3rd International Seminar on Pink salmon in the Barents region and in Northern Europe 2023

Abstract report

October 25th and 26th | NIBIO Svanhovd, Norway

Statsforvalteren i Troms og Finnmark
County Governor of Troms and Finnmark

Norwegian Environment Agency

M-2633|2023

The County Governor of Troms and Finnmark/ Statsforvalteren i Troms og Finnmark Statens hus, PB 700, 9815 Vadsø Norge https://www.statsforvalteren.no/troms-finnmark/	Date: 17.11.2023
	Miljødirektoratet/ Norwegian Environment Agency M-2633|2023

Title:

3rd International Seminar on Pink salmon in the Barents region and in Northern Europe 2023

Authors: The paragraphs are written by the participants and listed in the report
Edit: Tiia Kalske, County Governor of Troms and Finnmark

Summary:

The topics in this seminar report are related to the recent development of the invasion, monitoring, actions on removal of pink salmon, and effects on other fish and organisms after the increasing invasion of pink salmon.

The report with paragraphs is a collection of the topics presented during the two days.

This 3rd international seminar on pink salmon has been a good opportunity for sharing information, meeting old and new colleagues, and even finding new opportunities for collaboration and combining of resources to answer the many questions that we have, related to the pink salmon invasion.

The situation we are all in is something that has never happened before, and it is unknown what the future will look like in our rivers, potentially across the North Atlantic. The seminar has given us a good overview of recent developments in the different countries, what we can expect in terms of possible ecological effects. Topics from sea lice to increased algae production in the rivers have been very interesting to hear about, although we are just starting to touch on these themes. However, when we look back on the key questions that we started asking in the first meeting, after the 2017 season, we think we have made good progress since then.

Key words:

Pink salmon, *Oncorhynchus gorbuscha,* international seminar 2023

Front cover photo: Pink salmon in Skallelv river, Norway. Malin S. Høstmark/ County Governor of Troms and Finnmark. Back cover photo: Pink salmon in trap, Skallelv river, Norway. Malin S. Høstmark/ County Governor of Troms and Finnmark

Disclaimer:
The meeting has been implemented with the support from the Norwegian Climate and Environment Ministry. The contents of this publication can in no way be taken to reflect the views of the Ministry. Each author and contributor are solely responsible for their own views.

Contents

PREFACE

The 3rd International seminar on pink salmon in The Barents Region and in Northern Europe 2023.

The County Governor of Troms and Finnmark in cooperation with the Norwegian Environment Agency arranged this seminar on pink salmon on 25th and 26th October 2023. The seminar took place at NIBIO Svanhovd in Svanvik and for those who could not attend in person, participation was available on a digital platform. In total over 100 people participated during the two days.

The aim for the seminar was to gather scientists and environmental management for sharing experiences and knowledge about the invasive species pink salmon in the Barents Region and in Northern Europe and to find the needs for future research and management. The topics are related to the recent development of the invasion, monitoring, actions on removal of pink salmon, and effects on other fish and organisms after the increasing invasion of pink salmon.

The following report with paragraphs is a collection of the topics presented during the two days.

This 3rd international seminar on pink salmon has been two good days for sharing information, meeting old and new colleagues, and even finding new opportunities for collaboration and combining of resources to answer the many questions that we have, related to the pink salmon invasion.

The situation we are all in is something that has never happened before, and it is unknown what the future will look like in our rivers, potentially across the North Atlantic. Over these two days we have got a good overview of recent developments in the different countries, what we can expect in terms of possible ecological effects. Topics from sea lice to increased algae production in the rivers have been very interesting to hear about, although we are just starting to touch on these themes. We pleased to learn that there is good work in progress. There is no shortage of research topics here – the shortage is on research funding.

However, when we look back on the key questions that we started asking in the first meeting, after the 2017 season, we think we have made good progress since then. Without exception, we think the scientists are working to solve questions that are highly relevant for us working in management. This is promising for the years to come.

We also know that we have different opinions on what should be done, or what can be done, with regards to the pink salmon invasion. But whatever your view is on this, or what policy your country has, we all need knowledge. And we need to share, discuss, and cooperate.

We would like to thank you all for contributing; presenters, organizers, and participants, asking good questions and offering comments.

Lisa B. Helgason
County Governor of Troms and Finnmark

Eirik Frøiland
Norwegian Environment Agency

PROGRAM

AGENDA
International Seminar on Pink salmon
in the Barents region and in Northern Europe 2023

Time: Wednesday 25th - Thursday 26th October 2023 (arrival on Tuesday 24th).
Venue: NIBIO Svanhovd (auditorium), Svanvik, Norway and online (Zoom)

Day 1 – 25th October 2023 (09:00- c. 17:20)		
09:00 - 09:05	**Welcoming speech and opening the seminar** *Lisa B. Helgason, Director of Environment, Office of the County Governor of Troms and Finnmark (tbc)*	5 min
09:10 - 12:00	**Session 1:** **Occurrence of pink salmon in the Barents region and in the Norwegian Sea - overview of status per 2023**	
09:10 – 10:00	Trends in pink salmon occurrence in Northern Norway, incl. border rivers *Eirik Frøiland, Norwegian Environment Agency* *Henrik Berntsen, Norwegian Institute for Nature Research (NINA)*	45 min
10:00 – 10:15	Pink salmon in the River Teno/Tana *Jaakko Erkinaro Natural Resources Institute Finland (Luke)*	15 min
10:15 – 11:00	Summary of status from other countries: ➢ State of pink salmon stocks in Ireland after 2023: *Michael Millane, Inland fisheries Ireland (online)* ➢ Situation in Scotland: *Colin Bean, University of Glasgow (online)* ➢ Situation in Iceland: *Gudni Gudbergsson, Marine and Freshwater Research Institute (MRFI)*	c. 10 min/ presentation/ country
Short break (10 min)		
11:10 – 11:25	Pink salmon in Sweden – project presentation *Tom Staveley, Swedish University of Agricultural Sciences (SLU)*	15 min
11:25 – 11:40	Summary of bycatches at sea and along the coast of Norway *Kjell Rong Utne, Institute of Marine Research (IMR), Norway*	15 min
11:40 – 11:55	~~Sea surface temperature and pink salmon: are we where we thought we would be?~~ ~~*Kyrre Kausrud, Norwegian Veterinary Institute (online)*~~	15 min
Questions and comments to session 1		
LUNCH 12:00-13:00		
13:00 – 14:15	**Session 2:** **Methodologies for detecting and monitoring pink salmon**	
13:00 – 13:15	Tracking distribution and population changes of pink and Atlantic salmon in Tana river using eDNA – status 2023 *Frode Fossøy, Norwegian Institute for Nature Research (NINA)*	15 min
13:15 – 13:30	Molecular genetic methods to understand the spread of pink salmon *Sten Karlsson, Norwegian Institute for Nature Research (NINA)*	15 min
13:30 – 13:45	Using population genomics and ecological niche modelling as a tool to understand the population expansion of pink salmon in Norway *Snorre Hagen, Norwegian Institute for Bioeconomy Research (NIBIO), Svanhovd*	15 min
13:45 – 14:00	Other Pacific salmonids and use of otolith tool to inform management *Malte Willmes, Norwegian Institute for Nature Research (NINA)*	15 min

14:00 – 14:15	Using stable isotopes to describe pink salmon feeding grounds at sea - results from the PinkSIES project *Michal Skora, Queen Mary University of London*	15 min
Questions and comments to session 2		
14:20 – 16:10	**Session 3:** **The impacts of pink salmon on native species and ecosystems**	
14:20 – 14:40	The feeding ecology of pink salmon juveniles in northern Norwegian rivers and their role as prey to native salmonids *Katherine Dunlop, Institute for Marine Research (IMR), Norway*	20 min
14:40 – 15:00	Impact of pink salmon carcasses on a subarctic aquatic and terrestrial food web – Grense Jakobselv *Jenny Jensen, Akvaplan – niva, Norway*	20 min
Coffee break 15:00-15:30 (30 min)		
15:30 – 15:45	Ecological effects of pink salmon (incl. carcass decomposition and nutrient release etc.) – presentation of ongoing research project *Kaisa-Leena Huttunen, Finnish Environment Institute (SYKE) and Aino Erkinaro, University of Oulu, Finland*	15 min
15:45 – 15:55	Terrestrial implications of invasive Pacific pink salmon in northern Norway - aggregative responses in white-tailed eagles *Bror Mathias Bonde, Student/ UiT The Arctic university of Norway*	10 min
15:55 – 16:10	Review article - Prospects for the future of pink salmon in the three oceans: From the native Pacific to the novel Arctic and Atlantic *Kjetil Hindar, Norwegian Institute for Nature Research (NINA) (online)*	15 min
Questions and comments to session 3		
16:20 – c. 17:20	**Session - Perspectives from Northern America:** **Perspectives from Canadian Arctic, Alaska, and North Pacific Ocean**	
16:20 – 17:10	Perspectives from Alaska: *Ed Farley, NOAA Alaska Fisheries Science Center (online)* Perspectives from Overview of effects of pink salmon on the North Pacific ecosystem: *James Irvine, Fisheries and Oceans Canada and Greg Ruggerone, Natural Resources Consultants, Seattle USA (online)* Canadian Arctic: *Karen Dunmall, Fisheries and Oceans Canada (online)*	30 min
Questions and comments to session – Northern America		

