Tana Monitoring and Research Group

Status of the Tana/Teno River salmon populations in 2021

Report from the Tana Monitoring and Research Group 1/2021

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Summary

Anon. 2021. Status of the Tana/Teno River salmon populations in 2021. Report from the Tana Monitoring and Research Group nr 1/2021.

This report is the fifth status assessment of the re-established Tana Monitoring and Research Group (MRG) after the new agreement between Norway and Finland. After a summary of salmon monitoring time series in Tana/Teno, we present an updated status assessment of 8 stocks/areas of the Tana/Teno river system. All stocks are evaluated in terms of a management target defined as a 75 % probability that the spawning target has been met over the last four years. A scale of four years has been chosen to dampen the effect of annual variation on the status.

Assessing the stock status is answering the question about how well a salmon stock is doing, how many salmon were left at the spawning grounds and how many should there have been. The question about how many salmon should spawn has been addressed by the defined spawning targets for the different populations (Falkegård et al. 2014). The unprecedented situation in fisheries in 2021 when a total moratorium of salmon fisheries was in place both in the Teno/Tana river system and in large areas in Tanafjord and in adjacent coastal areas. In contrast to the several alternative ways of estimating the spawning stock used in earlier years (Anon. 2020), only direct counts of ascending and spawning salmon were used in assessment in 2021 because of the absence of salmon catches.

The map below summarizes the 2018-2021 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates the management target attainment, defined as probability of reaching the respective spawning targets over the last four years. The management target was classified into five groups with the following definitions:

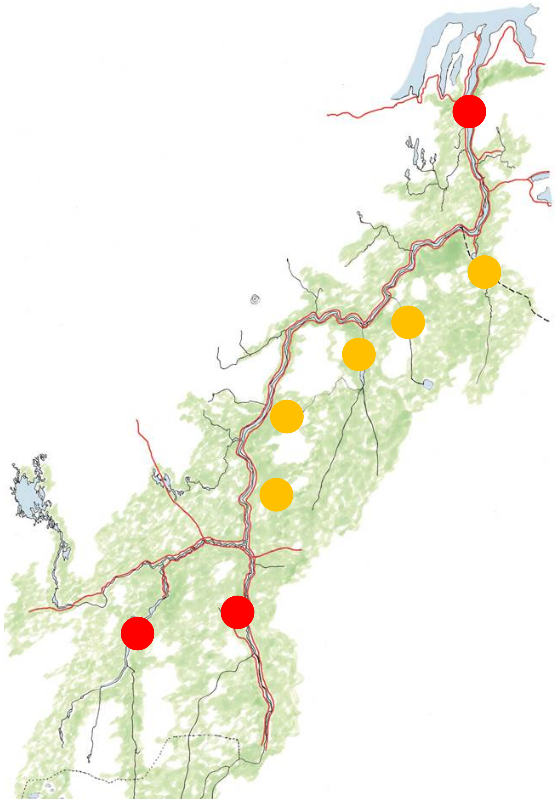
1) Probability of reaching the spawning target over the last four years higher than 75 % and attainment higher than 140 % (dark green color in the summary map below)
2) Probability higher than 75 %, attainment lower than 140 % (light green)
3) Probability between 40 and 75 % (yellow)
4) Probability under 40 %, at least three of the four years with exploitable surplus (orange)
5) Probability under 40 %, more than one year without exploitable surplus (red)

Based on the status assessment, all eight evaluated areas had a management target attainment below 40 %, and three of the areas were placed in the worst status category with very little exploitable surplus over the last four years.

Of the stocks with poor status, the most important thing to note is the status of the upper main headwater areas of Kárášjohka, Iešjohka and Anárjohka/Inarijoki and of the Tana/Teno main stem. These areas had low target attainment and low exploitable surplus. These four areas constitute 84 % of the total Tana/Teno spawning target and over the last four years, these areas together have lacked 30-35 000 kg female spawners annually to reach their combined management targets.

To conclude, the situation for different salmon stocks of the Tana/Teno system in 2021 show a continued overall negative status with low spawning stocks and low estimates of pre-fishery abundance. The numbers of large MSW salmon were particularly low, in line with what was predicted for 2021. Overall low returns of 1SW salmon continued, and it is therefore expected that the return of MSW salmon will continue to be extremely low in 2022 and that there likely will not be any sustainable surplus available.

Given this forecast, we strongly advise keeping the salmon fisheries either closed or allow only very limited salmon fishing in 2022. This recommendation is based on biological considerations only.



The table below summarizes the stock-specific management targets and status numbers for 2021 and previous four years, and the probability for reaching the spawning target over the previous 4 years (=the management target).

	2021 target attainment	**2021 probability**	**4-year target attainment**	**Management target**
Tana/Teno MS	48 %	0 %	44 % %	0 %
Buolbmátjohka/Pulmankijoki	79 %	8 %	94 %	36 %
Veahčajohka/Vetsijoki	110 %	68 %	87 %	22 %
Ohcejohka/Utsjoki (+tributaries)	100 %	46 %	94 %	34 %
Njiljohka/Nilijoki	62 %	0 %	82 %	14 %
Áhkojohka/Akujoki	45 %	0 %	36 %	0 %
Kárášjohka (+tributaries)	53 %	0 %	38 %	0 %
Anárjohka/Inarijoki (+tributaries)	27 %	0 %	24 %	0 %

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Contents

1 Introduction

The new Tana Monitoring and Research Group (hereafter MRG) was formally appointed in 2017 based on a Memorandum of Understanding (MoU) signed by Norway and Finland in December 2017. The mandate of the MRG is:

1) Deliver annual reports within given deadlines on the status of the salmon stocks, including trends in stock development.
2) Evaluate the management of stocks considering relevant NASCO guidelines.
3) Integrate local and traditional knowledge of the stocks in their evaluations.
4) Identify gaps in knowledge and give advice on relevant monitoring and research.
5) Give scientific advice on specific questions from management authorities.

The MoU is based on the Agreement between Norway and Finland on the Fisheries in the Tana/Teno Watercourse of 30 September 2016. This agreement outlines a target- and knowledge-based flexible management regime for salmon fisheries in the Tana.

According to the MoU, the MRG shall consist of four scientists, two appointed by the Ministry of Agriculture and Forestry in Finland and two by the Ministry of Climate and Environment in Norway. The currently appointed members are:

- Jaakko Erkinaro (Finland, scientist working at Natural Resources Institute Finland (Luke) in Oulu)
- Panu Orell (Finland, scientist working at Luke in Oulu)
- Morten Falkegård (Norway, scientist working at Norwegian Institute for Nature Research (NINA) in Tromsø)
- Anders Foldvik (Norway, scientist working at NINA in Trondheim)

1.1 Report premises

1.1.1 The Precautionary Approach

Both Norway and Finland (through EU) are members of the North Atlantic Salmon Conservation Organisation (NASCO; www.nasco.int). This is an international organization, established by an inter-governmental Convention in 1984, with the objective to conserve, restore, enhance and rationally manage Atlantic salmon through international cooperation. NASCO parties have agreed to adopt and apply a Precautionary Approach (Agreement on Adoption of a Precautionary Approach, NASCO 1998) to the conservation and management and exploitation of Atlantic salmon to protect the resource and preserve the environments in which it lives. The following list summarizes the approach outlined in the Precautionary Approach:

1) Stocks should be maintained above a conservation limit using management targets.
2) Conservation limits and management targets should be stock-specific.
3) Possible undesirable outcomes, e.g. stocks depleted below conservation limits, should be identified in advance.
4) A risk assessment should be incorporated at all levels, allowing for variation and uncertainty in stock status, biological reference points and exploitation.
5) Pre-agreed management actions should be formulated in the form of procedures to be applied over a range of stock conditions.

6) The effectiveness of management actions in all salmon fisheries should be assessed.
7) Stock rebuilding programmes should be developed for stocks that are below their conservation limits.

The conservation limit is defined as the minimum number of spawners needed to produce a maximum sustainable yield (NASCO 1998).

The above process is highly demanding in terms of knowledge, evaluation and implementation. A follow-up document from 2002 (Decision Structure for Management of North Atlantic Salmon Fisheries, NASCO 2002) helps systematizing the approach as a tool for managers by providing a consistent approach to the management of salmon exploitation. Further deepening elaborations and clarifications have been given in a document from 2009 (NASCO Guidelines for the Management of Salmon Fisheries, NASCO 2009).

All assessments and evaluations found in this report have been done to comply with the Precautionary Approach.

1.1.2 Single- vs. mixed-stock fisheries

The management of salmon fisheries should be based on advice from the International Council for the Exploration of the Sea (ICES). These advices primarily imply that salmon fisheries should exploit stocks that are at full production capacity, while exploitation of depleted stocks should be limited as much as possible. In this context, it becomes important to distinguish a single-stock fishery from a mixed-stock fishery.

NASCO defines a mixed-stock fishery as a fishery that concurrently exploits stocks from two or more rivers. A mixed-stock fishery might exploit stocks with contrasting stock status, with some stocks well above their conservation limits and others well below. The fishery in the Tana main stem is an example of a complex mixed-stock fishery. NASCO (2009) has emphasized that management actions should aim to protect the weakest stocks exploited in a mixed-stock fishery.

1.1.3 Management and spawning targets

It follows from the Precautionary Approach that managers should specify stock-specific reference points that then should be used to evaluate stock status. The conservation limit is important, and management targets should be defined to ensure that stocks are kept above their conservation limit. The management target therefore designates the stock level that safeguards the long-term viability of a stock.

The spawning target is founded on the premise that the number of recruits in a fish stock in some way is depending on the number of eggs spawned and that each river has a maximum potential production of recruits. The number of eggs necessary to produce this maximum number of recruits is the spawning target of a river.

1.2 Definition and explanation of terms used in the report

Accumulated/sequential/total exploitation. This term is used to describe a sequence of fisheries which together exploit a salmon stock. The sequence that impact salmon stocks in Tana is the following: (1) Coastal fisheries in the outer coastal areas of Nordland, Troms and Finnmark; (2) Coastal fishery in the Tana fjord; (3) Tana main stem; and (4) home tributary (only applies to tributary stocks in the system). In such a sequence the exploitation pressures add up.

An example: 100 salmon are returning to a stock in one tributary in Tana. 10 are taken in the outer coastal fisheries, 10 are taken in the fjord, 10 in the Tana main stem and 10 in the tributary. A total of 40 out of 100 salmon are taken, which gives an accumulated exploitation rate of 40 %. The exploitation efficiency in each fishing area is much lower, e.g. 10 % in the outer coastal area in this example.

Exploitation rate/efficiency. The proportion of fish taken in an area out of the total number of fish that is available for catch in the area. For example, if 10 out of 50 fish are taken, the exploitation rate is 20 %.

Exploitation estimate. See exploitation rate above. Ideally, we want to have a direct estimate of the exploitation rate using catch statistics and fish counting. Such estimates are available only in rivers with a detailed monitoring. In most cases, indirect estimates of exploitation rates must be used. Such estimates must be based on available data in rivers of comparative size and comparative regulation.

Management target. The management target, as defined by NASCO, is the stock level that the fisheries management should aim for to ensure that there is a high probability that stocks exceed their conservation limit (spawning target, see definition below). The management target is defined as a 75 % probability that a stock has reached its spawning target over the last 4 years.

Maximum sustainable exploitation. This is the amount of salmon that can be taken in each year while ensuring that the spawning target is met. The maximum sustainable exploitation therefore equals the production surplus in a year.

Overexploitation. This refers to the extent of a reduction in spawning stock below the spawning target that can be attributed to exploitation.

Pre-fishery abundance. This is the number of salmon that is available for a fishery. For example, the total pre-fishery abundance of a stock is the number of salmon coming to the coast (on their spawning migration) and therefore is available for the outer coastal fisheries. The pre-fishery abundance for a tributary in the Tana river system is the number of salmon of the tributary stock that have survived the coastal and main stem fisheries and therefore are available for fishing within the tributary.

Production potential. Every river with salmon has a limited capacity for salmon production. The level of this capacity is decided by environmental characteristics and river size.

Spawning stock. These are the salmon that have survived the fishing season (both coastal and river fisheries) and can spawn in the autumn. Usually the spawning stock estimates focus only on females.

Spawning target. The spawning target is defined as the number of eggs needed to make sure that the salmon stock reaches its production potential. As it is used in Tana/Teno, the spawning target is analogous to NASCOs conservation limit.

1.3 A procedure for target-based stock evaluation in Tana/Teno

The MRG is tasked with reporting stock status and trends in stock development, and the Precautionary Approach outlines the premises for how a stock status evaluation should be done. In the following we give a brief outline of the procedure we have used in order to produce the stock-specific evaluations in chapter 3. A much more detailed description of the procedure can be found in a previous report of the MRG (Anon. 2016).

1.3.1 Spawning stock assessment

At its most fundamental, stock status is about answering a question about how well a salmon stock is doing. How many salmon were left at the spawning grounds and how many should there have been? What was the exploitable surplus and how was that surplus reflected and distributed in the catch of various fisheries?

The question about how many salmon should spawn has been thoroughly answered with the spawning targets given in Falkegård et al. (2014). We then need an estimate of the actual spawning stock size. There are several alternative ways of estimating this:

1) **Direct counting of spawners**, e.g. through snorkelling. This approach is most useful in small tributaries of the Tana/Teno river system (Orell & Erkinaro 2007) where it has been shown to be relatively accurate, especially under good environmental conditions with an experienced diving crew (Orell et al. 2011).
2) **Combine fish counting and catch statistics**. Fish counting of migrating salmon, either through video or sonar (ARIS or Simsonar), will give an estimate of the salmon run size (the number of salmon entering a salmon river). Catch statistics provides an estimate of how many salmon were removed and run size minus catch is an estimate of the spawning stock.
3) **Combine estimates of exploitation rate and catch statistics**. In most of the evaluated stocks, we lack both spawner and fish counts. We then must rely directly on the catch statistic and use an estimate of the exploitation rate to calculate the spawning stock size. Because the exploitation rate must be estimated, it is necessary to have access to monitoring data from comparable rivers in the area where the exploitation rate have been calculated (either through counting of spawners or through counting of ascending salmon).
4) **Combine genetic information, exploitation rates and catch statistics**. Some of the stocks we evaluate are either in an area of mixed-stock fishing (the Tana/Teno main stem stock) or are in tributaries with very limited fishing and catch. In these cases, we must rely on genetic stock identification of main stem catch samples and main stem catch statistics in order to estimate a run size and a spawning stock size.

Detailed descriptive tables with annual data points and assumptions used in the status assessment of each stock are given in the stock-specific assessment chapters. The entire spawning stock assessment procedure can be accessed online at this link:

https://github.com/mortenfalkegard/Tana_status_assessment

River-specific information are found in the *data/rivers*-directory. The actual steps of the assessment are provided in the source file *gbm-eval.all.R*, found in the *src*-directory. The entire content of the repository can easily be downloaded (green code download button). In order to replicate the analysis, you will need the R statistical package installed. This is available for free at the following link:

https://www.r-project.org/

1.3.2 Pre-fishery abundance and catch allocation

During their spawning migration from open ocean feeding areas towards their natal areas in the Tana/Teno river system, Tana/Teno salmon experience extensive exploitation in a sequence of areas. The first area of the sequence is the outer coast of northern Norway. The second area is the Tana fjord, while the third area of exploitation is the Tana/Teno main stem. Finally, salmon are further exploited in their respective home tributaries.

Along the coast and in the main stem, salmon are exploited in mixed-stock fisheries. A mixed-stock fishery represents a major impediment when the exploitation rate on different stocks is to be evaluated, as the level of exploitation on each stock participating in a mixed-stock fishery is not apparent without specific knowledge gained e.g. through genetic stock identification of catch samples or some large-scale tagging program.

For the main stem mixed-stock fishery, genetic stock identification has been done on mixed-stock catch samples from several years with different genetic methods. Microsatellites were used for catch samples from 2006-2008, 2011-2012, whilst single-nucleotide polymorphism (SNP) were used for catch samples from 2018-2019. The result is main stem catch proportions for each stock.

For the coastal mixed-stock fishery, we have used data from a recent project (EU Kolarctic ENPI CBC KO197) where genetic stock identification was used to identify stock of origin of salmon caught along the coast of northern Norway in 2011 and 2012. This provides us with a catch proportion estimate of Tana/Teno salmon in various regions along the coast.

The following back-calculating procedure is used to estimate the pre-fishery abundance of Tana/Teno stocks and how each stock is affected by fisheries in various areas:

1) Spawning stock sizes for each stock is taken from the spawning stock assessment.
2) For the tributary stocks, tributary catches are added to the respective spawning stock sizes.
3) Main stem catches are estimated from main stem catch proportions.
4) Tributary and main stem catch estimates and spawning stocks are summed, giving us an estimate of the relative size of each stock when entering the Tana/Teno main stem.
5) The coastal catch proportion of Tana/Teno salmon is multiplied with the coastal catch statistic, giving us an estimate of the number of Tana/Teno salmon caught in coastal fisheries.
6) The coastal catch estimate is distributed to the various Tana/Teno stocks based on the relative abundance of the stocks (from point 4 above).
7) Pre-fishery abundances (the total amount of salmon from each stock available for fisheries each year) are obtained by adding the coastal catch to the river catch and the spawning stock estimate.

The entire catch allocation and pre-fishery abundance estimation procedure can be accessed online in the Github-link above. Data files used in the catch allocation are found in the *data*-directory, while the actual steps of the procedure are found in the source file *catch-distribution.R* found in the *src*-directory.

2 Salmon stock monitoring

Monitoring of the salmon stocks in the Tana/Teno started back in the 1970s and is based on long-term surveys carried out and funded jointly by Finnish and Norwegian research bodies and authorities. The long-term monitoring programme with the longest time series includes:

- Catch and fishery statistics (present form since 1972)
- Catch samples (since 1972)
- Estimating the juvenile salmon abundances at permanent sampling sites (since 1979)

Following the NASCOs Precautionary Approach and Decision Structure, the need for a closer and more detailed monitoring of the mixed-stock fisheries has become evident. Therefore, several monitoring programmes for individual tributaries have been established in later years.

Monitoring activities that have been at use for a shorter period include counting of:

- Ascending adult salmon and descending smolts by a video array in Ohcejohka/Utsjoki (since 2002) and Lákšjohka (in 2009-2020)
- Spawning adult salmon by snorkelling in three tributaries (Áhkojohka/Akujoki, Buolbmátjohka/Pulmankijoki, since 2003 and Njiljohka/Nilijoki, since 2009)
- Ascending adult salmon by a sonar in Kárášjohka (in 2010, 2012, 2017-2021)
- Ascending adult salmon by a sonar in Anárjohka/Inarijoki (in 2018-2019, 2021)
- Ascending adult salmon by a sonar in the Tana/Teno main stem (2018-2021)

These fish counts have provided useful information on tributary-specific salmon abundance and diversity. In addition, counts of adult salmon combined with catch data have been used in estimating compliance with the tributary-specific spawning targets (see chapter 3).

Recently, fish counts have also been carried out at some tributaries, e.g. Váljohka (video, 2015 and some snorkelling counts), Veahčajohka/Vetsijoki (sonar+video, 2016 and 2021), Iešjohka (sonar, 2019-2020) and Máskejohka (sonar, 2020). These pieces of information from individual tributaries are useful as reference levels for estimating their stock status, which in most years make use of catch data only.

A brief overview of the current monitoring activities and their recent results is presented below.

2.1 Catch and fisheries data in 2021

As the Tana/Teno salmon fisheries were totally closed because of poor stock status there were no salmon catch or fisheries data collected in 2021. Data from earlier years can be found from last year’s report (Anon. 2020).

2.2 Juvenile salmon monitoring

The juvenile salmon densities are estimated in a long-term monitoring programme started in 1979. This programme includes 32 sampling sites in the Tana/Teno mainstem, 12 in the Ohcejohka/Utsjoki and 10 in the Anárjohka/Inarijoki. Each site has been fished with standardized methods once a year in a strict rotation, so that the fishing took place on almost the same date in successive years. During the years 2017-2021 some of the Tana/Teno main stem and Anárjohka/Inarijoki sampling sites have not been electrofished because of research license problems and the Covid-19 border crossing issues.

Although the juvenile salmon abundance is not used directly in assessing stock status for individual populations (chapter 3), information on juvenile abundance is still an important index of spatial distribution of spawning and juvenile production and their yearly variation.

In 2021 juvenile salmon densities at the permanent electrofishing sites were within the limits of earlier years (Figure 1). In both Ohcejohka/Utsjoki and Anárjohka/Inarijoki the densities were, however, among the lowest observed in the 2000s (Figure 1).

In addition to permanent electrofishing sites in the Tana/Teno main stem, Ohcejohka/Utsjoki and Anárjohka/Inarijoki the River Kevojoki juvenile densities were monitored in 2021 (Figure 2) including 22 sites as in 2009 and 2017. The densities in 2021 (66,3 fish/100 m^2) were generally lower than in 2009 (82,7 fish/100 m^2) and 2017 (81,7 fish/100 m^2), but still at rather good levels compared e.g. to the annually electrofished permanent sites in the Tana/Teno main stem, Ohcejohka/Utsjoki and Anárjohka/Inarijoki. The River Kevojoki is among the best salmon production areas of the Tana/Teno system.

Overall, the juvenile densities in the Tana/Teno system are not dramatically low even though the spawning populations have been at low levels during the last few years. It seems that there are still enough spawners to maintain the juvenile production within the long-term density ranges at least in the sampled sites.

