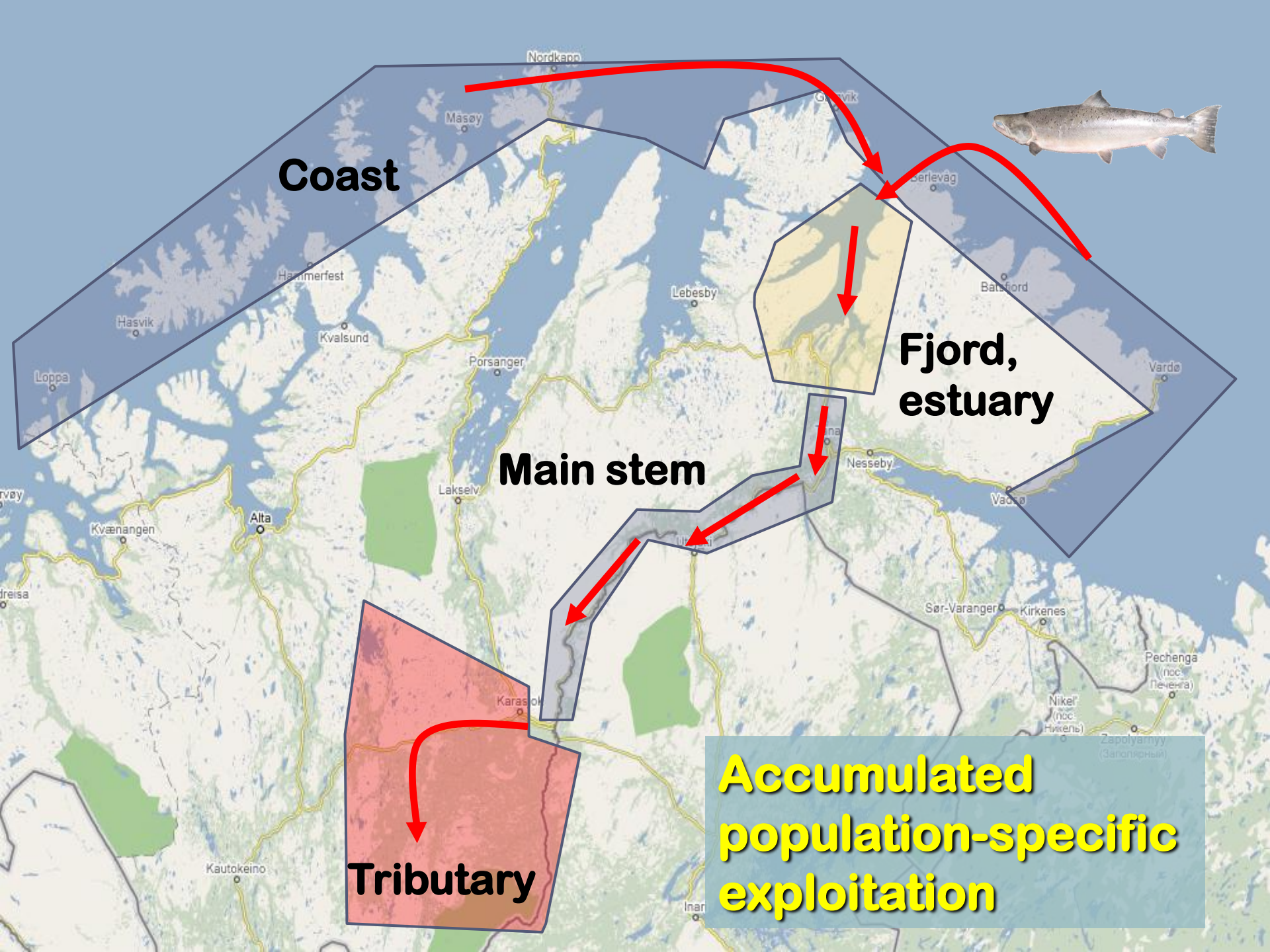
Univ Turku



Genetics of the River Teno salmon

- Substantial genetic differences between populations
 - Mean pairwise F_{ST} 0.10 (max 0.21) (Vähä et al. 2007)
- Large populations more diverse, small more diverged
 - Life history matters: % of MSW females linked to gen variation → large females important in maintaining biodiversity (Vähä et al. 2007 Mol. Ecol)
- Temporal stability in population complex structure
 - 1970s > 80s > 90s > 2000s (Vähä et al. 2008 Evol. Appl.)
- Run timing of salmon to the Teno is population-specific
 - Life history matters: 1SW males from populations with high % of MSW females migrate later (Vähä et al. 2011 Evol. Appl.)

