Tana/Teno Monitoring and Research Group

# Status of the Tana/Teno River salmon populations in 2022

**Report from the Tana/Teno Monitoring and Research Group** 1/2023

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# Summary

Anon. 2023. Status of the Tana/Teno River salmon populations in 2022. Report from the Tana/Teno Monitoring and Research Group nr 1/2023.

This report is the sixth status assessment of the re-established Tana/Teno Monitoring and Research Group (MRG) after the 2017 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 2021 and 2022, when a total moratorium of salmon fisheries was put in place both in the Teno/Tana river system and in large areas in Tanafjord and in adjacent coastal areas, meant that 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 the assessments in 2021 and 2022 because of the absence of salmon catches.

The map below summarizes the 2019-2022 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates the management target, 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:

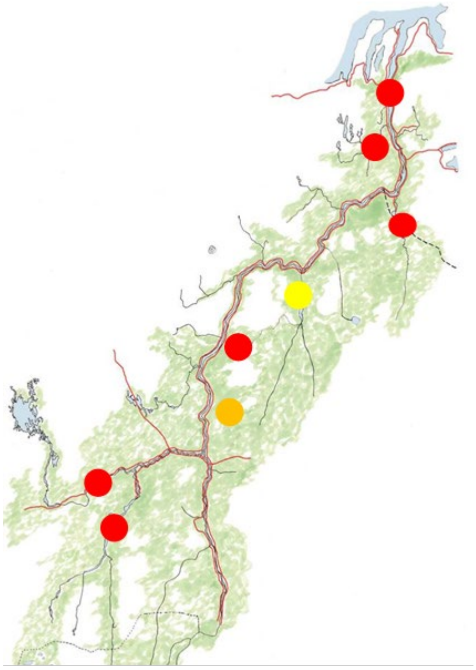
1) Probability of reaching the spawning target over the last four years higher than 75 % and attainment higher than 140 % (dark green color in the summary map below)
2) Probability higher than 75 %, attainment lower than 140 % (light green)
3) Probability between 40 and 75 % (yellow)
4) Probability under 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, seven of the eight evaluated areas had a management target below 40 %, and six of the areas were placed in the worst (red) status category with no exploitable surplus in at least two of 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 (evaluated in last years report) and of the Tana/Teno main stem. These areas, which constitute 84 % of the total Tana/Teno spawning target, have had consistently low target attainment and low to none exploitable surplus over several years.

To conclude, the situation for different salmon stocks of the Tana/Teno system in 2022 continued to show an overall negative status with very 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 2022. Overall low returns of 1SW salmon continued, and it is therefore expected that the return of MSW salmon will continue to be low also in 2023 and that there likely will not be any sustainable surplus available.

Given the critical red status category for 6 of 8 assessed areas, the biological advice, based on the recommended stock recovery procedure given in Anon (2022), is that no exploitation should take place for stocks placed in the red category. until the forecast indicates the return of an exploitable surplus and status categories increase to at least orange.



The table below summarizes the stock-specific management targets and status numbers for 2022 and previous four years, and the probability for reaching the spawning target over the previous 4 years (=the management target).

| | 2022 target attainment | 2022 probability | 4-year target attainment | Management target |
|---|---|---|---|---|
| Tana/Teno MS | 69 % | 0 % | 61 % | 0 % |
| Máskejohka | 36 % | 0 % | 67 % | 0 % |
| Buolbmátjohka/Pulmankijoki | 51 % | 0 % | 77 % | 8 % |
| Ohcejohka/Utsjoki (+tributaries) | 134 % | 97 % | 98 % | 42 % |
| Njiljohka/Nilijoki | 63 % | 0 % | 71 % | 4 % |
| Áhkojohka/Akujoki | 94 % | 32 % | 48 % | 0 % |
| Kárášjohka (+tributaries) | 56 % | 0 % | 50 % | 0 % |
| Iešjohka | 36 % | 0 % | 29 % | 0 % |

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# 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, 2017-2022)
- 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 (2018-2022)

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, 2022) and Máskejohka (sonar, 2020 and 2022). 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 2022

The Tana/Teno salmon fisheries were totally closed in 2022 because of poor stock status. There were, however, a short period of time (1.-10.6.2022) when salmon fishing was open on the Finnish side because of slow legislation process. During this period *c*. 240 kg of salmon was estimated of being caught on the Finnish side. This is, however, probably a significant under-estimate as catch reporting was weak, especially on net fishing methods, including drift netting. Most probably the catch was between 500-1 000 kg.

Catch and fisheries data from earlier years can be found from an older 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 in assessing stock status for individual populations (chapter 3), information on juvenile abundance is still an important index of spatial distribution of spawning, juvenile production and long-term development in production in some of the most important rearing areas in the Tana/Teno system.

In 2022 mean densities of juvenile salmon at the permanent electrofishing sites were among the lowest observed throughout the time series and especially low when compared to the mean densities observed during 2000s (Figure 1). Juvenile densities were best in the River Anárjohka/Inarijoki (Figure 1).

Overall, the lowered juvenile densities may indicate poorer recruitment during the last few years. This would be logical as the spawning populations throughout the Tana/Teno system have been very low since 2019.

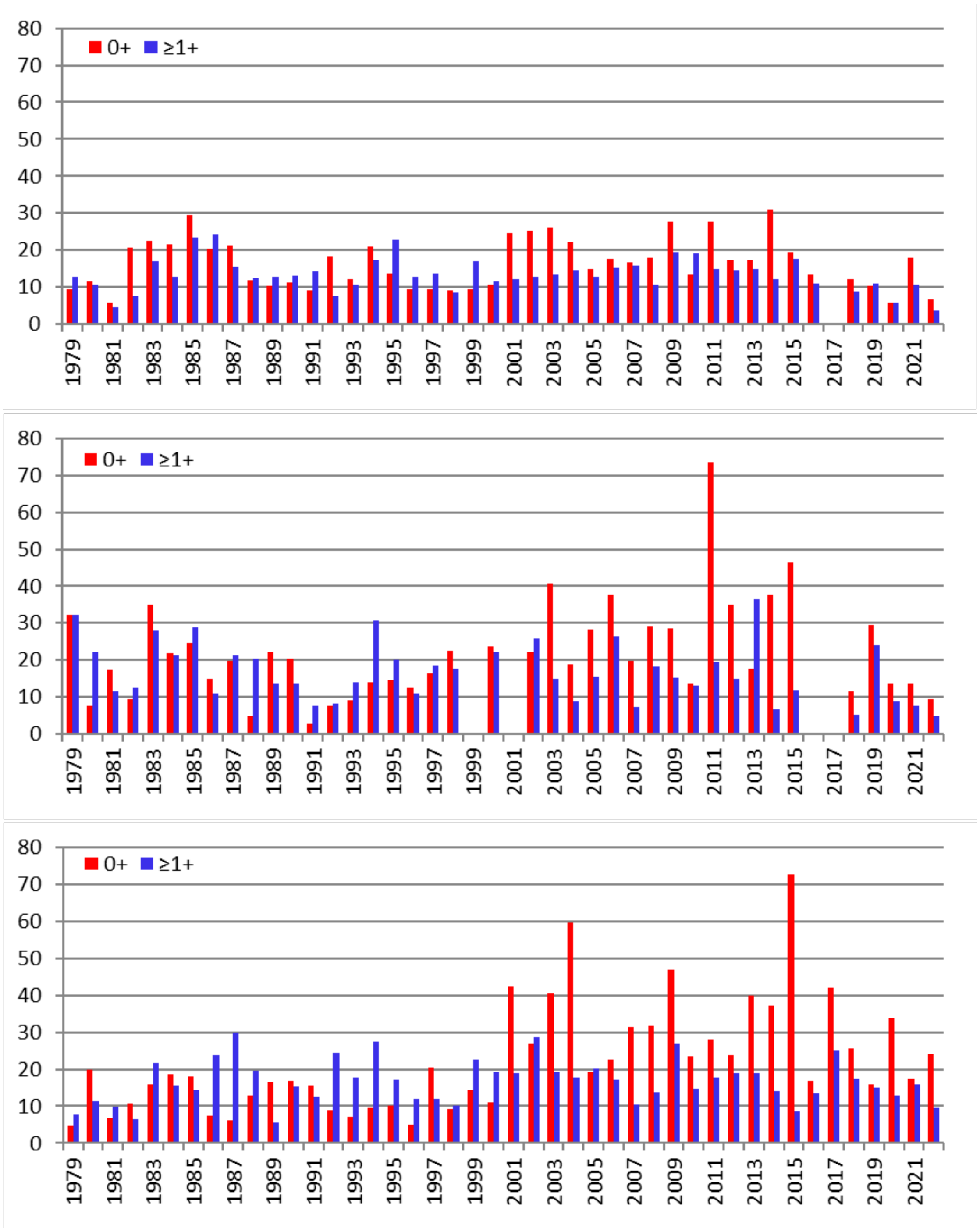


*Figure 1. Mean densities (fish/100 m$^2$; one pass, uncorrected) of salmon fry (0+) and parr (≥1+) at permanent electrofishing sites in the rivers Tana/Teno (uppermost panel), Ohcejohka/Utsjoki (middle panel) and Anárjohka/Inarijoki (lowermost panel) in the years 1979-2022. Note: this data only includes 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.*

## 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 2).

In 2022 adult salmon counts were performed at the following sites (Figure 2): Tana/Teno main stem (sonar), Ohcejohka/Utsjoki (video), Kárášjohka (sonar), Iešjohka (sonar), Máskejohka (sonar), Buolbmátjohka/Pulmankijoki (snorkelling), Njiljohka/Nilijoki (snorkelling) and Áhkojohka/Akujoki (snorkelling).