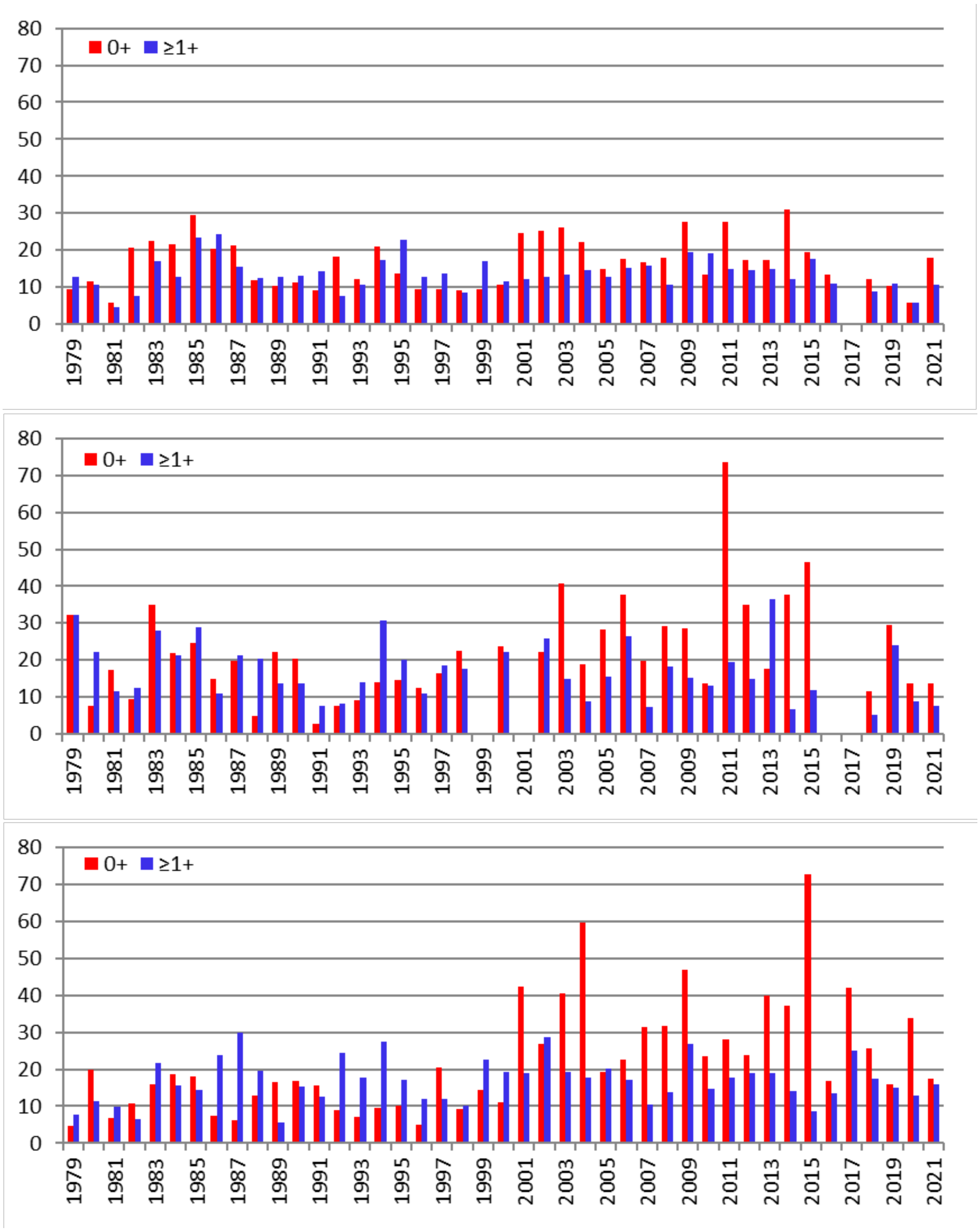

Figure 1. Mean densities (fish/100 m²; one pass) of salmon fry (0+) and parr (≥1+) at permanent electrofishing sites in the rivers Tana/Teno (uppermost panel), Ohcejohka/Utsjoki (middle panel) and Anárjohka/Inarijoki (lowermost panel) in the years 1979-2021. Note: this data only includes electrofishing sites (Tana/Teno 16-22 sites, Ohcejohka/Utsjoki 11-12 sites and Anárjohka/Inarijoki 5-7 sites) that have been the same throughout the monitoring period.

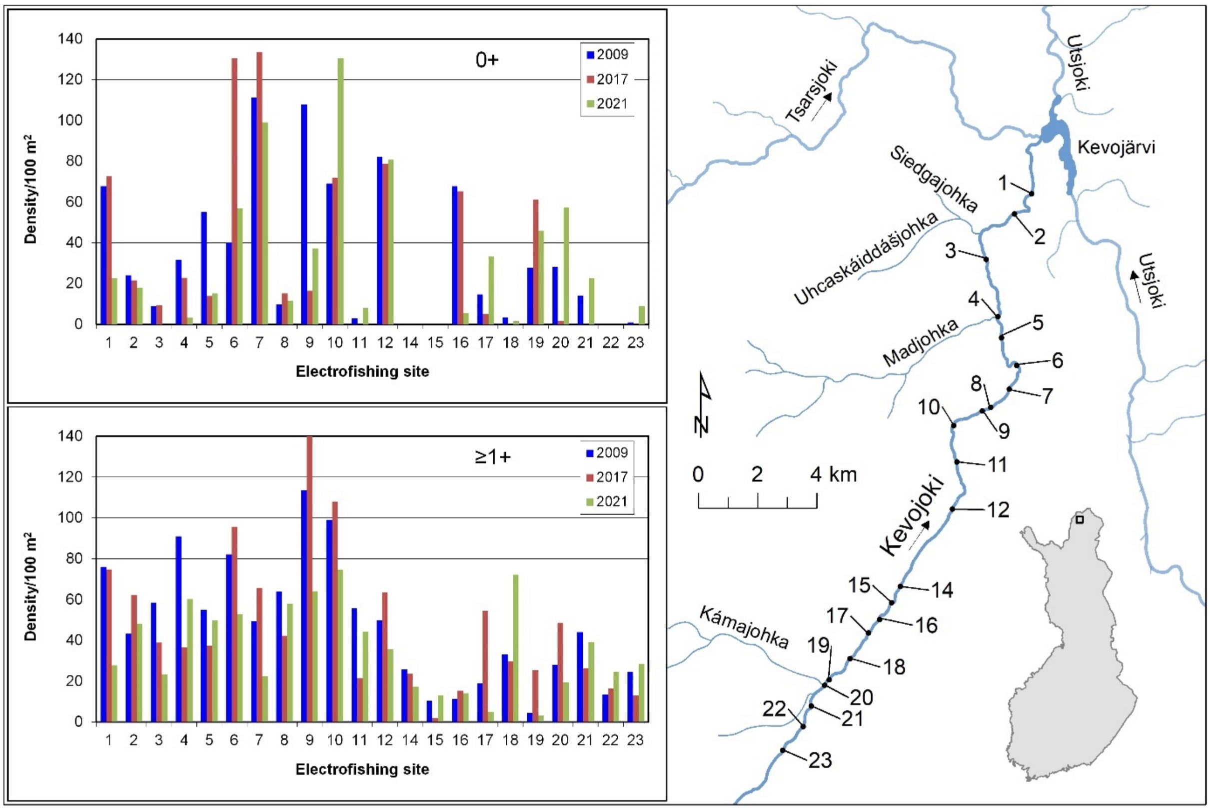

Figure 2. Densities (fish/100m^2; one pass el-fishing) of salmon fry (0+) and parr (≥1+) in the sampling sites (n=22) of the River Kevojoki in 2009, 2017 and 2021.

2.3 Adult salmon counting

Counting of adult salmon ascending the Tana/Teno main stem and its tributaries, or being present at spawning areas, has been carried out in several sites using multiple methods, including video monitoring, sonar counts and snorkelling counts (Figure 3).

In 2021 adult salmon counts were performed at the following sites (Figure 3): Tana/Teno main stem (sonar), Veahčajohka/Vetsijoki (sonar/video), Ohcejohka/Utsjoki (video), Kárášjohka (sonar), Anárjohka/Inarijoki (sonar), Buolbmátjohka/Pulmankijoki (snorkelling), Njiljohka/Nilijoki (snorkelling) and Áhkojohka/Akujoki (snorkelling).

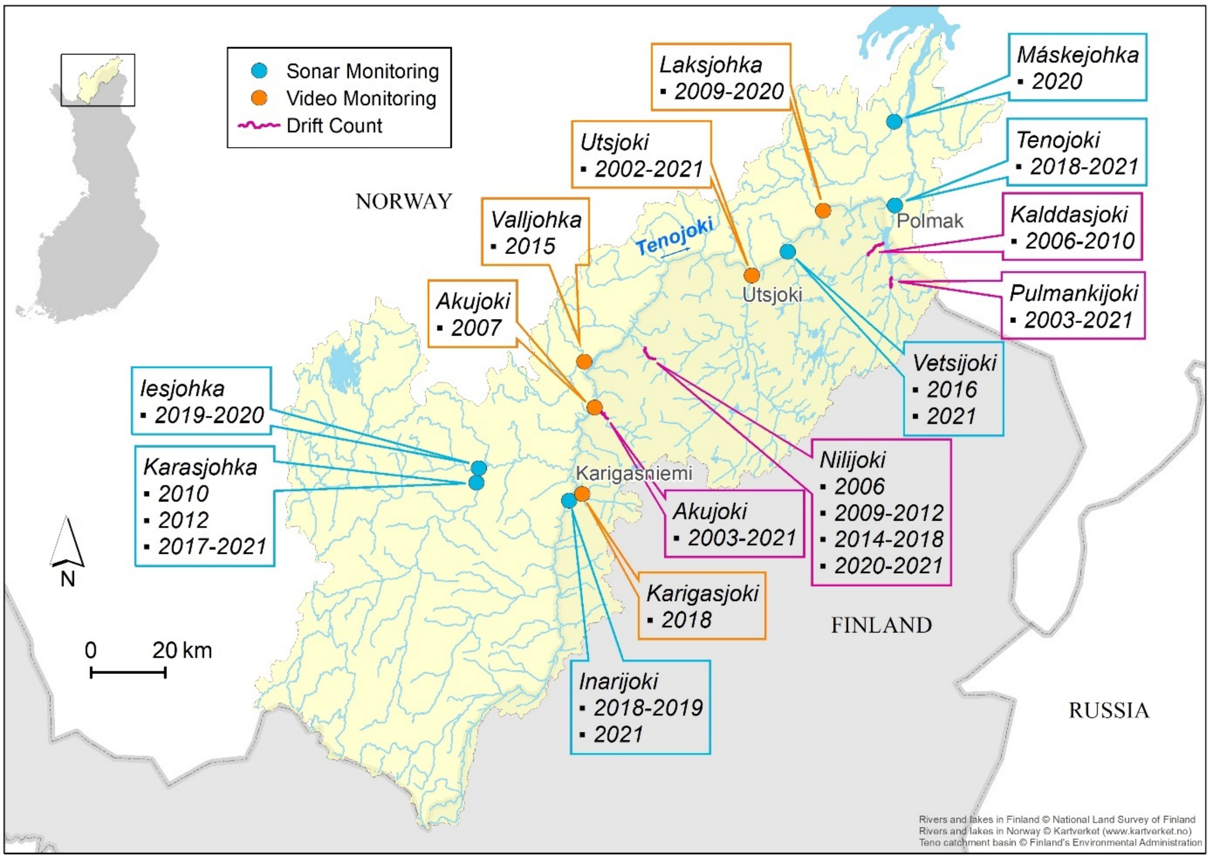

Figure 3. Map of the Tana/Teno river system indicating the most important adult salmon counting sites and counting methods between 2002 and 2021.

2.3.1 Long-term video monitoring in Ohcejohka/Utsjoki

Monitoring of ascending adult salmon and descending smolts has been conducted in Ohcejohka/Utsjoki since 2002 by an array of eight video cameras below the bridge close to the river mouth (Orell et al. 2007). Numbers of ascending salmon have varied between 1 000 and 6 700 in 2002-2020 (Figure 4).

In 2021 the video counting was performed in good environmental conditions without any significant problems. The adult salmon count was slightly less than 2 000 fish. Salmon numbers almost doubled from 2020 but were significantly lower (77 %) than the long-term average (3 460 fish) (Figure 4).

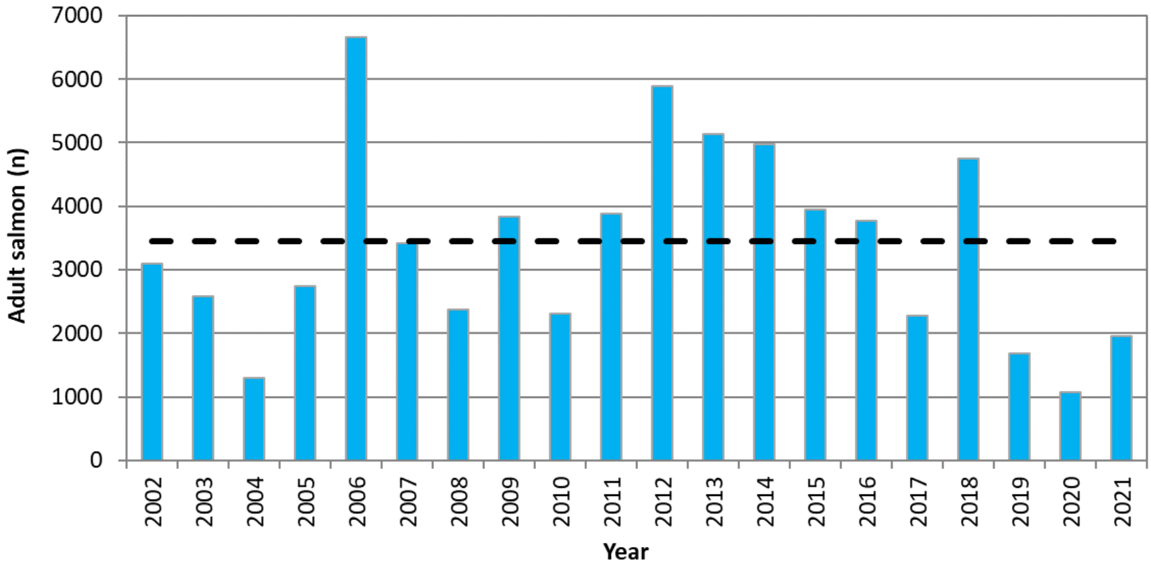

Figure 4. Video counts of ascending adult salmon at the video monitoring site at the river mouth of Ohcejohka/Utsjoki. The dashed black line indicates the long-term average between 2002-2020. All sea-age groups are combined.

2.3.2 Snorkelling counts

Salmon spawners have been counted by snorkelling on annual basis in rivers Áhkojohka/Akujoki and Buolbmátjohka/Pulmankijoki since 2003. In Áhkojohka/Akujoki, the counting area covers the entire salmon production area (6 km) below an impassable waterfall, whereas a stretch of 4 km in the central spawning areas of the Buolbmátjohka/Pulmankijoki has been snorkelled every year. In addition, counts have been conducted in shorter time spans or individual years in some other small tributaries as well; the best data is available from the river Njiljohka/Nilijoki, where a 5 km stretch on the upper reaches has been counted almost annually since 2009 (Figure 5).

The number of spawning salmon has varied between 31 and 171 in Áhkojohka/Akujoki, between 29 and 215 in Buolbmátjohka/Pulmankijoki and between 49 and 216 in Njiljohka/Nilijoki (Figure 5). In 2021 the snorkelling counts were performed in good environmental conditions and the results are fully comparable to other years. Numbers of spawning salmon roughly doubled in Áhkojohka/Akujoki Njiljohka/Nilijoki and tripled in Buolbmátjohka/Pulmankijoki compared to 2020 (Figure 5). The spawning populations in all three monitored tributaries were dominated by grilse (1SW salmon) and numbers on larger multi-sea-winter (MSW) salmon were extremely low.

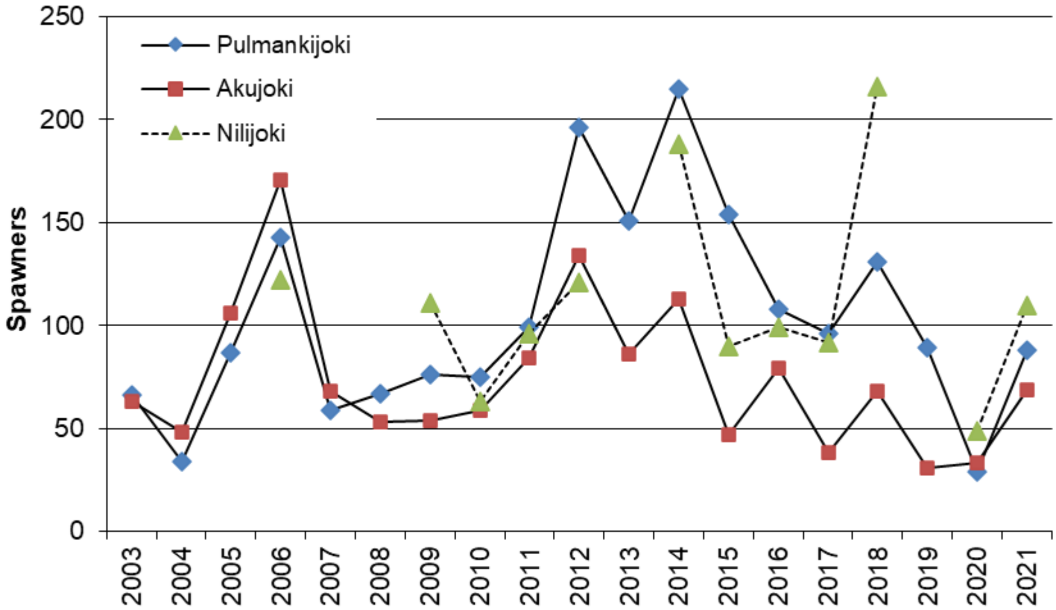

Figure 5. Snorkelling counts of spawning salmon in the rivers Buolbmátjohka/Pulmankijoki, Áhkojohka/Akujoki and Njiljohka/Nilijoki in 2003-2021. All sea-age groups are combined.

2.3.3 Sonar and video counts

During the last 10 years sonar monitoring have been used in counting the numbers ascending salmon. In 2021 sonar counts were performed in the Tana/Teno main stem, in Kárášjohka, in Anárjohka/Inarijoki and in Veahčajohka/Vetsijoki (Figure 3). ARIS-sonars were used in other sites than Veahčajohka/Vetsijoki, where a Simsonar unit was used.

In the sonar data, a minimum size for fish considered as a salmon has been set to 45-50 cm depending on the counting site. This cutting point was chosen to account for other fish species like grayling and sea trout, which are mostly smaller than these lengths. In addition, species distribution and proportion of salmon have been estimated based on nearby catch information or by video monitoring within the sonar window.

Tana/Teno main stem

Sonar counting of ascending salmon numbers was continued for fourth year in the Tana/Teno main stem in 2021, at Polmak, c. 55 km upstream from the river mouth (Figure 6). The aim of this survey is to estimate the total salmon run of the Tana/Teno system. Two sonars units were used, one on each shore. The river width at the monitoring site (c. 130 m) was narrowed to c. 100 m with guiding fences to be covered by the two sonars (Figure 6).

Species distribution and proportion of salmon in the Tana/Teno main stem sonar count was earlier (2018-2020) estimated based on sonar length frequency data and species distribution of the catch in the Norwegian Tana Bru-national border area. In 2021, however, salmon fisheries were closed and catch data was not available. At the same time earlier unseen quantities of pink salmon ascended the Tana/Teno system significantly complicating the estimation procedure of the small (<65 cm) salmon numbers. The salmon run (and pink salmon run) estimate in 2021 was based on three different data sources: sonar length frequency data (all ≥65 cm fish regarded as salmon), earlier years (2018-2020) daily salmon proportions in relation to the whole season and video data from four underwater cameras installed within the sonar window. In addition, we used assumption that significant pink salmon migration at Polmak counting station did not start before 1st July.

