CoASal

Summary report

Conserving our Atlantic salmon as a sustainable resource for the people in the north.

CoASal 2020 – 2022

County Governor of Troms and Finnmark
Department of Environmental Affairs

CoASal

Summary report

County Governor of Troms and Finnmark
Department of Environmental Affairs


Eero Niemelä

CoASal

SUMMARY REPORT

AUTHORS: Abdullah Sami Madhun, Anti Vasemägi, Eero Niemelä, Mikhail Ozerov, Vidar Wennevik
GRAPICH DESIGN AND TECHNICAL PRODUCTION: Hannu Tikkanen, Tikkanen Workshop
PRINTING: Painotalo Seiska Oy, Iisalmi Finland 2024
DESIGN AND PRODUCTION OF MAPS AND GRAPHS: Mikhail Ozerov, Vidar Wennevik, Anti Vasemägi, Eero Niemelä, Yara Nieuwenhuis
PHOTO CREDITS: Copyright holders of the photographic material mentioned under each photograph
TECHICAL PRODUCTION MANAGEMENT: Yara Nieuwenhuis, Tiia Kalske, Malin S. Høstmark

This publication is also available on the internet: www.statsforvalteren.no/coasal
This report was prepared in English and translated into Norwegian and Northern Sami.
The English version constitutes the official version.

ISBN 978-82-94021-24-6 Printed
978-82-94021-25-3 PDF

Eero Niemelä

Contents

Preface

Norwegian, Finnish and Swedish partners began a collaboration in 2020 through the Kolarctic CBC ENI project 'CoASal' *Conserving our Atlantic salmon as a sustainable resource for the people in the North; fisheries and conservation in the context of growing threats and a changing environment (KO4178)*. The project aimed to document and examine the new salmon sea fishery regulations and to study the effects of growing threats Atlantic salmon populations face today with climate change, growing cage culture industry and emerging diseases.

Throughout our project, local fishers have been of immense help, as they have contributed greatly by collecting scales and noting basic information about every salmon they have caught. Thanks to these fishers we have been able to gather a lot of vital information about our Atlantic salmon, and without them the CoASal project would simply not have been possible.

- **We updated the existing genetic map from 2013**
  The genetic map shows us that the genetic structure and genetic variation of the salmon stocks are stable over time. We now know more in detail, which salmon stocks are being harvested in different regions at different times during the allowed fishing season; genetic stock identification (GSI) results show that catch composition during the first fishery period (June) were more diverse and consisted of a mix of stocks from a wide geographical area, whereas during the second fishing period (July-early August) more local salmon stocks are present in the coastal catches and consequently harvested on.

- **We observed a drastic decline in Tana salmon stocks in the coastal fishery**
  Generally, most of the salmon stocks investigated have stable stock proportions in the coastal catches, between this recent and the previous


Eero Niemelä

study (Kolarctic Salmon 2011-2013). However, we observe a drastic decline of Tana salmon stocks contributing to the coastal catches throughout the project area. Moreover, we also observe a decline of North-Western Kola Peninsula salmon stocks (including River Kola) contributing to the coastal catches in the Varangerfjord and Sør-Varanger areas.

- **We elaborated on possible long-term consequences to salmon stocks due to the rising of temperatures**
  Higher river temperatures in summer can cease the salmon migrations into or within the rivers. Juvenile salmon loose territorial behavior, stop feeding and become more exposed to predation. Increased water temperatures might also cause disease outbreaks. Earlier ice-breakup in spring may cause mismatch between migration of smolt to the sea and when sea feeding is not optimal.

- **We studied and assessed the risk of the spreading of both a specific salmon parasite *(T. bryosalmonae)* and viral diseases, both due to a warming climate and salmon cage culture**
  The myxozoan parasite (*T. bryosalmonae*) screening compared to the temporal patterns over 10 years revealed no signs of contemporary spread of the parasite to previously uninfected rivers. However, since the Proliferative Kidney Disease (PKD) caused by *T. bryosalmonae* is temperature-dependent, a warming climate can enhance the spread and severity of the disease. Viral disease outbreaks in salmon cage culture may lead to increased infection pressure on wild fish populations. There is an increasing public concern of this negatively impacting wild salmonids in Norway. Screening of wild juveniles from the rivers in the study area showed a very low prevalence of viruses that are prevalent in salmon farming.