Applicable management implications - - - >



Coast

**Fjord,
estuary**

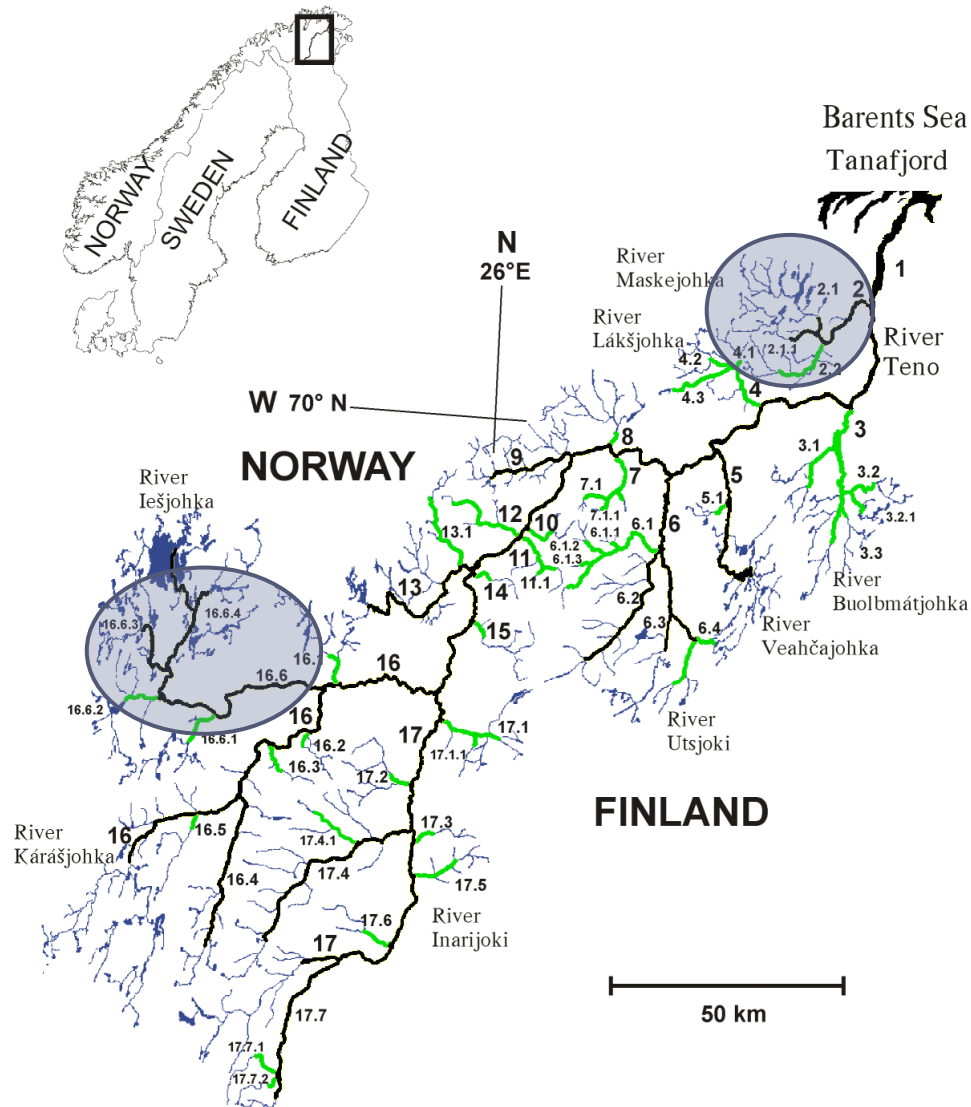
Main stem

Tributary

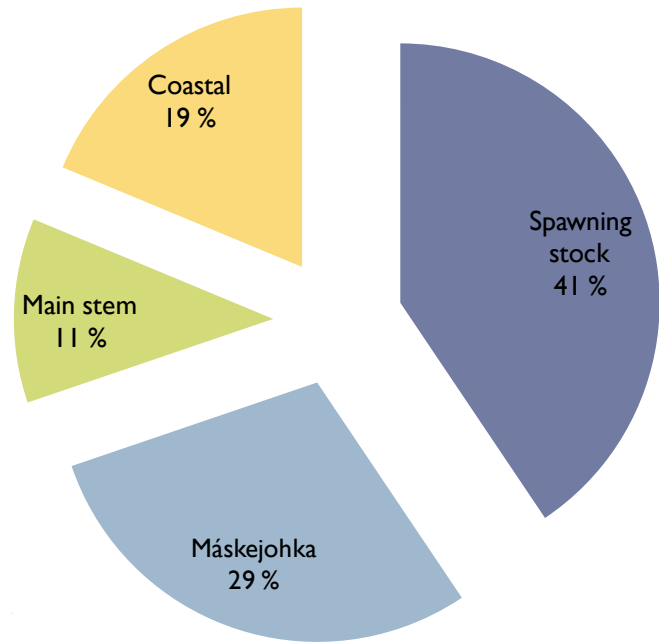
**Accumulated
population-specific
exploitation**



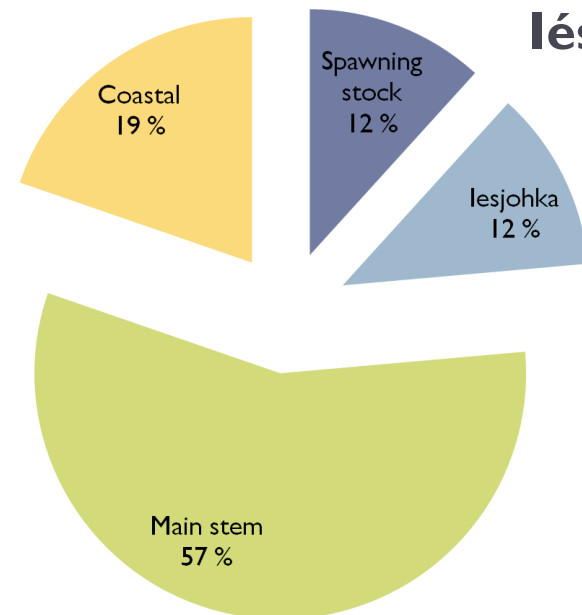
Exploitation in different fisheries and spawning escapement in two River Teno tributaries (% of pre-fishery abundance)