Day 2

Day 2 – 26th October 2023 (09:00 – c. 14.00)		
09:00 - 09:05	**Introduction to day 2** *Lisa B. Helgason, County Governor's office*	5 min
09:10 – 10:15	**Session 4:** **Health monitoring and pink salmon parasites and infections**	
09:10 – 09:30	Health monitoring of pink salmon in Norway, results from 2023 *Åse Helen Garseth, Norwegian Veterinary Institute*	20 min
09:30 – 09:45	New molecular methods in studying pink salmon infections *Tor Atle Mo, Norwegian Institute for Nature Research (NINA)*	15 min
09:45 – 10:00	Enemy release potential of pink salmon in Norway *Rachel Paterson, Norwegian Institute for Nature Research (NINA)*	10 min
10:00 – 10:10	Monitoring salmon lice on pink salmon in Norway *Rosa Maria Serra-Llianares, Institute of Marine Research (IMR)*	10 min
Questions and comments to session 4		

10:15 – 13:30	**Session 5:** **Measures to control the invasion of pink salmon**	
10:15 – 11:00	Measures to control pink salmon in Northern Norway - 2023 *Eirik Frøiland, Norwegian Environment Agency and Malin Solheim Høstmark, County Governor of Troms and Finnmark*	45 min
Short break (10 min)		
11:10 – 11:30	Evaluation of the fish trap in Tana river *Roy Langåker, Norwegian Environment Agency and* *Roar Sandodden, Norwegian Veterinary Institute*	10 + 10 min
11:30 – 11:45	Pink salmon invasion in River Teno, Finnish measures *Tapio Hakaste, Ministry of Agriculture and Forestry Finland*	15 min
LUNCH 12:00 – 13:00		
13:00 – 13:10	Evaluation of measures to control pink salmon invasion by fishing at sea – Report *Eva Thorstad, Norwegian Scientific Advisory Committee for Atlantic salmon*	10 min
13:10 – 13:25	Bag net fishing for Atlantic and pink salmon in the Varangerfjord; how many Atlantic salmon could potentially be released alive? *Torgeir Havn, Norwegian Institute for Nature Research (NINA)*	15 min
Questions and comments to session 5		
c. 13:30	**Closing remarks** *Eirik Frøiland, Norwegian Environment Agency*	10 min
c. 13:45	**Closing the seminar** *Lisa B. Helgason, Office of the County Governor of Troms and Finnmark*	

The seminar is partly funded by Norwegian Climate and Environment Ministry, and arranged by the County Governor of Troms and Finnmark, Environmental Department and the Norwegian Environment Agency.

SESSION 1: OCCURRENCE OF PINK SALMON IN THE BARENTS REGION AND IN THE NORWEGIAN SEA - OVERVIEW OF STATUS PER 2023

1. TRENDS IN PINK SALMON OCCURRENCE IN NORTHERN NORWAY, INCL. BORDER RIVERS

Henrik Hårdensson Berntsen, henrik.berntsen@nina.no
Norwegian Institute for Nature Research (NINA)

Preliminary catch data from 2023 show that approximately 250 000 pink salmon has been reported captured in 130 rivers covering the entire Norwegian coast. In comparison, the total number of observations of pink salmon in rivers in 2021 was 165 000 fish. Most of the pink salmon in 2023 were caught in northern Norway, and 80 % of the total river catches were made in eastern Finnmark, between the North cape and the Russian border. This is roughly the same geographical distribution that we have seen in earlier years. The catches of pink salmon in northern Norway (Troms and Finnmark) were higher in 2023 than in 2021, however the biggest increase was seen in the western part of Finnmark and further south in Troms. This region had an increase of ~200 % from 2021. South of Troms the catches reported so far (Oktober 2023) are lower than in both 2019 and 2021.

The majority of pink salmon captured in 2023 (243 000 fish) were caught in a targeted removal fishery in rivers. Targeted removal fishing was conducted in 92 rivers and included traps covering the entire width of the river (42 rivers), net-fishing (58 rivers), removal of fish in fish ladders (3 rivers) and harpooning (24 rivers).

The available catch data for 2023 show a considerable increase in pink salmon in Norway compared to earlier years. However, the 10-fold increase we observed from 2019 to 2021 will not be repeated this year. Catches of pink salmon in the bag-net fishery in the fjords combined with the remaining observations from rivers in 2023 is believed to amount to approximately 200 000 - 250 000 fish. Hence, it is likely that this year's catch of pink salmon will be around twice as big as in 2021.

2. DEVELOPMENT IN ABUNDANCE AND DISTRIBUTION OF PINK SALMON IN THE LARGE RIVER TENO/TANA CATCHMENT, FINLAND/NORWAY

Jaakko Erkinaro[1], Panu Orell[1], Mikko Kytökorpi[1], Karl Gjelland[2], Morten Falkegård[2]

[1]Natural Resources Institute Finland (Luke), Oulu, Finland; contact: jaakko.erkinaro@luke.fi
[2]Norwegian Nature Research Institute, Tromsø, Norway

Introduction of the alien pink salmon in Northwest Russia have resulted in variable occurrence and catches in the large River Teno/Tana catchment since 1960s, but since 2017, their abundance and distribution quickly increased to unprecedented levels in odd years.

Development in pink salmon abundances have been monitored as part of the standard monitoring programs in the Teno/Tana system designed for Atlantic salmon population assessment, using sonar monitoring, video arrays, snorkelling counts and catch statistics.

In 2017, the total run of pink salmon in the Teno/Tana system was likely higher than ever before, estimated at c. 5000 individuals, which mostly based on catch information, but since 2019 a sonar in the main stem of the river has been used for run size estimation. In 2019, the pink salmon run was estimated at 5000 ind., in 2021 c. 50 000 ind., and the preliminary estimate for 2023 is 130 000 – 150 000 individuals.

In 2023, a barrier fence and a trap for pink salmon were installed in the lower part of the Teno/Tana river with an aim of preventing pink salmon migration further upstream. The operation was not successful: only less than 8000 pink salmon were captured in the trap, and the vast majority of the run continued upstream from the fence. Large catches of pink salmon were captured in different areas in the Teno/Tana main stem upstream from the trap by local people with special permits for using drift nets, gill nets and seine.

Pink salmon have mostly entered and colonized the main stem, the largest tributaries, and the three large headwater branches of the uppermost part of the river system, but in later years, an increasing number of the smaller tributaries have been colonized as well. In 2023, again, a few new tributaries, and tributaries to tributaries, were included in the known distribution area of pink salmon in the Teno/Tana system. Obviously, only some of the tributaries of the Teno/Tana are monitored by electronic or visual observations, and eDNA surveys have complemented the understanding of development in distribution of the alien species in this large river system.

3. STATE OF PINK SALMON STOCKS IN IRELAND AFTER 2023

Michael Millane, michael.millane@fisheriesireland.ie
Contributors: Conor McCormick and Paddy Gargan

Inland Fisheries Ireland

Pink salmon were first recorded in Ireland in August 1973 in the River Moy when a single specimen was caught by an angler. Until 2017, pink salmon have been rarely observed in Irish waters. Between 2017 to 2021, pink salmon were recorded in unprecedented numbers in odd years (2017, n=36; 2019, n=11; and 2021, n=45) in a number of river systems throughout Ireland. In 2023 to date, only a single pink salmon has been recorded in Ireland, in the River Moy.

Since 2017, in advance of the main fishing season in odd years, anglers have been requested by the competent State Authority, Inland Fisheries Ireland (IFI) to report observations and catches of pink salmon in Irish river systems to assist with monitoring of the occurrence and distribution of the species and enable the collection of specimens for verification and examination. In 2019, IFI published a report, "Assessment of potential ecological impacts of pink salmon and their capacity for establishment in Ireland" which concludes that environmental and ecological conditions are considered favorable for establishment of pink salmon but the information to evaluate the potential impacts remains limited. Overall, the level of impact is likely to be predicated on the extent of establishment and local abundance of pink salmon in Ireland. If pink salmon become a regular feature in Irish rivers, better understanding of their lifecycle will be required to evaluate their potential for long-term establishment and concomitant impacts.