Introduction

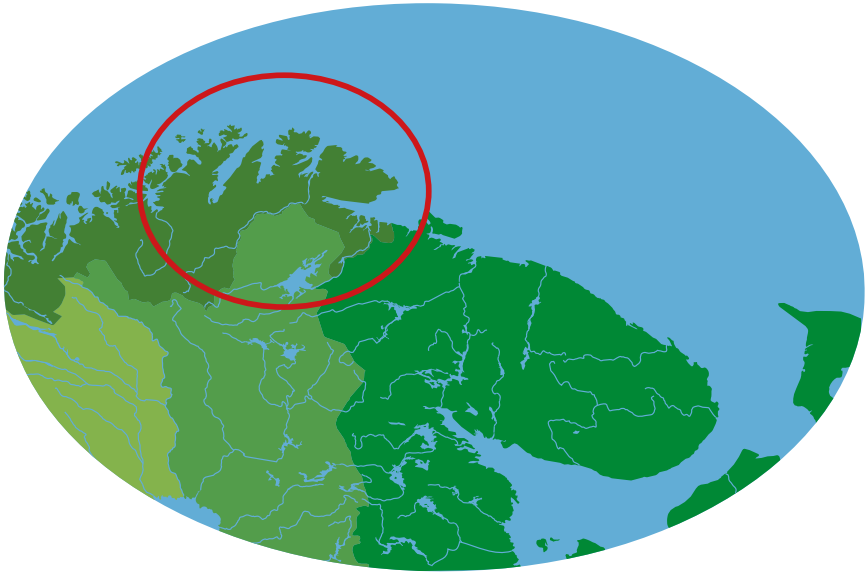
Atlantic salmon has played an important role within northern history and culture for centuries and has long been a symbol of healthy and vital ecosystems. The salmon's fascinating ability to undergo great physiological adaptations to change its habitat from freshwater to seawater, while also undertaking huge migrations across thousands of kilometers from their feeding grounds to the coastal areas while also being able to accurately return to their river of birth makes it almost impossible to not be fascinated by this amazing fish.

Despite implementation of stronger conservation and management measures and international and bilateral agreements to protect both salmon stocks and their habitats, the current situation for wild salmon stocks is alarming, and most likely caused by a range of different factors. Norwegian, Finnish, and Swedish partners have cooperated between 2020 and 2022 in Kolarctic CBC ENI project 'CoASal' – *Conserving our Atlantic salmon as a sustainable resource for the people in the North; fisheries and conservation in the context of growing threats and a changing environment (KO4178)*. This project has addressed the currently alarming situation regarding wild salmon stocks in Northern-Norway and studied some of the likely multiple factors that can be the cause of the observed salmon stocks decline.

In the CoASal project we have studied and documented salmon biology and ecology, origin, and the catch composition in the mixed-stock coastal fisheries. Another major threat to the wild salmon is the transmission of various pathogens from farmed fish to wild salmon. Outbreaks of diseases can be driven by global increase of temperatures. The present knowledge about pathogen transmission and disease outbreaks is limited, emphasizing the importance of conducting research within this field.

We have also aimed to raise awareness and share knowledge while enhancing communication between local fishermen, fishery managers and scientists in Norway, Finland, and Sweden.

Atlantic salmon is a common nature resource and an icon of viable and healthy ecosystems. It is therefore of great importance for local communities and traditions. As nature does not follow man-made borders, cross-border scientific collaboration is necessary to obtain relevant knowledge and find the best solution as to how to help conserve our Atlantic salmon stocks as a sustainable resource, and to take care of and contribute towards maintaining healthy wild salmon stocks for the future generations, and for the viability and attractiveness of the Arctic region.



The CoASal project had multiple aims.

- To document and investigate possible changes in the coastal salmon fishery due to new regulations.
- To document and examine salmon ecology, origin, and the catches composition in the mixed-stock fisheries.
- To examine major threat factors to wild salmon stocks in the Barents region: effects of climate change, growing cage culture industry and emerging diseases (PKD and viruses).
- To raise awareness and knowledge, and enhance communication between local fishermen, fishery managers and scientists in Norway, Finland, and Sweden.

The project follows up and builds upon the unique results from the "Kolarctic salmon (KO197)" project (2011-2013).

Chapter 1
A better common understanding of our rich fishing traditions

Salmon fishery at sea has been a long-term tradition in Finnmark. Even during present days, it provides an income and a source of healthy food for people living in coastal areas. The Atlantic salmon not only serves as an economical and nutritional resource, but also has a long cultural history within Northern coastal areas and its residents.

In order to gain a better understanding of these traditions, collaboration between scientists and fishers is of great importance. Local fishers have been of great help throughout the CoASal project, as they have contributed by collecting scales and noting basic information about each salmon they have caught.