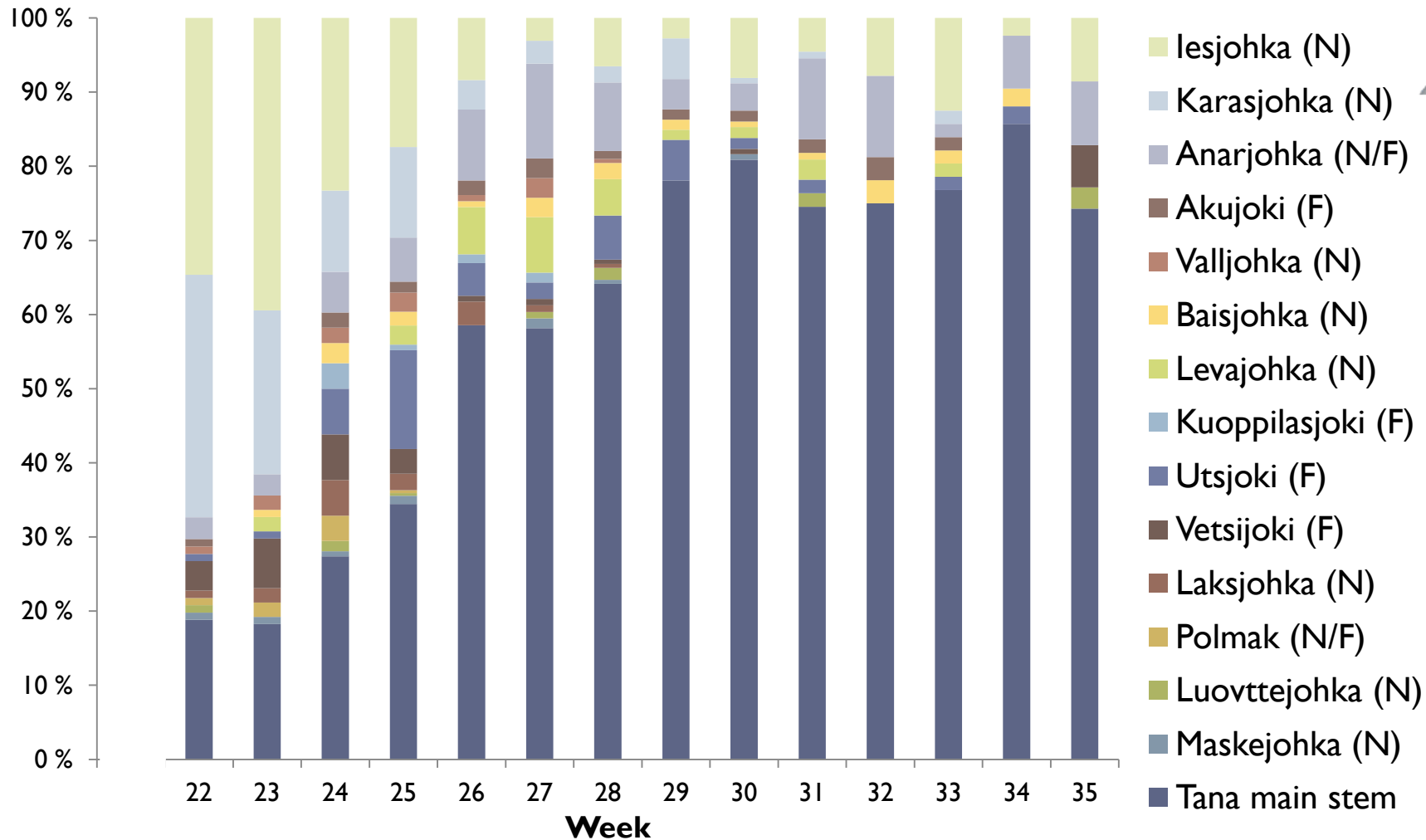
Máskejohka



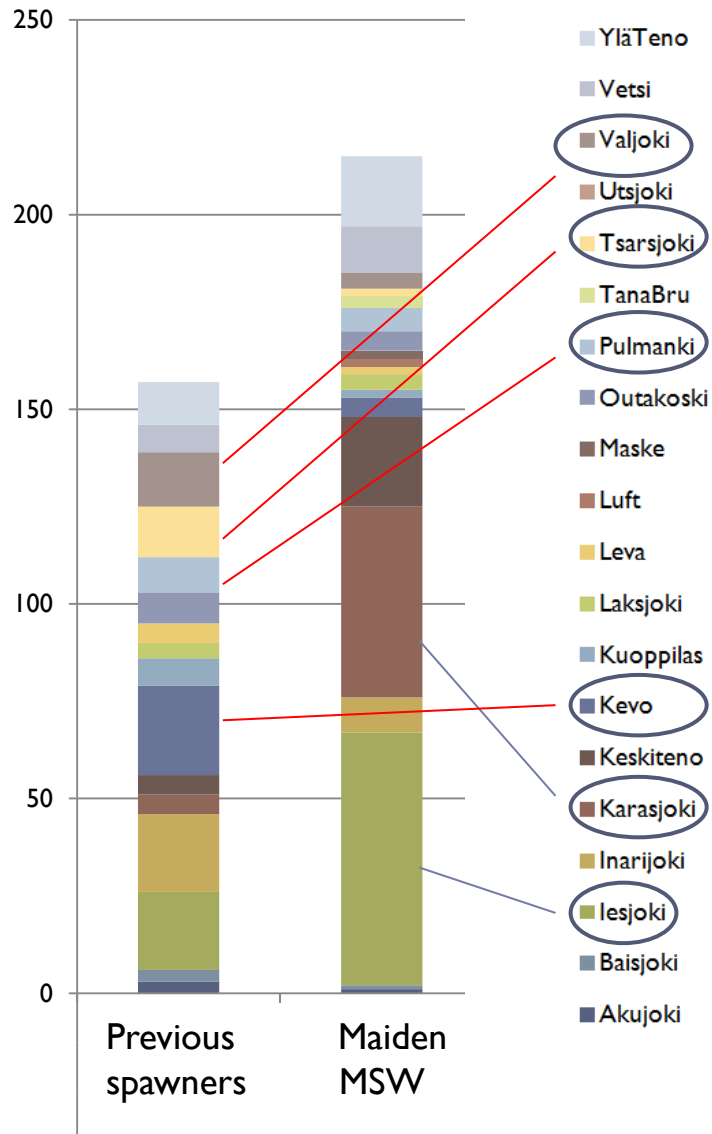
Iešjohka



Mixed-stock exploitation in the River Teno main stem fishery; Multi-sea-winter-salmon catch in 2008



Early season exploitation of populations and life-history groups: – Driftnet catch in lower part of the River Teno main stem



- ▶ Karasjohka and lesjohka salmon are important contributors to the maiden MSW salmon catch
- ▶ Lots of previously spawned salmon in the driftnet catches
 - ▶ Many small grilse populations well represented (e.g. Pulmanki, Kevo, Tsars, Valjoki) where PS salmon are the ~only large females
 - ▶ Critical exploitation on the largest females in multiple populations of small tributaries?