Inland Fisheries Ireland is currently involved in a number of pink salmon related projects. This includes the PinkSIES project which aims to assess potential impacts on native salmonids both at sea and in recently invaded rivers throughout the North-east Atlantic. In addition, in 2023, IFI initiated an eDNA surveillance project for pink salmon in Irish rivers. This is a precursor initiative to the recently approved NASCO-led, EU-funded PINKTRACK project which will evaluate eDNA approaches to detect pink salmon with the intention of supporting the establishment of an EU network for monitoring in this regard.

4. PINK SALMON IN SCOTLAND: STATUS AND FURTHER ACTION

Colin W. Bean, colin.bean@glasgow.ac.uk
University of Glasgow

The occurrence of Pink salmon in Scottish rivers is not new, with the first fish being captured in the River Dee (Aberdeenshire) as far back as 1960. The numbers of Pink salmon recorded in Scotland from that date were few however, and from 1960 until 2016 a total of just 16 fish had been recorded from 12 locations. In common with other parts of northern Europe, 2017 saw a significant increase in the number of Pink salmon records in Scottish waters with 139 fish being recorded from 23 separate river catchments. A smaller number of fish (21) were recorded in 2019 and this was followed by another significant invasion, of 169 Pink salmon, in 2021. The expected increase in Pink salmon numbers in 2023 did not materialise, and only 46 fish were recorded. It is unclear why these fluctuations in Pink salmon abundance have occurred. This may be due to a number of factors, including (amongst others): year-class strength of adult fish, sea surface temperatures around the Scottish coast and river discharge. Both 2017 and 2021 were drought years in Scotland and high summer flows dominated during key spawning migration periods in 2019 and 2023. High river levels may also have impacted the ability of river managers, anglers and others to observe and report Pink salmon within watercourses and it is possible that the actual number of fish present has been significantly under-reported because fewer anglers are active or fish are less visible during high flow events.

Since 2017 Pink salmon observations (captures and sightings) have been recorded within a bespoke Pink salmon Reporting App (https://fms.scot/pink-salmon-in-scotland/). Whilst this tool yields a significant volume of useful data, experience from 2017 has shown that: 1) not all Pink salmon sightings are reported and recorded; 2) not all records entered into the system have been properly validated; and 3) records may be spatially biased towards rivers that are more commonly visited by anglers. These are located predominantly on the eastern side of the country.

With this in mind, 2023 saw the development of a newly designed eDNA-based surveillance programme. The sampling design of this new surveillance network removes spatial bias through the provision of a wider network of sampling sites from around the country. Two monitoring tiers exist. The first of these (Tier 1) involves the collection of samples from a network of 31 sites at two locations in the lower mainstem of rivers. Samples are also taken at two time-periods (late June and late August). Tier 2 sites are fewer in number (13) but involve the collection of eDNA samples from a number of sites within selected river catchments, during the same late June and late August time periods. Whilst not all samples have been analysed at the time of writing, it is clear that eDNA data is useful in: 1) confirming the presence of Pink salmon in rivers for which a record exists for that year; and 2) confirming the presence of Pink salmon in rivers for which no sighting has been made in that year or validating records within the Pink salmon reporting App which have not been physically confirmed. eDNA samples have also proved useful is determining whether a trap installed in one Scottish river (the River Thurso) to intercept Pink salmon has been successful.

Funding to progress a programme of monitoring, research and pre-emptive management on Pink salmon remains a challenge, particularly when the numbers of fish remain relatively low in comparison to those observed in Norway and Finland. The recent confirmation that Pink salmon can successfully recruit within Scottish rivers serves as a warning that if significant numbers of Pink salmon arrive in Scottish rivers then the likelihood of establishment, at least in some rivers, is high.

5. PINK SALMON IN ICELAND

Gudni Gudbergsson, gudni.gudbergsson@hafogvatn.is
Marine and Freshwater Research Institute, Iceland

Pink salmon (*Oncorhynchus gorbuscha)* was caught for the first time in Iceland in 1960. For the next five decades the number of pink salmon caught annually was in low numbers until 2015 when the present odd year increase. Mainly males were detected and reported, and females likely mistaken as Arctic charr by many fishermen. From 2015 the number of pink salmon registered in logbooks in the angling fisheries have been increasing and in reports coming from several rivers all over Iceland although the highest number are in rivers in East Iceland. The provisional number of pink salmon caught in Icelandic rivers in 2023 are close to 800 fish compared to 368 in 2021. It is known that some fisheries associations are not willing to report the catches since the pink salmon can affect the image of their pristine Atlantic salmon river. No evidence of recruitment or establishment of local populations were found until the spring 2022 when close to 600 pink salmon smolts were caught in three rivers in SW-Iceland. The impacts of pink salmon on the three salmonid species found in rivers in Iceland; the Atlantic salmon, Seatrout and Arctic charr is not known at this stage. A change was made to the Salmon Trout and Charr fishing act in 2023 giving fisheries associations allowance to take actions and fish for pink salmon with nets to delay the pink salmon invasion if possible. The fisheries associations that fish with nets in rivers need to report the action as well as the catches to the Directorate of Fisheries. Further research of the impacts of pink salmon on the local fish populations in Iceland is needed.

6. PINK SALMON IN SWEDEN

Tom Staveley, tom.staveley@slu.se
Swedish University of Agricultural Sciences

In recent years, pink salmon have been observed and reported on the west coast of Sweden, mainly in river systems and in relatively low numbers (i.e., 5-70). From 2017, and continuing every 2 years, due to the odd year population cycle, the majority of observations have come from a monitoring camera in the river Ätran in the Halland County. Due to the explosion of numbers of pink salmon in Norway and the unprecedented numbers occurring in other European countries of late, the research project ‘pink salmon in Sweden’ was established and will run between 2023-2024. The project is divided into three work packages. The first is to establish the current distribution of pink salmon on the Swedish west and southern coasts using environmental DNA (eDNA). This is conducted over three sampling occasions across 27 river systems with a total of 58 sites, where water samples are taken for eDNA analysis both for pink salmon and the whole fish community. The second work package will determine spawning success by examining whether there are any pink salmon fry in selected rivers from the expected spawning during 2023. Thirdly, intertwined through the project, is the need to increase public awareness and reporting of pink salmon, which is conducted through means such as posters, stickers, website, webinars and exhibitions. The new knowledge generated in the project will help develop proposals for future monitoring programs for pink salmon in Sweden and discuss potenital needs for future migitation measures. The project is conducted in collaboration with The County Administrative Boards of Halland, Västra Götaland, and Skåne, Mix Research AB och the Norwegian Institute for Nature Research.

7. PINK SALMON – BYCATCH IN THE NORWEGIAN SEA AND ALONG THE NORWEGIAN COAST

Kjell Rong Utne, kjell.rong.utne@hi.no
Institute of Marine Research

Pink salmon have been caught as bycatch during marine surveys targeting other pelagic species in the period 2013-2023. Most of these fish have been caught in the eastern part of the Norwegian Sea although some have been caught into the Barents Sea, which probably reflect geographic differences in sampling effort more than the true distribution of pink salmon. The number and geographic variation of pink salmon sampled in the Norwegian varies among years, potentially due to interannual variation in migration patterns and habitat use. The geographic distribution and growth of pink salmon post-smolt are still unknown, but 12 post-smolts sampled in 2022 have provided the first information of this life-stage in the Barents Sea. Pink salmon post-smolts were sampled both along the coast and further out in the open ocean. The size distribution of the post-smolts indicate that the growth in the Northeast Atlantic is equal to or faster than in the Pacific Ocean. The stomach content of pink salmon overlaps with the diet of salmon and has large geographic variation. Large zooplankton is the dominating prey in the open Norwegian Sea while 0-group fish is dominating the diet close to the Norwegian coast.

SESSION 2: METHODOLOGIES FOR DETECTING AND MONITORING PINK SALMON

8. TRACKING DISTRIBUTION AND POPULATION CHANGES OF PINK AND ATLANTIC SALMON IN TANA RIVER USING EDNA – STATUS 2023

Frode Fossøy, frode.fossoy@nina.no
Norwegian institute for nature research (NINA)

Analyses of environmental DNA (eDNA) is a new cost-efficient method for detecting rare and invasive species. In the river Tana, eDNA has been used to monitor the invasion of pink salmon (*Oncorhynchus gorbuscha*) since 2019. Currently, 24 locations representing different tributaries are sampled yearly in an attempt to assess changes in distribution and biomass of both pink and Atlantic salmon (*Salmo salar*) in the Tana watershed. Here, we present the results from the latest sampling in 2023, summarise the findings across all years and discuss how eDNA can contribute to monitoring the pink salmon invasion and implemented mitigations.