Salmon fishing has been, and still is an important activity within Sami culture. Alongside the rivers, salmon fishing often serves as an additional resource besides agriculture, small scale farming, fjord fishing and other forms of labor. The activity of fishing salmon also creates the opportunity to build connections within the local environment, as well as it can help create stronger bonds within families, helping to maintain and pass on traditional methods to the next generations.

In recent years, the numbers of sea salmon fishers have declined along with the numbers of salmon fishing sites. In Finnmark, salmon catches from the sea salmon fishery have steadily declined from 250 tonnes a year during the early 2000's to approximately 50 tonnes in 2021. This decline is caused by the shortening of the fishing season and fewer fishers catching salmon along the coast together with the declining trend in salmon stocks abundance.

- **Fishing prohibited**
  In the years 2021 and 2022 salmon fishing was prohibited in the River Tana, Tanafjord and in its adjacent areas in an attempt to improve salmon stocks for Tana salmon. Over the years salmon catches in Finnmark have been distributed quite evenly between the four salmon areas: Alta, Hammerfest, Tana and Varanger.

- **Distribution between the use of bend nets and bag nets**
  During 2021, the last year that the use of bend net was legal, 50% of the salmon caught at sea in Finnmark was caught in bend nets. During the period from 1993-2017 60-80% of the salmon catches were caught with bend nets while the remaining catch percentages were caught with bag nets.

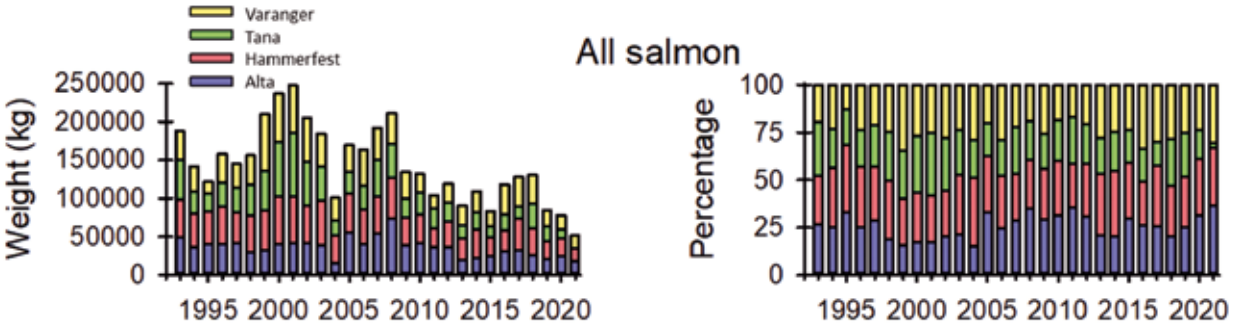


Figure 1. Sea salmon catches in Finnmark, the years 1993–2021.

Bend net.

Bag net.

Chapter 2
The genetic map from Kolarctic Salmon (2013) has been updated

Genetic stock identification (GSI) is a method that aids in estimating an individual's population of origin and stock proportions in the catches. This is achieved by comparing the genetic profile (based on several genetic markers) of an individual with those of reference populations from a genetic juvenile salmon baseline.

Recently we have supplemented the previously generated genetic baseline for GSI of Atlantic salmon caught at sea by sampling and analyzing juvenile salmon parr (0 – 4 years old) from 27 different rivers and river locations in Northern Norway with the focus on the cross-border area between Norway and Russia. In addition, 6 rivers draining into Reppar- and Alta-fjords have been added to the previously genotyped genetic profiles.

- **Sampling in the years 2020 and 2021**
  During the ordinary fishing seasons in the years 2020 and 2021 adult Atlantic salmon were caught by local fishers using commercial fishing gear (bend nets and/or bag nets) along approximately 550 km of the coast of Finnmark county. After implementation of quality control procedures, 2857 coastal samples were included to identify their river/region of origin by applying GSI analysis.

- **More than 2000 new samples**
  In total, genetic profiles of 2 384 newly analyzed samples were combined with the previously generated baseline data of 12 860 specimens resulting in a total of 15 244 individuals included in the updated Atlantic salmon genetic juvenile baseline for further analysis.

- **Genetic structure and variation also stable in updated baseline**
  The genetic structure and genetic variation in the updated baseline remained stable, showing the same major and minor population genetic subdivisions as in the previous baseline version. The level of genetic variation among populations remained similar to what was observed earlier, which was in line with the low level of genetic variation due to temporal component.