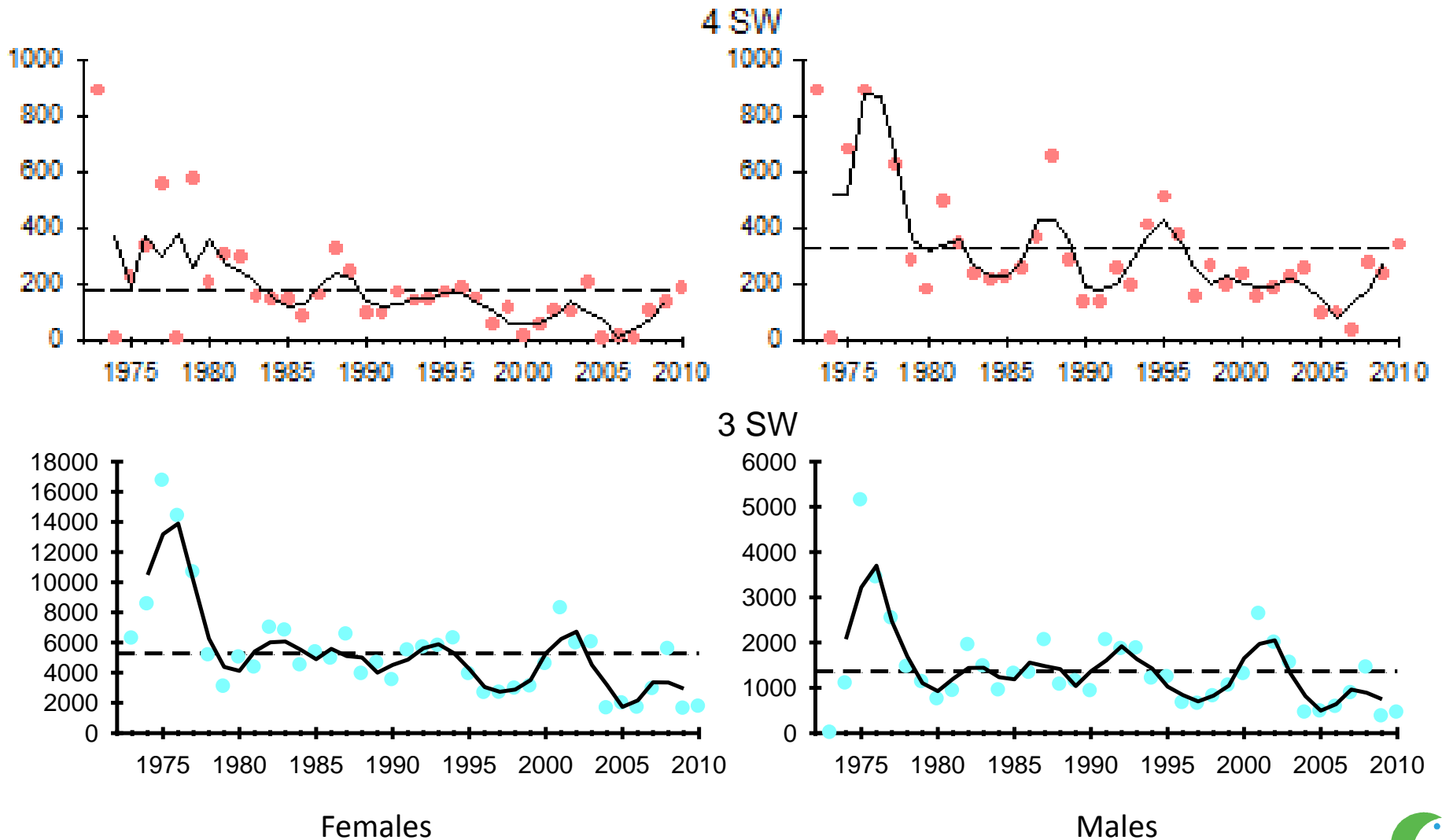


Univ Turku



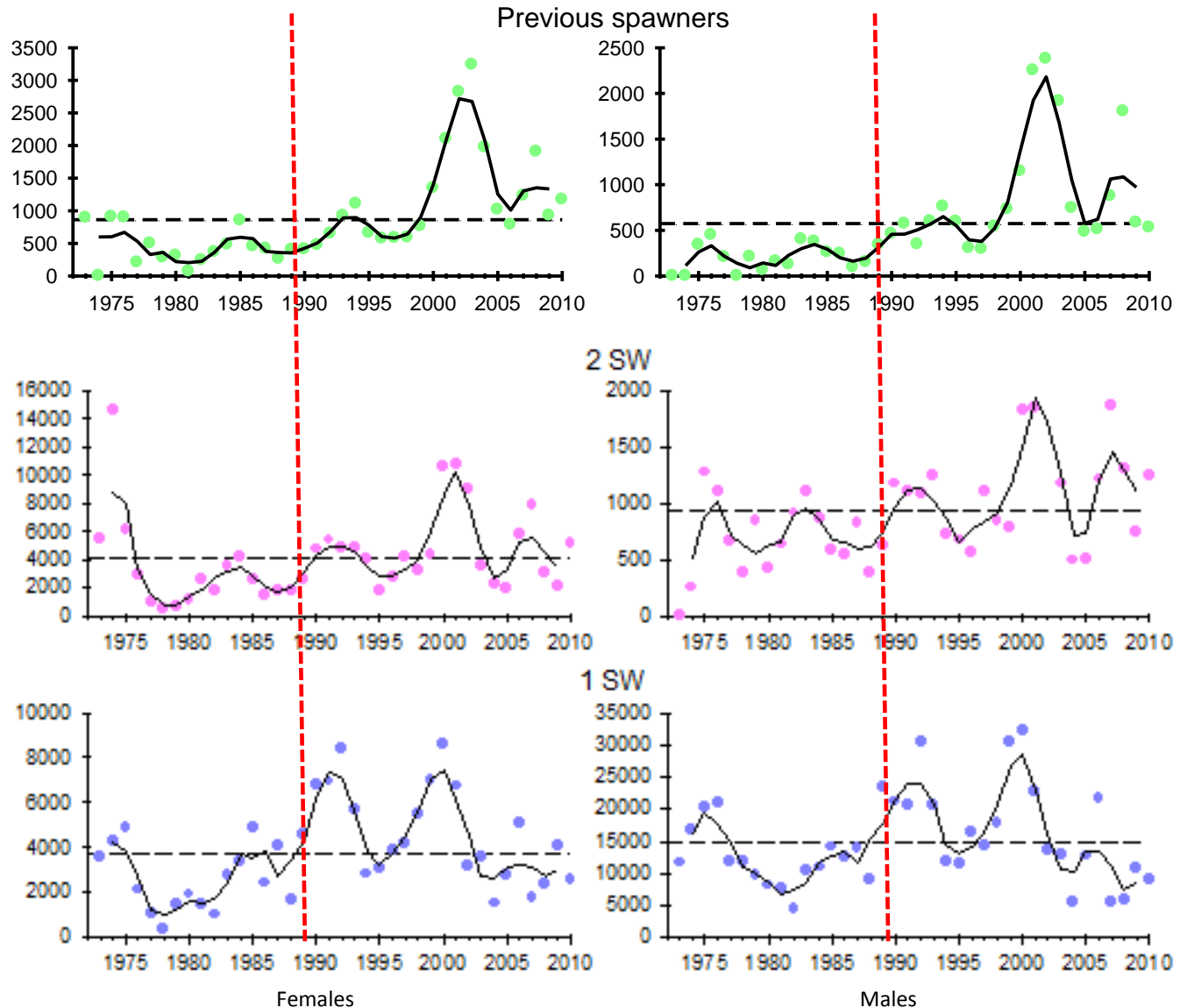
NINA

Negative trend for 3-4SW-salmon in the River Teno salmon catches



Positive trend for previous spawners; 1-2SW?