9. MOLECULAR GENETIC METHODS TO UNDERSTAND THE SPREAD OF PINK SALMON

Sten Karlsson, sten.karlsson@nina.no; Sebastian Wacker, sebastian.wacker@nina.no
Norwegian Institute for Nature Research, NINA

Applications of molecular genetic markers have proven valuable in research of pink salmon. Here we present results from the NPAFC technical report from the Northern Hemisphere Pink Salmon Experts Meeting, held: October 2–3, 2022, Vancouver, Canada, showing the genetic structure of pink salmon in the Northern hemisphere of The Pacific and The Atlantic with a special emphasis on the origin of the newly colonized areas. Pink salmon on the East coast of Canada are genetically similar to the Norwegian pink salmon and pink salmon in the Western Canadian Arctic are genetically similar to the native pink salmon in Asia Beringia. With the same set of genetic markers, we show that the pink salmon caught along the Norwegian coast can be used to improve our understanding of the homing behaviour of pink salmon. We show that full- and halfsiblings can be identified with high precision. From a restricted number of individuals analysed we identified 13 different sibling pairs. The sibling pairs were not randomly distributed geographically, with seven of the pairs caught in the same river and most of the remaining pairs caught within the same geographical region. We conclude that molecular genetic analyses contribute valuable information about the origin of the spread of pink salmon both on a large and at a smaller scale.

10. USING POPULATION GENOMICS AND ECOLOGICAL NICHE MODELLING AS A TOOL TO UNDERSTAND THE POPULATION EXPANSION OF PINK SALMON IN NORWAY

Snorre B. Hagen, snorre.hagen@nibio.no
NIBIO – Norwegian Institute for Bioeconomic Research

The pink salmon (*Oncorhynchus gorbuscha*) has in recent years shown a rapid demographic and geographic population expansion within its non-native distribution range in the North Atlantic Ocean, with Northern Norway being a potentially new epicentre of population expansion. By combining species distribution modelling and genetic methods, our aim has been to develop tools for management and research to identify environmental drivers, source populations, and dispersal pathways during the ongoing population expansion. Our preliminary results indicate that several climate-related variables contribute to the population expansion of invasive pink salmon in Norway and that the development and use of genetic methods will be an important part of a balanced approach to identify source populations and routes of spread.

11. TRACKING THE PINK SALMON INVASION VIA OTOLITHS

Malte Willmes, malte.willmes@nina.no
Norwegian Institute for Nature Research (NINA)

Fish otoliths (*ear stones*) are a valuable tool to study and manage fishes because they can be used to reconstruct many key life history metrics such as age, growth, natal origins, and migration routes. In Pacific salmonids otolith analyses have been extensively applied across their native range to provide critical information for management and conservation efforts. Here we outline the key life history metrics that can be reconstructed via otoliths and how this information can be linked to other methods such as genetics and field monitoring to study the invasion of the North Atlantic Region by Pink Salmon.

Otoliths are small calcium carbonate structures located in the inner ear of fishes where they help hearing and balance functions. They are metabolically inert and accrete incremental daily layers, which preserve a record of age and growth throughout the life of a fish. Elemental ratios (Sr/Ca, Ba/Ca) and strontium isotopes ($^{87}Sr/^{86}Sr$) in otoliths are related to the environmental conditions a fish experienced, and these may vary among watersheds based on the geology. The combination of different analytical techniques on otolith thus allows for the reconstruction of natal origins, juvenile migration timing, adult migratory pathways, and habitat specific growth rates. Because the entire life history, including the juvenile phase, can be obtained from returning (adult) fish, otoliths provide an ideal tool to study questions about selection and survival of different phenotypes and to evaluate the impact of different management strategies.

12. USING STABLE ISOTOPES TO DESCRIBE PINK SALMON FEEDING GROUNDS AT SEA - RESULTS FROM THE PINKSIES PROJECT

Michał E. Skóra, m.skora@qmul.ac.uk
Queen Mary University of London, School of Biological and Behaviour Sciences

Michał E. Skóra, J. Iwan Jones, Bryony Townhill, Colin W. Bean, Henrik H. Berntsen, Elena Couce, Gareth D. Davies, Kirstin Eliasen, Guðni Guðbergsson, Paul Hopper, Rasmus B. Lauridsen, Shona Marshall, Michael Millane, Julius Nielsen, Sean Robertson, Finn Sivebæk, Øystein Skaala, Linda Söderberg, Eva B. Thorstad, Clive Trueman, Jamie Urquhart, Kjell Rong Utne, Alan Wells, Alan F. Youngson, Gordon H. Copp

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In 2017, the numerous intrusions of pink salmon spawners into rivers around the North Atlantic rim generated much concern about the potential implications of pink salmon invasion on native fishes both at sea and fresh waters. To address these questions, the EU funded PinkSIES project used using stable isotope analysis (SIA: δ13C, δ15N) to understand the impacts of pink salmon in the North Atlantic and in recently invaded rivers through determination of their distribution at sea, the potential competition against Atlantic salmon, assessment of the field metabolic rate of both salmon species, and projection of the future distribution of pink salmon under climate warming. The project also focused on short freshwater phase of the life cycle, with the objective of assessing the ecological role of pink salmon juveniles in the fresh waters.

PinkSIES had strong support from colleagues in North Atlantic countries who provided biological samples and supported fieldwork. In spring 2022, surveys were undertaken in Scotland and Iceland (Skóra et al. 2023a, Skóra et al. 2023b). These studies confirmed that pink salmon had successfully reproduced in both countries and provided evidence that pink salmon juveniles overwinter in Scotland. Our field observations indicated that pink salmon fry were feeding in fresh waters prior to the migration and were consumed by sea trout parr (unpublished results).

Biological samples (muscle tissue, otoliths, scales) were collected from more than 500 specimens, caught in rivers, inshore and offshore around the North Atlantic. The distribution of pink salmon feeding grounds at sea were established using a base map of $\delta^{13}C$ and assuming two trophic levels between phytoplankton and pink salmon, suggesting that the feeding grounds span a wide arc across the North Atlantic (unpublished results). However, $\delta^{15}N$ provided evidence that pink salmon at sea feed on prey from a variety of different trophic levels (unpublished results). Forthcoming weeks will provide further results on pink salmon at sea.

This study was carried out under the PinkSIES project which has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101026030.

SESSION 3: THE IMPACTS OF PINK SALMON ON NATIVE SPECIES AND ECOSYSTEMS

13. THE FEEDING ECOLOGY OF INVASIVE PINK SALMON JUVENILES IN NORWEGIAN RIVERS AND THEIR ROLE AS PREY TO NATIVE SALMONIDS

Katherine Dunlop[1], Antti P. Eloranta[2], Jenny Jensen[3], Sigurd Slåteng[4], Rune Knudsen[4], Mikko Kiljunen[2], Hallvard Jensen[5], Karl Øystein Gjelland[6], Martin Svenning[6], Vegar Seljestokken[6], Rune Muladal[7], André Frainer[6]*

1. Institute of Marine Research, Framsenteret, Tromsø, Norway; katherine.mary.dunlop@hi.no
2. Department of Biological and Environmental Science, University of Jyväskylä, Jyväskylä, Finland 3. Akvaplan-niva AS, Framsenteret, Tromsø, Norway, 4. Department of Arctic and Marine Biology, Faculty of Biosciences, Fisheries and Economics, UiT The Arctic University of Norway, Tromsø, Norway, 5. Norwegian Institute of Bioeconomy Research, Tromsø, Norway, 6. Norwegian Institute for Nature Research (NINA), Framsenteret, Tromsø, Norway, 7. Naturtjenester i Nord, Tromsø, Norway

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Pacific pink salmon (*Oncorhynchus g*orbuscha) have been spawning in growing numbers in Norwegian rivers, leading to millions of pink salmon smolts descending rivers during even years' springs and summers. Amid growing concerns regarding the ecological effect of large numbers of invasive pink salmon is the potential competition for food between juvenile pink salmon and native salmonids. It remains to be confirmed what pink salmon smolts are eating and their feeding timing in Norwegian rivers during the descent. In addition, pink salmon smolts have the potential to be an attractive food source to juvenile salmonids native to Norwegian rivers. 431 pink salmon smolts were collected from 10 rivers in northern Norway between April and July 2022 and their food resources quantified using stomach content and stable isotope (δ13C, δ15N and δ34S) analyses. The same methods were used to examine the feeding ecology of juvenile native salmonids caught in two rivers (Vesterelva and Skallelva) during pink salmon juvenile migration to the sea in May and July. The majority of smolts sampled in May did not feed in the river and had no stomach contents and high δ15N values indicative of a reliance on the marine derived yolk sac. The 58 pink salmon that contained freshwater invertebrate stomach contents were almost all larger individuals without yok sacs sampled in Kongsfjordelva and Skallelva in July. The same individuals showed a shift in isotope values around 35 mm in length. The freshwater invertebrates found in the stomachs of the feeding smolts were dominated by invertebrate families which are also utilized by native salmonids. Based on a two-source (freshwater versus marine) isotopic mixing model, some of the larger pink salmon had a 20-25% reliance on freshwater prey. Out of 91 Atlantic salmon and brown trout smolts, three salmon from Vesterelva in May contained pink salmon smolts in their stomachs. However, in addition to these individuals, relatively high δ15N values for some other larger Atlantic salmon in May in Vesterelva could indicate feeding on pink salmon smolts. This study provides novel results that can be used to improve confidence in the risk assessment of the potential impact of resource competition between the juvenile pink salmon and native salmonids in northern Norway.