- **Stable stock variations**
  The genetic map shows us that the genetic structure and variation of the stocks are stable. We know more about which salmon stocks are being fished from in different regions at different times during a season.

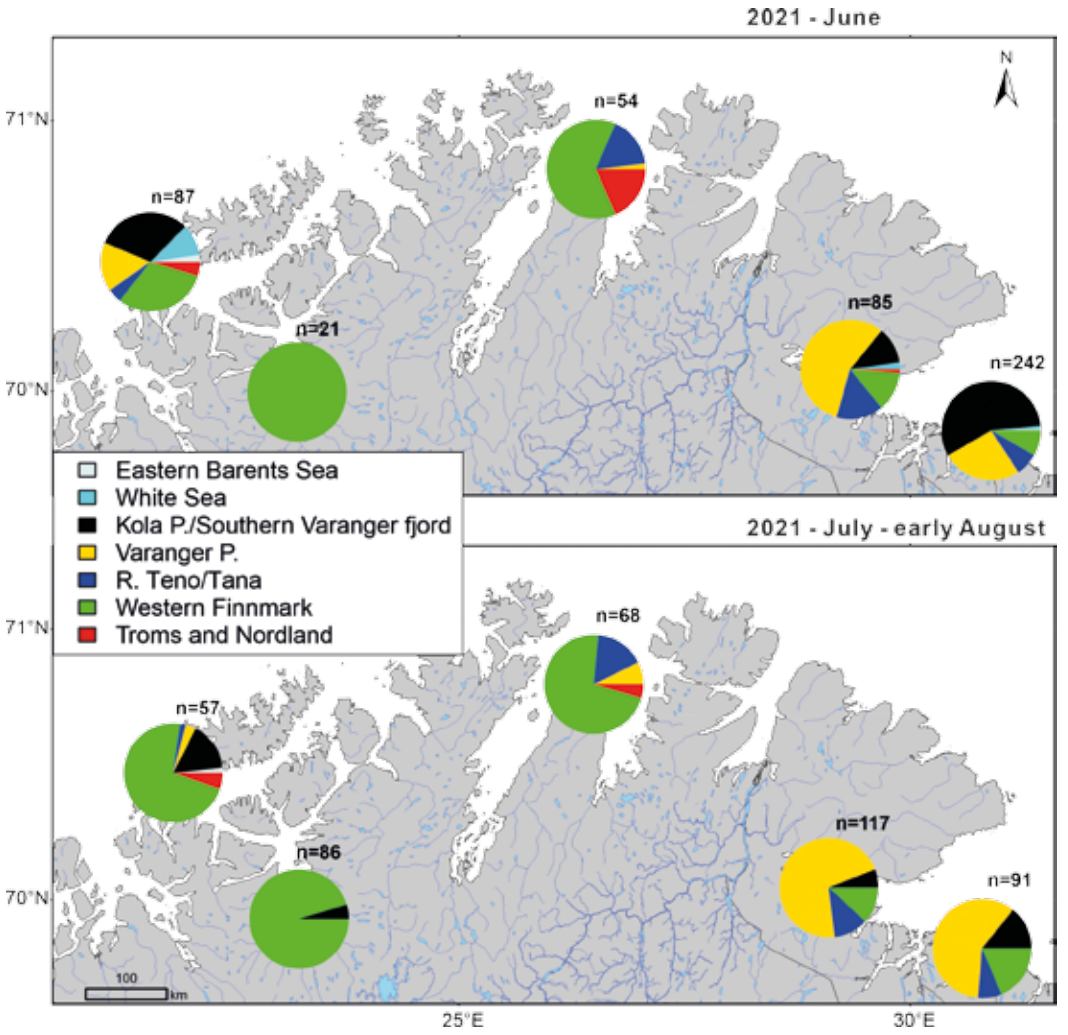


Figure 2 a and b. GSI results show that catch composition during the first period (June) were more diverse and consisted of various populations from a wide geographical area, whereas during the second period (July–early August) local salmon populations contributed to the fishery catches at a larger extent.

Chapter 3
Drastic decline in Tana salmon stocks

GSI research observations show that many rivers and river locations promise a relatively stable stock composition, specifically in Sør-Varanger, Nesseby-Vadsø, Nordkapp, Lebesby-Porsanger, Hasvik, and Alta fishery areas.