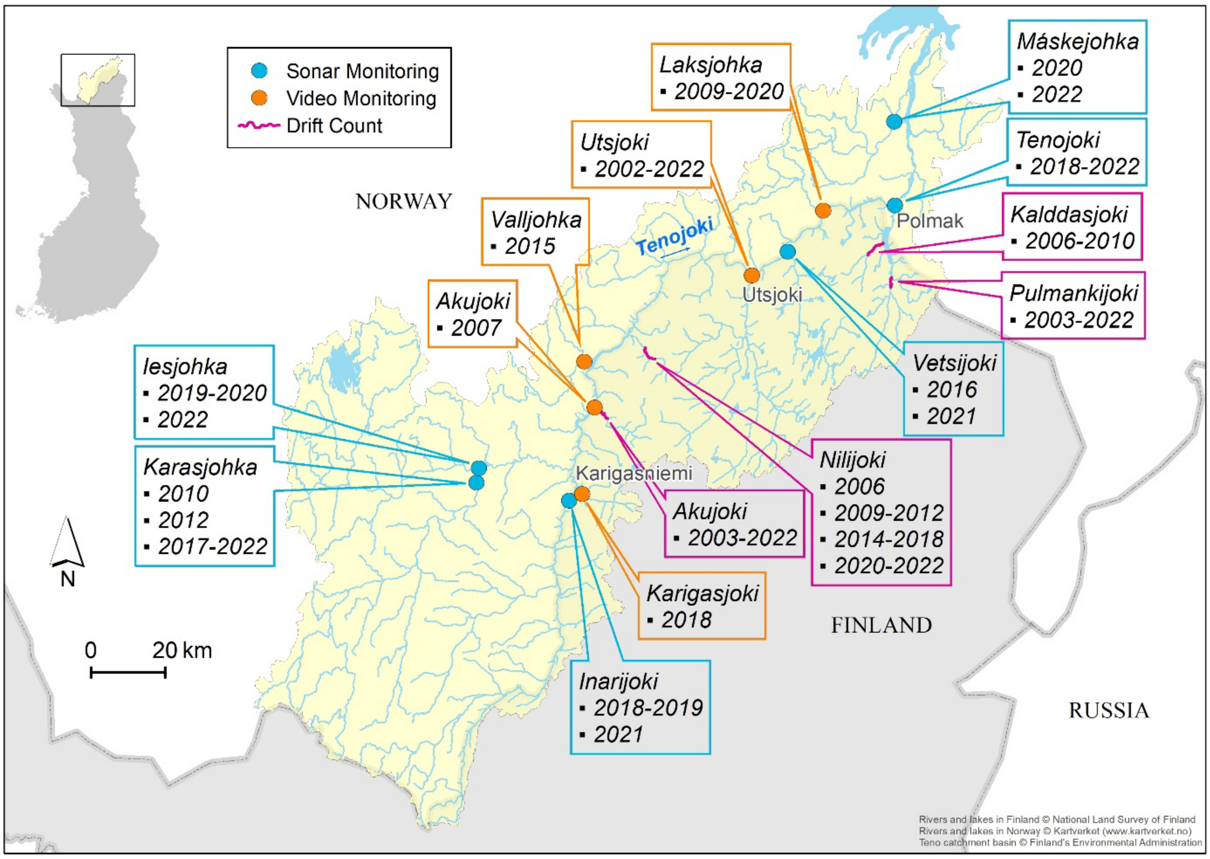


*Figure 2. Map of the Tana/Teno river system indicating the most important adult salmon counting sites and counting methods between 2002 and 2022. Note that the Iešjohka sonar counts in 2019-2020 are not comparable to year 2022, because of low data quality in 2019-2020.*

### 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 2002-2022 (Figure 3).

In 2022 the video counting was performed in good environmental conditions without any significant problems. The adult salmon count was 2 000 fish, being at the same level as in 2021. Salmon numbers were almost double as high as in 2020, which was the last season when salmon fishing was allowed. The salmon run of 2022 was still significantly lower (40%) than the long-term average (3 380 fish) (Figure 3).

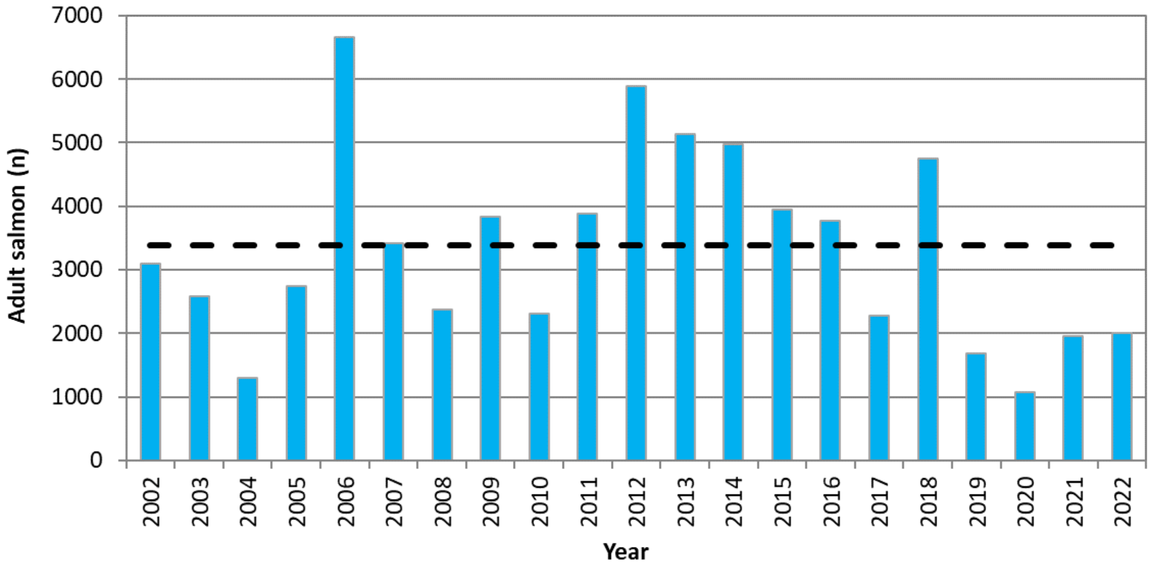


*Figure 3. Video counts of ascending adult salmon at the river mouth of Ohcejohka/Utsjoki in 2002-2022. The dashed black line indicates the long-term average between 2002-2021. All sea-age groups are combined.*

Counting of descending smolts is considerably difficult and more unreliable than counting of adult salmon in Utsjoki video monitoring, especially in years with high summer flows. Therefore, smolt numbers have not been annually reported in the Tana/Teno status report. During the last few years some extra data (smolts migrating from the shore channels) and new modelling approaches (Bayesian smolt model, e.g., Pulkkinen *et al*. 2020) have made the estimation process possible and first preliminary results are now presented in Figure 4 for the years 2002-2021. Annual median smolt production estimates have varied between *c*. 10 000 and 35 000 smolts. The smolt numbers seem to be the lowest duringhigh flow summers (2005, 2008, 2010, 2011, 2012, 2017 and 2020) indicating severe problems in observing and counting smolts, and therefore the model development is still underway for better accounting for the observing error. Overall, there is no indication of significant long-term changes on annual smolt production in Utsjoki (Figure 4).

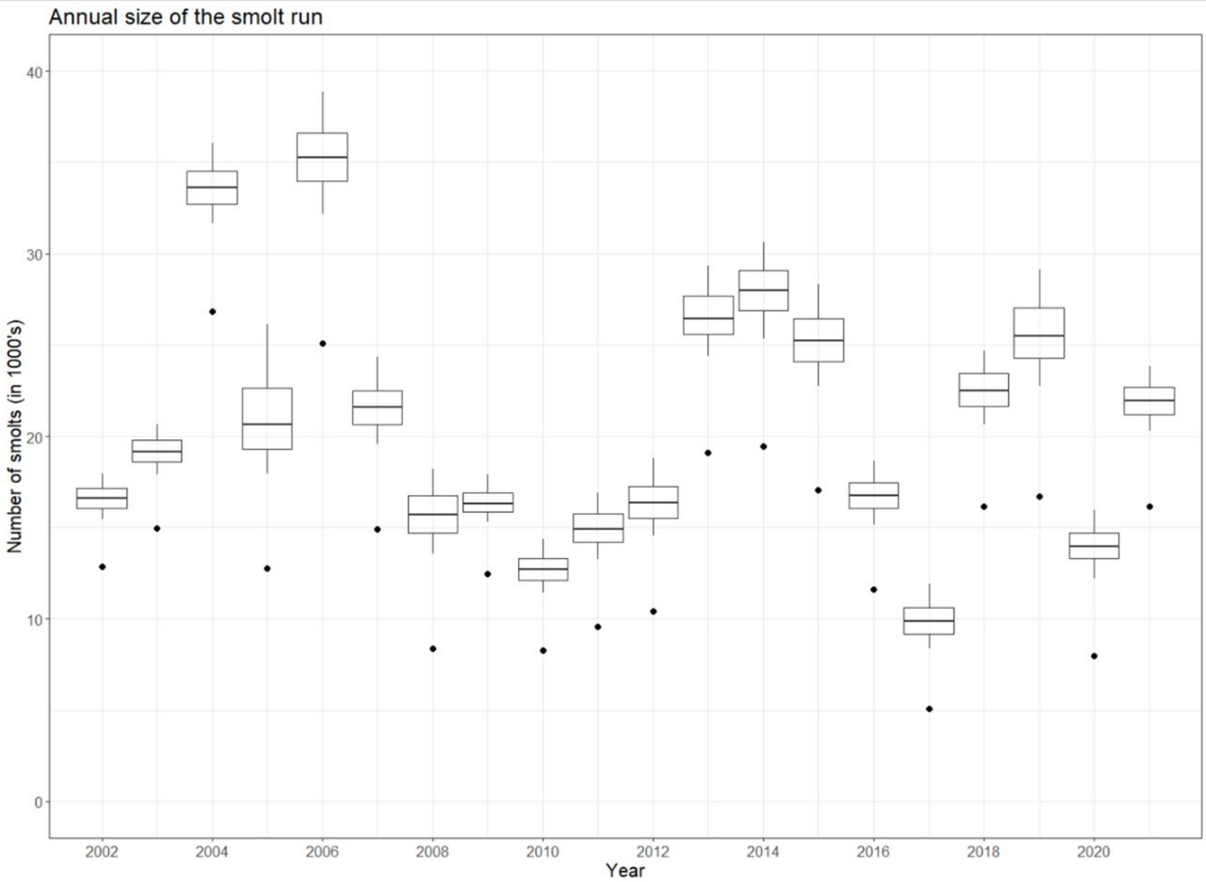


*Figure 4. The preliminary estimated total smolt numbers in the Utsjoki video monitoring in 2002-2021 including the posterior probability distributions. Black dots are the number of smolts counted (raw data) and the boxplots indicate the model estimated numbers and their uncertainty. The thick line is the median of the posterior distribution, the box covers 50% and the whiskers 95% of the probability mass, respectively. Note: the estimated numbers are prone to changes in the future as the modelling process is being improved.*

### 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 2022 the snorkelling counts were performed in rather good environmental conditions and the results are mostly comparable to other years. The count in Buolbmátjohka/Pulmankijoki may be somewhat underestimated compared to other years because of lower experience level of the snorkelling crew in 2022.

Numbers of spawning salmon in 2022 were approximately at the level observed in 2021, but there were some deviations in spawner numbers between different rivers (Figure 5). in Áhkojohka/Akujoki spawner numbers clearly increased from 2021, in Njiljohka/Nilijoki they stayed on the level observed in 2021 and in Buolbmátjohka/Pulmankijoki they decreased from previous year. Numbers on larger multi-sea-winter (MSW) salmon clearly increased from previous year in all surveyed tributaries.