14. IMPACT OF PINK SALMON CARCASSES ON A SUBARCTIC AQUATIC AND TERRESTRIAL FOOD WEBS and PINK SALMON MIGRATORY BEHAVIOUR ON SVALBARD

Jenny Jensen[1], Katherine Dunlop[2], Guttorm Christensen[1], Antti P. Eloranta[3], Sigurd Slåteng[4], Rune Knudsen[4], Mikko Kiljunen[2], Hallvard Jensen[5], Karl Øystein Gjelland[6], Martin Svenning[6], Vegar Seljestokken[6], Rune Muladal[7], André Frainer[6]*

1. *Akvaplan-niva AS, Framsenteret, Tromsø, Norway, jen@akvaplan.niva.no,*
2. *Institute of Marine Research, Framsenteret, Tromsø, Norway*
3. *Department of Biological and Environmental Science, University of Jyväskylä, Jyväskylä, Finland*
4. *Department of Arctic and Marine Biology, UiT The Arctic University of Norway, Tromsø, Norway*
5. *Norwegian Institute of Bioeconomy Research, Tromsø, Norway*
6. *Norwegian Institute for Nature Research (NINA), Framsenteret, Tromsø, Norway*
7. *Naturtjenester i Nord, Tromsø, Norway*

Pink salmon (*Oncorhynchus gorbuscha*) have been increasing drastically in numbers in Norwegian rivers in odd-numbered years since 2017. The increase has been greatest in eastern Finnmark county, but large numbers occurred in rivers as far south as Nordland County in 2023. Topics defined as problematic in the risk assessment by the Norwegian Scientific Committee for Food Safety (increased nutrients in water, transfer of marine derived nutrients to aquatic and terrestrial food-webs) were investigated in Vesterelva in 2017 and 2022, and in Grense Jakobselva in 2022 and 2023. Transferral of marine derived nutrients was studied by stable isotope analysis (δ13C, δ15N and δ34S), in a BACI- design (before/after – control/impacted), and Grense Jakobselv was chosen for further studies as this river did not have any pink salmon removal efforts in 2023. Water, primary producers, benthic and terrestrial invertebrates, and native fish have been sampled in order to investigate how the nutrients from pink salmon carcasses and eggs are incorporated into the food webs and their impacts on invertebrate community composition. Native young salmonids have been demonstrated to feed on pink salmon eggs, and the remaining analysis will be performed in 2023/2024. In addition, cameras were placed on the river shore, documenting terrestrial and sub-aquatic vertebrate scavengers on pink salmon carcasses.

Increasing numbers of pink salmon have also been documented in the fjords around Svalbard, where Arctic charr (*Salvelinus alpinus*) is the only naturally occurring salmonid. Dietary overlap between Arctic charr and pink salmon along the coast during summer was moderately high, where both species had strong associations with intertidal invertebrates in areas where direct comparisons were possible (Kongsfjorden/Krossfjorden). Arctic charr is a more generalist feeder, while pink salmon is more of a dietary specialist. During summer 2023, 12 pink salmon were tagged with acoustic transmitters and their movements were recorded in Isfjorden on Svalbard on submerged mounted hydrophones. The tagged pink salmon showed a wide range of behaviours, where some individuals were only recorded around the tagging area close to river mouths, while others migrated across the entire fjord system. None of the tagged pink salmon were registered entering lakes in Isfjorden, although pink salmon is often registered in Svalbard lakes later in the autumn.

15. ECOLOGICAL EFFECTS OF PINK SALMON – PRESENTATION OF ONGOING RESEARCH PROJECT

Kaisa-Leena Huttunen, kaisa-leena.huttunen@syke.fi, Finnish Environment Institute & University of Oulu
Aino Erkinaro, aino.erkinaro@oulu.fi, University of Oulu

Nutrients and other resources released and provided by decaying pink salmon carcasses are expected to have various direct and indirect ecological effects in its non-native distribution area. One potential effect is increased algal production in Arctic rivers. In 2022 we used an experimental field set-up based on nutrient diffusing substrates (NDS) to study the response of riverine primary producers to increased availability of key nutrients. Additional nitrogen clearly enhanced primary productivity measured as amount of chlorophyll-a in epilithic biofilm. Additional phosphorus boosted productivity further but had no effect alone suggesting that nitrogen is the primary limiting factor for algal production in Arctic rivers. The experiment was based on assumption that additional nutrients are constantly available for primary producers at least for few weeks and that they are available as NO_3 and PO_4. However, this far rather little is known about the rate of pink salmon carcass decomposition and consequent release, concentrations, and storage of nutrients. Thus in 2023 we followed pink salmon carcass decomposition and nutrient release over two months in an experimental set-up mimicking hotspots of carcass accumulation sites. Based on the first set of preliminary results it seems that especially NH_4 and organic N were released from carcasses to water column and absorbed to bottom substrates. Benthic primary producers seemed to readily response to additional nutrients by having in general higher total chlorophyll-a concentration and amount of green algae in vicinity of pink salmon carcass piles after two months' exposure compared to control spots. However there seems to be high among and within sites variation in responses. More information on carcass decomposition rates, composition of decomposer communities and temporal patterns of nutrient release, as well as on local effects of pink salmon carcasses on ecological processes and biotic communities (e.g., bacteria, diatoms, invertebrates) will be available after further laboratory work and statistical analyses.

16. TERRESTRIAL IMPLICATIONS OF INVASIVE PACIFIC PINK SALMON (*ONCORHYNCHUS GORBUSCHA*) IN NORTHERN NORWAY - AGGREGATIVE RESPONSES IN WHITE-TAILED EAGLES

Bror Mathias Bonde, bonden.bror@gmail.com
Student, UiT the Arctic University of Norway

The spawning population of invasive Pacific pink salmon (*Oncorhynchus gorbuscha*) has increased in the river systems in northern Norway over the last 10 years, causing concerns about their impact on endemic fauna and ecosystem processes. Research efforts on the impact of Pacific pink salmon focus to a large degree on the consequences for in marine- and freshwater ecosystems, while terrestrial ecosystems have received less attention. The trophic linkage between riverine- and terrestrial ecosystems is likely to be a key determinant of the scale of Pacific pink salmon transfer into the terrestrial ecosystem. In my study I show how nutrients from Pacific pink salmon became available to the terrestrial scavenger community through the movement of fish by white-tailed eagles (*Haliaeetus albicilla*). Data materials were collected at Skallelv river on the Varanger peninsula in Norway from July 1st to September 5th in 2021 and 2022. I find that the relative abundance of white-tailed eagles was indeed much higher when Pacific pink salmon spawned in Skallelv in 2021 than in 2022, when no spawning occurred. The spatiotemporal synchrony of white-tailed eagles and Pacific pink salmon was observed at several scales, suggesting an aggregative response of white-tailed eagles. The aggregation of white-tailed eagles corresponded to the time that an increasing number of Pacific pink salmon had entered the post-spawning stage and observations showed that they were the main actor in the transport of Pacific pink salmon onto land. Based on my observations I suggest a model for the main processes involved in the cross-boundary transfers of marine-derived nutrients from the Pacific pink salmon into the terrestrial ecosystem in Finnmark.

17. REVIEW – PROSPECTS FOR THE FUTURE OF PINK SALMON IN THREE OCEANS: FROM THE NATIVE PACIFIC TO THE NOVEL ARCTIC AND ATLANTIC

Kjetil Hindar, kjetil.hindar@nina.no
Norwegian Institute for Nature Research (NINA), Trondheim

This talk summarizes the main findings of a recent review paper by **Robert J. Lennox**, H. H. Berntsen, Å. H. Garseth, S. G. Hinch, K. Hindar, O. Ugedal, K. R. Utne, K. W. Vollset, F. G. Whoriskey & E. B. Thorstad. 2023. Prospects for the future of pink salmon in three oceans: From the native Pacific to the novel Arctic and Atlantic. *Fish and Fisheries* **24**: 759-776. DOI: 10.1111/faf.12760.
I was a co-author of the review and so were some who are present in the audience at Svanhovd.