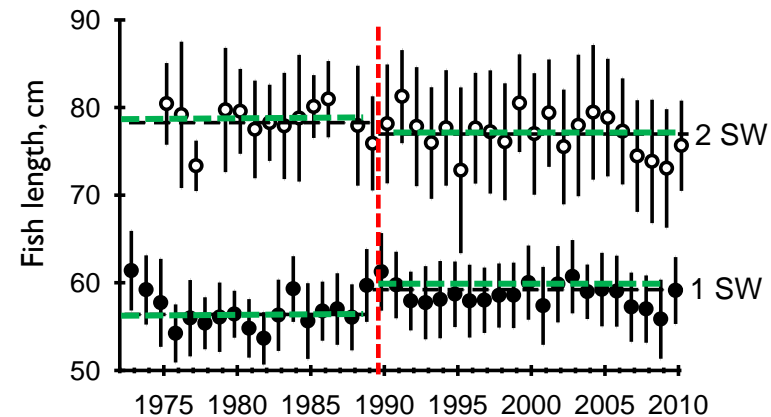
Major change in fishing regulations





Selectivity of marine drift nets

- ▶ Coastal drift nets in Norway mostly 65–70 mm knot to knot
- ▶ Especially selective for mid-size salmon, 60–80 cm (TL)
- ▶ Ban in Norway in 1989
 - Abundance of PS, 2SW, large grilse increased in the Teno
 - Size of 1SW increased (more large grilse escaped), 2SW decreased (more small 2SW escaped)

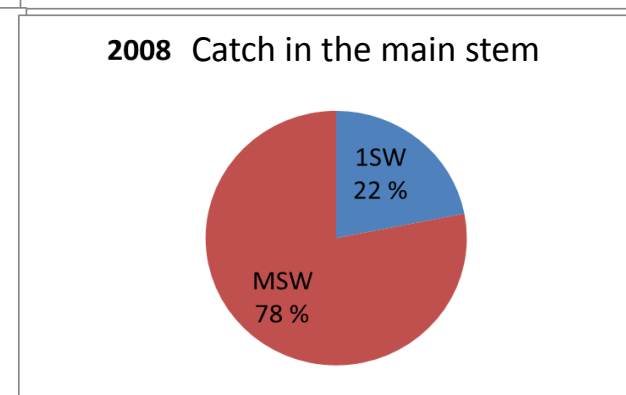
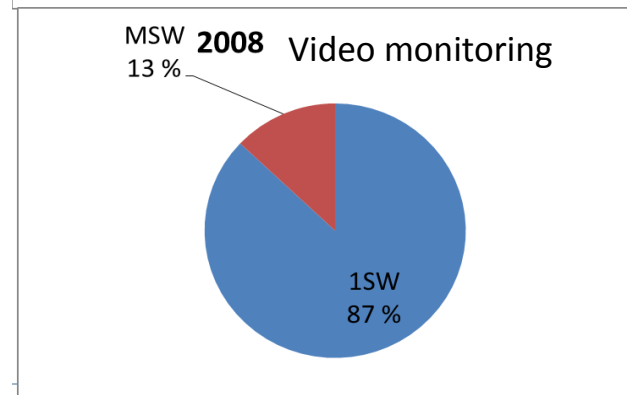
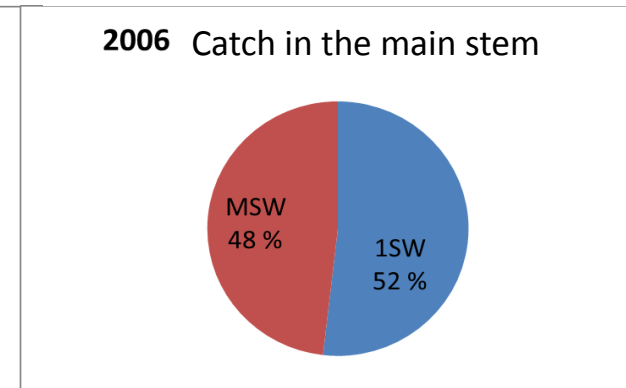
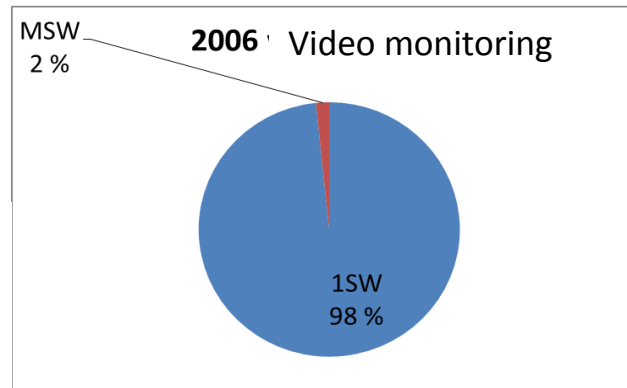
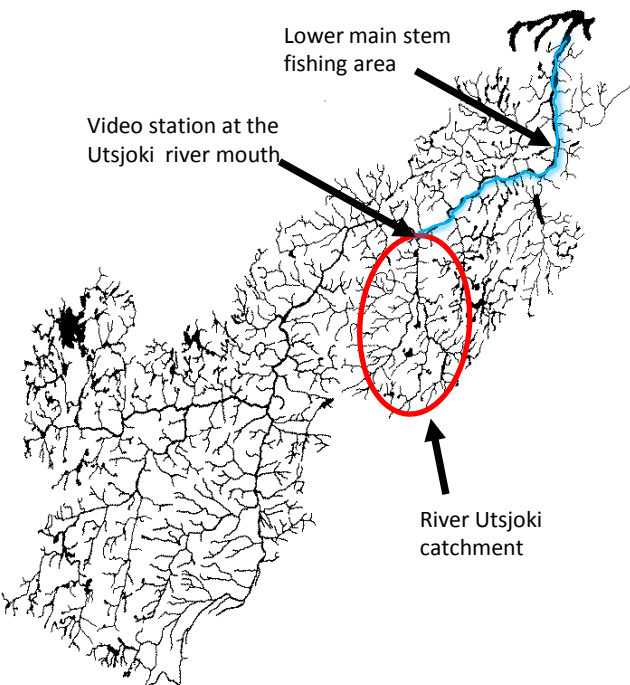