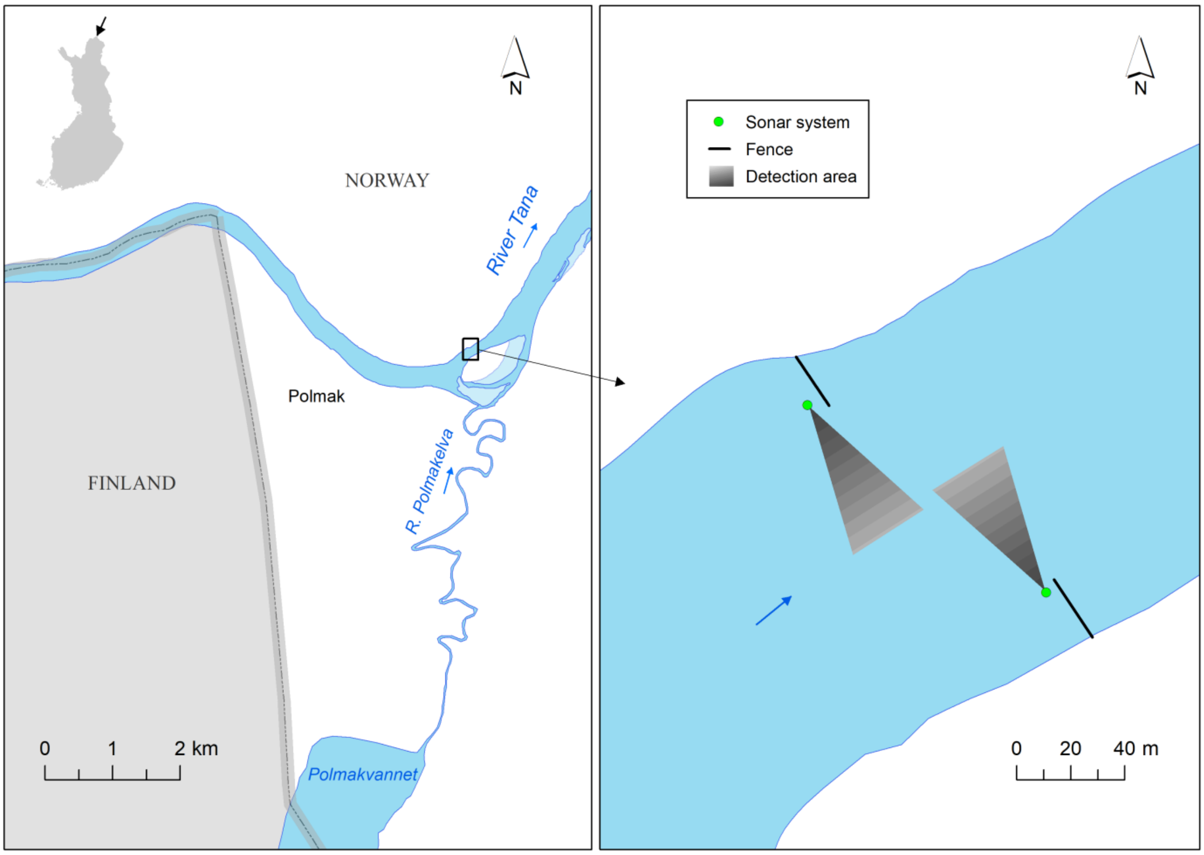

Figure 6. Schematic map of the Tana/Teno main stem sonar counting site including the locations of the two sonar units and guiding fences in 2018-2021.

Numbers of ≥65 cm salmon passing the sonar counting site at Polmak in 27.5.-31.8.2021 was c. 8 200 individuals (Table 1). The estimate of the grilse run (salmon between 50 and 65 cm) was between 16 250-19 800 fish (median estimate 18 025 grilse), depending on the assumptions used. Altogether the salmon run estimate at Polmak was c. 26 350 fish when using the grilse median estimate (Figure 7, Table 1).

Table 1. Annual estimated numbers of salmon and their size distribution (n, %) divided to three size classes in the Tana/Teno main stem sonar count in 2018-2021.

			Number of salmon			**%-distribution**		
Year	Time period	Salmon estimate	50-65 cm	65-90 cm	≥90 cm	50-65 cm	65-90 cm	≥90 cm
2018	1.6-31.8.	32 445	20 272	10 378	1 795	62 %	32 %	6 %
2019	22.5.-17.9.	21 013	7 447	9 920	3 646	35 %	47 %	17 %
2020	5.6.-14.9.	14 656	7 122	4 827	2 707	49 %	33 %	18 %
2021	27.5.-31.8.	26 348	18 025	6 665	1 658	68 %	25 %	6 %

The salmon run size at Polmak counting site clearly increased compared to 2019-2020 (21 013 and 14 656 salmon) but was smaller than in 2018 (32 455). One noteworthy thing is the abundance of large salmon (≥90 cm) that reached the lowest point in 2021 (Table 1). The length distribution data, however, includes considerable amount of uncertainty because of the long (50 m) sonar windows used in the Tana/Teno main stem survey.

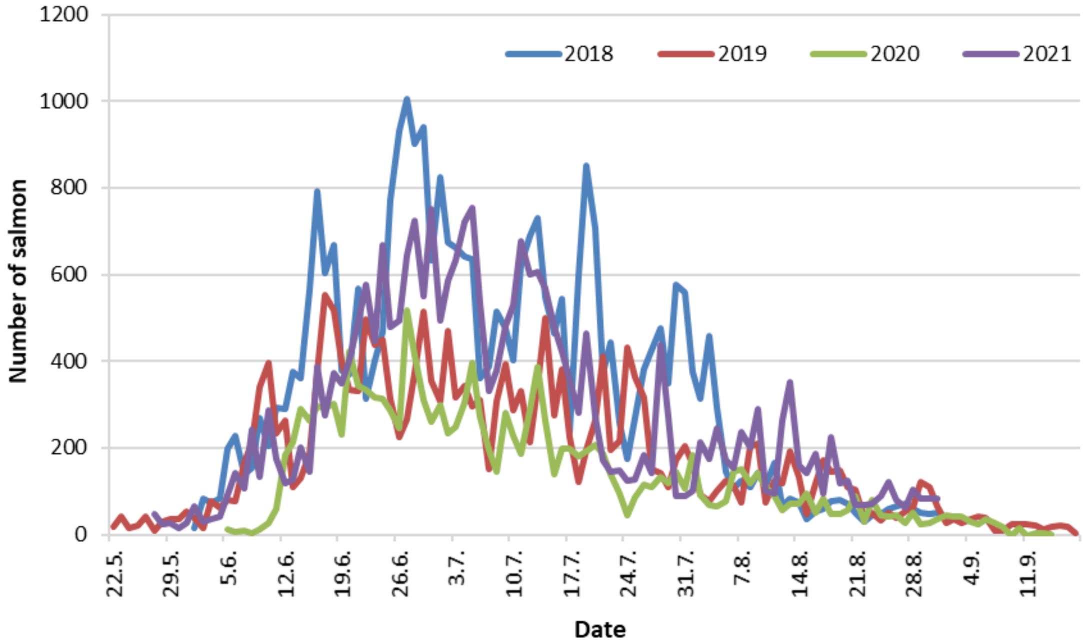

Figure 7. Estimated daily numbers of ascending salmon (≥50 cm) in the Tana/Teno main stem sonar count at Polmak in 2018 (blue line), 2019 (red line), 2020 (green line) and 2021 (purple line). All size categories are combined. The estimate of the total ascendance through the site in 2018, 2019, 2020 and 2021 was 32 455, 21 013, 14 656 and 26 348 salmon, respectively.

Kárášjohka

In the River Kárášjohka, sonar technology to count ascending salmon has been used in 2010, 2012 and 2017-2021. The counting site is in Heastanjárga, close to the bridge (69 23’50’’N, 25 08’40’’E). The Kárášjohka counting has been conducted by one sonar unit and with different types of guiding fences. In recent four years the monitored river width has been c. 30-35 m. During recent two years species distribution and proportion of salmon of the sonar count is estimated based on data from four underwater cameras installed within the sonar counting line.

In total c. 2 400 salmon were estimated to pass the sonar counting site in Kárášjohka in 28.5.-12.9.2021 (Figure 8). The run size was almost doubled from levels observed in 2019-2020 but was clearly less than in 2018 (Figure 8, Table 2).

The length distribution data of salmon passing the sonar site in 2021 indicated that 67 % of salmon were <65 cm fish, 26 % were fish between 65 and 90 cm and only 7 % were fish ≥90 cm. The length distribution data includes some uncertainty because of a rather long (30-35 m) sonar window used in the survey.

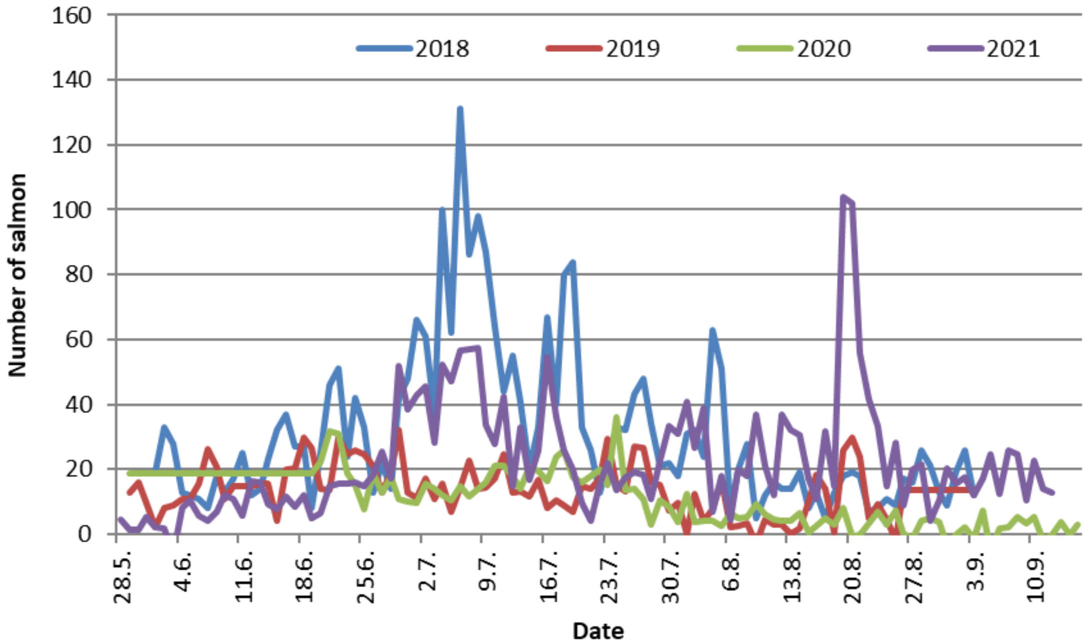

Figure 8. Estimated daily numbers of ascending salmon (≥45 cm) in the Kárášjohka sonar count in 2018 (blue line), 2019 (red line), 2020 (green line) and 2021 (purple line). All size categories are combined. The estimate of the total ascendance through the site in 2018, 2019, 2020 and 2021 was 2 962, 1 343, 1 241 and 2 423 salmon, respectively.

Table 2. Sonar count results of ascending salmon numbers in the River Kárášjohka in 2010, 2012, and 2017-2021 divided to 1SW (<65 cm) and MSW (≥65 cm) salmon. Data from 2012 and 2017 are not fully comparable to other years because of differences in used sonar techniques (2012) and unsuitable (high water levels) counting conditions (2017).

Time period	1SW	MSW	All	Note	Equipment
9.6.-31.8.2010	1 016	661	1 677	Missing time estimated	Didson
6.6.-27.8.2012	1 038	1 589	2 627	Missing time not estimated	Simsonar
7.6.-31.8.2017	371	492	863	Missing time not estimated	Aris/Simsonar
1.6.-3.9.2018	1 786	1 176	2 962	Missing time not estimated	Aris
29.5.-3.9.2019	569	774	1 343	Missing time estimated	Aris
29.5.-15.9.2020	426	815	1 241	Missing time estimated	Aris
28.5.-12.9.2021	1 616	807	2 423	Missing time estimated	Aris

Anárjohka/Inarijoki

In the River Anárjohka/Inarijoki, sonar counting of ascending salmon have been performed in 2018-2019 and in 2021. The counting site is located just above the Gáregasjohka/Karigasjoki confluence, c. 220 km upstream from the Tana/Teno river mouth. The monitoring is done with one sonar unit, which is pointing from the Norwegian side to the Finnish side. Guiding fences are installed on both shores to narrow the river (c. 30 m) for full sonar coverage. Species distribution and proportion of salmon of the sonar count is estimated based on data from four underwater cameras installed within the sonar counting line.

In total c. 2 100 salmon were estimated to pass the sonar counting site in Anárjohka/Inarijoki in 2.6.-13.9.2021 (Figure 9). The run size was c. 36 % larger than was observed in 2019 (1 536) but was clearly less than in 2018 (2 848).

The length distribution data of salmon passing the Anárjohka/Inarijoki sonar site in 2021 indicated that 72 % of salmon were <65 cm fish, 27 % were fish between 65 and 90 cm and only 1 % were fish ≥90 cm. The length distribution data includes some uncertainty because of a rather long (30-35 m) sonar window used in the survey.

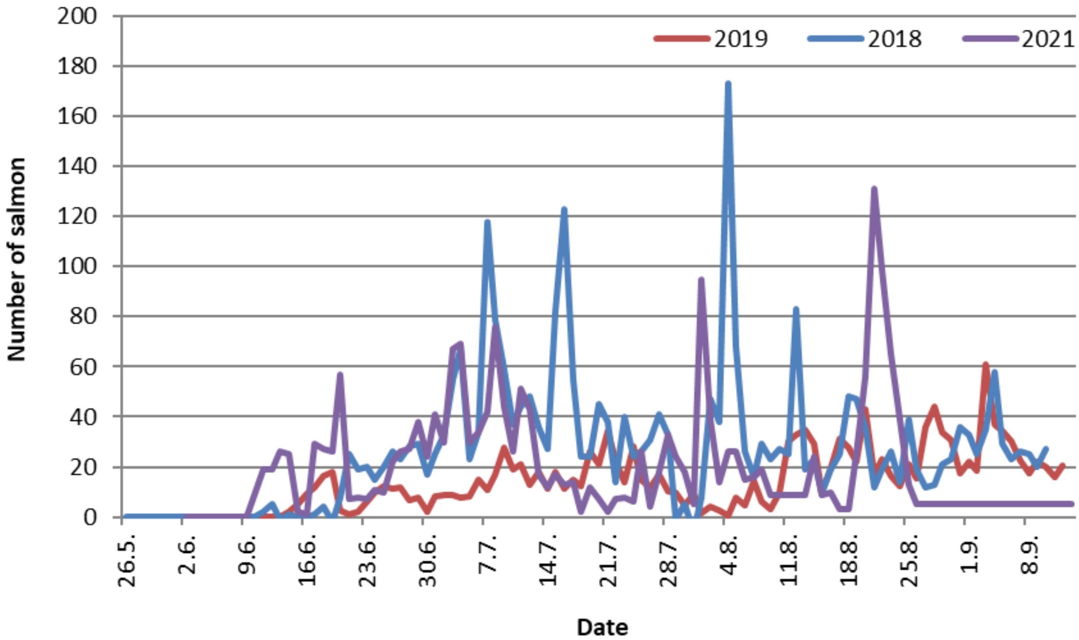

Figure 9. Estimated daily numbers of ascending salmon (≥45 cm) in the Anárjohka/Inarijoki sonar count in 2018 (blue line), 2019 (red line) and 2021 (purple line). All size categories are combined. The estimate of the total ascendance through the site in 2018, 2019 and 2021 was 2 848, 1 536 and 2 085 salmon, respectively.

Veahčajohka/Vetsijoki

A combined sonar (Simsonar) and video monitoring was conducted at the river mouth of Veahčajohka/Vetsijoki in 2021, five years after the first counting in 2016. The results presented in here are, however, based on the video monitoring data only because the reliability of the sonar counting has not been evaluated yet. The video monitoring was conducted between 10.6. and 16.8. in good environmental conditions using four underwater cameras. The river was narrowed to c. 8 m width by using short guiding fences on both shores.

The salmon run estimate in 1.6.-31.8.2021 was c. 1 040 individuals (Figure 10). The estimated sea-age distribution of 1SW (<65 cm), 2SW (65-90 cm) and MSW (≥90 cm) salmon was 67 %, 30 % and 3 %, respectively. Veahčajohka/Vetsijoki salmon run size proportion compared to Utsjoki run size was almost identical in both 2016 and 2021 (Figure 11).

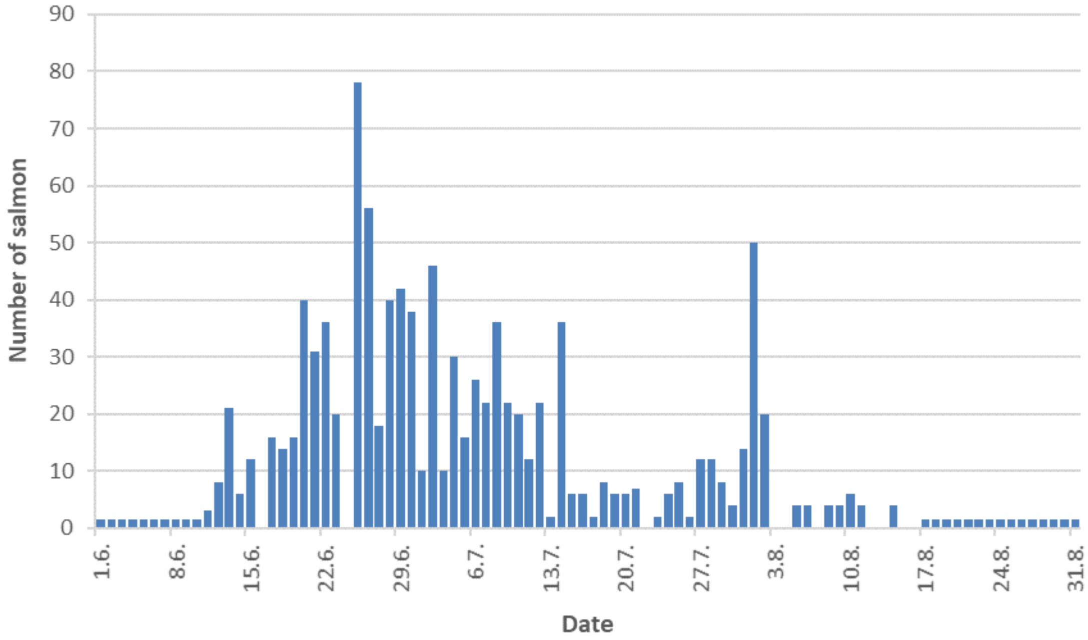

Figure 10. Estimated daily numbers of ascending salmon in the River Veahčajohka/Vetsijoki in 2021 based on video monitoring. All sea-age groups are combined. Video data in 1.-9.6. and in 17.-31.8. are missing and salmon numbers during these periods are based on mean daily run proportions observed in the 2016 Veahčajohka/Vetsijoki sonar monitoring.

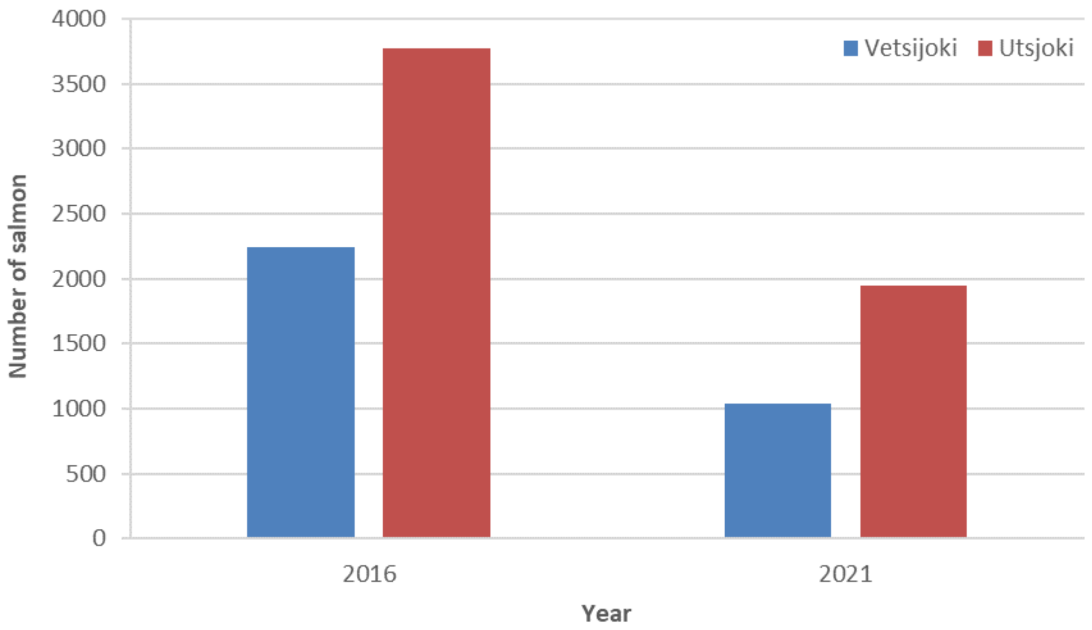

Figure 11. Estimated ascending salmon numbers in the rivers Veahčajohka/Vetsijoki (blue bars, sonar and video monitoring) and Ohcejohka/Utsjoki (red bars, video monitoring) in 2016 and 2021. All sea-age groups are combined.

2.4 Summary of counting results

Adult salmon numbers in 2021 were generally doubled from previous year throughout the Tana/Teno system (Figure 12). This increase in salmon numbers was mostly caused by the fishing closure and without the closure the numbers would have been at the level observed in 2020 or even lower. It should also be noted that the abundances in 2020 were mostly all-time low.

The 1SW salmon abundance was still poor in Tana/Teno system indicating continued poor sea conditions. Overall, this was a large-scale phenomenon in 2021 with poor 1SW return rates over large parts of middle and northern Norway.