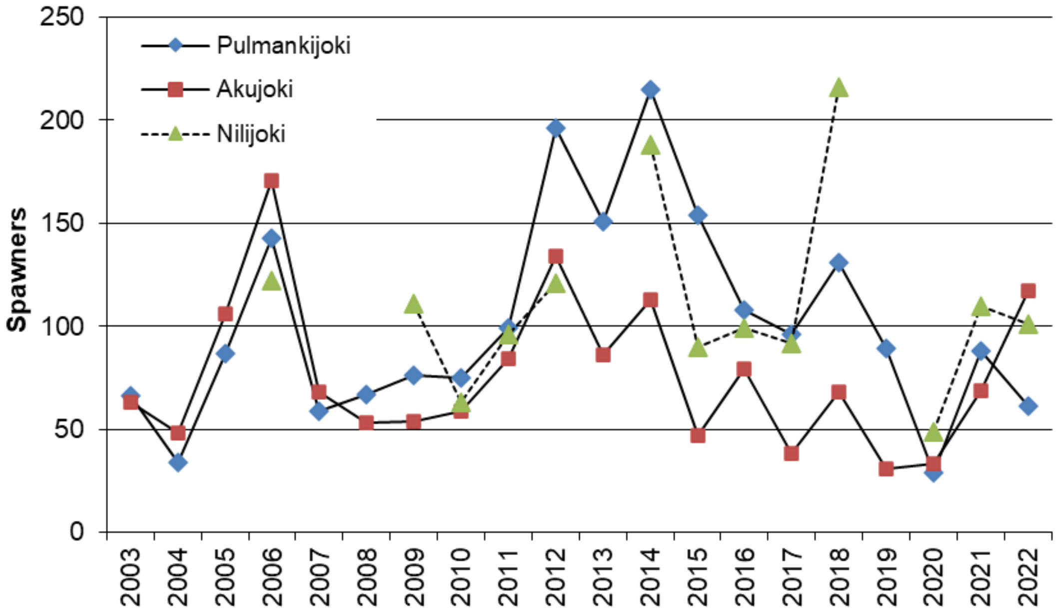


*Figure 5. Snorkelling counts of spawning salmon in the rivers Buolbmátjohka/Pulmankijoki, Áhkojohka/Akujoki and Njiljohka/Nilijoki in 2003-2022. All sea-age groups are combined.*

### 2.3.3 Sonar counts

During the last 10 years sonar monitoring have been used in counting the numbers ascending salmon. In 2022 sonar counts were performed in the Tana/Teno main stem, in Kárášjohka, in Iešjohka and in Máskejohka (Figure 2). ARIS-sonars were used in all sites.

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, whitefish, 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 sonar windows.

**Tana/Teno main stem sonar**

Sonar counting of ascending salmon numbers was continued for fifth year in the Tana/Teno main stem in 2022, at Polmak, c. 55 km upstream from the river mouth (Figure 6). The aim of this survey is to estimate the total salmon run size of the Tana/Teno system on annual basis. 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 small salmon (50-65 cm) 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 2022, however, salmon fisheries were closed and catch data was not available. Therefore, we used combined Tana bru-national border catch data from 2017-2020 to correct the species distribution of the 50-65 cm long sonar fish observations in 2022. This correction was done throughout the counting season in 5-day intervals (Figure 7).

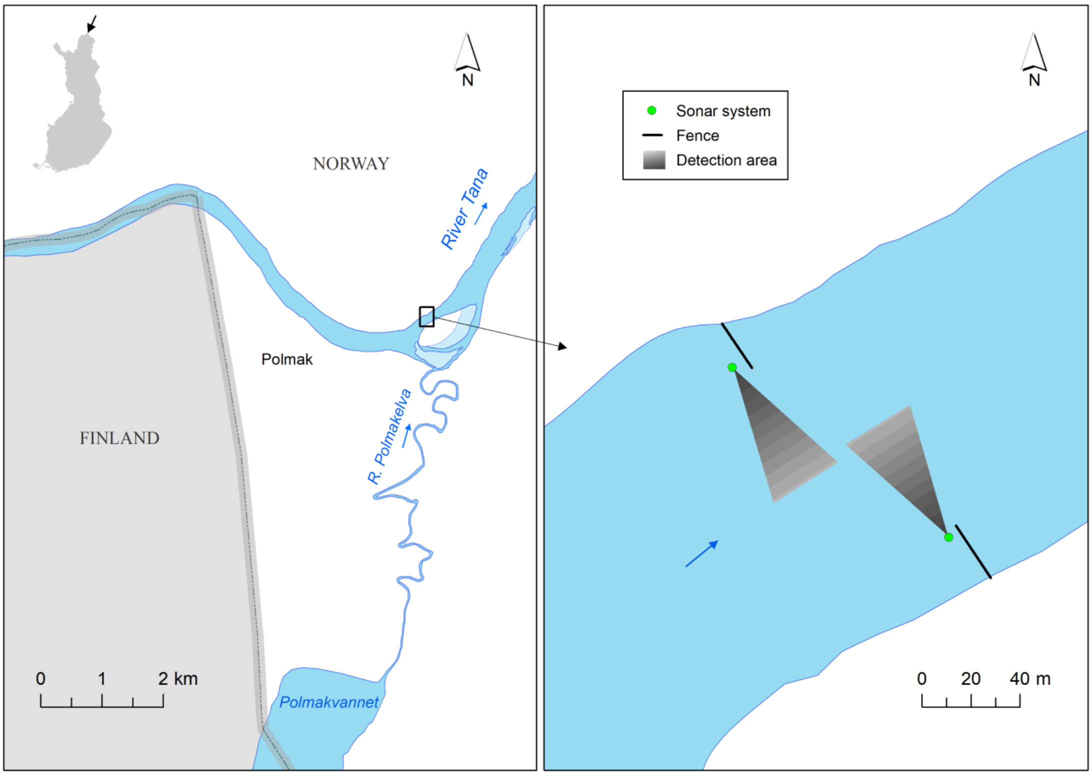


*Figure 6. Schematic map of the Tana/Teno main stem sonar counting site including the locations of the two sonar units and guiding fences in 2018-2022.*

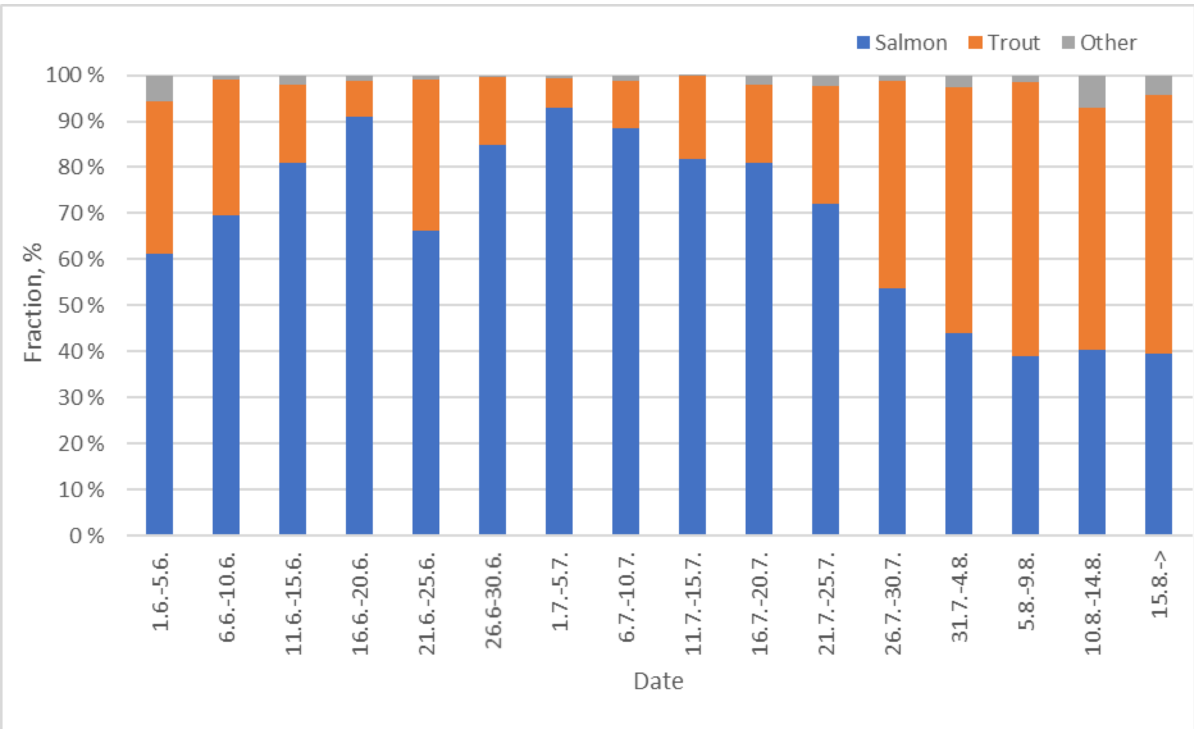


*Figure 7. Percentage (%) distribution of catches of different fish species (excluding pink salmon) in the Tana Bru-national border area in 2017-2020 divided to 5-day intervals. Salmon catches include only fish that are classified to <3 kg weight class.*

The estimate of the grilse run (50-65 cm salmon) was c. 9 500 fish in 2022. The estimates of 2SW (65-90 cm) and MSW (≥90 cm) salmon were 8 750 and 1 700 fish, respectively (Table 1). Altogether the salmon run estimate at Polmak was *c*. 20 000 fish (Figure 8, 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 2018-2022. *= The small salmon (50-65 cm) estimate in 2021 is most probably an overestimate because of the huge pink salmon run. The estimate will be re-evaluated in near future by using Bayesian modelling approaches.*

| | | | 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 % |
| **2022** | 30.5.-31.8. | 19 943 | 9 473 | 8 747 | 1 723 | 48 % | 44 % | 9 % |

The salmon run size at Polmak counting site in 2022 was larger than observed in the poorest year (2020) but clearly less than in 2018 (Table 1). The positive thing was the increase of medium sized salmon (65-90 cm) numbers. On the other hand, the abundance of large salmon (≥90 cm) continued to be very low (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 sonar survey.