Selective fishing on River Utsjoki (tributary) salmon in the River Teno main stem?

Sea age distribution of salmon in:

Video at the Utsjoki river mouth

Teno main stem catch of salmon assigned to R. Utsjoki origin





Challenge



How to manage the mixed-stock fishery and diverse salmon stock complex in the Teno system?



Univ Turku



Run timing of 1SW salmon in the lowest part of the River Teno main stem

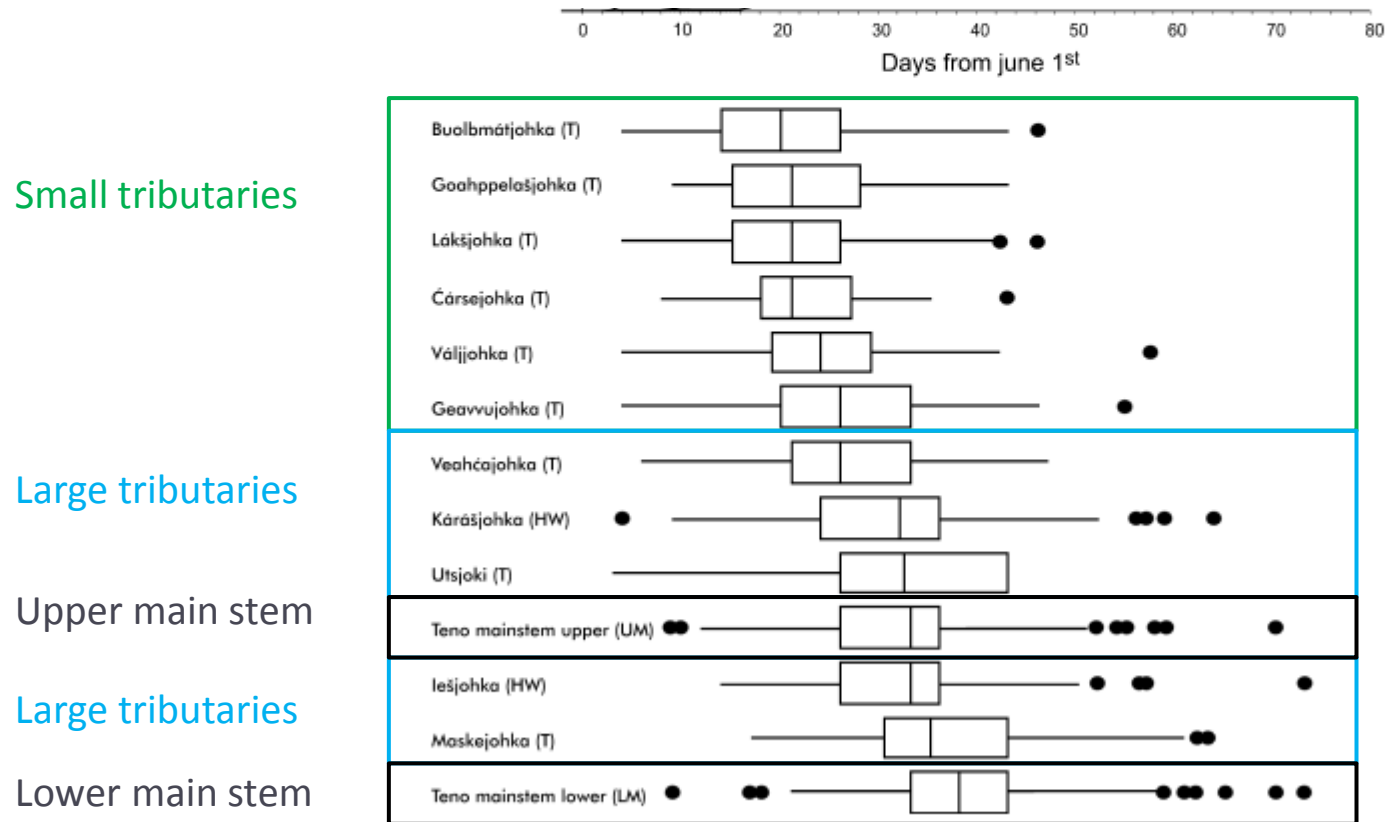


Figure 2 Variation in run timing of one-sea-winter salmon returning to the Teno River. (A) Accumulated catch percentage of tributary, upper mainstem and headwaters, the lowermost tributary Maskejohka and the lower mainstem salmon. (B) Variation in run timing of each population with a box plot (median and 25th and 75th percentiles) with whiskers to the most extreme point within 1.5 inter-quartile ranges and extreme values.