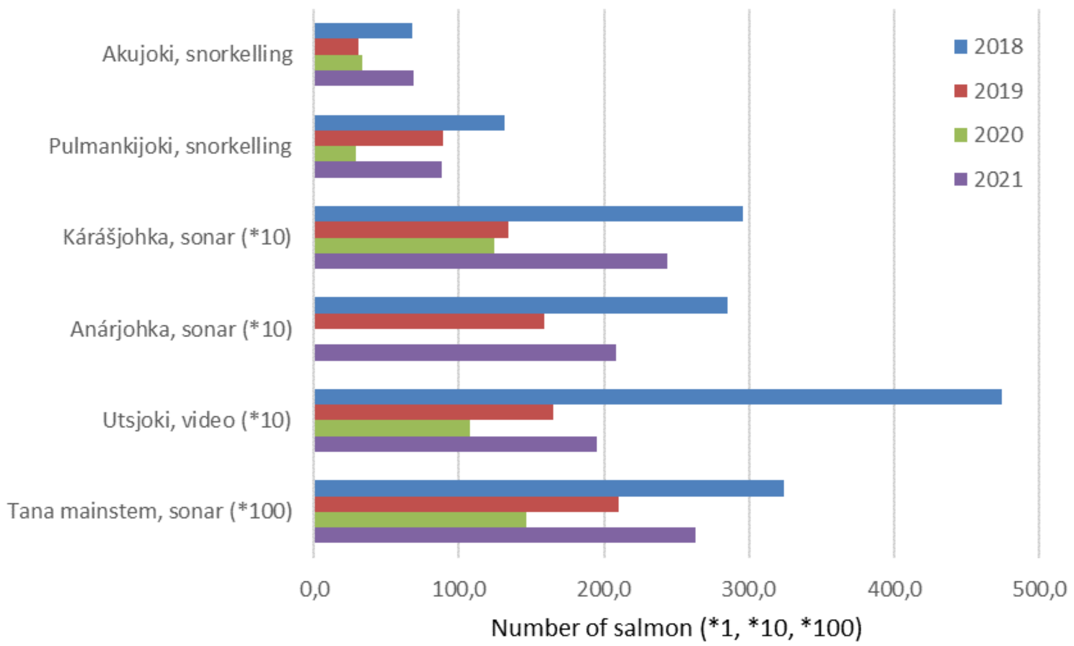

Figure 12. Counting results (number of adult salmon) in different parts of the Tana/Teno system in 2018-2021. Note: Kárášjohka sonar, Anárjohka/Inarijoki sonar and Ohcejohka/Utsjoki video counts are divided by a factor of 10 and the Tana/Teno mainstem sonar numbers by a factor of 100.

2.5 Pink salmon occurrence and stock size development

Pink salmon, an invasive species originating from the Pacific area, has since 2017 occurred in much higher numbers in the Tana/Teno system than earlier. Overall, abundance of this odd-year pink salmon stock has increased substantially within large areas of the North Atlantic. A new peak in pink salmon occurrence in the Tana/Teno system took place in 2021 and it is estimated that their numbers increased c. tenfold compared to 2019. Similar increase was also observed throughout the eastern Finnmark area.

In the Tana/Teno mainstem sonar count a preliminary estimate of the pink salmon run in 2021 was c. 45 000-50 000 individuals depending on assumptions used (see Figure 13). The corresponding estimate in 2019 was slightly less than 5 000 pink salmon.

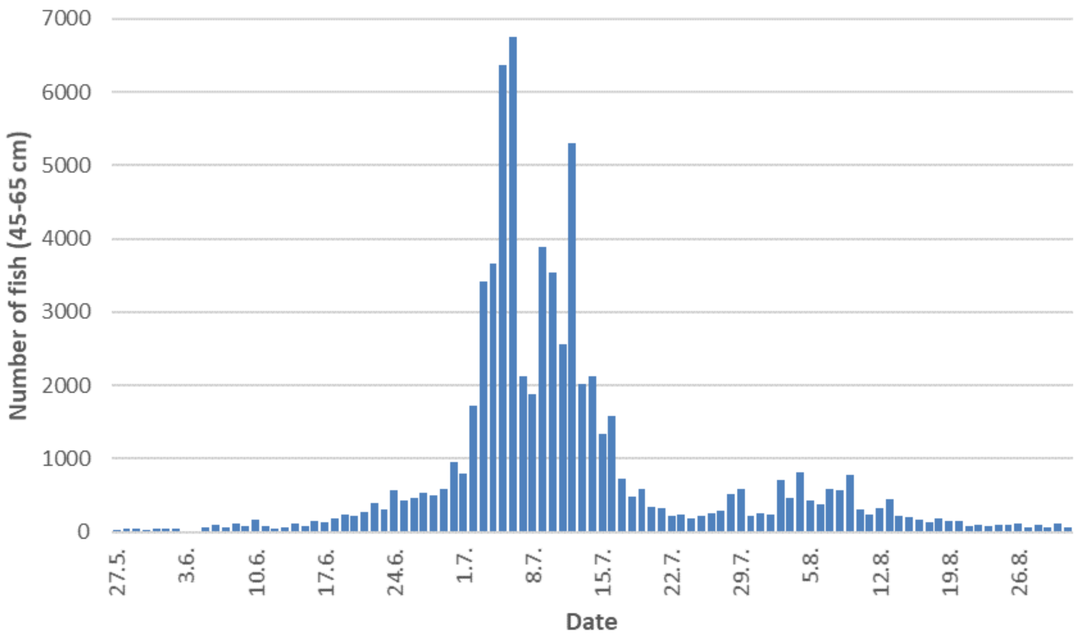

Figure 13. Estimated daily numbers of ascending fish between 45-65 cm in the Tana/Teno main stem sonar count at Polmak in 2021. The bars include all fish species in this size category. The total abundance of this size category was 70 349 fish. From this we estimate that c. 18 000 individuals were 1SW salmon, c. 47 000 pink salmon and c. 5 000 sea trout and other species. Pink salmon largely dominated the ascendance during the first three weeks of July.

In the River Utsjoki pink salmon activity at the video monitoring site increased strongly in 2021 compared to earlier years, when only a few individuals have been observed annually. First pinks were observed on 6th July and detections of pinks were frequent until early August. The pink salmon run estimate of Utsjoki was c. 470 individuals in 2021. The estimate, however, contains significant uncertainty as pink salmon moved back and forth through the camera line. In addition, pink salmon may have been using the shoreline migration routes (between shores and bridge pillars) to a larger extent than Atlantic salmon, and the Utsjoki camera set-up does not produce data from these areas. Therefore, the pink salmon run size may be somewhat underestimated.

In the River Vetsijoki first pink salmon individuals were observed on 29th June and from there onwards back and forth movement trough the camera counting line was active until the end of the video monitoring (16.8.). The pink salmon run size estimate was c. 400 individuals, but this estimate contains significant uncertainty. This is mainly caused by the fact that a major pink salmon spawning site was located right below the camera counting line at the Vetsijoki river mouth and these spawning fish moved randomly up- and downstream disturbing the video data analysis.

In the River Kárášjohka counting station first pink salmon appeared on 1st July and their migration continued until mid-August (Figure 14). In total c. 950 pink salmon were estimated to pass the counting site in 2021. This is c. 6.6 times higher than was observed in 2019.

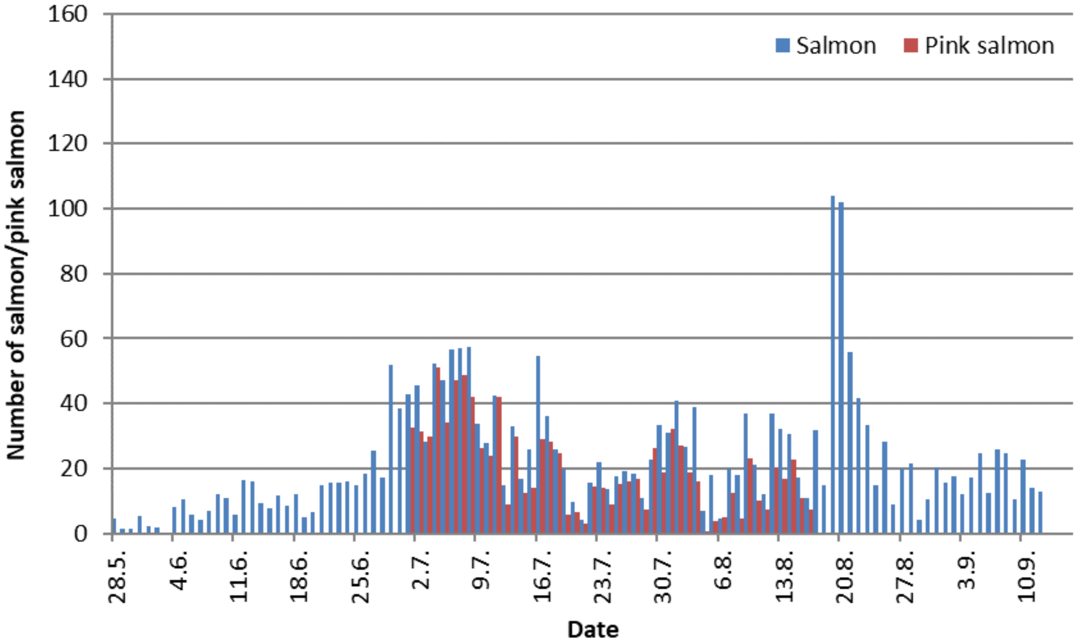

Figure 14. Estimated daily numbers of salmon (2 423) and pink salmon (948) in the Kárášjohka sonar count in 2021. Separation of salmon and pink salmon was based on length distribution data of the sonar count and video monitoring data from the sonar counting line.

In the River Anárjohka/Inarijoki first pink salmon individuals were observed on 2nd July and their run peaked at late July (Figure 15). The pink salmon numbers passing the sonar counting site in 2021 (3 188 pinks) were approximately nine times higher than in 2019 (350 pinks). Frequent back and forth movements of pinks complicated their abundance estimation process at the sonar counting site.

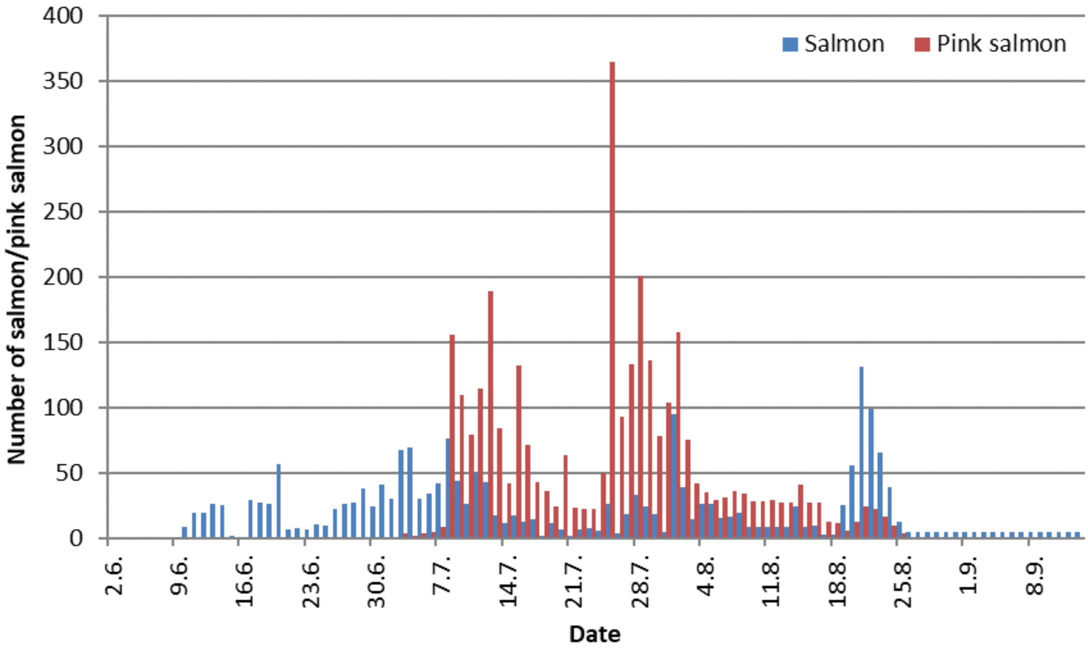

Figure 15. Estimated daily numbers of salmon (2 085) and pink salmon (3 188) in the Anárjohka/Inarijoki sonar count in 2021. Separation of salmon and pink salmon was based on length distribution data of the sonar count and video monitoring data from the sonar counting line.

In contrast to the Tana/Teno mainstem and its large tributaries, pink salmon, their redds or carcasses were not observed in the small tributaries that were snorkelled (e.g. Buolbmátjohka/Pulmankijoki, Njiljohka/Nilijoki and Áhkojohka/Akujoki) in early September. This observation was also confirmed by the eDNA monitoring conducted in the Tana system in 2021 (Frode Fossøy, preliminary results, 27.10.2021).

3 Stock status assessment

In this chapter we do a status assessment of 8 different areas/stocks of the Tana/Teno river system in addition to an overall assessment of the whole river system. The assessment of each stock contains two parts: First a spawning stock estimate and evaluation of management targets, secondly an evaluation of development in pre-fishery abundance. We present the estimated pre-fishery abundances with estimates of the stock-specific exploitation surplus threshold in each figure. This threshold is calculated by dividing the middle female biomass spawning target with the average female proportion of the stock. The threshold is also used to calculate the maximum sustainable exploitation of each stock. A pre-fishery abundance smaller than the exploitation surplus indicates that there was no exploitable surplus.

3.1 Tana/Teno main stem

The Tana/Teno main stem starts with the confluence of Kárášjohka and Anárjohka/Inarijoki, from which the main stem flows 211 km in a northern direction towards the Tana fjord.

3.1.1 Status assessment

The spawning target for the Tana/Teno main stem (MS) salmon stock is 41 049 886 eggs (30 787 415-61 574 829 eggs). The female biomass needed to obtain this egg deposition is 22 189 kg (16 642-33 284 kg) when using a stock-specific fecundity of 1 850 eggs kg^{-1}.

The following basic formula estimates the annual spawning stock size for Tana/Teno MS stock:

*Spawning stock size = ((Catch / Exploitation rate) - Catch) * Female proportion*

The data input for the variables in this formula are summarized in Table 3. Female proportions in Table 3 in the years 2006-2008 and 2011-2012 are based on Tana/Teno main stem stock-identified samples from the Genmix project, while female proportions in other years are based on the size composition of the main stem catch and the 5-year Genmix average female proportion of different size groups weighted with 50 % of the up or down variation of the annual female proportion observed in the scale sampling project.

There were no sonar counts of ascending salmon in the Tana/Teno main stem before 2018, so the exploitation estimates for the prior years must be based on other sources of information. Based on a combination of the 5 years of comprehensive genetic stock identification of main stem samples and fish counting, it is possible to set up a model that estimates the proportion of catches of different stocks in various parts of Tana/Teno. Back-calculating then from spawning stock estimates and tributary catches, we can obtain estimates of pre-fishery abundances and stock-specific exploitation rates in the main stem. The main stem exploitation estimates range from around 20 % for the lowermost tributaries (Máskejohka, Buolbmátjohka/Pulmankijoki) up to 60 % for the stocks located in the main headwater rivers. The latter salmon must pass the full length of the Tana/Teno main stem before reaching their respective home rivers and therefore likely provide an accurate estimate of the main stem exploitation experienced by the Tana/Teno MS stock. An exploitation rate of 60 % was therefore selected for the Tana/Teno MS stock for the years 2006-2016.

For 2017, monitoring results indicated that the new fishing rules had reduced exploitation by approximately 10 %, and the main stem exploitation rate estimate was therefore set to 45 %. For 2018, the combined information from the main stem (sonar counting) and tributary counting indicate a further reduced exploitation rate, and the exploitation estimate for 2018 was therefore set to 38 %, representing a 33 % reduction in exploitation with the implementation of a new agreement (Table 3).

Monitoring information from 2019 indicated an exploitation rate of 39 %. Conditions for monitoring and fishing, especially with gillnet-based gear, were both difficult in 2020 and the exploitation estimate for 2020 was reduced slightly to 35 %.

The 2021 closure of the Tana/Teno salmon fisheries means that we have to base the spawning stock estimate solely on the Polmak sonar count and average values for size and female proportions. We base the estimation on a total count of 18 025 grilse and 8 323 MSW salmon and a Tana/Teno MS proportion of 0.3155. Average sizes were 1.7 and 5.6 kg and female proportions 0.10 and 0.69, respectively. A fraction of the Tana/Teno MS stock spawn in areas below the Polmak count and these lowermost production areas are therefore not counted at the counting site in Polmak. The production areas below Polmak constitutes 1.22 % of the total main stem production areas, and the Polmak count were adjusted with this percentage in the evaluation.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 3 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 22 189 kg as the mode, 16 642 kg as the minimum and 33 284 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

Table 3. Summary of stock data used to estimate annual spawning stock sizes of the Tana/Teno MS stock.

Year	Total main stem catch (kg)	Tana/Teno MS proportion	Tana/Teno MS catch (kg)	Exploitation rate	Female proportion
2006	88 873	0.4358	38 731	0.60	0.47
2007	88 443	0.4443	39 298	0.60	0.62
2008	104 659	0.5820	60 907	0.60	0.63
2009	53 450	0.4667	24 945	0.60	0.50
2010	75 340	0.4667	35 161	0.60	0.53
2011	68 256	0.4902	33 457	0.60	0.52
2012	91 636	0.3770	34 550	0.60	0.51
2013	68 344	0.4667	31 896	0.60	0.53
2014	83 312	0.4667	38 881	0.60	0.51
2015	65 287	0.4667	30 469	0.60	0.55
2016	72 814	0.4667	33 982	0.60	0.57
2017	52 880	0.3155	16 684	0.45	0.61
2018	41 673	0.3270	13 627	0.38	0.49
2019	33 556	0.3040	10 201	0.39	0.57
2020	26 799	0.3155	8 455	0.35	0.59
2021	0	0.3155	0	0	0.46

The spawning target attainment was 48 % in 2021 and the probability of meeting the spawning target was 0 % (Figure 16). The management target was not reached as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 0 % with an overall attainment of 44 %.

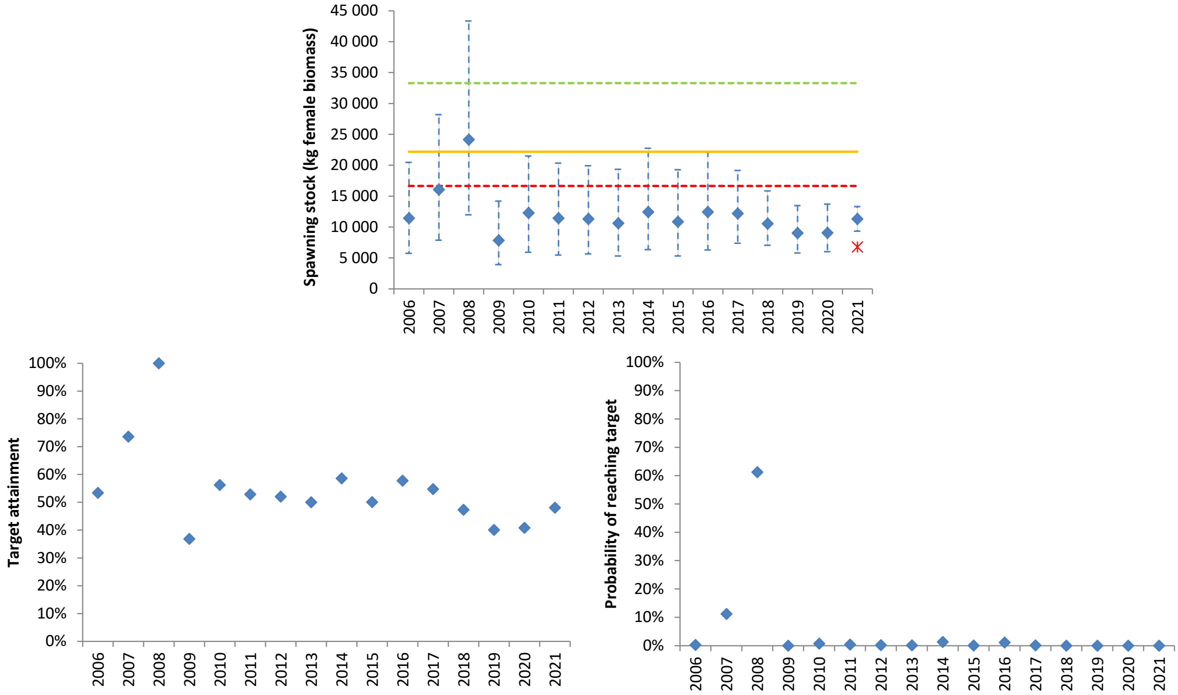

Figure 16. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2021 for the Tana/Teno MS stock. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.1.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock has varied from a maximum of 125 786 kg (2008) down to 26 422 kg (2021) (Figure 17).

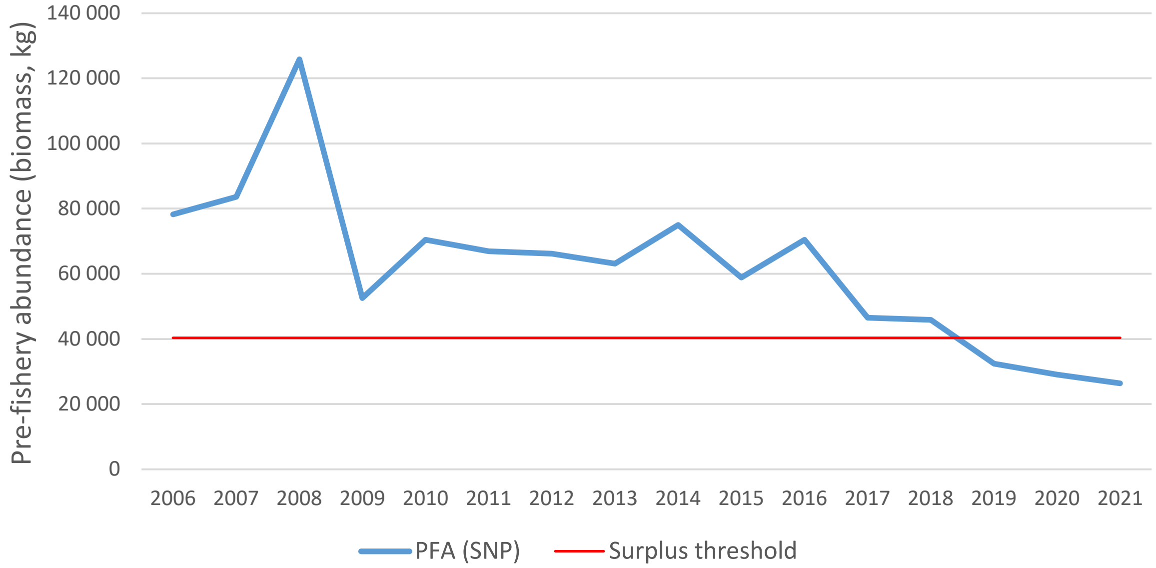

Figure 17. The estimated pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being a decrease from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA decreased with 11 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 58 % (Table 4). The reason for this is that the catch difference between 2020 and 2021 (11 856 kg [13 714 kg *v*. 1 858 kg]) is higher than the difference in spawning stock size (9 231 kg).