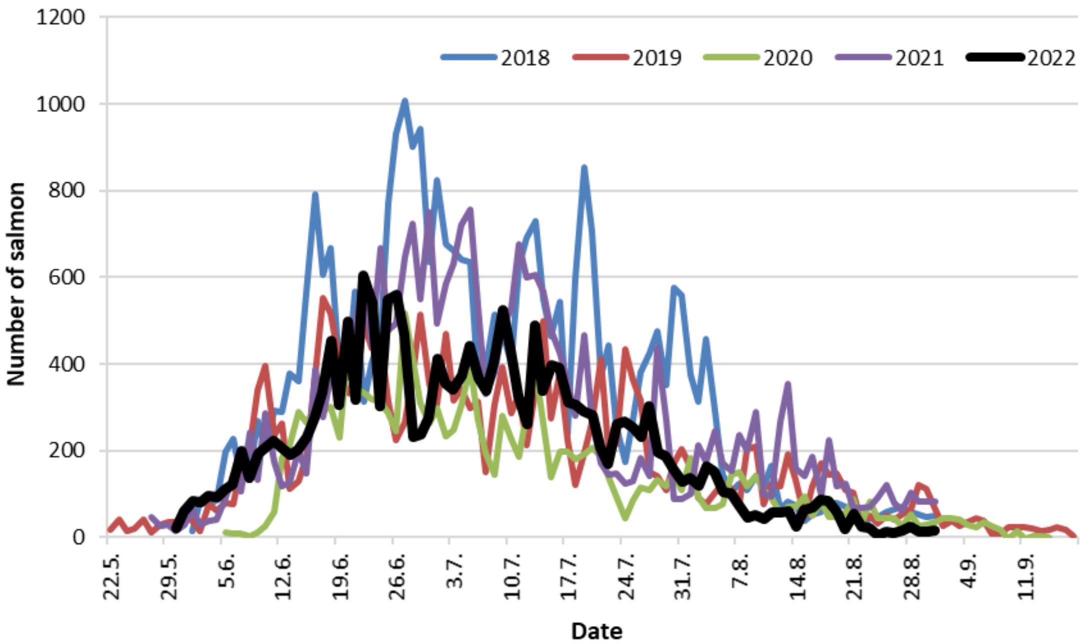


*Figure 8. Estimated daily numbers of ascending salmon (≥50 cm) in the Tana/Teno main stem sonar count at Polmak in 2018 (blue line), 2019 (red line), 2020 (green line), 2021 (purple line) and in 2022 (black line). All size categories are combined. The estimate of the total ascendance through the site in 2018, 2019, 2020, 2021 and 2022 was 32 455, 21 013, 14 656, 26 348 and 19 943 salmon, respectively.*

**Kárášjohka sonar**

In the River Kárášjohka, sonar technology to count ascending salmon has been used in 2010, 2012 and 2017-2022. 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 five years the monitored river width has been c. 30-35 m. During the past three years, species distribution and proportion of salmon of the sonar count have been estimated based on data from four underwater cameras installed within the sonar counting line.

In total c. 2 250 salmon were estimated to pass the sonar counting site in Kárášjohka in 1.6.-14.9.2022 (Figure 9). The salmon run of the first seven days in June was estimated based on the relative percentage of salmon during these days in earlier years. Overall, the run size was very similar to that observed in 2021, and clearly larger than in 2019-2020, but less than in 2018 (Figure 9, Table 2).

The length distribution data of salmon passing the sonar site in 2022 indicated that 58% of salmon were <65 cm fish, 32% were fish between 65 and 90 cm and 10% 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.

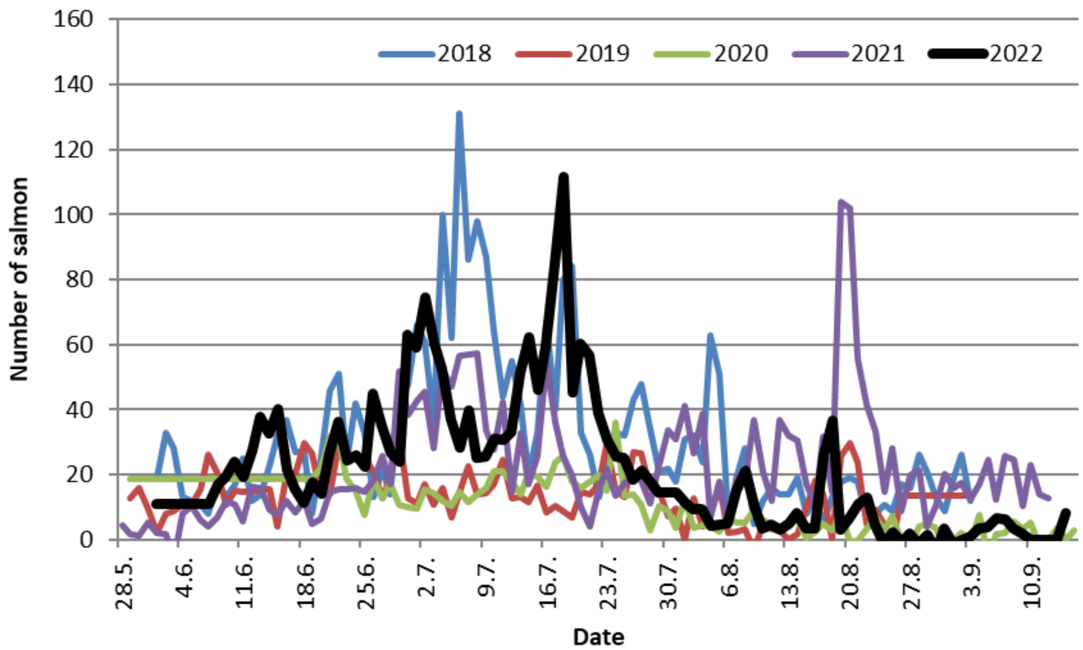


*Figure 9. Estimated daily numbers of ascending salmon (≥45 cm) in the Kárášjohka sonar count in 2018 (blue line), 2019 (red line), 2020 (green line), 2021 (purple line) and in 2022 (black line). All size categories are combined. The estimate of the total ascendance through the site in 2018, 2019, 2020, 2021 and 2022 was 2 962, 1 343, 1 241, 2 423 and 2 261 salmon, respectively.*

*Table 2. Sonar count results of ascending salmon numbers in the River Kárášjohka in 2010, 2012, and 2017-2022 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 |
| **1.6.-14.9.2022** | 1 304 | 957 | 2 261 | Missing time estimated | Aris |

**Iešjohka sonar**

Sonar counting in River Iešjohka was tested with Simsonar sonar in 2019-2020 close to the confluence of rivers Kárášjohka and Iešjohka, *c*. 247 km from the Tana/Teno mouth. Because of the equipment used in 2019-2020 these counts included considerable amount of uncertainty and are of limited value.

In 2022 an Aris sonar unit located at the same site in Iešjohka was used to count numbers of ascending salmon (Figure 10). The counting period was 9.6.-15.9. Guiding fences were used on both shores to narrow the sonar counting area to *c*. 25-30 m (Figure 10). Four underwater video cameras were also installed to the sonar counting line to estimate the species distribution in the 45-65 cm length class fish of the sonar counts. This video material was, however, of limited quality because of problems in deploying the cameras in proper positions in the fast currents of water. Therefore, the species distribution of length class 45-65 cm fish was taken from the nearby Kárášjohka counting and may include some uncertainty.

*Figure 10. Sonar monitoring set-up in the River Iešjohka in 2022. Photo: Sigurd Domaas.*

Overall, the total salmon ascendance of Iešjohka was extremely low, being 1 040 salmon (Figure 11). The length distribution data of salmon passing the sonar site in 2022 indicated that 43% (471 individuals) of salmon were <65 cm fish, 41% (428) were fish between 65 and 90 cm and 14% (141)

were fish ≥90 cm. The length distribution data includes some uncertainty because of a rather long (25-30 m) sonar window used in the survey.

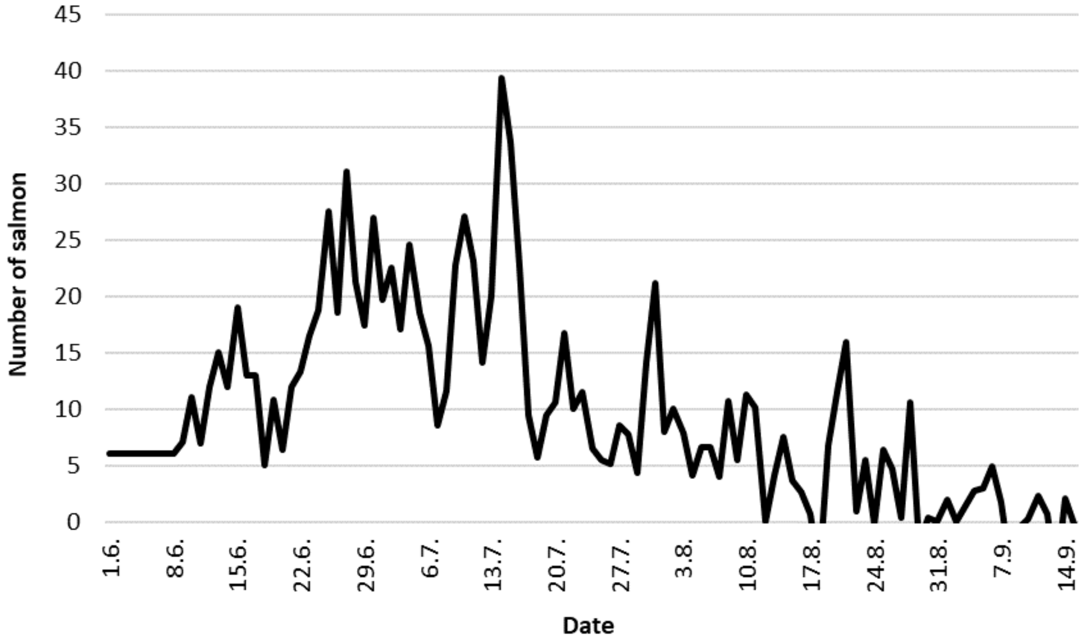


*Figure 11. Estimated daily numbers of ascending salmon (≥45 cm) in the Iešjohka sonar count in 2022. All size categories are combined. Note: salmon numbers in 1.-8.6. were estimated based on the relative numbers found on these dates in the nearby Kárášjohka sonar count.*

**Máskejohka sonar**

Sonar counting in Máskejohka was conducted in 2022 at the same site as in 2020 (see Pedersen 2021), *c*. 10 km upstream from the river mouth. The counting period was 14.6.-7.9. Guiding fences were used on both shores to narrow the sonar counting area to *c*. 10 m (Figure 12). Three underwater video cameras were also installed to the sonar counting line to estimate the species distribution in the 45-65 cm length class fish of the sonar count.

Salmon ascendance to the Máskejohka was very low, only 957 salmon being counted during the monitoring period (Figure 13). This estimate is, however, larger than the estimated salmon run in 2020 (*c*. 530 fish) (Pedersen 2021).

The length distribution data of salmon passing the sonar site in 2022 indicated that 80% (767 individuals) of salmon were <65 cm fish, 18% (173) were fish between 65 and 90 cm and only 2% (18) were fish ≥90 cm.

