Project information

Keywords

Tana salmon, Barents Sea, stable isotope signatures

Project title

Salmon at sea in a changing world: Variation in stable isotopes and marine growth zones in Tana salmon scales during 35 years, related to changes in marine physical and biological conditions

Year

2017

Project leader

Martin-A. Svenning

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)

69-80o N and 12-49oE

Participants

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UIT: Nigel Yoccoz

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University of Waterloo, Canada (UW): Mike Power

Flagship

Fjord and Coast

Funding Source

Norwegian Research Council

Fjord and Coast

NINA

Summary of Results

The main objective was to identify the long-term (40 year) patterns of SIA (δ13C and δ15N) and marine growth in Tana salmon (collected along the coast of northern Norway, in the sea-fishery 2011-2012) with the long-term monitoring of physical and biological data from the Barents Sea.

Based on a genetic baseline developed from 185 separate rivers in North Norway and Russia, we have identified the home river of more than 16 000 wild Atlantic salmon caught in the mixed-stock coastal salmon fishery in North-Norway, i.e. we were now able to pick out "real" Tana salmon from historical scale samples (see Ozerov et eal. 2017).

Stable isotope signatures (*^{13}C and *^{15}N) were obtained from 700 scale samples from 1SW and 3SW Tana salmon sampled annually between 1975 and 2010. For all years n=10, matching biological data as length and weight. In addition to the isotope data, relative abundance of prey species was obtained, i.e. 1) Barents sea age-0 abundance indices for capelin, cod, haddock and herring, 2) Barents Sea cod catches, 3) Barents Sea capelin estimated abundances ages 1 to 5 and total biomass and 4) Krill biomass (missing 2002). Further, climate and temperatures were also included, i.e. Atlantic multidecadal oscillation (AMO), Hurrell North Atlantic oscillation index (NAOI), Arctic oscillation index (AO), Monthly SST values for the Kola Section Transect and Sea ice extent in the Barents Sea in April.

Mean annual *^{13}C and *^{15}N signatures of Tana salmon scales for all sites ranged from approximately –18.5‰ to –16‰ and 10.5–15‰, respectively (Fig. 1). The variation in *^{13}C for both 1SW and 3SW salmon is positively correlated with abundance of capelin in the Barents Sea (r^2>0.37). Further, *^{15}N, significantly correlated with

abundance of age-0 herring (r^2>0.15). Still, prey availability in the Barents Sea does not explain majority of the observed variation in Tana salmon scale isotopes. Correlations with the AMO, AO and NAOI, either annual or seasonal indices were almost exclusively insignificant. The sole exception, however, was the correlation for 1SW salmon *^{13}C and the Arctic oscillation index in winter (r= -0.332, *P* =0.048). Thus, we conclude that climate indices do not seem to have any strong explanatory power. Of interest, when correlated amongst themselves, the AMO indices correlate very strongly with the Kola Section Transect (KST) with virtually every annual or seasonal version of the AMO correlating the annual or seasonal version of the KST. Correlations of *^{15}N with the Kola Section Transect at 0-50m and 0-200m were much more encouraging, with several significant correlations, for instance KST from January to March (r^2=0.5). Correlations (*^{15}N) were, however, consistently stronger and more prevalent for the 1SW data. These correlations are positive, suggesting warmer temperatures lead to higher *^{15}N values.

Table 1 *Correlations between 1SW (upper) and 3SW (lower) salmon isotope values and the biological data. If coloured green, the same correlation is significant in the 1SW data. If coloured yellow, the correlation is unique to the 3SW CapeX = abundance of age-X capelin, Cape0 = age-0 etc., Ctotal = total biomass, CTSB = total spawningBM, CMSB = total m BM, CRecruits = tot.num.rec., catch=tot.BM.catch; Cod0 = abundance of age-0 cod, Herr0 = abundance of age-0 herring, Krill = Krill biomass).*

Table 2 *Correlations between 1SW (small)/3SW (large) salmon isotope values and temperatures (Kola Section Transect). As above (Table 1), if coloured green, the same correlation is significant in the 1SW, or if coloured yellow the correlation is unique to the 3SW data.*

Figure 1 Correlation between mean annual *^{15}N (left) and *^{13}C (wright) for 1SW and 3SW Tana salmon (1975-2010).