However, there has unfortunately been a drastic decline of Tana salmon contribution to the fishery in Tana fjord and in its adjacent fishery areas. During the period between 2008 and 2012, the stock composition in Vardø, Båtsfjord, Berlevåg and Gamvik fishery area was mainly characterized by a relatively even contribution of salmon from northern Varanger Peninsula rivers and populations of River Tana system. However, in 2020 the proportion of Tana populations in the catches was exceptionally low.

The River Tana is an incredibly well-known salmon river, being the biggest of its kind and recognized for its excellent fishery and important role within river-Sami culture. The drastic decline in Tana salmon stocks therefore raises big concerns and questions regarding the possible cause(s) to these changes.

- **Decreased nearly 10 times in certain fishery areas**
  In 2008 Tana populations made up 47.4% of salmon catches in Tana fjord and in Vardø, Båtsfjord, Berlevåg and Gamvik fishery areas, while in 2020 the Tana populations only made up 4.7% of the catches in the same fishery areas. This means that in 12 years' time the proportion of Tana salmon populations have concerningly decreased by nearly 10 times.

- **Also decline in overall proportion of Tana origin fish in Tana fjord catches**
  Similarly, in 2020 the overall proportion of Tana origin fish in Tana fjord catches was approximately 60%, which was significantly lower compared to the previous years (ca. 80-90%). Generally, we observed a declining trend of River Tana populations proportion in Tana fjord catches, with a decline from 89.8% in 2008 to 62.1% in 2020.

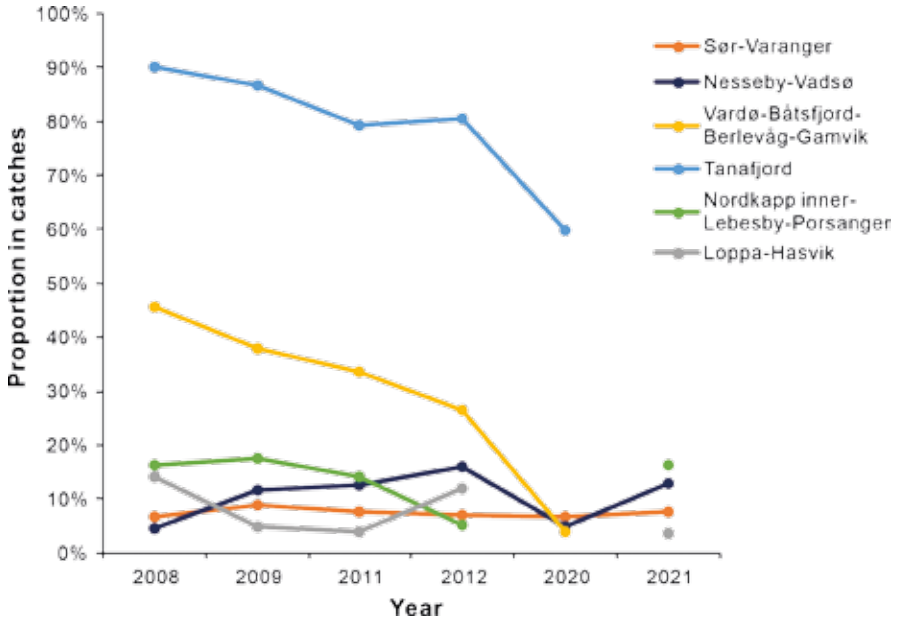


Figure 3. Contribution of River Tana salmon stocks to coastal catches in seven fishery areas the years 2008–2021.


Eero Niemelä


Eero Niemelä

Chapter 4
Salmon stocks may in the long-term be negatively affected by increasing temperatures in air and water

The Finnish Meteorological Institute has been following air temperatures and other weather parameters at Kevo meteorological station (Utsjoki) since 1962. Graphical summaries show large annual and seasonal variations in both air and running water temperatures. Despite these large variations, there has been a visible increase in mean air and water temperatures in August from the late 1970's and until present time. In recent decades daily water temperatures in River Tana have exceeded 15°C more frequently than in the 1960's. Significantly warm water temperatures reaching up to 25°C have been measured during the last years. Naturally, this raises the question of whether these changes in weather conditions, air temperatures, and precipitation could be affecting salmon stocks.

Rising air temperatures and low water levels in July, happens simultaneous with main migration period for the small salmon (one sea winter fish) into the rivers, this can hamper the migration. If the water temperatures are too high, the juvenile salmon can lose their territorial behavior. Further, they tend to move more, their appetite changes and their feeding ceases, which might expose them to increased predation. High water temperatures also seem to affect the rod fishery, as salmon does not bite lures and flies due to the loss of appetite. Lower water levels might make gillnet and weir fishery more efficient.