Table 4. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	5 259 kg	8 455 kg	-	15 333 kg	29 047 kg
2021	1 858 kg	0	-	24 564 kg	26 422 kg

3.2 Buolbmátjohka/Pulmankijoki

Buolbmátjohka/Pulmankijoki is a small-sized tributary located approximately 55 km upstream of the Tana estuary. A large lake (Buolbmátjávri/Pulmankijärvi) is situated close to 10 km upstream in this tributary. The border between Norway and Finland runs through the lake, leaving the northernmost quarter of the lake and the outlet river as Norwegian and the rest of the system as Finnish. There are two inlet rivers on the Finnish side of the lake: the upper Pulmankijoki entering the lake from the south and Kalddasjoki flowing from the west.

The lowermost 10 km (below the lake) are still-flowing and meandering with substratum consisting mainly of clay and silt. No spawning areas are present in this part. The main spawning areas are found in Kalddasjoki and the upper Pulmankijoki. The salmon stock is dominated by 1SW and small 2SW salmon.

3.2.1 Status assessment

The Buolbmátjohka/Pulmankijoki spawning target is 1 329 133 eggs (996 849-1 993 698 eggs). The female biomass needed to obtain this egg deposition is 511 kg (383-767 kg) when using a stock-specific fecundity of 2 600 eggs kg^{-1}.

Very little fishing occurs in the outlet river of Pulmankijärvi. There is a gillnet salmon fishery with accurate catch statistics operating in the lake, while fishing is prohibited in the upper Pulmankijoki and partly in Kalddasjoki.

The following basic formula estimates the annual spawning stock size for Buolbmátjohka/Pulmankijoki:

*Spawning stock size = ((Catch / Exploitation rate) - Catch) * Female proportion*

The data input for the variables in this formula are summarized in Table 5. Female proportions in Table 5 are based on the sex distribution observed in the autumn snorkelling counts.

Table 5. Summary of stock data used to estimate annual spawning stock sizes in Buolbmátjohka/ Pulmankijoki.

Year	Catch (kg)	Snorkelling count	Snorkelling efficiency	Area covered	Exploitation rate	Female proportion	Main stem proportion
2003	860	66	0.60	0.2	0.49	0.54	
2004	300	34	0.80	0.2	0.49	0.41	
2005	600	87	0.80	0.2	0.44	0.48	
2006	1 010	143	0.80	0.2	0.45	0.47	0.0062
2007	805	59	0.80	0.2	0.56	0.46	0.0063
2008	650	67	0.80	0.2	0.50	0.48	0.0045
2009	745	76	0.70	0.2	0.53	0.44	0.0048
2010	590	75	0.80	0.2	0.43	0.47	0.0048
2011	610	99	0.80	0.2	0.42	0.42	0.0027
2012	935	196	0.70	0.2	0.30	0.49	0.0041
2013	890	151	0.80	0.2	0.42	0.50	0.0048
2014	1 090	215	0.80	0.2	0.31	0.54	0.0048
2015	630	154	0.80	0.2	0.35	0.43	0.0048
2016	665	108	0.70	0.2	0.37	0.64	0.0048
2017	348	96	0.70	0.2	0.26	0.49	0.0080
2018	856	131	0.70	0.2	0.39	0.42	0.0090
2019	435	89	0.80	0.2	0.26	0.66	0.0070
2020	148	29	0.80	0.2	0.37	0.72	0.0080
2021	0	88	0.80	0.2	0	0.53	

So far, there have not been any fish counts of ascending salmon in Buolbmátjohka/Pulmankijoki. There has, however, been snorkelling counts of the spawning stock in a 4 km stretch of upper Pulmankijoki since 2003. The monitored area covers the best spawning areas of Pulmankijoki with a size approximately 20 % of the salmon-producing river length. The annual spawning count can be used to estimate the exploitation rate of the Buolbmátjohka/Pulmankijoki fisheries with the following formulas:

*Spawning count = Snorkelling count / (Snorkelling efficiency * Area covered)*

Exploitation rate = Catch / (Spawning count + Catch)

To account for uncertainty, the exploitation rate and female proportion estimates in Table 5 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 511 kg as the mode, 383 kg as the minimum and 767 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

The spawning target attainment was 79 % in 2021 and the probability of meeting the spawning target was 8 %. (Figure 18). The management target was not reached, as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 36 % with an overall attainment of 94 %.

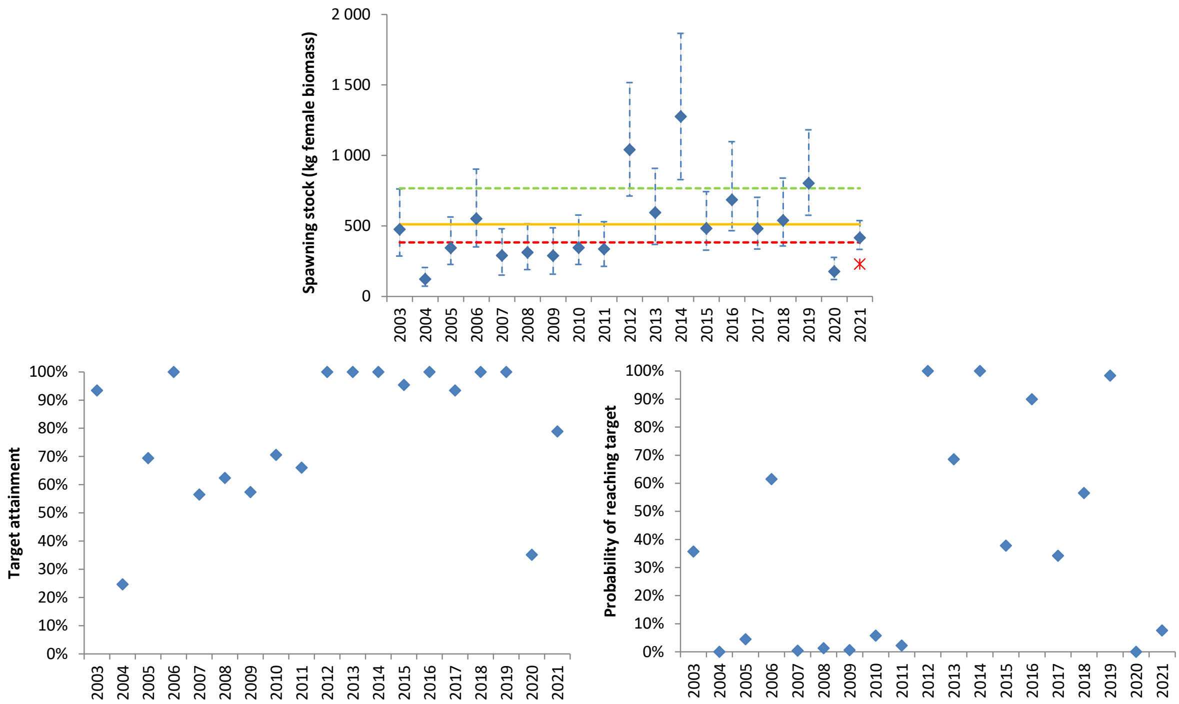

Figure 18. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2021 in the Norwegian/Finnish tributary Buolbmátjohka/Pulmankijoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.2.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock has varied from a maximum of 4 181 kg (2014) down to 718 kg (2020) (Figure 19)

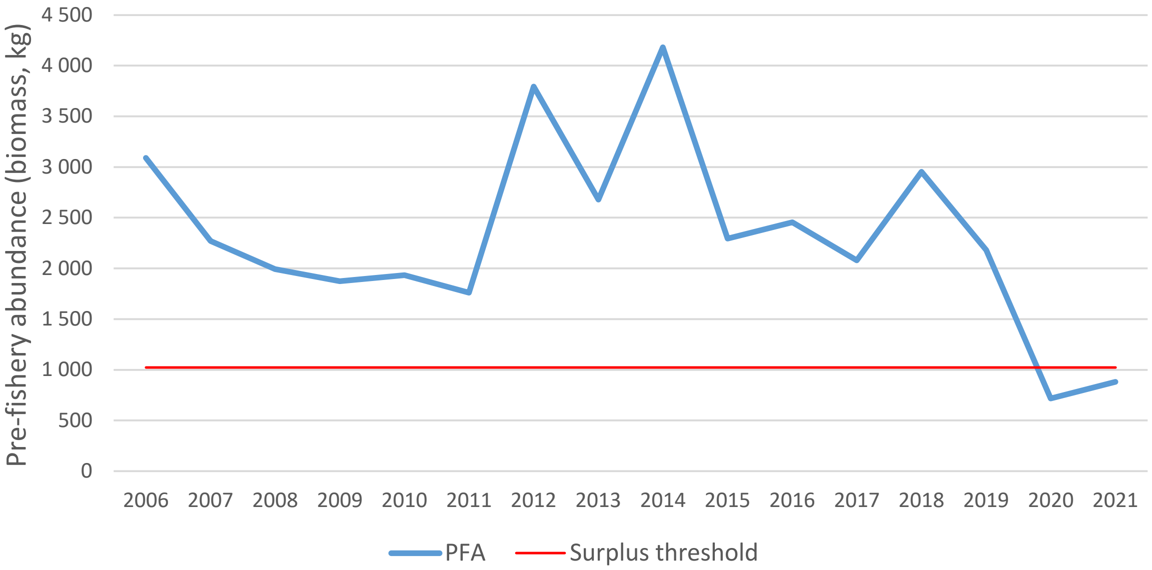

Figure 19. The estimated pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being much less of an increase. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA increased with only 23 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 194 % (Table 6). The reason for this is that a significant proportion of the increase in spawning stock is offset by the catch difference between 2020 and 2021 (356 kg [451 kg *v*. 95 kg]).

Table 6. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	89 kg	214 kg	148 kg	267 kg	718 kg
2021	95 kg	0	0	785 kg	880 kg

3.3 Veahčajohka/Vetsijoki

Veahčajohka/Vetsijoki is a middle-sized river flowing into the Tana main stem approximately 95 km from the Tana estuary. It is one of the most important salmon tributaries flowing to the Tana from the

Finnish side, with a sizeable proportion of MSW salmon. Vetsijoki itself has a salmon-producing length of around 42 km. In addition, approximately 6 km is available in the small tributary Vaisjoki.

3.3.1 Status assessment

The revised Vetsijoki spawning target is 2 505 400 eggs (1 754 240-3 758 130 eggs). The female biomass needed to obtain this egg deposition is 1 101 kg (771-1 652 kg) when using a stock-specific fecundity of 2 275 eggs kg^{-1}.

The following basic formula estimates the annual spawning stock size for Veahčajohka/Vetsijoki:

*Spawning stock size = ((Catch / Exploitation rate) - Catch) * Female proportion*

The data input for the variables in this formula are summarized in Table 7. Female proportions in Table 7 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project.

Ascending salmon was counted in Vetsijoki with an acoustic counting system (ARIS) in 2016. The results indicate an exploitation of under 15 % in Vetsijoki. However, catch estimates from Vetsijoki are among the most uncertain on the Finnish side of Tana/Teno. It is known that Vetsijoki is a popular fishing site, but accurate information on fishing activity is partly missing and, consequently, catch estimation is very challenging and it is likely that there is significant unreported catch. We therefore selected 20 % as the median exploitation estimate in 2016. The same median exploitation was used also in 2017 and 2020 because of relatively low in-river catch estimates in those years compared with the overall Tana/Teno catch, while a median exploitation of 25 % was used in all other years (Table 7).

The salmon migration was again counted in 2021 and due to the closed salmon fishery in 2021, the status assessment can be based solely on the fish count results.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 7 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation for all years except 2016 when a 10 % uncertainty was used due to the fish counting. In all years, 10 % uncertainty was used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 1 165 kg as the mode, 864 kg as the minimum and 1 747 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

Table 7. Summary of stock data used to estimate annual spawning stock sizes in Veahčajohka/Vetsijoki.

Year	Catch (kg)	Exploitation rate	Female proportion	Main stem proportion
2006	860	0.25	0.63	0.0390
2007	560	0.25	0.71	0.0256
2008	415	0.25	0.56	0.0192
2009	630	0.25	0.52	0.0290
2010	930	0.25	0.56	0.0290
2011	485	0.25	0.57	0.0311
2012	755	0.25	0.51	0.0305
2013	375	0.25	0.56	0.0290
2014	1 020	0.25	0.52	0.0290
2015	885	0.25	0.57	0.0290
2016	755	0.20	0.56	0.0290
2017	406	0.20	0.58	0.0745
2018	603	0.25	0.52	0.0720
2019	545	0.25	0.56	0.0770
2020	358	0.20	0.57	0.0745
2021	0	0	0.45	

The spawning target attainment was 111 % in 2021 and the probability of meeting the spawning target was 68 %. The management target was not reached, as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 22 % with an overall attainment of 87 % (Figure 20).

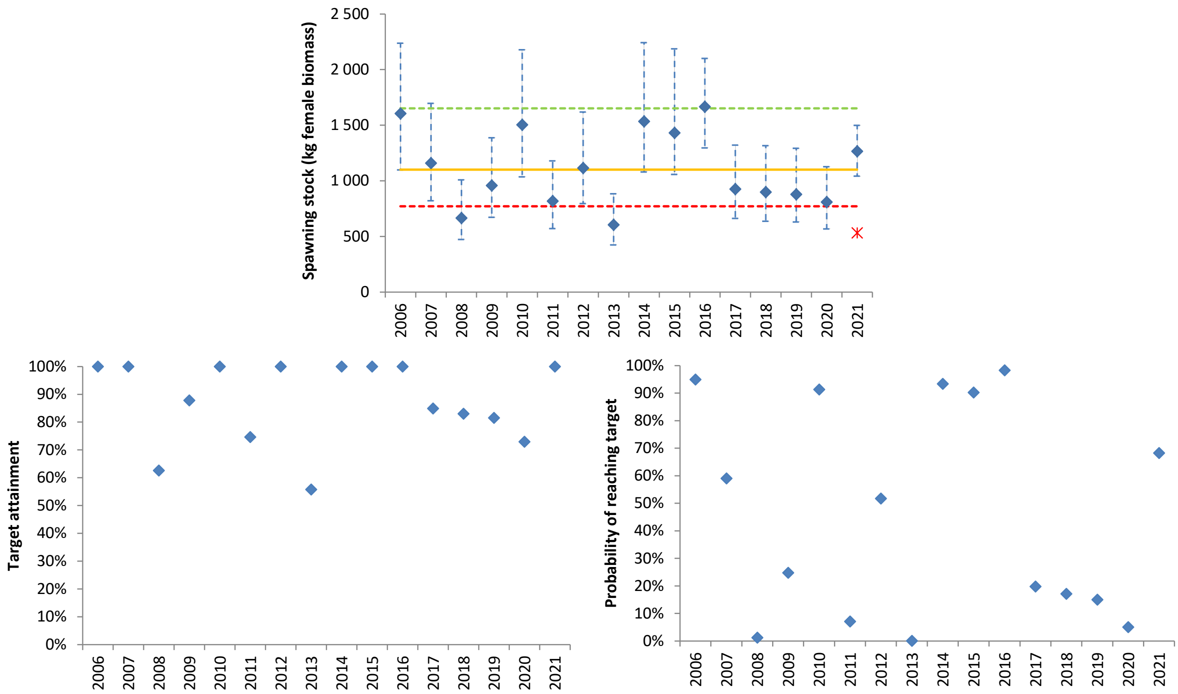

Figure 20. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2021 in the Finnish tributary Veahčajohka/Vetsijoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.3.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Veahčajohka/Vetsijoki stock has varied from a maximum of 8 112 kg (2006) down to 3 067 kg (2021) (Figure 21).

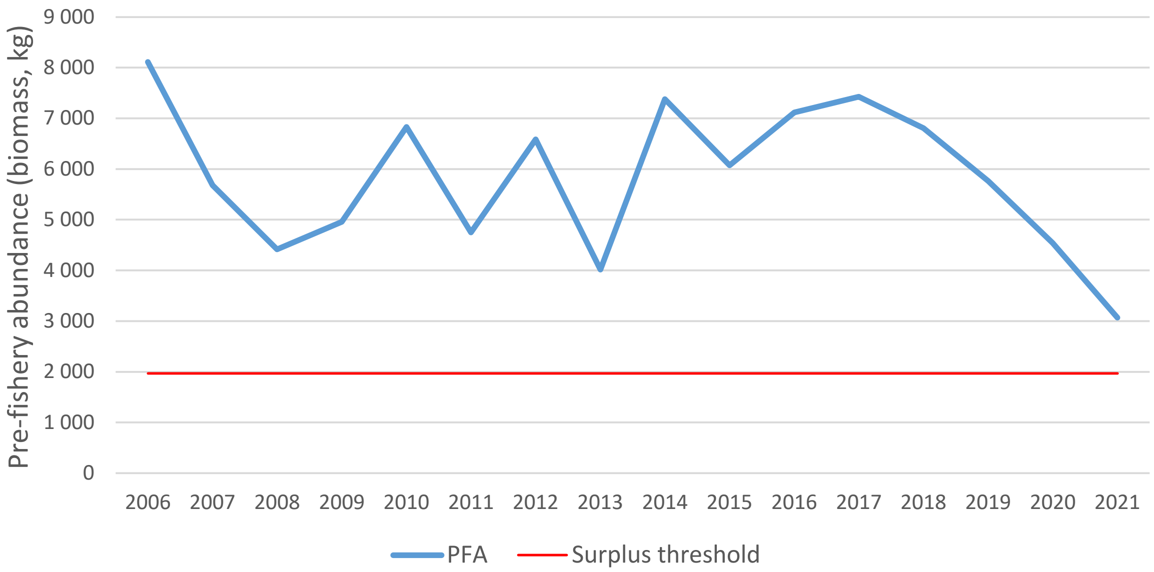

Figure 21. The estimated pre-fishery abundance (PFA) of salmon belonging to the Veahčajohka/Vetsijoki stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being a decrease from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA decreased with 32 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 92 % (Table 8). The reason for this discrepancy is that the catch difference between 2020 and 2021 (2 801 kg [3 098 kg *v*. 297 kg]) is higher than the 2021 increase in spawning stock size (1 327 kg).

Table 8. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Veahčajohka/Vetsijoki stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	744 kg	1 997 kg	358 kg	1 442 kg	4 540 kg
2021	297 kg	0	0	2 770 kg	3 067 kg

3.4 Ohcejohka/Utsjoki + tributaries

Ohcejohka/Utsjoki is one of the largest tributaries of the River Tana with a catchment area of 1 665 km^2. The river flows 66 km in a mountain valley before connecting to the Tana main stem 108 km upstream from the sea. The main stem of Utsjoki comprises several deep lakes with connecting river stretches. Two major tributaries, the rivers Kevojoki and Tsarsjoki, drain to the middle part of Utsjoki. The salmon stock of Utsjoki consist of several distinct sub-stocks with grilse (1SW) populations dominating the two major tributaries while larger salmon form a considerable portion of the spawning stock in the Utsjoki main stem.

3.4.1 Status assessment

The Utsjoki (+tributaries) spawning target is 4 979 107 eggs (3 599 272-7 211 017 eggs). The female biomass needed to obtain this egg deposition is 2 059 kg (1 486-2 972 kg) when using stock-specific fecundities for the stocks in the Utsjoki main stem, Kevojoki and Tsarsjoki.

The following basic formula estimates the annual spawning stock size for Ohcejohka/Utsjoki:

*Spawning stock size = ((Catch / Exploitation rate) - Catch) * Female proportion*

The data input for the variables in this formula are summarized in Table 9. Female proportions in Table 9 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project.

A video camera setup has counted the number of ascending salmon in Utsjoki since 2002. Annual exploitation rates can therefore be estimated from the video counts and used in the status evaluation. Conditions in most years were good with major exceptions in 2017 and 2020, which both had prolonged periods of difficult water level conditions.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 9 were treated as modal values, with a 10 % uncertainty used to estimate minimum and maximum values of exploitation for all years. In all years, 10 % uncertainty was used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 2 059 kg as the mode, 1 486 kg as the minimum and 2 972 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

Table 9. Summary of stock data used to estimate annual spawning stock sizes in Ohcejohka/Utsjoki. Sea-age groups are combined in the years 2017-2021.