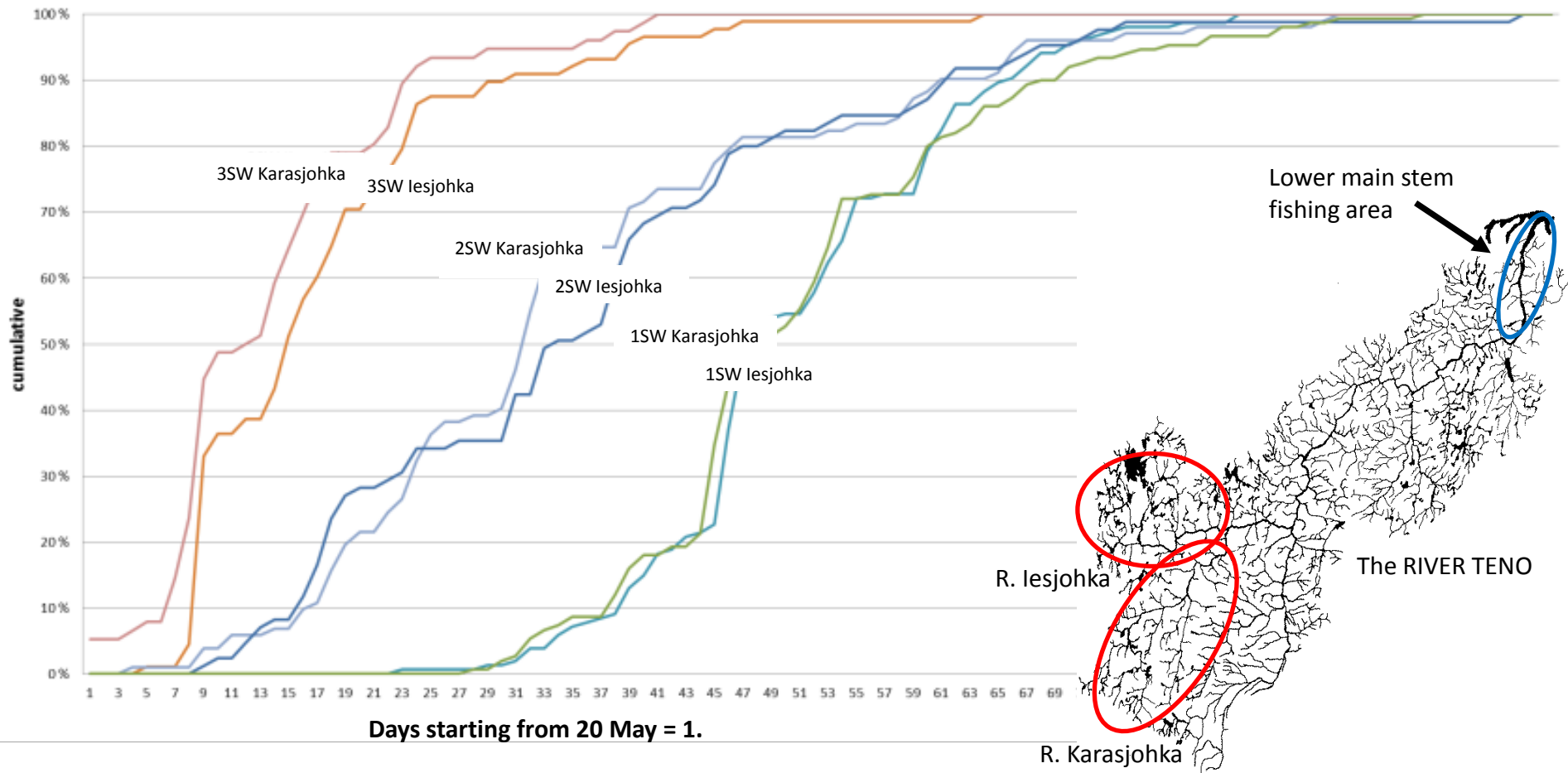
Run timing of 1-3 SW salmon originating from the rivers Karasjohka and Iesjohka, captured in the lowest part of the Teno main stem



Univ Turku




NINA





Modern genetic methods, rigorous catch data, and monitoring programmes → collection of stock status data and spatial and temporal information on population-specific exploitation in mixed-stock fisheries → tailoring of population- and life-history group-specific management actions, depending on the status of different populations

Negotiations on a new bilateral Finnish–Norwegian fishery agreement for the River Teno, started in 2012

- 
- A wide river flows through a valley with forested hills in the background. In the middle ground, a long, narrow island of reddish-brown rocks or sediment extends across the water. Several small boats are visible on the river; one is in the foreground on the right, and others are further away on the left. The sky is overcast.
- ▶ Management will be flexible, adaptive, knowledge (science)-based and population-specific
 - ▶ Decision structure (NASCO):
 - ▶ Criteria for stock status (conservation limits) for all populations
 - ▶ Monitoring the stock status: spawning stock size and diversity
 - ▶ Pre-agreed management actions, effective automatically when criteria are not met



Concluding remarks

- Large variety of life histories and genetic groups in the Teno salmon
- Diversity improves resilience and economy (!?) – worth safeguarding
- Management and conservation should be population- and life history-specific → Challenges! Opportunities!