*Figure 12. Sonar monitoring set-up in the River Máskejohka in 2022. Photo: Karl Øystein Gjelland.*

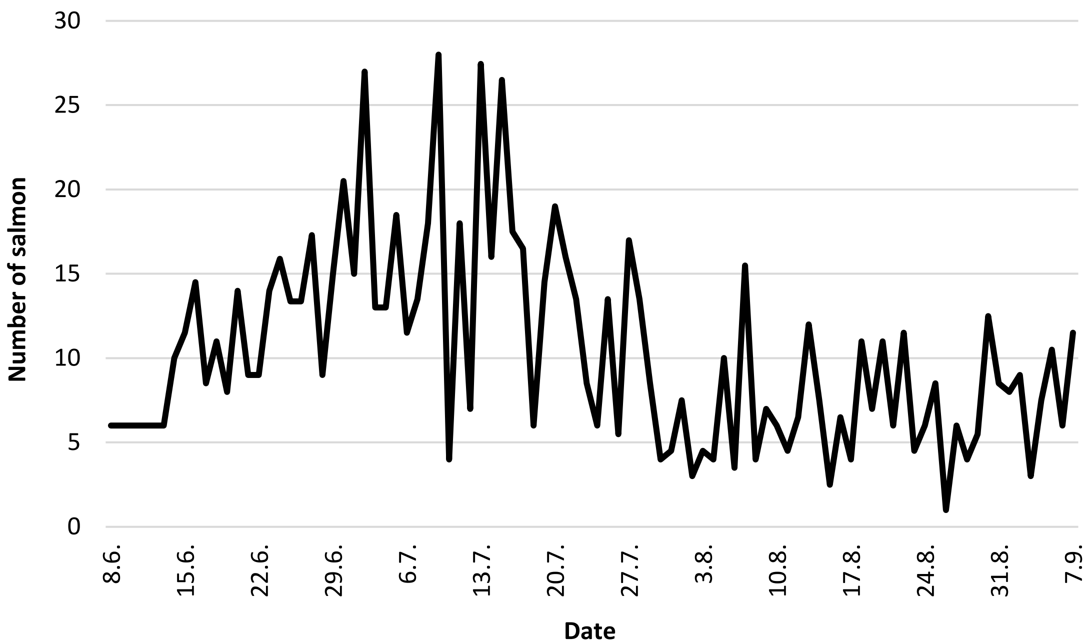


*Figure 13. Estimated daily numbers of ascending salmon (≥45 cm) in the Máskejohka sonar count in 2022. All size categories are combined. Note: salmon numbers in 8.-13.6. were estimated based on the pattern of ascending salmon during the first days of observation.*

## 2.4 Summary of counting results

Adult salmon numbers in different parts of the Tana/Teno system were roughly at the level observed in 2021 and considerably larger than in 2020 (Figure 14). The increase in salmon numbers in 2021-2022 was mostly caused by the salmon 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.

One sea-winter (1SW) salmon abundance was poor in Tana/Teno system for the fourth successive season, indicating continued poor sea conditions and low sea-survival of salmon. Results from other Finnmark rivers indicate that conditions improved to an extent in 2022, with most rivers having increased catches compared to the very low results of 2021. Results in 2022 were, however, still relatively poor compared to the average salmon catches of the preceding decade (2010-2020).

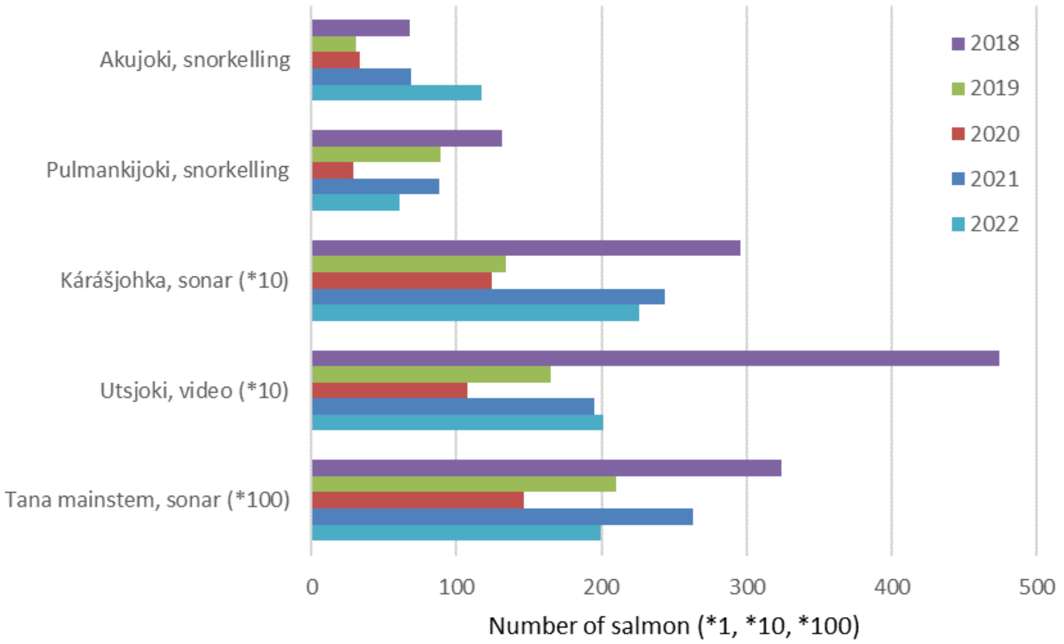


*Figure 14. Counting results (number of adult salmon) in different parts of the Tana/Teno system in 2018-2022. Note: Kárášjohka sonar and Ohcejohka/Utsjoki video counts are divided by a factor of 10 and the Tana/Teno mainstem sonar numbers by a factor of 100.*

# 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, and secondly an evaluation of development in female pre-fishery abundance.

## 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 Spawning stock

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.

In order to obtain a catch estimate of salmon belonging to the Tana/Teno MS stock for the period 2006-2020, we have used the biomass-based proportions of Tana/Teno MS salmon found among stock-identified samples from the Genmix project. Annual proportions were used in 2006-2008 and 2011-2012 while 5-year averages were used for the other years (Table 3).

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 indicated 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 and 2022 closures of the Tana/Teno salmon fisheries meant that we had to base the spawning stock estimate on the Tana/Teno main stem sonar count located at Polmak combined with average values for female proportions and sizes based on stock-identified fish caught above the Polmak counting site in the Genmix project. Average female proportions for salmon <65 cm, 65-90 cm and ≥90 cm, respectively, were 0.08, 0.62 and 0.72. Corresponding average female sizes for the three size groups were 1.86 kg, 5.14 kg and 9.85 kg.

A proportion of the salmon counted at the Polmak sonar site belongs to the Tana/Teno MS stock, and an estimate of this proportion was also calculated from the stock-identified fish caught above the Polmak counting site in the Genmix project. Tana/Teno MS proportions for salmon <65 cm, 65-90 cm and ≥90 cm were 0.27, 0.24 and 0.73, respectively.

The 2021 estimate was based on a count of 18 025 salmon <65 cm, 6 814 salmon between 65-90 cm and 1 684 salmon ≥90 cm. The 2022 estimate was based on a count of 9 473 salmon <65 cm, 8 747 salmon between 65-90 cm and 1 723 salmon >90 cm. A fraction of the Tana/Teno MS stock spawn in areas below the Polmak counting site and these lowermost production areas are therefore not counted in sonar monitoring. 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. With these additions, the total run of Tana/Teno MS salmon in 2021 was estimated at 4 890 salmon <65 cm, 1 605 salmon between 65-90 cm and 1 218 salmon ≥90 cm. The total run of Tana/Teno MS salmon in 2022 was estimated at 2 570 salmon <65 cm, 2 106 salmon between 65-90 cm and 1 265 salmon ≥90 cm.

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.

*Table 3. Summary of stock data used to estimate annual spawning stock sizes of the Tana/Teno MS stock in 2006-2020.*

| Year | Total main stem catch (kg) | Tana/Teno MS proportion | Tana/Teno MS catch (kg) | Exploitation rate | Female proportion |
|---|---|---|---|---|---|
| 2006 | 88 873 | 0.44 | 38 731 | 0.60 | 0.47 |
| 2007 | 88 443 | 0.44 | 39 298 | 0.60 | 0.62 |
| 2008 | 104 659 | 0.58 | 60 907 | 0.60 | 0.63 |
| 2009 | 53 450 | 0.47 | 24 945 | 0.60 | 0.44 |
| 2010 | 75 340 | 0.47 | 35 161 | 0.60 | 0.48 |
| 2011 | 68 256 | 0.49 | 33 457 | 0.60 | 0.52 |
| 2012 | 91 636 | 0.38 | 34 550 | 0.60 | 0.51 |
| 2013 | 68 344 | 0.47 | 31 896 | 0.60 | 0.48 |
| 2014 | 83 312 | 0.47 | 38 881 | 0.60 | 0.45 |
| 2015 | 65 287 | 0.47 | 30 469 | 0.60 | 0.50 |
| 2016 | 72 814 | 0.47 | 33 982 | 0.60 | 0.52 |
| 2017 | 52 880 | 0.47 | 24 679 | 0.45 | 0.58 |
| 2018 | 41 673 | 0.47 | 19 449 | 0.38 | 0.43 |
| 2019 | 33 556 | 0.47 | 15 660 | 0.39 | 0.52 |
| 2020 | 26 799 | 0.47 | 12 507 | 0.35 | 0.56 |

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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 69 % in 2022 and the probability of meeting the spawning target was 0 % (Figure 15). The management target was not reached as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 0 % with an overall attainment of 61 %.