Year	Catch (kg)	Video count (1SW)	Video count (MSW)	Avg. size (1SW)	Avg. size (MSW)	Expl. rate	Female proportion	Main stem proportion
2002	1 965	2 744	345	1.59	3.59	0.35	0.61	
2003	1 305	2 308	274	1.59	3.59	0.28	0.61	
2004	800	1 202	95	1.59	3.59	0.36	0.62	

2005	1 400	2 699	47	1.59	3.59	0.31	0.58	
2006	2 375	6 555	109	1.61	3.61	0.22	0.61	0.0451
2007	1 945	3 251	167	1.39	3.29	0.38	0.66	0.0506
2008	2 605	2 061	307	1.32	3.58	0.68	0.69	0.0403
2009	2 095	3 712	124	1.59	3.59	0.33	0.57	0.0432
2010	1 305	1 932	377	1.59	3.59	0.30	0.61	0.0432
2011	1 625	3 349	534	1.59	3.86	0.22	0.58	0.0305
2012	2 605	5 029	868	1.75	4.16	0.21	0.61	0.0454
2013	1 695	4 765	367	1.59	3.59	0.19	0.61	0.0432
2014	2 955	3 659	1 319	1.59	3.59	0.28	0.57	0.0432
2015	2 149	3 346	602	1.59	3.59	0.29	0.62	0.0432
2016	2 090	2 934	836	1.59	3.59	0.27	0.62	0.0432
2017	1 853	2 734		2.67		0.25	0.64	0.0820
2018	1 926	4 743		1.72		0.15	0.57	0.0710
2019	1 557	1 650		2.13		0.36	0.62	0.0930
2020	885	1 290		2.71		0.26	0.62	0.0820
2021	0	1 952		1.90		0	0.57	

The spawning target attainment was 100 % in 2021 and the probability of meeting the spawning target was 46 %. The management target was not reached as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 34 % with an overall attainment of 94 % (Figure 22).

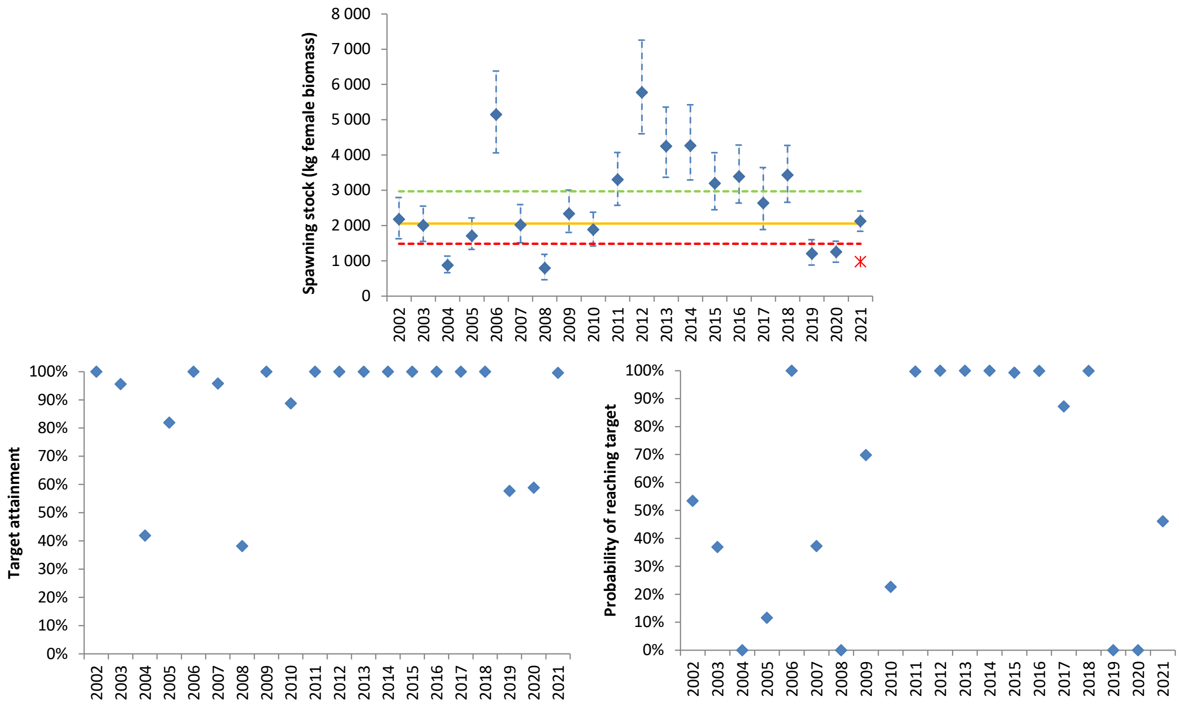

Figure 22. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2002-2021 in the Finnish tributary Ohcejohka/Utsjoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.4.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock complex has varied from a maximum of 18 493 kg (2012) down to 4 182 kg (2021) (Figure 23).

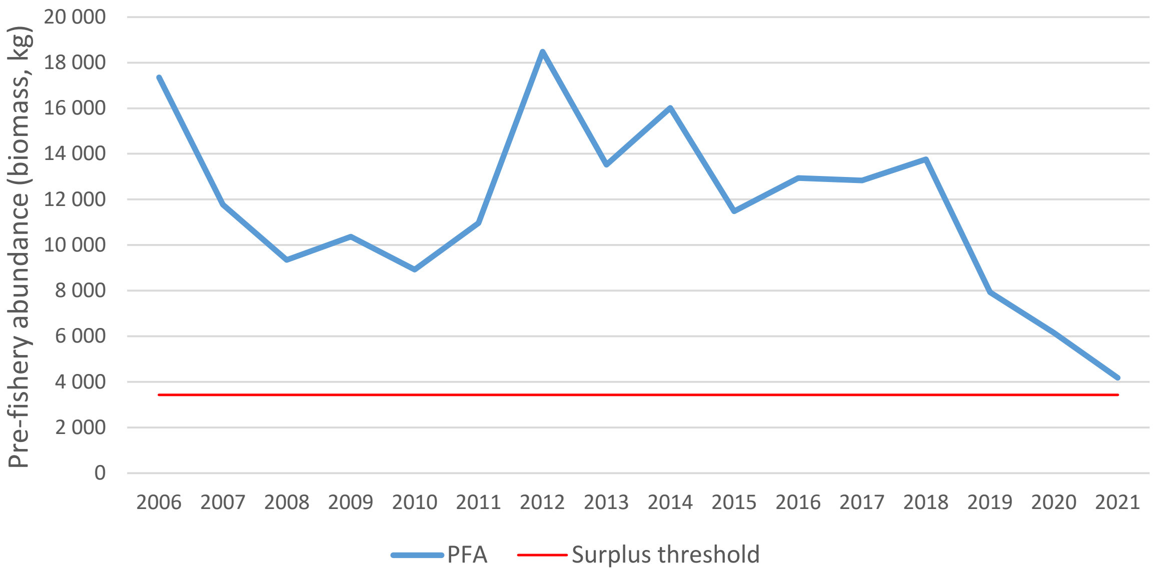

Figure 23. The estimated pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being a decrease from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA decreased with 32 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 81 % (Table 10). The reason for this discrepancy is that the catch difference between 2020 and 2021 (3 604 kg [4 114 kg *v.* 511 kg]) is higher than the 2021 increase in spawning stock size (1 637 kg).

Table 10. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	1 032 kg	2 198 kg	884 kg	2 034 kg	6 148 kg
2021	511 kg	0	0	3 671 kg	4 182 kg

3.5 Njiljohka/Nilijoki

Njiljohka/Nilijoki is a small river (catchment area 137 km^2) entering the Tana main stem from the east approximately 160 km from the Tana estuary opposite to the River Baisjohka. The salmon-producing river length in Njiljohka/Nilijoki is c. 13 km, after which a “stone field” with extremely shallow water prevents further migration of adult salmon.

3.5.1 Status assessment

The Njiljohka/Nilijoki spawning target is 519 520 eggs (355 130-776 280 eggs). The female biomass needed to obtain this egg deposition is 221 kg (151-330 kg) when using a stock-specific fecundity of 2 350 eggs kg^{-1}.

Spawning salmon have been counted almost annually in Njiljohka/Nilijoki in the autumn with snorkelling in the years 2006-2021, with the exceptions of 2007, 2008, 2013 and 2019. The snorkelling counts can be used directly as a basis for the target assessment of Njiljohka/Nilijoki and the following basic formula estimates the annual spawning stock size in the snorkelling years:

*Spawning stock size = (Snorkelling count * Average size * Female proportion) / (Detection rate * Area covered)*

The data input for the variables in this formula are summarized in Table 11. Female proportions in Table 11 are based on snorkelling detections of males and females each year. Fishing pressure in Njiljohka/Nilijoki is low and no catch statistics is available. Average sizes in Table 11 are based on a combination of main stem Genmix samples from 2006-2008 and 2011-2012.

Table 11. Summary of snorkelling data used to estimate annual spawning stock sizes in Njiljohka/Nilijoki.

Year	Snorkelling count (1SW)	Snorkelling count (MSW)	Average size (1SW)	Average size (MSW)	Detection rate	Area covered	Female prop. (1SW)	Female prop. (MSW)
2006	210	6	1.3	3.6	0.80	1	0.41	0.83
2007								
2008								
2009	127	14	1.3	3.6	0.75	1	0.37	0.64
2010	65	24	1.3	3.6	0.80	1	0.42	0.70
2011	131	16	1.3	3.6	0.80	1	0.40	0.75
2012	151	14	1.3	3.6	0.75	1	0.51	0.43
2013								
2014	154	34	1.3	3.6	0.80	0.7	0.52	0.65
2015	75	15	1.3	3.6	0.80	0.7	0.36	0.80
2016	70	29	1.3	3.6	0.75	0.7	0.40	0.93
2017	65	27	1.3	3.6	0.75	0.7	0.36	0.63
2018	205	11	1.3	3.6	0.75	0.7	0.43	0.50
2019								
2020	42	7	1.3	3.6	0.8	0.7	0.29	0.86
2021	102	8	1.3	3.6	0.8	0.7	0.50	0.50

In the years without snorkelling (2007, 2008, 2013, 2019), an alternative approach can be taken based on the proportion of Njiljohka/Nilijoki salmon found in the main stem fisheries and an estimate of the main stem exploitation rate (Table 12). We have direct estimates of the main stem proportion of Njiljohka/Nilijoki salmon in 2007-2008 and can use the five-year Genmix average in 2013. A new SNP-based estimate was used in 2019. The main stem exploitation in 2007, 2008 and 2013 was estimated at 45 % based on the location along the Tana main stem and the main stem exploitation of other stocks. An exploitation of 35 % was used in 2019.

Table 12. Summary of stock data used to estimate annual spawning stock sizes in Njiljohka/Nilijoki in the years without snorkelling data.

Year	Estimated main stem catch (kg)	Main stem proportion	Main stem exploitation rate	Female proportion
2006				
2007	751	0.0085	0.45	0.78
2008	500	0.0048	0.45	0.63
2009				
2010				
2011				
2012				
2013	538	0.0079	0.45	0.58
2014				
2015				
2016				
2017				
2018				
2019	567	0.0160	0.35	0.58
2020				

To account for uncertainty, the exploitation rate and female proportion estimates in Table 11 and Table 12 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation for all years. In all years, 10 % uncertainty was used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 221 kg as the mode, 151 kg as the minimum and 330 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

The spawning target attainment was 62 % and the probability of meeting the spawning target was 0 % (Figure 24). The management target was not reached as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 14 % with an overall attainment of 82 %.

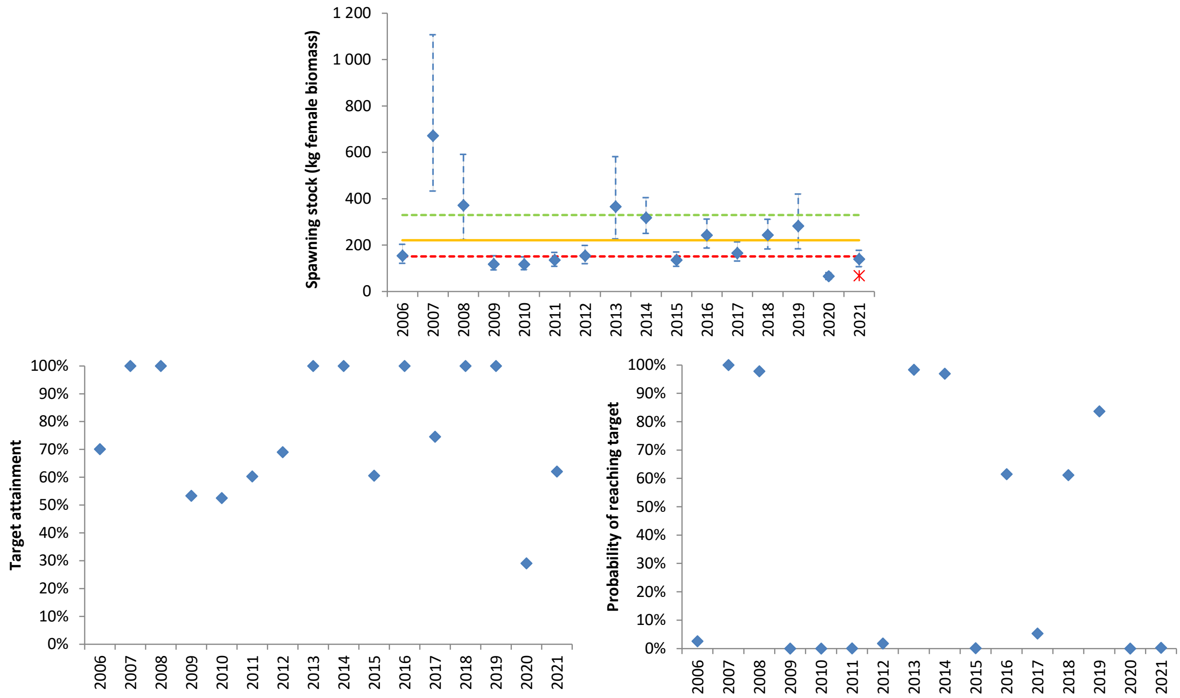

Figure 24. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2021 in the Finnish tributary Njiljohka/Nilijoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.5.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock has varied from a maximum of 2 100 kg (2007) down to 342 kg (2021) (Figure 25).

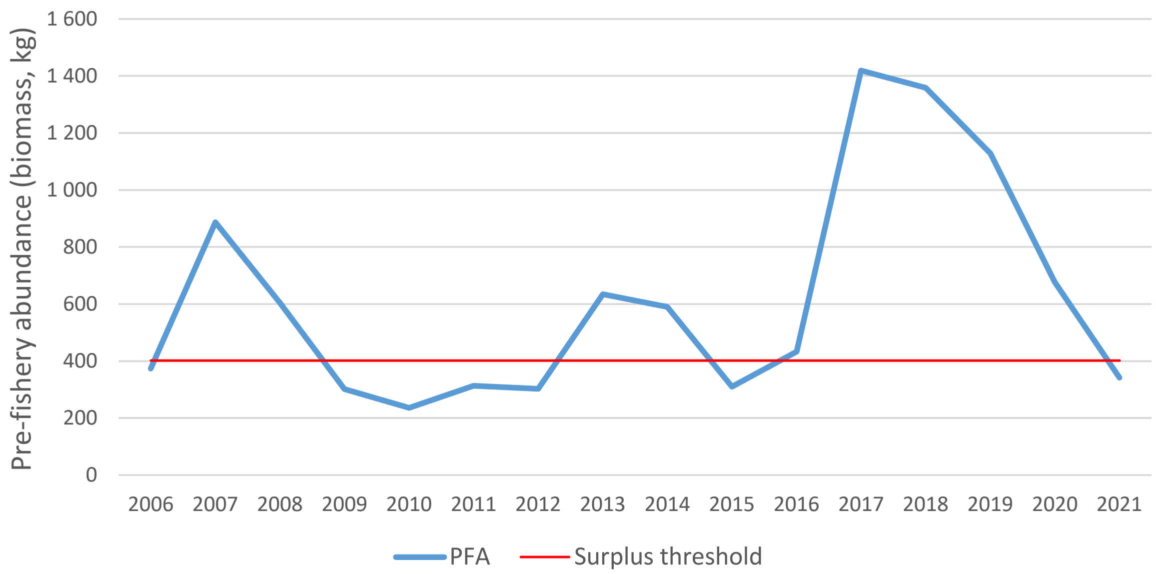

Figure 25. The estimated pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being a decrease from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA decreased with 49 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 64 % (Table 13). The reason for this is that the catch difference between 2020 and 2021 (437 kg [503 kg *v*. 65 kg]) is higher than the 2021 increase in spawning stock size (110 kg).

Table 13. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	114 kg	389 kg	0 kg	172 kg	675 kg
2021	65 kg	0 kg	0 kg	282 kg	347 kg

3.6 Áhkojohka/Akujoki

The river Áhkojohka/Akujoki is a small Finnish tributary (catchment area 193 km^2) flowing into the Tana mainstem from the east approximately 190 km upstream of the Tana estuary. Only the lower 6.2 km of the river is available for salmon production as an impassable waterfall prevents further upstream migration.

3.6.1 Status assessment

The Áhkojohka/Akujoki spawning target is 282 532 eggs (211 899-423 798 eggs). The female biomass needed to obtain this egg deposition is 126 kg (94-188 kg) when using a stock-specific fecundity of 2 250 eggs kg^{-1}.

Spawning salmon have been counted annually in Áhkojohka/Akujoki in the autumn with snorkelling in the years 2003-2020. These counts can be used directly as a basis for the target assessment of Áhkojohka/Akujoki and the following basic formula estimates the annual spawning stock size:

*Spawning stock size = (Snorkelling count * Average size * Female proportion) / (Detection rate * Area covered)*

The data input for the variables in this formula are summarized in Table 14. Female proportions in Table 14 are based on snorkelling detections of males and females each year.

Fishing pressure in Áhkojohka/Akujoki is low and there is no catch statistic. Average sizes in Table 14 are based on a combination of main stem Genmix samples from 2006-2008 and 2011-2012 and salmon samples from within Áhkojohka/Akujoki in 2007 and 2011. Area covered under snorkelling is 100 % of the salmon distribution area in Áhkojohka/Akujoki each year.

Table 14. Summary of stock data used to estimate annual spawning stock sizes in Áhkojohka/Akujoki.

Year	Snorkel. count (1SW)	Snorkel. count (MSW)	Average size (1SW)	Average size (MSW)	Detection rate	Area covered	Female prop. (1SW)	Female prop. (MSW)	Main stem prop.
2003	60	3	1.3	3.6	0.85	1	0.66	0.33	
2004	42	6	1.3	3.6	0.85	1	0.45	0.83	
2005	101	5	1.3	3.6	0.85	1	0.42	0.80	
2006	162	9	1.3	3.6	0.85	1	0.26	0.89	0.0032
2007	50	18	1.3	3.6	0.85	1	0.27	0.89	0.0040
2008	35	18	1.3	3.6	0.85	1	0.34	0.61	0.0027
2009	47	7	1.3	3.6	0.80	1	0.28	0.86	0.0030
2010	45	14	1.3	3.6	0.85	1	0.56	0.64	0.0030
2011	70	14	1.3	3.6	0.85	1	0.31	0.71	0.0020
2012	116	18	1.3	3.6	0.80	1	0.53	0.78	0.0031
2013	62	24	1.3	3.6	0.85	1	0.33	0.54	0.0030
2014	90	23	1.3	3.6	0.85	1	0.44	0.61	0.0030
2015	40	7	1.3	3.6	0.85	1	0.45	0.71	0.0030
2016	53	26	1.3	3.6	0.80	1	0.32	0.81	0.0030
2017	21	17	1.3	3.6	0.80	1	0.48	0.29	0.0140
2018	65	3	1.3	3.6	0.80	1	0.51	0.33	0.0060
2019	24	7	1.3	3.6	0.85	1	0.54	1.00	0.0220
2020	23	10	1.3	3.6	0.85	1	0.17	0.40	0.0140
2021	65	4	1.3	3.6	0.85	1	0.42	1.00	

To account for uncertainty, the exploitation rate and female proportion estimates in Table 14 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation for all years. In all years, 10 % uncertainty was used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 126 kg as the mode, 94 kg as the minimum and 188 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

The spawning target attainment was 45 % in 2021 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 0 % with an overall attainment of 36 % (Figure 26).