- **Disease outbreaks**
  In the year 2018, air temperatures at Kevo station reached 32°C and caused the water temperature in River Tana to increase close to 25°C. These kind of surprising increases in water temperatures might cause disease outbreaks.


Erling Svensen

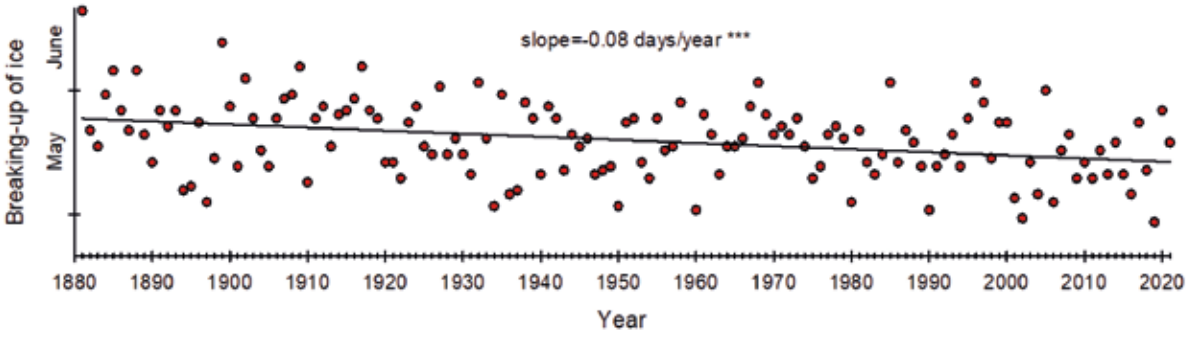


Figure 4. Ice breaking-up dates in the River Tana in Levajohka site. Regression line indicates that the ice breaking-up dates nowadays take place earlier than in the end of 1800´s in the River Tana.

Chapter 5
Some like it hot but don't mind the cold: the distribution of the myxozoan parasite *T. bryosalmonae* in northernmost Europe. A warming climate can enhance the spread of PKD

Global climate change is altering the abundance and spread of many aquatic parasites and pathogens. Proliferative kidney disease (PKD) of salmonids caused by the myxozoan parasite *T. bryosalmonae* is one of such emerging disorders, which is expected to increase its impact with the rise of water temperatures. Yet, distribution and prevalence of *T. bryosalmonae* in Northern Europe remains poorly characterized. Here, we studied 43 locations spread over 27 rivers in northernmost Norway and Finland to describe the infection frequency and patterns in 1389 salmonid juveniles.

- **12 out of 27 rivers**
  The causative agent of PKD was discovered in 12 out of 27 rivers (44%) and prevalence of *T. bryosalmonae* ranged from 4.2% to 55.5% in Atlantic salmon and from 5.8% to 75% in brown trout among infected rivers. In sympatric populations, brown trout was more frequently infected than salmon.
- **Warmer rivers more frequently contain *T. bryosalmonae***
  Age-specific parasite prevalence patterns revealed that in contrast to lower latitude, the infection of juvenile fish predominantly occurs during the second summer or later. Temperature monitoring over two years indicated that the mean water temperature in June was between 2.1 and 3.2 °C higher in rivers containing *T. bryosalmonae* compared to parasite-free rivers, confirming the important role of temperature in parasite occurrence.

Evaluation of kidney hyperplasia.