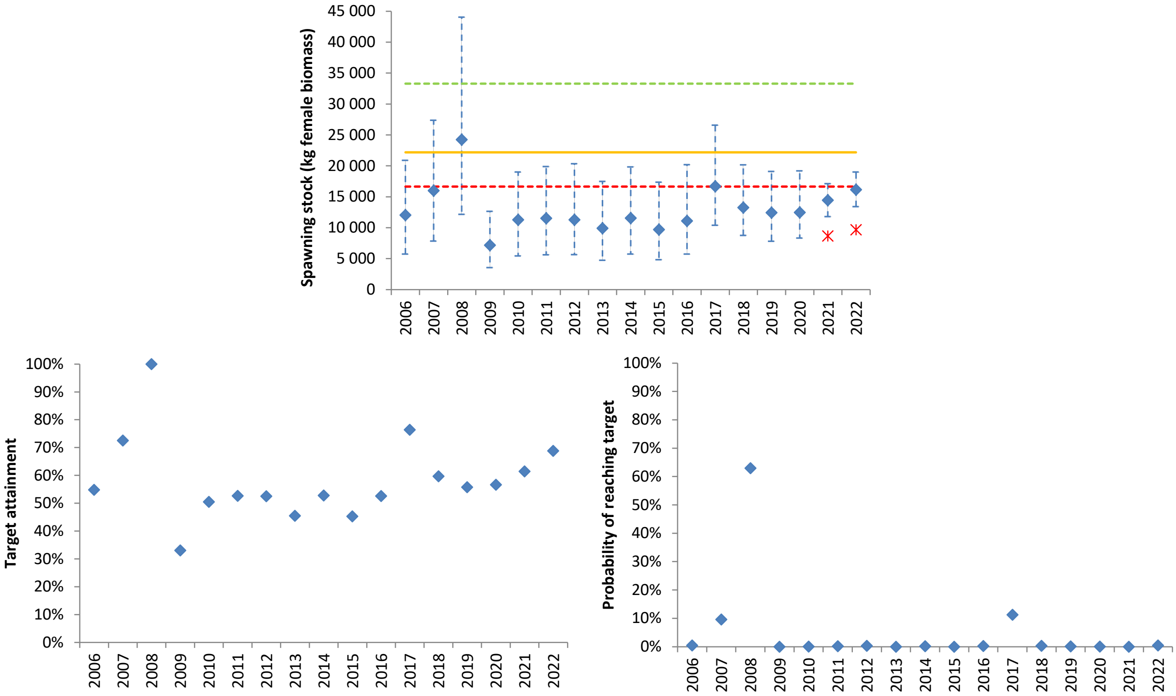


*Figure 15. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2022 for the Tana/Teno MS stock. The red symbol in the upper panel show what the spawning stock size would have been in 2021 and 2022 if fishing had continued.*

### 3.1.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Tana/Teno MS stock has varied from a maximum of 124 621 kg in 2008 down to 30 556 kg in 2022 (Figure 16; Table 4).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Tana/Teno MS stock is 22 189 kg. The female PFA has varied between a maximum of 78 511 kg in 2008 down to a minimum of 15 351 kg in 2021 (Figure 16; Table 4).

Of the years 2006-2022, an exploitable surplus has been missing in 2019-2022. As an exploitable surplus has been missing in all the last four years, the Tana/Teno MS stock is placed in the red status category, meaning that all exploitation should stop and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in recent years is reflected in the estimated sustainable exploitation rate that was estimated at 0 % in 2019-2022 (Table 4). In contrast, as much as 72 % of the female PFA could have been exploited sustainably as recent as 2008.

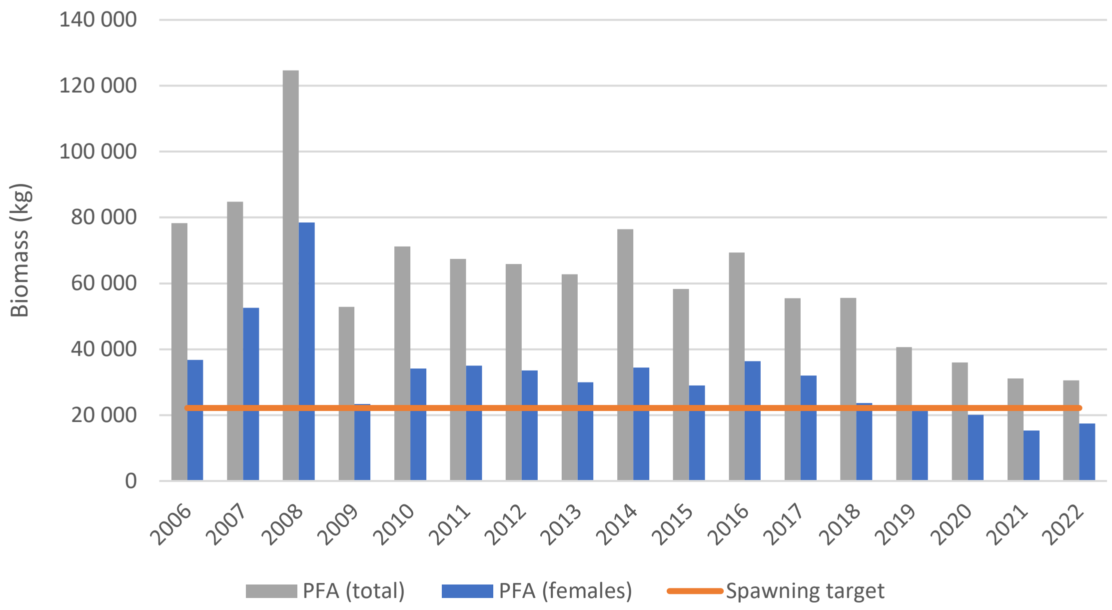


*Figure 16. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 4. Numbers involved in the calculation of pre-fishery abundance (PFA, kg) of salmon belonging to the Tana/Teno MS stock in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 13 936 | 38 731 | - | 12 033 | 0.47 | 78 268 | 36 786 | 0.40 |
| **2007** | 19 682 | 39 298 | - | 15 991 | 0.62 | 84 773 | 52 559 | 0.58 |
| **2008** | 25 256 | 60 907 | - | 24 229 | 0.63 | 124 621 | 78 511 | 0.72 |
| **2009** | 11 739 | 24 945 | - | 7 175 | 0.44 | 52 859 | 23 447 | 0.05 |
| **2010** | 12 585 | 35 161 | - | 11 284 | 0.48 | 71 243 | 34 214 | 0.35 |
| **2011** | 11 861 | 33 457 | - | 11 510 | 0.52 | 67 453 | 35 075 | 0.37 |
| **2012** | 9 188 | 34 550 | - | 11 280 | 0.51 | 65 856 | 33 586 | 0.34 |
| **2013** | 10 166 | 31 896 | - | 9 919 | 0.48 | 62 799 | 30 038 | 0.26 |
| **2014** | 11 930 | 38 881 | - | 11 551 | 0.45 | 76 482 | 34 415 | 0.36 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **2015** | 8 296 | 30 469 | - | 9 712 | 0.50 | 58 273 | 29 012 | 0.24 |
| **2016** | 14 233 | 33 982 | - | 11 107 | 0.52 | 69 376 | 36 414 | 0.39 |
| **2017** | 9 900 | 16 684 | - | 16 692 | 0.58 | 55 465 | 32 055 | 0.31 |
| **2018** | 10 751 | 13 741 | - | 13 253 | 0.43 | 55 623 | 23 679 | 0.06 |
| **2019** | 6 678 | 10 201 | - | 12 432 | 0.52 | 40 681 | 21 248 | 0.00 |
| **2020** | 5 259 | 8 455 | - | 12 463 | 0.56 | 36 043 | 20 118 | 0.00 |
| **2021** | 1 858 | 0 | - | 14 437 | 0.49 | 31 184 | 15 351 | 0.00 |
| **2022** | 2 327 | 0 | - | 16 135 | 0.57 | 30 556 | 17 465 | 0.00 |

## 3.2 Máskejohka

Máskejohka is the lowermost major tributary of the Tana/Teno main stem, situated approximately 28 km upstream from the Tana/Teno estuary. It is a middle-sized river with a total of 55 km available for salmon of which 30 km constitutes the main Máskejohka. The lowermost 10 km of the main river is slow-flowing and meandering with very little production areas available for salmon, but there are extensive areas available both for spawning and juvenile production further upstream. The rest of the Máskejohka-system consists of the tributaries Geasis (7 km), Uvjalátnjá (7 km) and Ciikojohka (11 km). In these smaller tributaries, salmon distribution is limited upwards by waterfalls. The Máskejohka salmon stock has a mixture of sea-age groups, mostly 1-3SW and a few 4SW.

### 3.2.1 Spawning stock

The spawning target for Máskejohka is 3 155 148 eggs (2 281 583-4 149 588 eggs). The female biomass needed to obtain this egg deposition is 1 521 kg (1 100-2 000 kg) when using a stock-specific fecundity of 2 075 eggs $kg^{-1}$.

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

*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 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.

No fish counting had been done in Máskejohka until 2020, and historical exploitation estimates therefore had to be based on other sources of information. In a comprehensive analysis of 214 historical estimates of exploitation rates from 40 river systems, a pattern was revealed of different exploitation rates among salmon weight classes and among rivers of various size and a table of standardized exploitation estimates were established (Forseth *et al*. 2013). Máskejohka is a medium-sized river, and historically there have been a relatively high number of fishermen and few restrictions in the river. Based on the exploitation rate table in Forseth *et al*. (2013) summarizing national Norwegian exploitation rate patterns, we selected 50 %, 40 % and 30 % as exploitation estimates for the three size-groups of salmon in the years 2006-2012 in previous reports (Table 5).

Decreasing numbers of fishermen lead us to subtract 5 % from the exploitation estimates in 2013 and a further 5 % in 2015. We reduced the exploitation rates by 10 % in 2017 and then 10 % further in 2018-2019 due to the new fishing regulations that were put in place in 2017 and difficult fishing conditions.

In 2020, acoustic (sonar) fish counting provided the first estimate of run size in Máskejohka. Based on the sonar count, an estimated 555 salmon <3 kg (<65 cm), 148 salmon 3-7 kg (65-90 cm) and 62 salmon

>7 kg (≥90 cm) entered the Máskejohka in 2020. Based on a catch of 103 salmon <3 kg, 46 salmon 3-7 kg and 18 salmon >7 kg, estimated exploitation rates in 2020 were 0.19 for salmon <3 kg, 0.31 for salmon 3-7 kg, and 0.29 for salmon >7 kg. Because of difficult monitoring conditions, these estimates are treated as maximum values, and median exploitation rates for the three size categories were set at 0.15, 0.25 and 0.25, respectively.

There was no counting of salmon in 2021. A new sonar count was however conducted in 2022. There are still some unresolved issues with the analyses of this count, but the current estimated run of Máskejohka in 2022 consists of 767 salmon <3 kg (<65 cm), 173 salmon 3-7 kg (65-90 cm), and 18 salmon >7 kg (≥90 cm).

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 1 521 kg as the mode, 1 100 kg as the minimum and 2 000 kg as the maximum value.