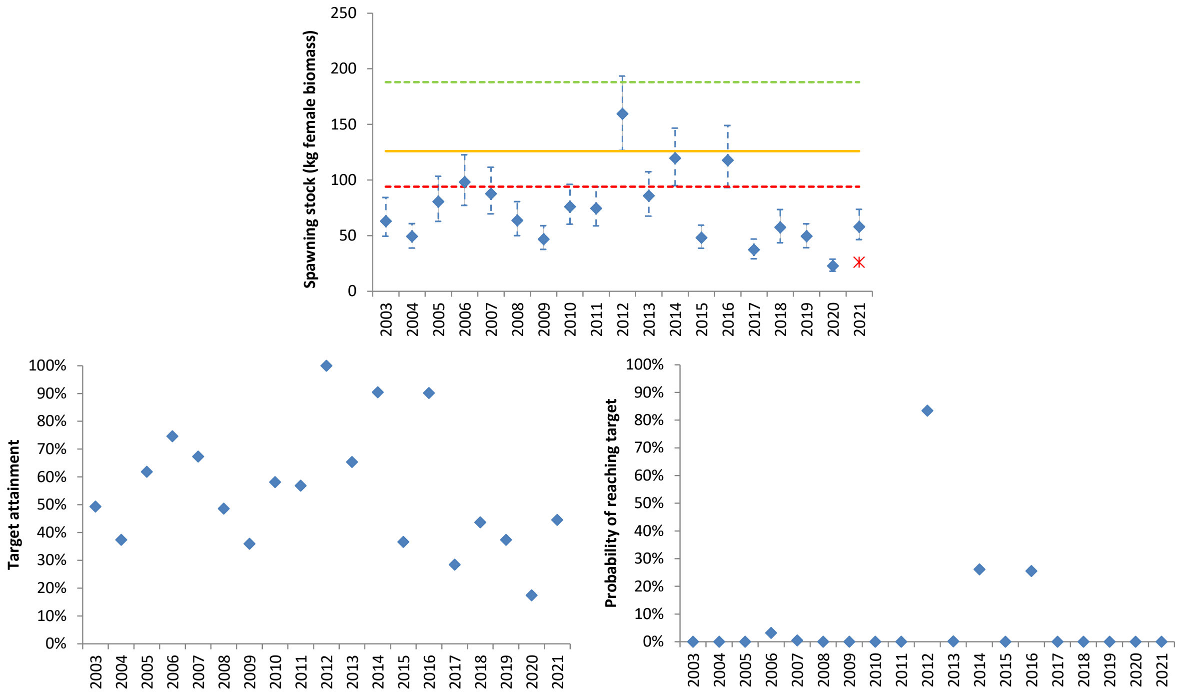

Figure 26. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2021 in the Finnish tributary Áhkojohka/Akujoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.6.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock has varied from a maximum of 734 kg (2006) down to 166 kg (2021) (Figure 27).

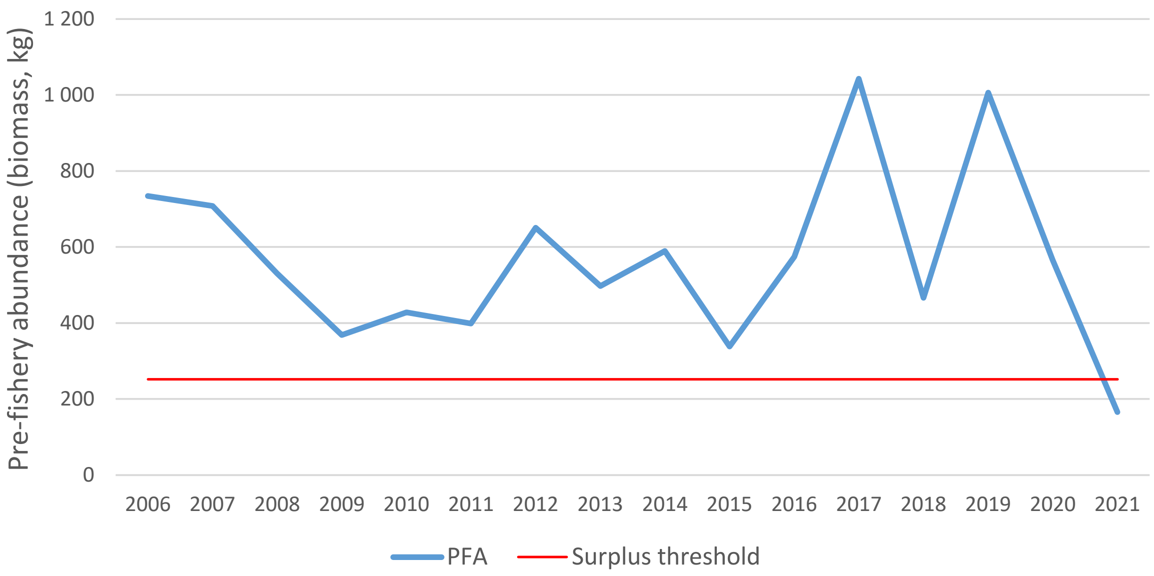

Figure 27. The estimated pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being a decrease from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA decreased with 71 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 36 % (Table 15). The reason for this is that the catch difference between 2020 and 2021 (433 kg [470 kg *v*. 37 kg]) is higher than the 2021 increase in spawning stock size (33 kg).

Table 15. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	95 kg	375 kg	0 kg	95 kg	565 kg
2021	37 kg	0 kg	0 kg	129 kg	166 kg

3.7 Kárášjohka + tributaries

The confluence of Anárjohka (Inarijoki) and Kárášjohka forms the Tana main stem. Close to 40 km upstream, Kárášjohka meets Iešjohka at Skáidegeahči. The lowermost 40 km are relatively slow flowing with sandy bottom, only a couple of places have higher water velocity and suitable conditions for salmon spawning. Above the confluence with Iešjohka, conditions in Kárášjohka become much better suited for salmon. There are several rapids and some waterfalls in Kárášjohka, with Šuorpmogorzi forming a partial obstacle. Electrofishing show, however, that salmon can pass and spawn above this waterfall. There is one major tributary, Bávttajohka, approximately 98 km upstream from Skáidegeahči. In this tributary, close to 40 km is available for salmon. Just downstream of the confluence between Kárášjohka and Iešjohka, there is another smaller tributary, Geaimmejohka, with 10 km available for salmon. The status assessment in this chapter is a combined evaluation of Kárášjohka and the tributaries Bávttajohka and Geaimmejohka.

3.7.1 Status assessment

The spawning target of Kárášjohka and its tributaries Bávttajohka and Geaimmejohka is 14 037 323 eggs (10 527 992-21 055 983 eggs). The female biomass needed to obtain this egg deposition is 7 290 kg (5 468-10 936 kg) when using stock-specific fecundities.

The following basic formula estimates the annual spawning stock size for Kárášjohka:

*Spawning stock size = ((Catch / Exploitation rate) - Catch) * Female proportion*

The data input for the variables in this formula are summarized in Table 16. Female proportions in Table 16 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix.

There were sonar counting of fish in 2010, 2012 and 2017-2021 at Heastanjárga, close to the upper bridge over Kárášjohka, approximately 5 km upstream from Skáidegeahči. These counts provide an estimate of the number of salmon of different size groups that migrated up into the upper part of Kárášjohka. The estimated exploitation rates in 2010 and 2012, in combination with the estimated catch of Kárášjohka-salmon downstream of the counting site, gave an estimated exploitation rate of 25 % for salmon <3 kg and 45 % for salmon >3 kg in the period 2006-2016. The estimate for 2017 was lower and 15 % was used for salmon <3 kg and 33 % for salmon >3 kg. Fish counting in 2018 indicated a further reduced exploitation, down to 15 % for salmon <3 kg and 25 % for salmon >3 kg. The 2019 and 2020 monitoring indicated continued low exploitation (Table 16).

Because the Tana/Teno salmon fisheries were closed in 2021, the spawning stock were estimated based solely on the sonar count at Heastanjárga.

Table 16. Summary of stock data used to estimate annual spawning stock sizes in Kárášjohka.

Year	Catch kg (<3 kg)	Catch kg (3-7 kg)	Catch kg (>7 kg)	Expl. rate (<3 kg)	Expl. rate (3-7 kg)	Expl. rate (>7 kg)	Female prop. (<3 kg)	Female prop. (3-7 kg)	Female prop. (>7 kg)	Main stem prop.
2006	1 774	1 277	1 110	0.25	0.45	0.45	0.09	0.79	0.73	0.1100
2007	272	1 281	761	0.25	0.45	0.45	0.23	0.70	0.82	0.0989
2008	245	1 160	2 716	0.25	0.45	0.45	0.25	0.69	0.72	0.1181
2009	456	291	619	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2010	506	894	1 210	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2011	500	908	1 163	0.25	0.45	0.45	0.06	0.73	0.73	0.1405
2012	1 259	1 525	1 129	0.25	0.45	0.45	0.06	0.63	0.67	0.1476
2013	565	1 325	1 145	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2014	772	1 229	1 571	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2015	435	1 691	1 661	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2016	246	743	2 158	0.25	0.45	0.45	0.09	0.71	0.73	0.1225
2017	121	523	1 473	0.15	0.33	0.33	0.09	0.71	0.73	0.1001
2018	352	403	638	0.15	0.25	0.25	0.09	0.71	0.73	0.1200
2019	80	507	814	0.15	0.25	0.25	0.09	0.71	0.73	0.0802
2020	124	225	755	0.15	0.25	0.2	0.09	0.71	0.73	0.1001
2021	0	0	0	0	0	0	0.09	0.71	0.73	

To account for uncertainty, the exploitation rate and female proportion estimates in Table 16 were treated as modal values, with a 10 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 7 290 kg as the mode, 5 468 kg as the minimum and 10 936 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

The spawning target attainment was 53 % in 2021 and the probability for meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 0 % with an overall attainment of 38 % (Figure 28).

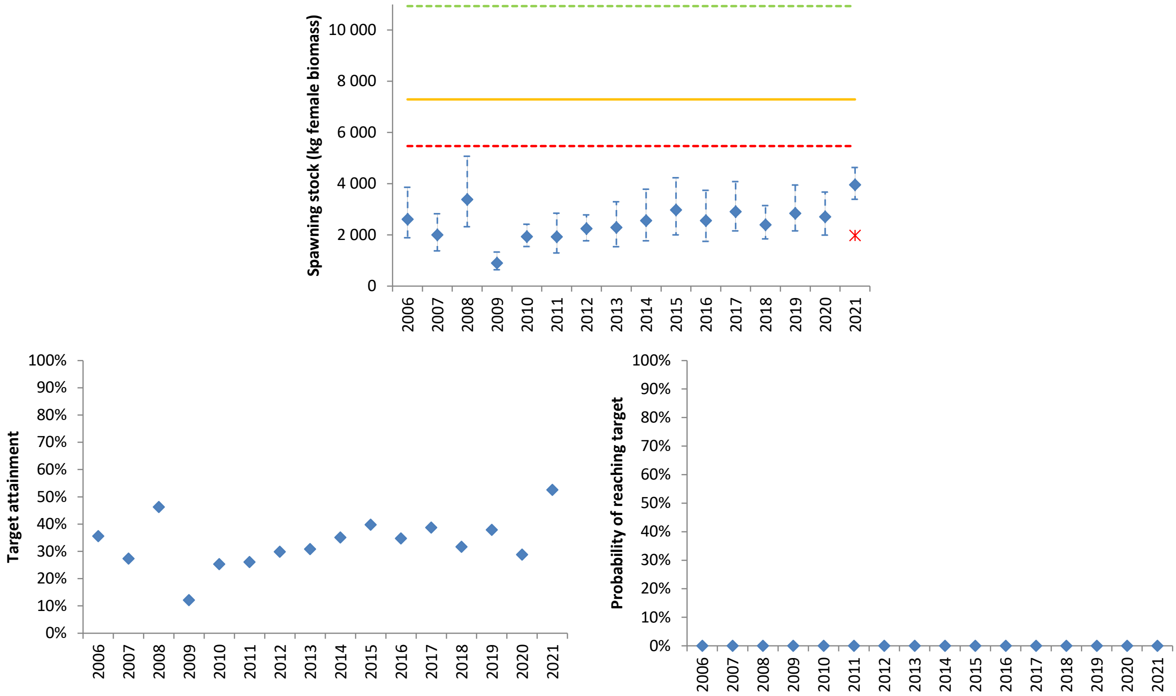

Figure 28. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2021 in the Norwegian tributary Kárášjohka. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.7.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock has varied from a maximum of 25 852 kg (2008) down to 9 313 kg (2020, Figure 29).

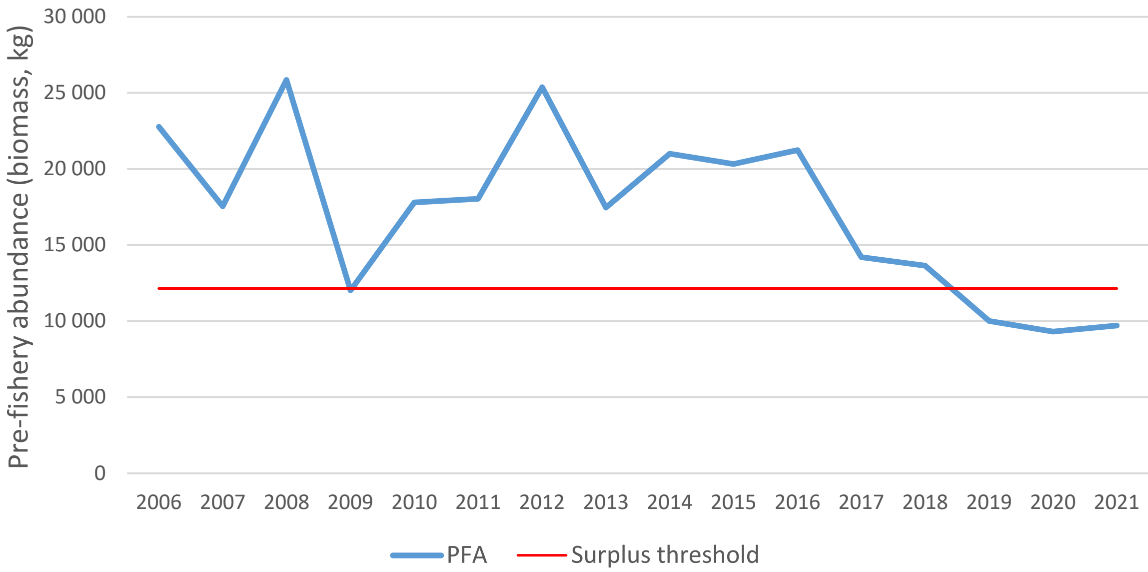

Figure 29. The estimated pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being a significant increase from 2020 and the 2021 PFA estimate being just a slight change from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA increased with only 4 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 121 % (Table 17). The reason for this discrepancy is that the catch difference between 2020 and 2021 (4 615 kg [5 173 kg *v*. 559 kg]) is almost as high as the difference in spawning stock size (5 004 kg).

Table 17. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	1 388 kg	2 683 kg	1 103 kg	4 140 kg	9 313 kg
2021	559 kg	0	0	9 144 kg	9 702 kg

3.8 Anárjohka/Inarijoki + tributaries

Anárjohka/Inarijoki is one of the three large headwater rivers that together form the Tana main stem. The lower 83 km of Anárjohka/Inarijoki are border areas between Norway and Finland, while the remaining uppermost 10 km are Norwegian only. The salmon are efficiently stopped at the 12-15 m high Gumpegorži. There are several tributaries with salmon stocks on both sides of the river. The lowermost tributary is Gáregasjohka/Karigasjoki on the Finnish side with a production potential of 3 % of the total potential of the Anárjohka/Inarijoki river system. Further up we find the small Iškorasjohka (1 % of the production area), Goššjohka (29 %) and at the top Skiehččanjohka/Kietsimäjoki (2 %). There is one tributary on the Finnish side, Vuomajoki, that is missing a spawning target and therefore is not included in the evaluation. Recent observations, however, indicate salmon reproduction occurring also in Vuomajoki.

3.8.1 Status assessment

The Anárjohka/Inarijoki (+tributaries) spawning target is 17 699 952 eggs (13 221 714-26 549 928 eggs). The female biomass needed to obtain this egg deposition is 7 937 kg (5 928-11 906 kg) when using stock-specific fecundities.

The following basic formula estimates the annual spawning stock size for Anárjohka/Inarijoki:

*Spawning stock size = ((Catch / Exploitation rate) - Catch) * Female proportion*

The data input for the variables in this formula are summarized in Table 18. Female proportions in Table 18 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are based on the size composition of the catch and the 5-year Genmix average female proportion of different size groups.

There have been no attempts at counting salmon in Anárjohka/Inarijoki before 2018. Sonar counting in Anárjohka/Inarijoki in 2018 indicate an exploitation rate of 0.14 and this estimate was used for 2018 (Table 18). A similar level of exploitation (0.15) was estimated from the counting in 2019. We used the same level of exploitation in 2017 and 2020, as a combination of difficult fishing conditions, few active fishermen and new regulatory measures aimed at decreasing exploitation likely led to significantly lower exploitation than previous years.

In older report (Anon. 2018), we used 0.25 as an exploitation rate estimate throughout the period 2006-2016. Based on the level of information that now (2018-2020) have accumulated about Anárjohka/Inarijoki and the catch distribution procedure over the period 2006-2020, a tributary exploitation of 0.25 clearly was an underestimation. When comparing the catch levels in Tana/Teno main stem, in the neighbouring Kárášjohka and in Anárjohka/Inarijoki, together with fish counting and genetic proportions, it is clear that the historic exploitation levels in Anárjohka/Inarijoki were significantly higher than 0.25 and the indications are that exploitation was in the region of 0.40. This is a level comparable to the historic exploitation in the neighbouring headwaters Kárášjohka and Iešjohka.

Because the Tana/Teno salmon fisheries were closed in 2021, the spawning stock were estimated based solely on the 2021 Anárjohka/Inarijoki sonar count.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 18 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 6 072 kg as the mode, 4 278 kg as the minimum and 9 107 kg as the maximum value.

Table 18. Summary of stock data used to estimate annual spawning stock sizes in Anárjohka/Inarijoki.

Year	Catch (kg)	Exploitation rate	Female proportion	Main stem proportion
2006	4 137	0.40	0.47	0.1903
2007	2 266	0.40	0.74	0.1648
2008	2 323	0.40	0.64	0.0755
2009	2 005	0.40	0.45	0.1516
2010	2 442	0.40	0.62	0.1516
2011	1 908	0.40	0.45	0.1370
2012	4 285	0.40	0.50	0.1920
2013	1 986	0.40	0.62	0.1516
2014	2 832	0.40	0.60	0.1516
2015	1 881	0.40	0.65	0.1516
2016	1 654	0.40	0.57	0.1516
2017	639	0.15	0.64	0.1845
2018	788	0.14	0.51	0.1650
2019	564	0.15	0.62	0.2040
2020	326	0.15	0.58	0.1845
2021	0	0	0.46	

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

The spawning target attainment was 27 % in 2021 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 0 % with an overall attainment of 24 % (Figure 30).

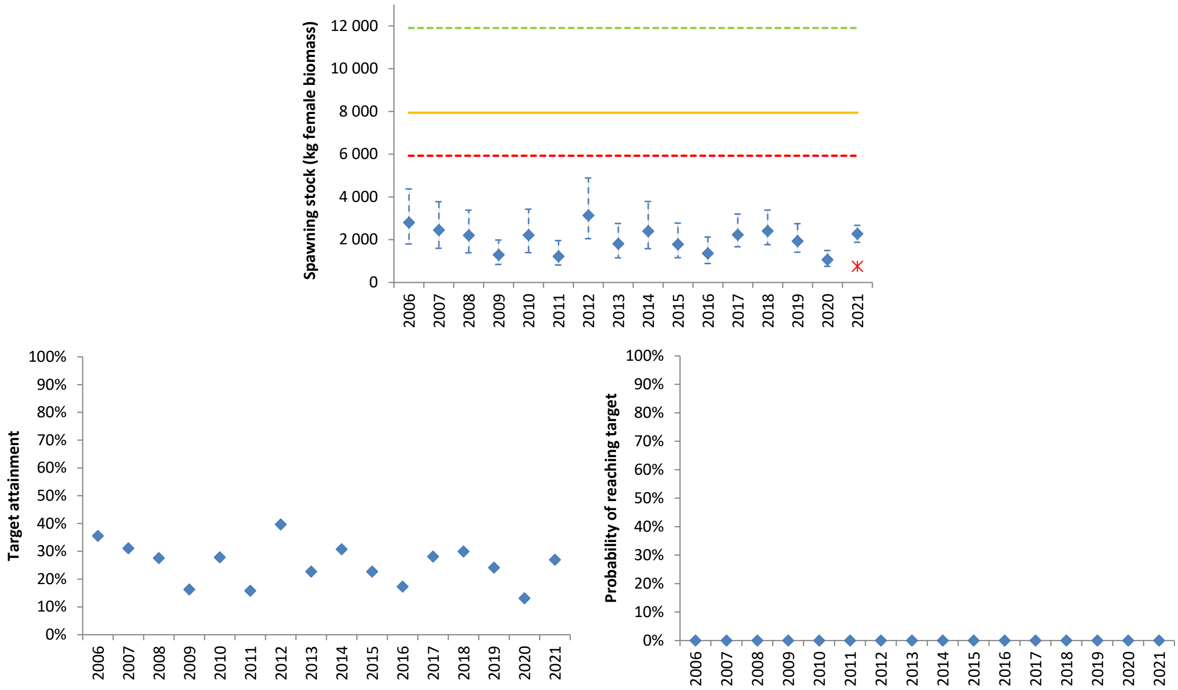

Figure 30. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2021 in the tributary Anárjohka/Inarijoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.8.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock has varied from a maximum of 31 779 kg (2006) down to 5 163 kg (2021) (Figure 31).

