Using environmental DNA (eDNA) to estimate the distribution of pink salmon

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eDNA as a monitoring tool

Analyses of environmental DNA (eDNA) is a cost-efficient method for detecting single species and/or monitoring biodiversity in water samples collected in rivers and lakes (Taberlet *et al.* 2018). eDNA consists of genetic material such as saliva, faeces, scales, hair, etc. that are shed to the environment by living organisms. By filtering water, we can collect this eDNA and use genetic analyses to identify the species living in the environment. Comparisons with conventional methods show that analyses of eDNA often are more sensitive in detecting rare species and can recover a larger part of the total biodiversity in each locality (Valentini *et al.* 2016). The method has also proven very effective in monitoring invasive species (Fossøy *et al.* 2019; Sepulveda *et al.* 2020; Taugbøl *et al.* 2021). At the Centre for Biodiversity Genetics (NINAGEN) at the Norwegian Institute for Nature Research (NINA), we have developed genetic tools for analysing eDNA and implemented standard protocols for many aquatic organisms (Fossøy *et al.* 2017; Taugbøl *et al.* 2017; Fossøy *et al.* 2018; Taugbøl *et al.* 2018; Fossøy *et al.* 2019; Wacker *et al.* 2019). Together with colleagues at the University College in Dublin (UCD), NINA has recently verified a new genetic eDNA marker for detecting pink salmon *Oncorhynchus gorbuscha* (Gargan *et al.* 2021). Several studies suggest that eDNA-concentrations also can reveal quantitative information on fish biomass (Rourke *et al.* 2021), hence making this tool suitable for monitoring population changes.

Monitoring the distribution of pink salmon in river Tana using eDNA

The river Tana represents one of the largest catchments in Norway and supports the largest Atlantic salmon *Salmo salar* population among Norwegian rivers (VRL. 2022). However, the Tana salmon stocks have declined dramatically in recent years (Anon. 2021) and salmon fishing have been ceased since 2021. At the same time the invasive pink salmon have increased explosively, particularly in odd years. From the occasional catch of tens or hundreds of fish per year during the last decades, ca. 5.000 pink salmon were assumed to enter the river in 2017 and 2019, more than 50.000 in 2021 and 170.000 individuals in 2023. Conventional monitoring has traditionally been limited to a few sites, and increasing the number of sites is costly. eDNA has therefore been implemented as a cost-effective alternative since 2019, monitoring 24 different tributaries covering most of the Tana Catchment (Fossøy 2022). Whereas pink salmon was detected in 6 out of 19 localities in 2019, it was detected in 15 out of 24 localities in 2021 and 22 out of 24 localities in 2023, showing a large increase in DNA-concentration. In comparison, the eDNA-concentration of Atlantic salmon has remained quite stable across the same period. The river Tana was also sampled in one even year, in 2022, where only 4 out of 24 localities showed sign of pink salmon (**Error! Reference source not found.**). Results from this and other studies suggest that eDNA can be used for monitoring changes in abundance using longitudinal data, at least within localities or rivers.

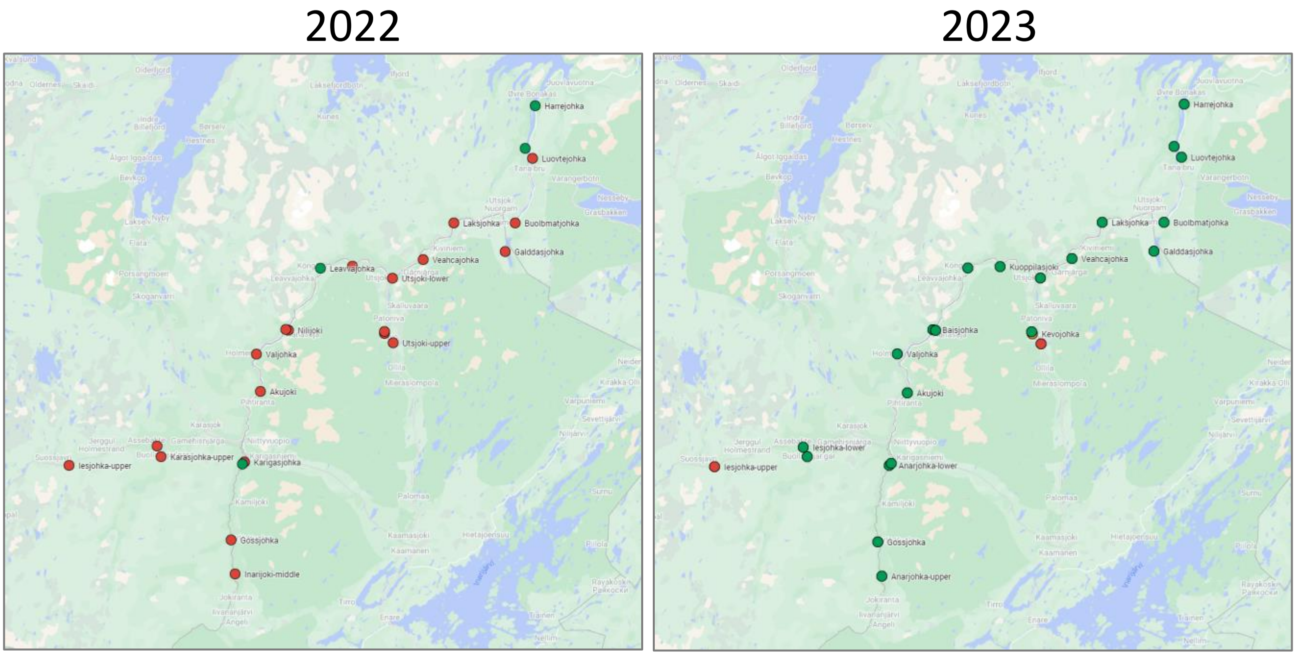

Figure 1. Map showcasing the difference between an even and odd year in the river Tana. Green circles show presence of pink salmon eDNA and red circles show negative results.

Monitoring pink salmon across Europe using eDNA – the PINKTrack project

This EU-funded project intends to address the concern about pink salmon invasion under the beneficiary of NASCO, through a consortium comprised of state agencies and research institutes based in EU jurisdictions which is supported by technical expertise from Norway. The project will undertake work to better understand the extent of occurrence of pink salmon in EU waters through the use of eDNA, which will enable it to elucidate temporal and geographic patterns of spread and provide an 'early warning system' of their presence to inform appropriate management responses. The project includes development of standardised protocols for eDNA sampling and standardised approaches for the analyses of eDNA with the intention that such methods can continue to be utilised in routine national monitoring programmes after the project concludes. This includes preparatory work to evaluate different approaches to sampling and analyses and their effect on the results for detection. Establishment of a repository of eDNA samples collected during the project and in subsequent years will be made to provide valuable material for future assessments as analytical technologies develop.

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