Pink salmon represent an ecological winner in a time where most salmonid species struggle. Their distribution is expanding both within their natural range and in the Atlantic and Arctic Ocean following introduction of the species to the White Sea. We are here to discuss the westward expansion from the White Sea to the Atlantic but must also keep in mind that pink salmon are expanding eastwards, so that eventually, they may become a Holarctic species.

What makes pink salmon so successful?

- Pink salmon are the earliest spawner among Pacific salmon
- Pink salmon can spawn in estuaries
- Pink salmon produce the smallest ocean migrants
- Pink salmon modify the habitat of their offspring
- Pink salmon growth rates at sea are among the fastest we know
- Pink salmon show the shortest life cycle of a medium-sized species
- Pink salmon can rapidly build up large populations
- Pink salmon are (potentially) adapting more rapidly to changing environments.

Northern oceans are undergoing rapid changes due to anthropogenic stressors and are now experiencing temperatures beyond what we have seen during more than 100 years of oceanographic investigations. The rapid environmental changes may favour pink salmon in competition with other similar-sized species. Modelling of sea surface temperature and pink salmon abundance suggests that pink salmon year class success is associated with warm spring and early summer. Data from the White Sea suggest that pink salmon have adjusted their spawning time during adaptation to local environmental conditions.

The invasion of pink salmon in the Atlantic basin is a massive ecological experiment and one of the first examples of a major faunal change in the North Atlantic Ocean. New research is needed to understand the role and potential future impacts of pink salmon in Atlantic and Arctic ecosystems.

SESSION - PERSPECTIVES FROM NORTHERN AMERICA: PERSPECTIVES FROM CANADIAN ARCTIC, ALASKA, AND NORTH PACIFIC OCEAN

18. PERSPECTIVES FROM THE CANADIAN ARCTIC, ALASKA, AND NORTH PACIFIC OCEAN

Karen Dunmall, karen.dunmall@dfo-mpo.gc.ca, Fisheries and Oceans Canada, Winnipeg Canada
Ed Farley, ed.farley@noaa.gov, Alaska Fisheries Science Center, NOAA Fisheries, Juneau USA
Jim Irvine, james.irvine@dfo-mpo.gc.ca, Fisheries and Oceans Canada, Nanaimo Canada
Greg Ruggerone, gruggerone@nrccorp.com, Natural Resources Consultants, Seattle USA

Natal to the Pacific Ocean, pink salmon in North America are increasing in range and production at their northern distributional extent while in the North Pacific, numbers remain near all-time highs. In the context of using what is known to help in understanding what is not known, we will provide information about the current status of pink salmon in North America and outcomes from research and monitoring efforts. While pink salmon are monitored throughout their Pacific freshwater distribution, our focus will be the Pacific marine environment, range expansions of pink salmon to the Canadian Arctic and North American Atlantic coasts, and results of recently published research describing ecological linkages between pink salmon and the North Pacific ecosystem of relevance elsewhere. In the Pacific, we will discuss monitoring activities that contribute to understanding the marine ecology and distribution of pink salmon under changing environmental conditions, and will consider harvest, hatcheries, and the economics of pink salmon. We will also discuss the carrying capacity in the North Pacific and evidence for density dependent effects from odd year pink salmon on other species. In the Arctic, we will demonstrate collaborative and community-led efforts that monitor an increasing trend in occurrence and widening distribution of pink salmon where they have no historic presence. We will highlight collaborative research approaches developed to address community-driven research priorities, derived from concerns about the potential impacts of salmon on Arctic fishes. Together, we will provide perspectives on pink salmon in North America to help inform efforts regarding pink salmon in the Barents Sea and Northern Europe.

SESSION 4: HEALTH MONITORING AND PINK SALMON PARASITES AND INFECTIONS

19. HEALT MONITORING OF PINK SALMON IN NORWAY-RESULTS FROM 2023

Åse Helen Garseth. Correspondence: ase-helen.garseth@vetinst.no

Contributors: Lisa Furnesvik, Torfinn Moldal, Kristoffer Vale Nielsen, Julie Svendsen, Haakon Hansen, Toni Erkinharju, Anne Berit Olsen, Duncan Colquhoun, Ewa Harasimczuk, David strand, Hanne Nilsen Norwegian Veterinary Institute, Norway

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Introduction Since 2019, the Norwegian Veterinary Institute (NVI) has conducted health monitored of pink salmon in Norway. The primary purpose has been to determine the presence of selected notifiable infections in pink salmon, but also to gain general knowledge to enable the assessment of risks to wild and farmed native salmonids.

The primary pathogen and disease related hazards are:

- Pink salmon introduce pathogens that are not already present.
- Pink salmon increase the number of susceptible hosts and contribute to translocation of pathogens between infected and non-infected fish populations
- Propagation of microorganisms in immunosuppressed, moribund and dead pink salmon.
    - Increased load of potentially pathogenic microorganisms in water.
    - Possible impact on aquatic wildlife and humans.

Material and methods Norwegian Veterinary Institute has used targeted, semi-targeted and risk based approaches. Approximately 180 pink salmon were sampled randomly from five rivers in the County of Troms & Finnmark: rivers Lakselv, Tana, Neiden, Komagelva, Kongsfjordelva and Karpelv. Targeted monitoring comprised specific PCR assays to detect infectious salmon anaemia virus, viral haemorrhagic septicaemia virus (VHSV), infectious hematopoietic necrosis virus (IHNV) *Renibacterium salmoninarum* and piscine orthoreovirus-1. Semi-targeted monitoring comprised cultivation on selected cell lines to detect cultivable virus and selected growth media to detect bacteria. In addition, histopathology was used to screen selected pink salmon. The risk-based approach was to inform the public about the notification system for disease and mortality in wild fish and to provide “preparedness kits” with sampling equipment and sampling protocols.

Results (preliminary)

- All PCR analyses were negative.
- Virus were not detected in cell cultures.
- Notifiable bacterial infections were not detected (preliminary result)
- Diverse bacteria that are associated with freshwater, fish skin, gills and intestines were detected. Some of these are opportunistic pathogens.
- Pink salmon with yellow spots and deformities were reported to the notification system.

Preliminary conclusion

- Notifiable infections not detected.
- Potentially opportunistic bacteria detected.
- Parasites detected during postmortem and histological screening.

20. NEW MOLECULAR METHODS IN STUDYING PINK SALMON INFECTIONS

Tor Atle Mo, tor.mo@nina.no, Sten Karlsson and Frode Fossøy
Norwegian Institute for Nature Research (NINA)

The occurrence and significance of microparasites in wild native salmonids and non-native pink salmon in the North Atlantic Ocean and the Barents Sea have been little studied. Such studies have become easier and more cost-effective when using the Biomark platform based on high-throughput qPCR (HT-qPCR). This method has been used with good results in salmonids in the Pacific Ocean. We sampled tissues from 30 pink salmon and 20 Atlantic salmon in July 2023 but the analysis using HT-qPCR is still in progress (October 2023). The occurrence of microparasites in fish scales and gills (non-lethal sampling) will be compared with findings in internal organs such as total skin, heart, and kidney (lethal sampling). Findings of microparasites in and on fish scales is of particular interest because NINA has a large geographical and historical collection of fish scales from Atlantic salmon which provides the opportunity to study changes in the abundance of selected microparasites between coastal regions in Norway and in time (i.e., before and after establishment of salmonid fish farms).

21. ENEMY RELEASE POTENTIAL OF PINK SALMON IN NORWAY

Rachel A. Paterson, rachel.paterson@nina.no
Norwegian Institute for Nature Research

The potential introduction of novel parasites and pathogens to native species (spillover) is often a primary focus when evaluating disease risks posed by an invasive species. However, invasive species commonly have fewer parasites and pathogens since their endemic parasites may have 'missed the boat' (their founding population was disease-free), 'sunk with the boat' (their invasive host failed to establish) or were 'lost overboard' (their parasites arrived but failed to establish). For parasites successfully invading with their invasive host, they may continue to be lost in the process of range expansion and thus establish an infection gradient from the invasion core to invasion front. This release from the population regulatory effects of parasites from their native range (enemy release) often allows invasive species to attain extremely high densities. Whilst invasive species may have lost their endemic parasites, they frequently acquire generalist native parasites and pathogens in their invasive range. Therefore, the presence of highly abundant novel hosts, such as pink salmon, has the potential to drive the emergence of infectious diseases, whereby formerly benign, relatively uncommon native parasites are transformed into highly prevalent, pathogenic species (parasite spillback, akin to Norway's salmon lice predicament). Preliminary evidence suggests that pink salmon in Norway may support at least 17 marine parasite species, of which many are previously known to infect both wild and farmed salmonids. This study aims to test the extent of enemy release (reduced parasite species richness, prevalence and abundance from invasion core to invasion front), and native parasite acquisition (precursor to spillback) in invasive pink salmon populations. This project will map the distribution of native parasites present in pink salmon along the Norwegian coastline during 2021 and 2023 and will compare parasite assemblages to those of pink salmon from the White Sea, Russia to evaluate the extent of enemy release and native parasite acquisition.