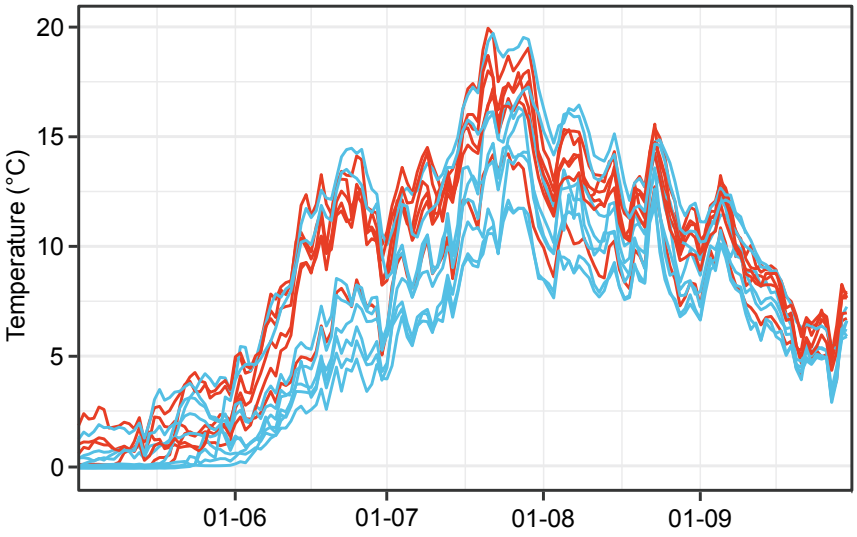


Figure 5. Water temperature profiles of fifteen rivers measured from June till October during 2020 growing season. Red and light blue lines indicate rivers where *T. bryosalmonae* was present and absent, respectively.

Temp logger.

Chapter 6
Wild juveniles have low occurrence of viral infections that are prevalent in salmon farms

Viral diseases in Atlantic salmon farming in Norway have a negative impact on the welfare of infected salmon and often cause substantial economic losses. Disease outbreaks in salmon farms may lead to increased infection pressure on wild fish populations. There is a growing public concern of this has a negative impact on wild salmonids in Norway.

- **Escapees**
  Wild salmon may be infected by viruses prevalent in salmon farming in rivers as fry or parr by virus-infected farmed escapees and spawning wild salmon. Therefore, infection status in juveniles in rivers may represent a direct indicator of infection pressure from salmon farming.

- **Climate and pathogens**
  Northern regions in Norway are experiencing an expansion of aquaculture activities along with rapid warming. The interaction between climate and pathogens could constitute a challenge for aquaculture as well as the native wild salmon stocks in the north.

- **Indications of low infection pressure**
  In the current project, wild juveniles from rivers located in northern Norway were tested for viruses prevalent in salmon farming by real-time PCR assay. ISAV (salmon anemia virus) was detected in 4 fish, while one fish was tested positive for PMCV (piscine myocarditis virus), and another fish was positive for IPNV (infectious pancreatic necrosis virus). The results show a very low occurrence of virus infection in wild juveniles collected from rivers in northern Norway. The results may indicate that wild juveniles in the rivers are exposed to a low infection pressure from fish farming in this region, so far.

- **Broader research needed for more accurate predictions**
  Time series of samples of all life stages of wild salmonids from rivers located in areas with different salmon farming intensities are necessary to better evaluate and understand the long-term effect of aquaculture on the virus infections in wild salmon populations. Such series will also enable us to assess changes in the prevalence due to increased fish farming activities, the emergence of new diseases and climate change.

Eero Niemelä

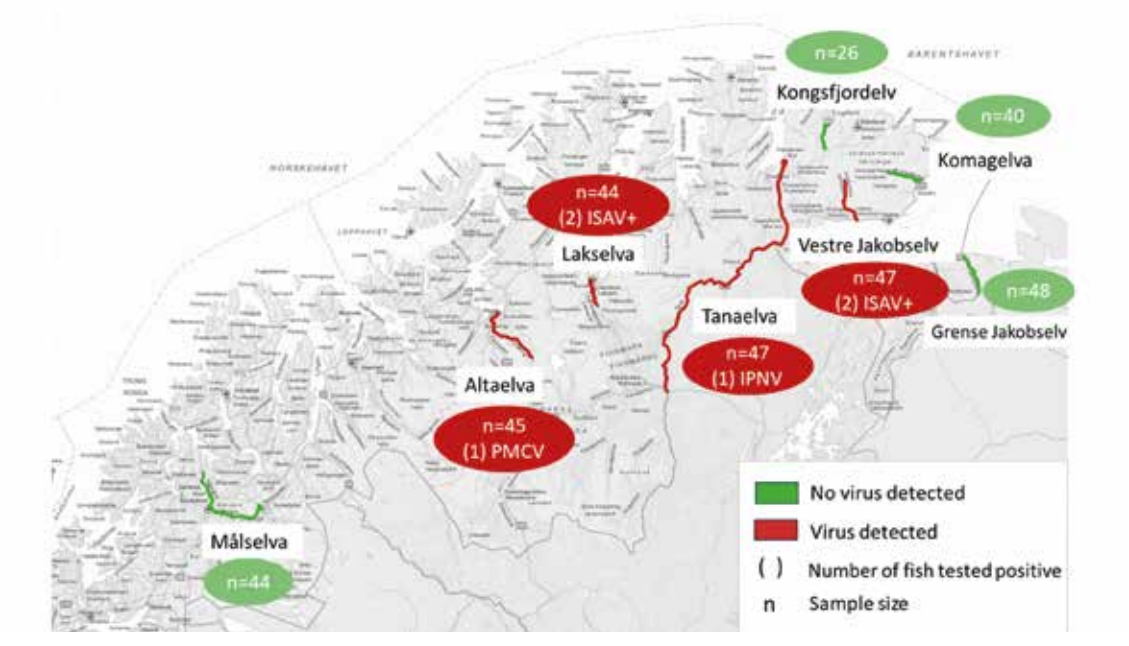


Figure 6. Map displaying results from real-time PCR assays testing for different viruses in the 8 different rivers.