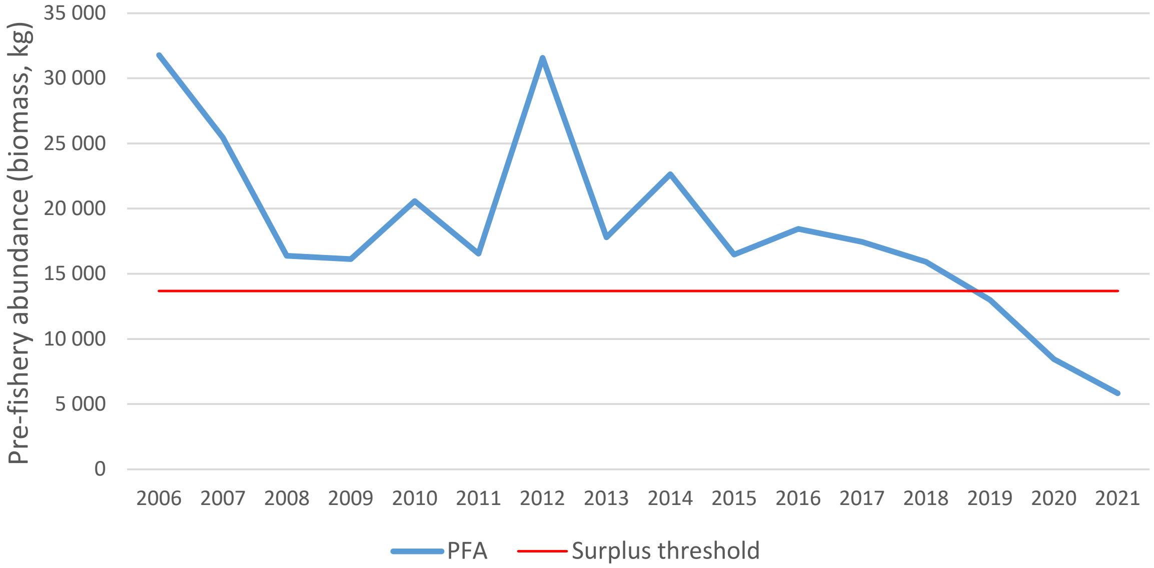

Figure 31. The estimated pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being a decrease from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA decreased with 31 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 198 % (Table 19). The reason for this discrepancy is that the catch difference between 2020 and 2021 (6 060 kg [6 721 kg *v*. 661 kg]) is higher than the difference in spawning stock size (3 432 kg).

Table 19. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	1 451 kg	4 944 kg	326 kg	1 731 kg	8 452 kg
2021	661 kg	0	0	5 163 kg	5 824 kg

3.9 Tana/Teno (total)

3.9.1 Status assessment

This chapter evaluates the Tana/Teno river system and its stock complex as if it was a single-stock system. This is accomplished by pooling all spawning targets into one total target for the entire river. The pooled target can then be evaluated by combining the annual total catch statistic with an estimate of the total exploitation rate in the river system.

Following the revision of the Leavvajohka spawning target, the Tana/Teno total spawning target becomes 105 107 245 eggs (77 315 400-156 578 775 eggs). The female biomass needed to obtain this egg deposition is 52 312 kg (38 510-78 070 kg) when using stock-specific fecundities.

The following basic formula estimates the annual spawning stock size for Tana/Teno (total):

*Spawning stock size = ((Catch / Exploitation rate) - Catch) * Female proportion*

The data input for the variables in this formula are summarized in Table 20. Female proportions in Table 20 are based on long-term scale data. The exploitation rates are based on the combined catch distribution estimates of the stock-specific evaluations above.

The 2021 closure of the Tana/Teno salmon fisheries means that we have to base the spawning stock estimate solely on the Polmak sonar count and average values for size and female proportions. We base the estimation on a count of 18 025 grilse and 8 323 MSW salmon with average size 1.7 and 5.6 kg, respectively, and female proportions of 0.1 and 0.69, respectively. Salmon from three areas of the Tana/Teno are missing from the Polmak count. These are salmon spawning in the lowermost part of the main stem, salmon from Máskejohka and salmon from Buolbmátjohka/Pulmankijoki. Salmon from the first two areas were estimated based on the relative production areas of these, while salmon from the Buolbmátjohka/Pulmankijoki were added based on the status assessment of this stock.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 20 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 52 312 kg as the mode, 38 510 kg as the minimum and 78 070 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The average extent that the spawning stock distribution exceeds the spawning target distribution becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

Table 20. Summary of stock data used to estimate annual spawning stock sizes of the Tana/Teno river system.

Year	Total catch (kg)	Exploitation rate	Female proportion
1993	152 635	0.60	0.49
1994	131 878	0.60	0.63
1995	104 631	0.60	0.49
1996	88 832	0.60	0.51
1997	92 506	0.60	0.43
1998	102 627	0.60	0.46
1999	143 821	0.60	0.44
2000	209 532	0.60	0.50
2001	248 585	0.60	0.55
2002	190 107	0.60	0.56

2003	153 738	0.60	0.58
2004	69 994	0.60	0.59
2005	77 190	0.60	0.52
2006	108 596	0.60	0.42
2007	100 542	0.60	0.67
2008	121 860	0.60	0.64
2009	63 499	0.60	0.50
2010	87 058	0.60	0.56
2011	79 342	0.60	0.54
2012	108 794	0.60	0.46
2013	79 883	0.60	0.56
2014	99 236	0.60	0.49
2015	78 124	0.60	0.60
2016	84 744	0.60	0.58
2017	60 608	0.50	0.62
2018	49 530	0.45	0.50
2019	40 006	0.50	0.58
2020	31 591	0.50	0.59
2021	0	0	0.46

The spawning target attainment was 65 % in 2021 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2018-2021) overall probability of reaching the spawning target was 0 % with an overall attainment of 50 % (Figure 32).

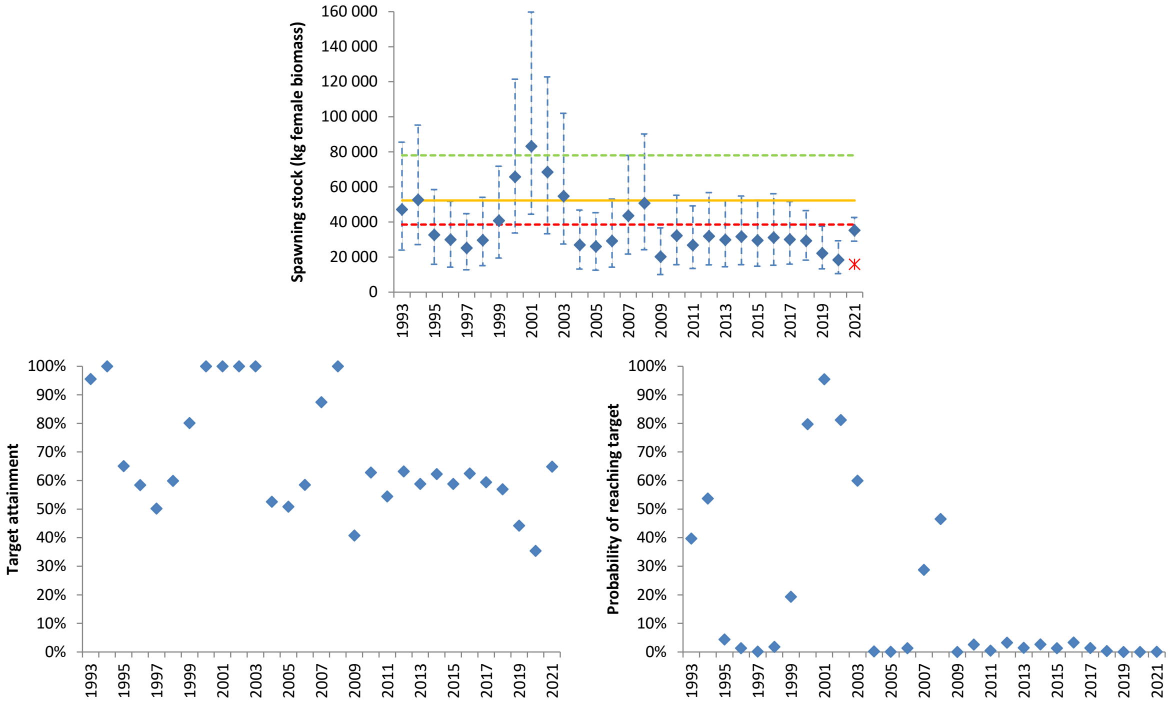

Figure 32. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 1993-2021 for Tana/Teno (total). The red symbol in the upper panel show what the spawning stock size would have been in 2021 if fishing had continued.

3.9.2 Pre-fishery abundance

The estimated pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system has varied from a maximum of 230 028 kg (2008) down to 73 053 kg (2021) (Figure 33).

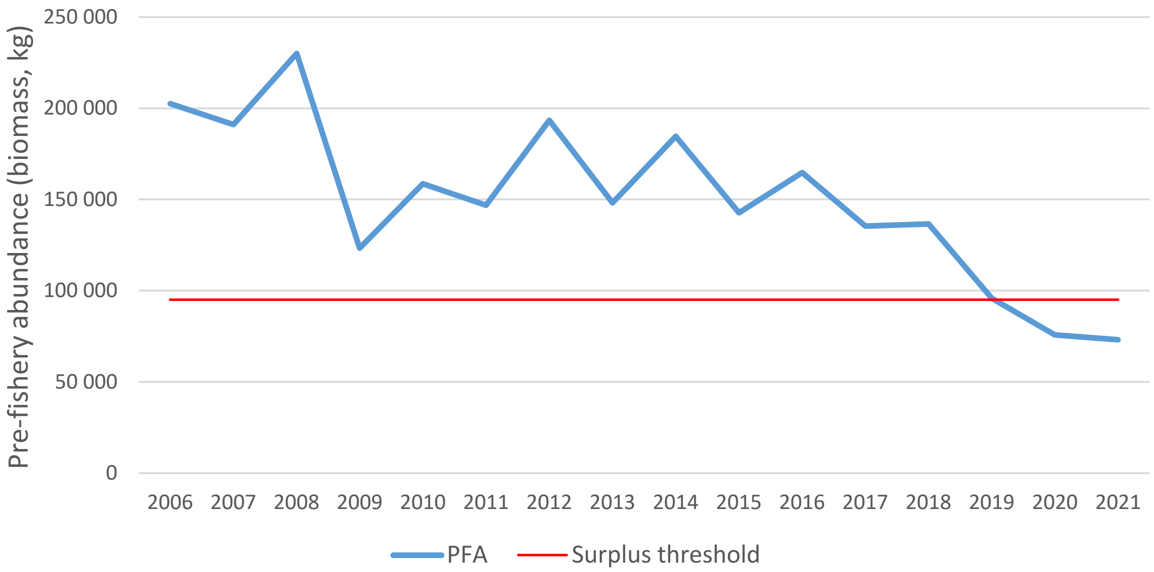

Figure 33. The estimated pre-fishery abundance (PFA) of salmon returning to the entire Tana/Teno river system in the period 2006-2021. Horizontal red line is the exploitable surplus threshold. The biomass above the threshold is the exploitable surplus and the salmon caught below this will be overexploitation.

There is seemingly a discrepancy between the 2021 spawning stock estimate being an increase from 2020 and the 2021 PFA estimate being a decrease from 2020. In order to better understand this, it is first of all important to remember the way the PFA is calculated and what the PFA is representing. The PFA is calculated by summing the number of salmon that survive the fishing season and the number of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning stock before any fishing takes place.

The PFA decreased with 4 % from 2020 to 2021 despite a spawning stock (both males and females) increase of 118 % (Table 21). The reason for this discrepancy is that the catch difference between 2020 and 2021 (39 410 kg [44 656 kg *v*. 5 246 kg]) is higher than the difference in spawning stock size (36 747 kg).

Table 21. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system in 2020 and 2021.

Year	Coastal catch	Main stem catch	Tributary catch	Spawning stock (both sexes)	Pre-fishery abundance
2020	13 122 kg	26 670 kg	4 864 kg	31 059 kg	75 716 kg
2021	5 246 kg	0	0	67 807 kg	73 053 kg

4 Conclusions and further insights into the status assessment

Stock status over the last four years (2018-2021) was poor in all the 8 areas that we evaluated (Figure 34). A lower than 40 % overall probability of reaching the spawning target over the last 4 years (corresponding to the orange and red colours in Figure 34) should, following NASCO guidelines, automatically trigger the formulation of a recovery plan for the affected stock. All of the evaluated areas fall below the 40 % management target threshold that indicates a need for stock recovery.

Of the stocks with poor status, the most important thing to note is the status of the upper main headwater areas of Kárášjohka, Iešjohka and Anárjohka/Inarijoki and of the Tana/Teno main stem. These areas had low target attainment and low exploitable surplus. These four areas constitute 84 % of the total Tana/Teno spawning target and over the last four years, these areas on average have lacked an annual total of 30-35 000 kg female spawners to reach their management targets.

Spawning stocks increased significantly in 2021 compared to 2020, increasing between 33 and 198 % in the various areas (Table 22). However, estimates of pre-fishery abundances decreased in most assessed areas with an overall decrease of 8 %. This illustrates the importance of the 2021 fishing closure. In practice, the 2021 fishing closure has been essential for avoiding further derailment of the Tana/Teno long-term stock recovery process.

Table 22. Changes in spawning stock and pre-fishery abundance (PFA) from 2020 to 2021 in the areas of Tana/Teno evaluated in this report.

Area	Change in spawning stock from 2020 to 2021	Change in PFA from 2020 to 2021
Tana/Teno MS	60 %	-9 %
Buolbmátjohka/Pulmankijoki	194 %	23 %
Veahčajohka/Vetsijoki	92 %	-32 %
Ohcejohka/Utsjoki	81 %	-32 %
Njiljohka/Nilijoki	64 %	-49 %
Áhkojohka/Akujoki	33 %	-71 %
Kárášjohka	121 %	4 %
Anárjohka/Inarijoki	198 %	-31 %
Tana/Teno (total)	118 %	-4 %

To conclude, the situation for different salmon stocks of the Tana/Teno system in 2021 show a continued overall negative status with low spawning stocks and low estimates of pre-fishery abundance. The numbers of large MSW salmon were particularly low, in line with what was predicted for 2021. Overall low returns of 1SW salmon continued, and it is therefore expected that the return of MSW salmon will continue to be extremely low in 2022 and that there likely will not be any sustainable surplus available.

Given this forecast, we strongly advise keeping the salmon fisheries either closed or allow only very limited salmon fishing in 2022. This recommendation is based on biological considerations only.

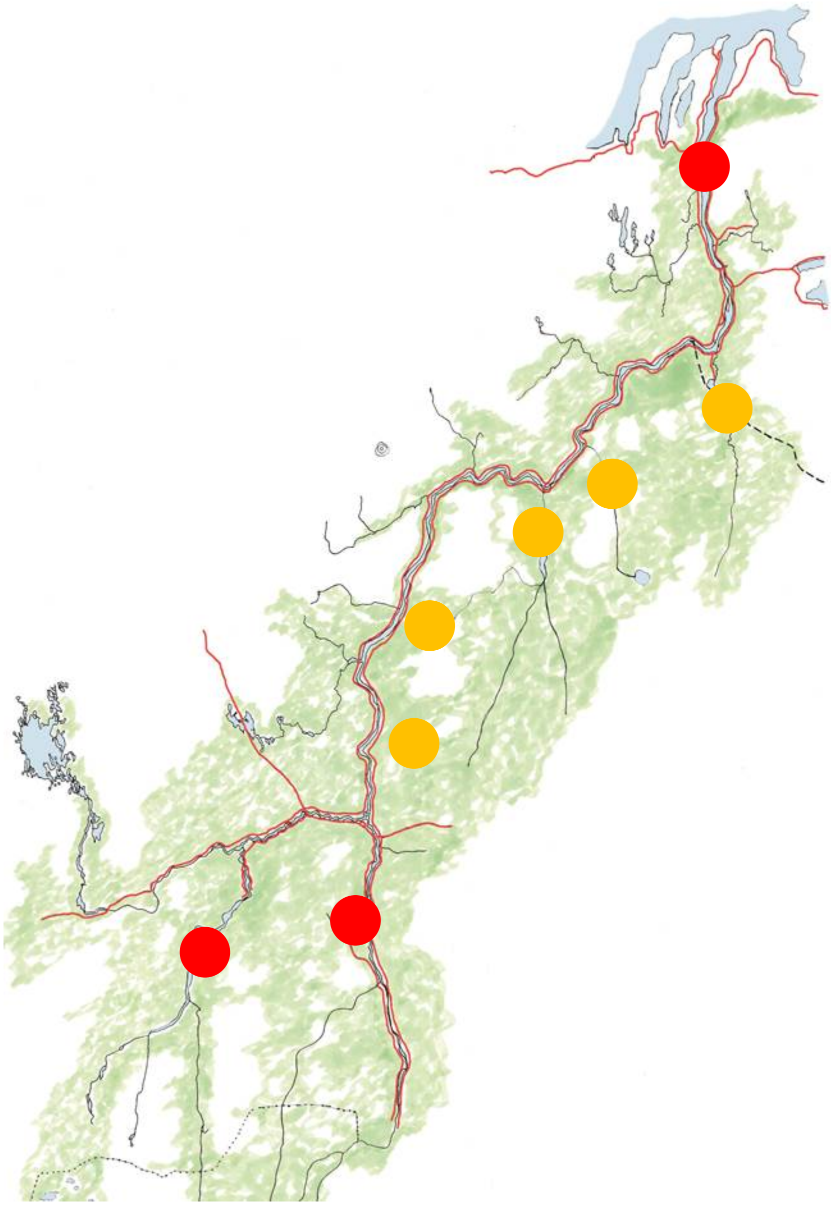

Figure 34. Map summary of the 2018-2021 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates stock status over the last four years. Possible colours are: Dark green = overall probability of attaining spawning target higher than 75 %, overall target attainment over 140 %. Light green = overall probability of attaining spawning target higher than 75 %. Yellow = overall probability of attaining spawning target between 40 and 74 %, overall target attainment above 75 %. Orange = overall probability of attaining spawning target below 40 %, stock has had an exploitable surplus in at least 3 of the last 4 years. Red = stock had an exploitable surplus in less than 3 of the last 4 years.

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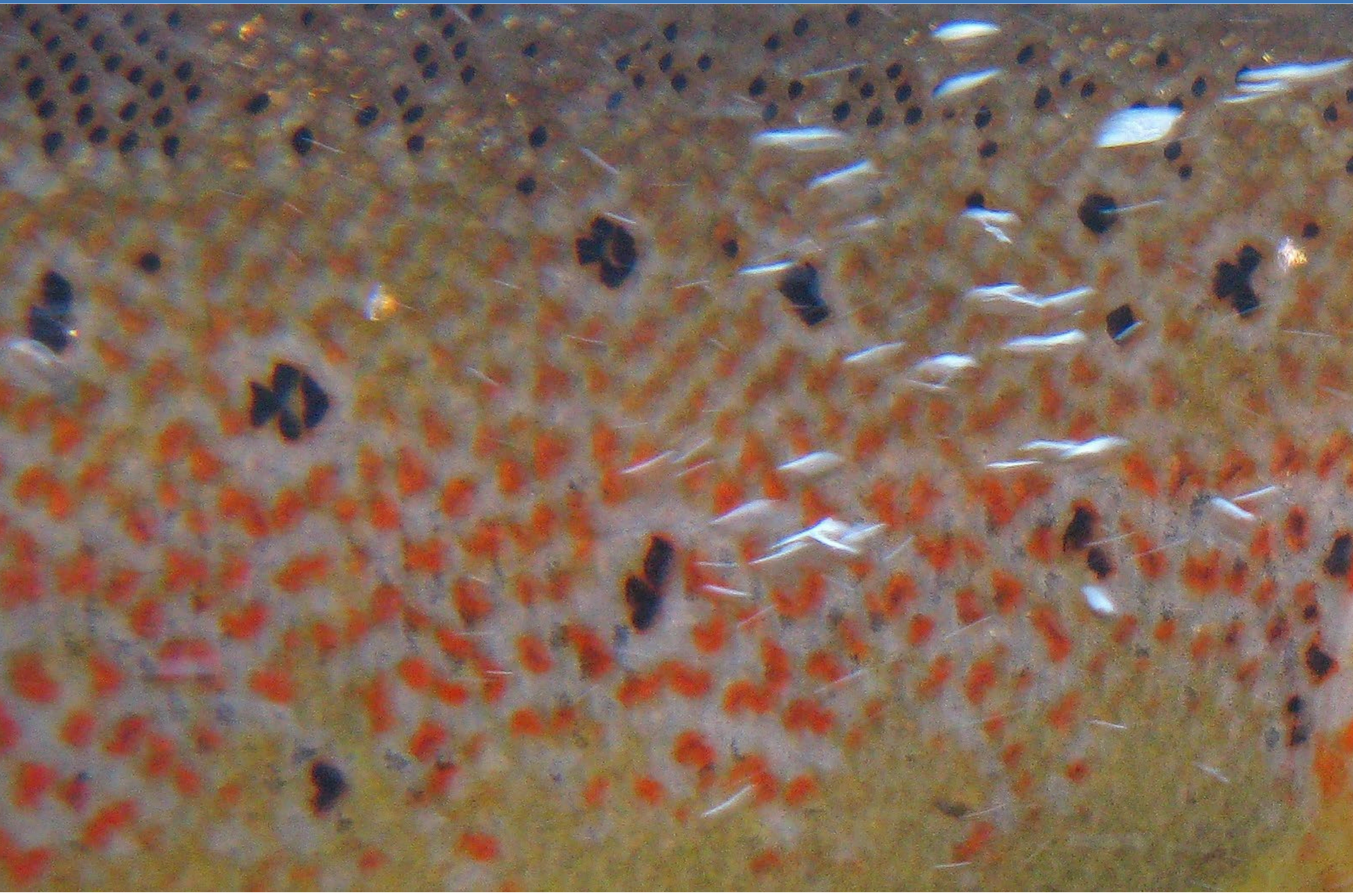

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