*Table 5. Summary of stock data used to estimate annual spawning stock sizes in Máskejohka.*

| 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 | 1 097 | 714 | 102 | 0.50 | 0.40 | 0.30 | 0.14 | 0.73 | 0.39 | 0.0175 |
| 2007 | 427 | 672 | 192 | 0.50 | 0.40 | 0.30 | 0.34 | 0.74 | 0.46 | 0.0346 |
| 2008 | 740 | 889 | 691 | 0.50 | 0.40 | 0.30 | 0.06 | 0.59 | 0.87 | 0.0086 |
| 2009 | 731 | 449 | 307 | 0.50 | 0.40 | 0.30 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2010 | 620 | 1 020 | 330 | 0.50 | 0.40 | 0.30 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2011 | 429 | 608 | 405 | 0.50 | 0.40 | 0.30 | 0.04 | 0.77 | 0.66 | 0.0155 |
| 2012 | 726 | 783 | 260 | 0.50 | 0.40 | 0.30 | 0.11 | 0.86 | 0.60 | 0.0095 |
| 2013 | 388 | 478 | 113 | 0.45 | 0.35 | 0.25 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2014 | 534 | 754 | 208 | 0.45 | 0.35 | 0.25 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2015 | 663 | 488 | 167 | 0.40 | 0.30 | 0.20 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2016 | 485 | 801 | 252 | 0.40 | 0.30 | 0.20 | 0.15 | 0.74 | 0.56 | 0.0169 |
| 2017 | 202 | 705 | 244 | 0.36 | 0.27 | 0.18 | 0.15 | 0.74 | 0.56 | 0.0250 |
| 2018 | 346 | 371 | 139 | 0.33 | 0.25 | 0.16 | 0.15 | 0.74 | 0.56 | 0.0290 |
| 2019 | 201 | 411 | 97 | 0.33 | 0.25 | 0.16 | 0.15 | 0.74 | 0.56 | 0.0210 |
| 2020 | 169 | 218 | 141 | 0.15 | 0.25 | 0.25 | 0.15 | 0.74 | 0.56 | 0.0250 |
| 2021 | - | - | - | - | - | - | - | - | - | - |
| 2022 | - | - | - | - | - | - | 0.15 | 0.74 | 0.56 | - |

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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 36 % in 2022 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 0 % with an overall attainment of 67 % (Figure 17).

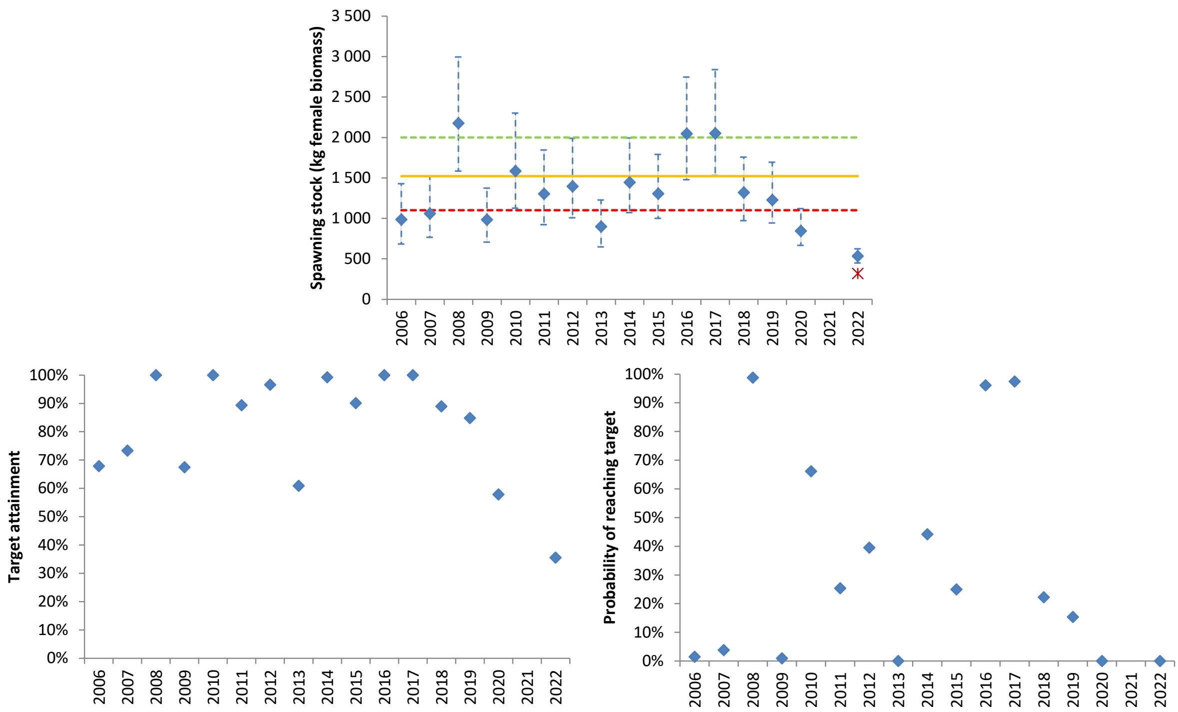


*Figure 17. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2022 for the Máskejohka stock. The red symbol in the upper panel show what the spawning stock size would have been in 2022 if fishing had continued.*

### 3.2.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Máskejohka stock has varied from a maximum of 8 828 kg in 2008 down to 1 828 kg in 2022 (Figure 18; Table 6).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Máskejohka stock is 1 521 kg. The female PFA has varied between a maximum of 4 452 kg in 2008 down to a minimum of 644 kg in 2022 (Figure 18; Table 6).

Of the years 2006-2022, an exploitable surplus were missing in 2022 and nearly missing in 2020 with an exploitable surplus of only 10 %. Given the overall Tana/Teno trend of low PFA also in 2021, it is likely that an exploitable surplus was missing also then. This would mean that an exploitable surplus has been missing in more than one of the last four years and the Máskejohka stock should therefore be placed in the red status category, meaning that all exploitation should stop and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in recent years is reflected in the estimated sustainable exploitation rate that was 0 % in 2022 (Table 6). In contrast, as much as 66 % of the female PFA could have been exploited sustainably as recently as 2008.

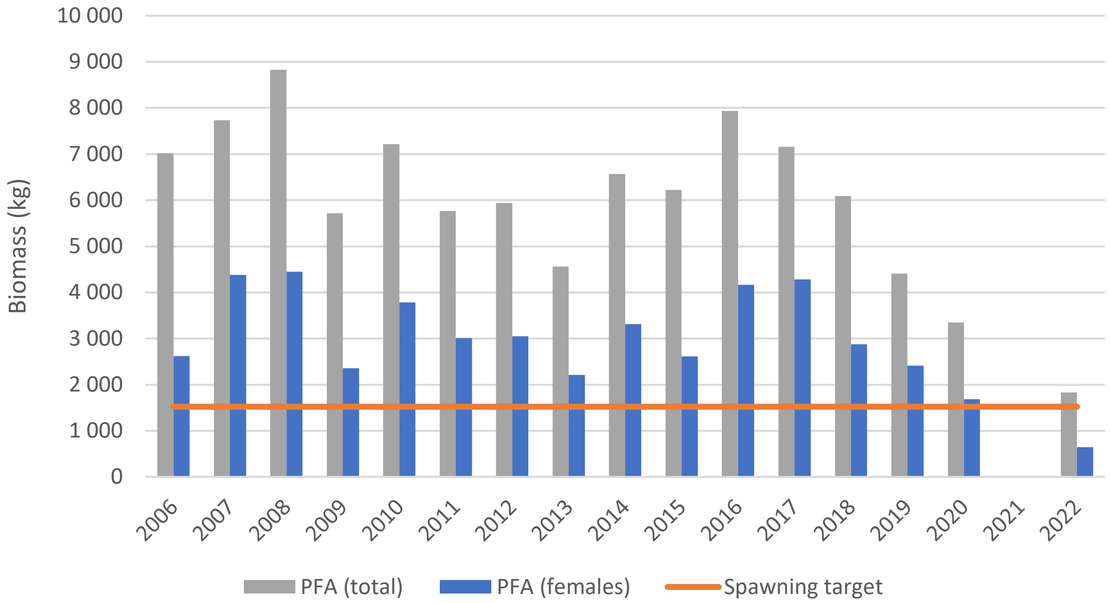


*Figure 18. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Máskejohka stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 6. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Máskejohka stock in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 913 | 1 555 | 1 911 | 985 | 0.37 | 7 017 | 2 621 | 0.42 |
| **2007** | 1 514 | 3 060 | 1 290 | 1059 | 0.57 | 7 734 | 4 378 | 0.65 |
| **2008** | 1 296 | 900 | 2 318 | 2176 | 0.50 | 8 828 | 4 452 | 0.66 |
| **2009** | 945 | 903 | 1 486 | 984 | 0.41 | 5 718 | 2 360 | 0.36 |
| **2010** | 950 | 1 273 | 1 968 | 1585 | 0.52 | 7 215 | 3 782 | 0.60 |
| **2011** | 770 | 1 058 | 1 441 | 1304 | 0.52 | 5 766 | 3 009 | 0.49 |
| **2012** | 589 | 871 | 1 768 | 1395 | 0.51 | 5 940 | 3 053 | 0.50 |
| **2013** | 573 | 1 155 | 978 | 899 | 0.49 | 4 558 | 2 213 | 0.31 |
| **2014** | 800 | 1 408 | 1 495 | 1445 | 0.50 | 6 569 | 3 313 | 0.54 |
| **2015** | 694 | 1 103 | 1 317 | 1307 | 0.42 | 6 222 | 2 616 | 0.42 |
| **2016** | 1 266 | 1 231 | 1 537 | 2047 | 0.52 | 7 936 | 4 162 | 0.63 |
| **2017** | 1 259 | 1 322 | 1 150 | 2051 | 0.60 | 7 159 | 4 283 | 0.64 |
| **2018** | 1 221 | 1 219 | 855 | 1320 | 0.47 | 6 088 | 2 876 | 0.47 |
| **2019** | 754 | 705 | 708 | 1228 | 0.55 | 4 408 | 2 416 | 0.37 |
| **2020** | 471 | 670 | 528 | 845 | 0.50 | 3 348 | 1 684 | 0.10 |
| **2021** | 252 | - | - | - | - | - | - | - |
| **2022** | 315 | 0 | 0 | 533 | 0.35 | 1 828 | 644 | 0.00 |

## 3.3 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 slow-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 in the upper Pulmankijoki. The salmon stock is dominated by 1SW and small 2SW salmon.

### 3.3.1 Spawning stock

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 7. Female proportions in Table 7 are based on the sex distribution observed in the autumn snorkelling counts.

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 7 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.

*Table 7. 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 | - | 0.52 | - |
| 2022 | 0 | 61 | 0.70 | 0.2 | - | 0.47 | - |

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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 51 % in 2022 and the probability of meeting the spawning target was 0 % (Figure 19). The management target was not reached, as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 8 % with an overall attainment of 77 %.