22. SALMON LICE MONITORING ON PINK SALMON IN NORWAY

Rosa Maria Serra-Llinares[1], Rune Nilsen[1], Rasmus Skern[2] and Ørjan Karlsen[2]*
1 Institute of Marine Research, Tromsø, Norway; rosa.maria.serra-llinares@hi.no
2 Institute of Marine Research, Bergen, Norway

In latest years, pink salmon (*Oncorhynchus gorbuscha*) have been returning in growing numbers to rivers in Northern Norway to spawn. There is still a big uncertainty regarding the ecological effects of this invasion. Among other concerns is the potential transmission of pathogens and parasites between the returning pink salmon and native salmonids. In Norway, the salmon lice *Lepeoptheirus salmonis* is the most common parasite on farmed salmon and pose a major threat for wild salmonids. Although less frequent, one other sea lice species, *Caligus elongatus*, can also be found on salmonid fish in Norway. Pink salmon are also natural host for *L. salmonis*, and in Western Canada this louse species is generally common on mature pink salmon returning to the coast. The arriving pink salmon stay at bays, estuaries and near streams for some time before migrating into the rivers and streams. During this time, the returning pink salmon may be an important host and vector for salmon lice, posing a novel and potentially important source of infestation for native salmonids. From 2023, pink salmon have been formally included in the Norwegian salmon lice monitoring program on wild salmonids (NALO) and the first official record of salmon lice on this invasive species is presented here. A total of 216 pink salmon were caught using fyke nets at sea in 3 different stations in Northern Norway (Oksfjord, Bugøynes and Jarfjord) in 2023. Both *L. salmonis* and *Caligus elongatus* were found on the examined pink salmon. Attached lice stages represented only a small proportion of all observed lice (~6%). Prevalence of L. salmonids ranged from 4 to 70%, with mean intensities ranging between 1 and 3.8 lice per fish (max = 17). Prevalence of C. elongatus ranged from 1 to 96%, with mean intensities ranging between 1 and 9 lice per fish (max = 49). These results support the hypothesis that pink salmon may become an increasingly important source of infection for wild salmonids in Norway and highlight the need for further monitoring.

SESSION 5: MEASURES TO CONTROL THE INVASION OF PINK SALMON

23. MEASURES TO CONTROL PINK SALMON IN NORTHERN NORWAY

Eirik Frøiland, eirik.froiland@miljodir.no, Norwegian Environment Agency
Malin Solheim Høstmark, malin.hostmark@statsforvalteren.no, The County Governor of Troms and Finnmark

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The Norwegian Environment Agency is responsible for the measures against pink salmon in Norway. The task of implementing the measures in Northern Norway was given to The County Governor of Troms and Finnmark. The main measure is to establish physical control of the spawning migration of all fish in all salmon rivers in a selected target area. The strategy was to use state funded temporary weirs/traps, operated by local angler's organizations to do this and, remove all ascending pink salmon and at the same time release all native fish with minimal harm and delay.

In the summer of 2023, there were state funded weirs/traps in 32 rivers from Karpelv in eastern Finnmark to Kvalsundelva in Western Finnmark. The traps are operated by local angler's organizations that the County Governor made contracts with, regarding the funding and how to operate the trap.

The County governor has mainly funded two types of traps/weirs: Picket weir and resistance board weir. They have been almost 100% efficient in some rivers in removing pink salmon and releasing native salmonids. Some of the larger rivers have had challenges regarding equipment and operation and injured native salmonids have been observed in some rivers. In some rivers, collapse of the weirs occurred during flood caused by heavy rain. We believe most of the challenges can be solved and a thorough evaluation of the causes and solutions are ongoing. With our current knowledge and experience we believe that picket weirs and resistance board weirs are suitable methods to control the pink salmon invasion in most rivers. Home-made traps have been used in approx. 25 rivers, most of which were not state funded. Based on feedback during the season, though yet to be confirmed through the evaluation, these weirs made from nets instead of pickets are more likely to collapse during floods, and more often cause harm to native fish in various ways. It will be discussed based on the evaluation report to replace them with picket or resistance board weir before 2025. Beach seine was used in some rivers downstream the trap, with great efficiency. We assess that it is suitable as an additional measure to remove pink salmon, given that the local anglers organization have the gear, skills, capacity, and are careful enough with the native salmon so that they can be released upstream the trap. Sea salmon fishery with bag nets for Atlantic salmon is allowed on parts of Norway´s coast and has been suggested to use as a measure to control the pink salmon invasion. However, research shows that more than 60% of bag net caught Atlantic salmon was either dead or too injured to be released. Bag net fishing in the fjords is not suitable as a measure to control the pink salmon invasion because of the high risk of overexploitation of Atlantic salmon.

Experience shows us that the local angler's organizations must receive enough funding to provide a salary to their workers. We are dependent on the help and cooperation, manpower, skills and local knowledge that can only be found in the local angler's organizations to carry out this project. A salary will make the work more stable and keep the motivation up. We had different solutions to deal with the pink salmon removed from the rivers. Agreements with local companies were made in advance of the season, to pick up pink salmon daily and provide clean boxes with ice. This pink salmon could be used a food commercially or as ensilage and biogas. Pink salmon was also donated to the local communities as food, dog food or crab bait. It is highly important to have the logistics plan for this in advance of the season, or else the removed pink salmon will become a waste problem. The preferred solution is to use them as food, either commercially or in private households, due to the costs imposed from other solutions and the ethical side of wasting the resource that the catch represents. The national group for measures against pink salmon is currently evaluating the effort in 2023, with two main focus areas; 1) how far should we expand in 2025 and, 2) what worked with the weirs and what can be improved? In 2024 the planning, procurement and testing of equipment and locations continue. There is a special attention to the unsolved problems in the large rivers, like Tana and Alta. There is also an ongoing pre-commercial procurement of AI-based traps with automatic recognition and sorting by species, we are aiming at testing the prototypes in 2025.

24. REMOVAL OF PINK SALMON IN TANA IN 2023

Roy M. Langåker[1], Sturla Brørs[1], Roar Sandodden[2] and Pål Adolfsen
1) Norwegian Environment Agency, roy.malvin.langaker@miljodir.no
2) Norwegian Veterinary Institute, roar.sandodden@vetinst.no

Removal of Pink salmon in River Tana was carried out in 2023 by the Norwegian Environment Agency in collaboration with the Norwegian Veterinary Institute and the Tana Fisheries Board (TF). In order to attain Norway's objectives on Pink salmon, in line with NASCO's statement on Pink salmon and Article 8 in the Convention on biological diversity, it was important to start developing near full-scale measures in Tana. Tana is perhaps the world's most important river for Atlantic salmon with about 30 genetically distinct salmon stocks. As all the large salmon stocks in Tana have been greatly reduced, it is a priority to avoid impacts of Pink salmon on the local stocks. The number of Pink salmon increased significantly from 2019 to 2021 in the River Tana. With the largest production area for Pink salmon in Norway, River Tana has the potential to become a main source for the further spread of Pink salmon in Norway and eventually harming salmon stocks throughout the North East Atlantic. Therefore, it was important to gather experience with a large-scale measure in Tana in 2023.

In addition to the main measure at Seidaholmen nearby Tana bru run by the Environment Agency, TF was responsible for organizing scattered Pink salmon fishing on spawning grounds up streams the fish trap in the main stem of Tana. TF also managed a fish trap in the Máskejohka tributary, which runs into River Tana down streams the Seidaholmen fish trap.

It is challenging and complicated to manage the fish stocks in Tana. In addition to the 30 salmon stocks, there are 16 other fish species, the Tana is a large watercourse (16,000 km2) in which salmon run more than 1200 km and it is situated in a core area for the Sami population. All these features are shared between Norway and Finland, but despite a common agreement, the management, legislation, and infrastructure differ a lot between the two countries. With this starting point, we placed great emphasis on extensive and frequent information and participation throughout the planning process both locally, nationally, and bilaterally. To facilitate this, we have had meetings with people with local knowledge, set up a Norwegian/Finnish coordination group and arranged two physical information meetings locally with Finnish interpretation in 2023.