Highlights:

- Stable isotope signature, *^{13}C, in Tana salmon is significantly positively correlated with capelin catches in the Barents Sea (1975-2010) for both 1SW (37 %) and 3SW salmon (32.5 %)

- Stable isotope signature, *^{15}N, in 3SW Tana salmon is positively significantly correlated with abundance of age-0 herring (15.2 %)

- Stable isotope signature, *^{15}N, in 3SW Tana salmon is significantly positively correlated with the Kola Section Transect, i.e. with Barents Sea water temperature

Master and PhD-students involved in the project

No master students involved (2017).

For the Management

We have produced extensive genetic baseline data, both to pick out Tana salmon in the coastal sea fishery (see Ozerov et al. 2017) and to pick out population segments in Tana River (see Vähä et al. 2016). The strong genetic structuring among salmon populations, both among Barents Sea rivers and within the Tana river systems, allowed for accurate stock identification of individuals and enabled assessment of stock compositions contributing to the mixed-stock fisheries along the North-Norwegian coast and within the Tana river. Thus, the biological knowledge gained from this study is essential for explaining the impact of the selective fishery on the Tana salmon, and clearly imply that the salmon stocks originating from the different tributaries in Tana, must be treated separately, to achieve a proper future management of Tana salmon.

Published Results/Planned Publications

Ozerov, M., Vähä, J-P., Wennevik, V., Svenning, M-A., Vasemägi, A., Diaz Fernandez, R., Unneland, L., Haapanen, K., Niemelä, E., Falkegård, M., Prusov, S., Lyzhov, I., Rysakova, K., Kalske, T. & Christiansen, B. 2017. *Comprehensive microsatellite baseline for genetic stock identification of Atlantic salmon (Salmo salar L.) in northernmost Europe*. ICES Journal of Marine Science, **74** (8), 2159-2169.

Svenning, M-A. (editor). "*The fight for the future of Tana salmon*" ("*Kampen om Tanalaksen*"), Ottar-hefte, juni 2017, 51 s (in Norwegian).

Svenning et al. *Stable isotope analysis of long-term marine feeding signatures of Atlantic salmon in the Barents Sea.* Still under preparation. Planned submitted before mid-February 2018.

Erkinaro et al. Variat*ion in synchrony of Atlantic salmon abundance in Barents Sea rivers within a 40 year period: influence of fishery and environmental factors*. Planned submitted before mid-January 2018.

Communicated Results

Workshop for the project was arranged in Tromsø 3-5. October 2017 and the last one will be arranged in Oslo in February 2018.

Interdisciplinary Cooperation

No direct inter-disciplinary cooperation so far.

Budget in accordance to results

This application to the Fjord and Coast flagship (FCF) is partly based on a project founded by the Norwegian Research Council (SALMAZE; 2015-2017). The funding from NRC, however, was reduced by 18.1 %, and the funding from FCF has been very important to achieve the project goals. In addition to the funding from FCF, the project has also been funded by NINA.

Could results from the project be subject for any commercial utilization

No

If Yes

No.

Conclusions

One base of this project is that we have identified the home river of more than 16 000 Atlantic salmon caught in the mixed-stock coastal salmon fishery in North-Norway. Thus, we can estimate the amount of the different Atlantic salmon river stocks contributing to the sea salmon fishery, and start developing a temporal and spatial stock-migration model for the largest salmon stocks in the Barents Sea (see Ozerov et al. 2017). Based on the latest genetic analyses (see Vähä et al. 2016) we may now estimate the historical exploitation rate of the more than 30 tributary stocks in Tana, and used this information in a future sustainable management of Tana salmon.

The results in 2016 show that sea stable isotope signatures in Tana salmon (1975-2010) is positively correlated to prey fish abundance (*^{15}N and *^{13}C) and water temperature (*^{15}N) in the Barents Sea. Thus, both biological and physical characteristics of the Barents Sea, will influence of the future development of Tana salmon.

Further, marine growth seems to vary both among the different Barents Sea salmon stocks, as well as between some of the Tana river stocks, indicating stock-specific differences among salmon stocks.