Disease	Cause
PD: pancreas disease	SAV: salmonid alphavirus
HSMI: heart and skeletal muscle inflammation	PRV1: piscine orthoreovirus 1
CMS: cardiomyopathy syndrome	PMCV: piscine myocarditis virus
ISA: salmon anaemia	ISAV: ISA virus
IPN: infectious pancreatic necrosis	IPNV: IPN virus

Table 1. Disease and the cause. Viral diseases in Atlantic salmon cage culture.

Acknowledgements

The project CoASal – *Conserving our Atlantic salmon as a sustainable resource for the people in the North; fisheries and conservation in the context of growing threats and a changing environment* (KO4178) was funded through EU's Kolarctic CBC ENI programme, national funding and funding from the partners.

A special thanks goes out to local fishers who have contributed greatly by helping us gather vital information about every salmon they have caught, thus making this project possible.

This publication is funded by the Norwegian Ministry of Foreign Affairs. We also want to thank the Norwegian Ministry of Climate and Environment.

Partners and associates

Norway:
County Governor of Troms and Finnmark
Institute of Marine Research
Sør-Varanger Sea salmon fishers Association

Finland:
University of Turku, Biodiversity Unit (UTU)
Olli van der Meer Company

Sweden:
Swedish University of Agricultural Sciences (SLU)

Contact:
Norway: Malin S. Høstmark (malin.hostmark@statsforvalteren.no)
Finland: Mikhail Ozerov (mikhail.ozerov@gmail.com)
Sweden: Anti Vasemägi (anti.vasemagi@slu.se)

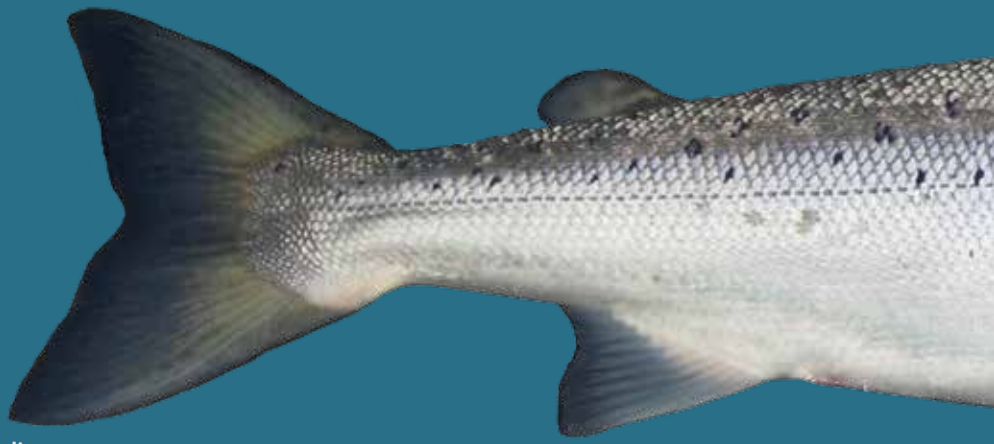
We gained a better common understanding of our rich fishing traditions

We updated the existing genetic map from 2013

We observed a drastic decline in Tana salmon stocks in the coastal fishery

We elaborated on possible long-term consequences to salmon stocks due to the rising of temperatures

We studied and assessed the risk of the spreading of both a specific salmon parasite (*T. bryosalmonae)* and viral diseases, both due to a warming climate and salmon cage culture



For more information and further reading:

www.statsforvalteren.no/coasal

Norway: Malin S. Høstmark (malin.hostmark@statsforvalteren.no)

Finland: Mikhail Ozerov (mikhail.ozerov@gmail.com)

Sweden: Anti Vasemägi (anti.vasemagi@slu.se)

ISBN 978-82-94021-24-6

Co-funded by the European Union

The project has been implemented with support from the European Union, but the contents of this publication can in no way be taken to reflect the views of the European Union.