The final estimates of the number of ascending pinks are not yet available but preliminary monitoring data indicate that we did remove a far lower proportion of the pinks than we aimed for. One of the main reasons for many Pink salmon being able to pass is most likely the one type of guiding fence. We are still evaluating the whole project but have already identified points for improvement on this year's operations and expect we will be able to resolve what did not work. This in parallel with possible alternative measures, will continue to be worked on towards 2025. Nevertheless, with this project, we have started to develop removal measures in large rivers. The experiences and knowledge from Tana in 2023 are useful when planning and implementing measures in other large rivers such as Alta, Neiden, Reisa, Lakselva and Målselva.

It is also important to point out that other aspects of the project have worked far better than many expected. Both the fish weir and the fleet resisted this year`s rather big summer floods very well. Safety for the 25 employed in the project had first priority. We are very pleased that there were no injuries or accidents. Thereafter, to avoid impact on migrating local fish was prioritized. While preliminary data from the monitoring (NINA) of the measure show that the salmon smolts appeared to migrate continuously through the downward migration solution, the fish weir and the guiding fence, we had to implement extra measures to ensure the timely upward migration of local fish. Analyses of the collected monitoring data still remain and will be reported at the end of this year.

25. PINK SALMON INVASION IN RIVER TENO, FINNISH MEASURES

Tapio Hakaste, tapio.hakaste@gov.fi
Ministry of Agriculture and Forestry, Natural resources department, Finland

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River Teno/Tana is a border river between Finland and Norway. There are about 30 genetically differentiated salmon stocks in this river-system. Atlantic salmon stock status has been poor for a long time, and no fishing for salmon was allowed in years 2021-2023.

Fishing for other species including pink salmon was allowed. With amendment to the common fishing rule, it was possible to start projects for targeted pink salmon fishing. In Finland, these projects were locally driven. Avoidance of Atlantic salmon bycatch was a very important starting point for fishing of pink salmon. A project plan was required to ensure correct allocation of fishing over time and regionally to avoid bycatch. Local knowledge on Atlantic salmon behaviour was also used to find areas where Atlantic salmon bycatch could be avoided.

Natural resources Institute Finland LUKE also continued a R & D project on pink salmon fishing methods. Local fishers played an important role in this project, as the development was based local fishing gears and traditional knowledge. The project tested seine net and drift nets. For seine net further development was needed, mainly to improve technical issues in fishing operations. Driftnets functioned well, both the light net version developed especially for shallow areas in this project, and the older, ”typical” drift nets. More information can be found at https://barents-ias.info/.

As a result, 13 locally driven pink salmon fishing projects were notified to ELY Centre for Lapland. Catch varied from less than 50 pink salmon to over 1500 pink salmon within projects. The reported Atlantic salmon bycatch was very low. Fishers used mainly drift nets, but also standing nets, seine net and rod were tried out. Fishers gained a lot of new experience on pink salmon fishing, for example that pink salmon migrated during the night, and the size of pink salmon varied during the season. In general driftnets with mesh size 45-50 mm, 1,8 – 3 m depth, 0,25-0,30 monofil strength were found most suitable for targeted pink salmon fishing.

As a preliminary estimate, 7500 – 9000 pink salmon were caught in these local projects. Adding the total catch of the R&D project by LUKE, total catch was 15 000-16 500 pink salmon in Tana on Finnish side of the river.

Local pink salmon removal projects could provide a good starting point for future measures. It is important to look for such pink salmon removal methods that can benefit the local community. Local actors must be better engaged in eradicating pink salmon projects in the future. Results from this year show that it is possible to find areas in the river whereby-catches of salmon can be avoided by combining research data and local knowledge.

Unfortunately, the bigger pink salmon removal project in Tana, at Seidaholmen, was not successful. Pink salmon was able to pass the weir but Atlantic salmon migration was ceased. Because of risks involved, the social acceptance of pink salmon removal measures taken by Norway were low in Finland. In the future pink salmon removal projects must be approved in both countries, if possible. It is important to work together, seek common solutions for the border stretch of the river so that burden, benefits, and risks can be assessed together.

26. EVALUATION OF MEASURES TO CONTROL PINK SALMON INVASION BY FISHING AT SEA

Eva B. Thorstad, eva.thorstad@nina.no
Norwegian Scientific Advisory Committee for Atlantic salmon

Results from the following report were presented:
Vitenskapelig råd for lakseforvaltning 2023. Vurdering av bruk av fiskeredskap i sjøen til bekjempelse av pukkellaks. Temarapport fra Vitenskapelig råd for lakseforvaltning nr 11: 1-107.

The mandate given by the Environment Agency was to assess if fishing methods at sea can be used to mitigate pink salmon without too high mortality of native Atlantic salmon, sea trout and anadromous Arctic char. An important premise for the assessment was that exploitation of Atlantic salmon should not be increased from 2021 and 2022 to protect vulnerable populations and to reach management goals based on spawning targets and the Quality Norm under the Nature Diversity Act.

Fishing for pink salmon at sea will result in bycatch of native salmonids, because they are in the same areas at the same time and overlap in body size. The proportion of Atlantic salmon, sea trout and Arctic char that become critically injured or die when caught in bag nets is relatively high. Studies in Middle and southern Norway showed that in bag nets with 58 mm mesh size, 18-31% of Atlantic salmon and 31-64% of sea trout were dead or too injured to be released. In bag nets with 40 mm mesh size, 22-23% of Atlantic salmon and 26-57% of sea trout were dead or too injured to be released. In bend nets and other type gill nets, we expect near 100% mortality of all fish caught.

An ordinary sea fishery using the same gears as in 2021 will not provide an efficient reduction of pink salmon – not even with an increased effort in terms of number of gears and fishing days, because many pink salmon are too small to be caught in these gears. A sea fishery with adjusted mesh sizes to catch pink salmon in addition to the ordinary sea fishery, will result in too high total exploitation of Atlantic salmon. To efficiently reduce pink salmon by a sea fishery - and at the same time reach management targets for Atlantic salmon – the ordinary sea fishing must be closed in pink salmon years and be replaced by a targeted fishery for pink salmon with the use of 55-58 mm bag nets, shortened fishing season to approximately 20 June to 15 July, and release of all live and unharmed salmon, sea trout and Arctic charr. A large bycatch mortality of sea trout and Arctic char will still take place. Other gears like drift nets, seine nets and several type traps were also evaluated, but none of these gears were regarded as very relevant, either because of high bycatch mortality, low efficiency, or both. For purse seine, a large bycatch mortality is expected, and this fishing method is therefore only relevant if methods to avoid bycatch of native salmonids are developed.

27. BAG NET FISHING FOR ATLANTIC AND PINK SALMON IN THE VARANGERFJORD; HOW MANY ATLANTIC SALMON COULD BE RELEASED ALIVE?

Torgeir B. Havn[1], Eva M. Ulvan[1], Kristin Bøe[2], Dag H. Karlsen[1]

1 Norwegian Institute for Nature Research (NINA); torgeir.havn@nina.no
2 Norwegian Veterinary Institute

We examined how many Atlantic salmon, sea char and sea trout caught in two bag nets in the Varangerfjord that could be released back to the sea alive. The bag nets were located in Ropelv outside of Kirkenes (58 mm mesh size) and in Vadsø (62-64 mm mesh size). The study was performed between 19 June to 14 July, a period where catches of pink salmon usually are high in the Varangerfjord in odd years. In total, 140 Atlantic salmon, 890 pink salmon and one sea trout were caught in the two nets. When the nets were emptied it was registered if the Atlantic salmon were dead, in such a poor condition that they could not be released or fit for release. Injuries caused by the net was registered for each individual fish. Mortality of Atlantic salmon was high in both the 58 mm net (60%) and in the 62-64 mm net (64%), higher than in similar studies in fjords further south in Norway (18-31% in 58 mm bag nets). In Varangerfjorden, catches consisted mostly of 1 SW salmon, while larger fish were scarce. Smaller body size of the fish in the current study compared to fish in previous studies is probably an important explanation for higher mortality rates in Varangerfjorden.

As a pilot, 35 pink salmon caught in the 58 mm net were floy-tagged and released. Recaptures were used to study how pink salmon migrated and distributed in the Varangerfjord. Three pink salmon were recaptured in Munkelv, one in Grense Jakobselv, one in Vestre Jakobselv and one in Vesterelva (17% recapture rate). The fish spent between 9 and 25 days before being recaptured in these rivers located 35-75 km from the release site.

Troms and Finnmark County Governor/
Statsforvalteren i Troms og Finnmark

Phone: +47 78 95 03 00
E-mail: sftfpost@statsforvalteren.no

Norwegian Environment Agency/
Miljødirektoratet

Phone: +47 73 58 05 00
E-mail: post@miljodir.no