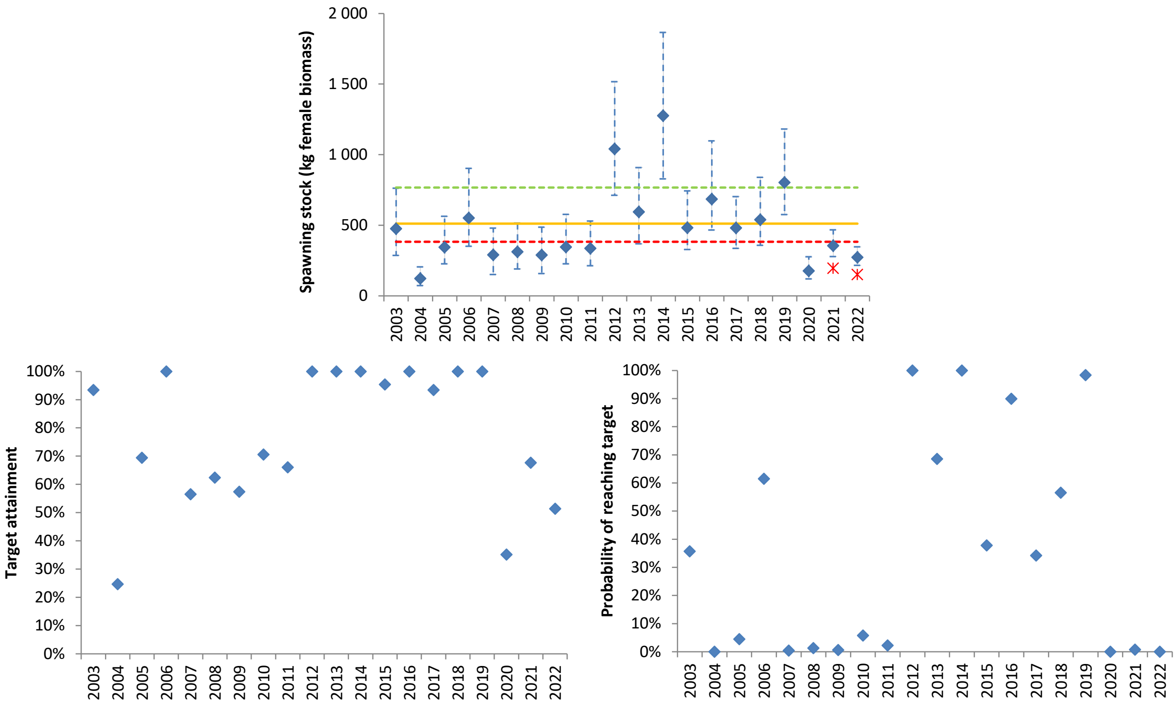


*Figure 19. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2022 in the Norwegian/Finnish tributary Buolbmátjohka/Pulmankijoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 and 2022 if fishing had continued.*

### 3.3.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Buolbmátjohka/Pulmankijoki stock has varied from a maximum of 4 178 kg in 2014 down to 697 kg in 2022 (Figure 20; Table 8).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Buolbmátjohka/Pulmankijoki stock is 511 kg. The female PFA has varied between a maximum of 2 251 kg in 2014 down to a minimum of 325 kg in 2022 (Figure 20; Table 8).

Of the years 2006-2022, an exploitable surplus has been missing in 2020-2022. As an exploitable surplus has been missing in more than two of the last four years, the Buolbmátjohka/Pulmankijoki stock is placed in the red status category, meaning that no exploitation should take place and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in recent years is reflected in the estimated sustainable exploitation rate that was estimated at 0 % in 2020-2022 (Table 8). In contrast, as much as 77 % of the female PFA could have been exploited sustainably as recent as 2014.

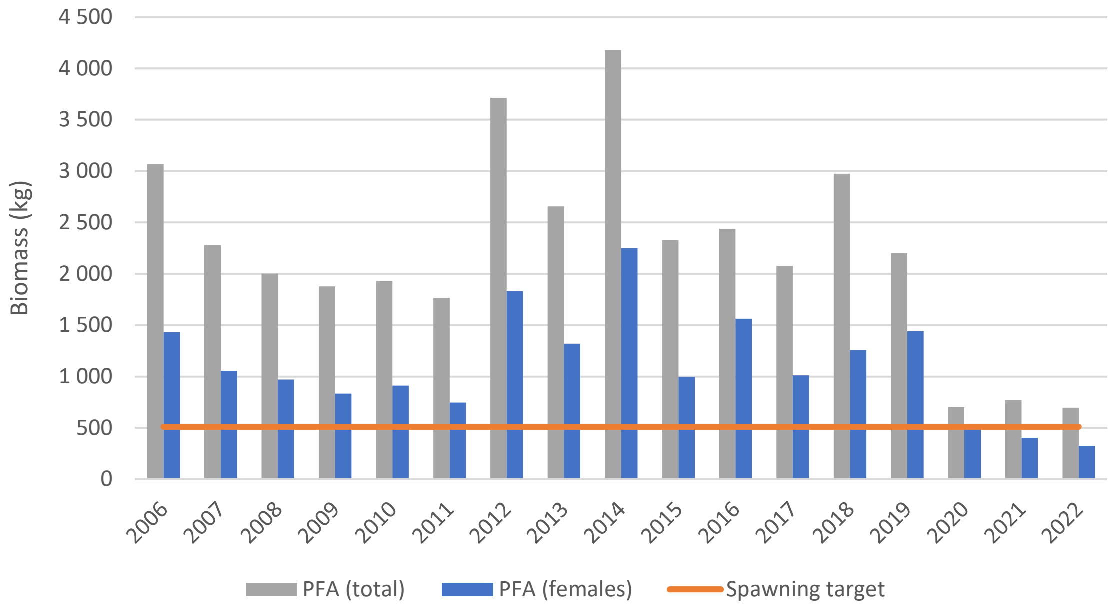


*Figure 20. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 8. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 325 | 551 | 1 009 | 552 | 0.47 | 3 069 | 1 432 | 0.64 |
| **2007** | 305 | 557 | 804 | 284 | 0.46 | 2 279 | 1 056 | 0.52 |
| **2008** | 237 | 471 | 649 | 312 | 0.48 | 2 002 | 971 | 0.47 |
| **2009** | 223 | 257 | 744 | 290 | 0.44 | 1 876 | 834 | 0.39 |
| **2010** | 211 | 362 | 590 | 362 | 0.47 | 1 927 | 911 | 0.44 |
| **2011** | 179 | 184 | 609 | 335 | 0.42 | 1 765 | 746 | 0.32 |
| **2012** | 346 | 376 | 934 | 1 014 | 0.49 | 3 715 | 1 830 | 0.72 |
| **2013** | 252 | 328 | 889 | 590 | 0.50 | 2 657 | 1 320 | 0.61 |
| **2014** | 430 | 400 | 1 089 | 1 217 | 0.54 | 4 178 | 2 251 | 0.77 |
| **2015** | 205 | 313 | 629 | 505 | 0.43 | 2 325 | 996 | 0.49 |
| **2016** | 319 | 350 | 664 | 708 | 0.64 | 2 439 | 1 561 | 0.67 |
| **2017** | 325 | 423 | 348 | 478 | 0.49 | 2 076 | 1 012 | 0.50 |
| **2018** | 435 | 378 | 853 | 553 | 0.42 | 2 976 | 1 256 | 0.59 |
| **2019** | 317 | 235 | 435 | 795 | 0.66 | 2 200 | 1 442 | 0.65 |
| **2020** | 89 | 214 | 148 | 182 | 0.72 | 703 | 506 | 0.00 |
| **2021** | 95 | 0 | 0 | 354 | 0.52 | 771 | 404 | 0.00 |
| **2022** | 119 | 0 | 0 | 270 | 0.47 | 697 | 325 | 0.00 |

## 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 stocks in the Utsjoki main stem.

### 3.4.1 Spawning stock

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. Note that we have now changed the approach used to estimate female proportions. In previous reports, we based the female proportions on Tana main stem catch samples that were stock identified in the Genmix-project. However, there are indications that the main stem fisheries are skewed towards exploitation of large salmon which would lead to an overestimation of the female proportion entering the Utsjoki (the female proportion is affected because a majority of 2- and 3SW salmon are females). We have therefore estimated new historic female proportions based on the size composition found in the video monitoring (1SW vs MSW) and female proportions of these size groups found in the Utsjoki scale data. The same approach was taken to estimate the average sizes that are being used to convert numbers from the video count into biomass.

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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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.*

| Year | Catch (kg) | Video count (1SW) | Video count (MSW) | Average size | Expl. rate | Female proportion | Main stem proportion |
|---|---|---|---|---|---|---|---|
| 2002 | 1 965 | 2 744 | 345 | 1.81 | 0.35 | 0.51 | - |
| 2003 | 1 305 | 2 308 | 274 | 1.80 | 0.28 | 0.51 | - |
| 2004 | 800 | 1 202 | 95 | 1.74 | 0.36 | 0.50 | - |
| 2005 | 1 400 | 2 699 | 47 | 1.62 | 0.31 | 0.48 | - |
| 2006 | 2 375 | 6 555 | 109 | 1.62 | 0.22 | 0.48 | 0.0451 |
| 2007 | 1 945 | 3 251 | 167 | 1.69 | 0.38 | 0.49 | 0.0506 |
| 2008 | 2 605 | 2 061 | 307 | 1.85 | 0.68 | 0.52 | 0.0403 |
| 2009 | 2 095 | 3 712 | 124 | 1.65 | 0.33 | 0.49 | 0.0432 |
| 2010 | 1 305 | 1 932 | 377 | 1.92 | 0.30 | 0.53 | 0.0432 |
| 2011 | 1 625 | 3 349 | 534 | 1.87 | 0.22 | 0.52 | 0.0305 |
| 2012 | 2 605 | 5 029 | 868 | 1.88 | 0.21 | 0.52 | 0.0454 |
| 2013 | 1 695 | 4 765 | 367 | 1.73 | 0.19 | 0.50 | 0.0432 |
| 2014 | 2 955 | 3 659 | 1 319 | 2.12 | 0.28 | 0.55 | 0.0432 |
| 2015 | 2 149 | 3 346 | 602 | 1.89 | 0.29 | 0.52 | 0.0432 |
| 2016 | 2 090 | 2 934 | 836 | 2.03 | 0.27 | 0.54 | 0.0432 |
| 2017 | 1 853 | 1 426 | 852 | 2.34 | 0.25 | 0.58 | 0.0820 |
| 2018 | 1 926 | 3 641 | 1 104 | 2.06 | 0.15 | 0.54 | 0.0710 |
| 2019 | 1 557 | 1 200 | 476 | 2.16 | 0.36 | 0.56 | 0.0930 |
| 2020 | 885 | 549 | 526 | 2.57 | 0.26 | 0.62 | 0.0820 |
| 2021 | - | 1 127 | 825 | 2.44 | - | 0.60 | - |
| 2022 | - | 1 198 | 810 | 2.40 | - | 0.59 | - |

The spawning target attainment was 134 % in 2022 and the probability of meeting the spawning target was 97 %. The management target was not reached as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 42 % with an overall attainment of 98 % (Figure 21).

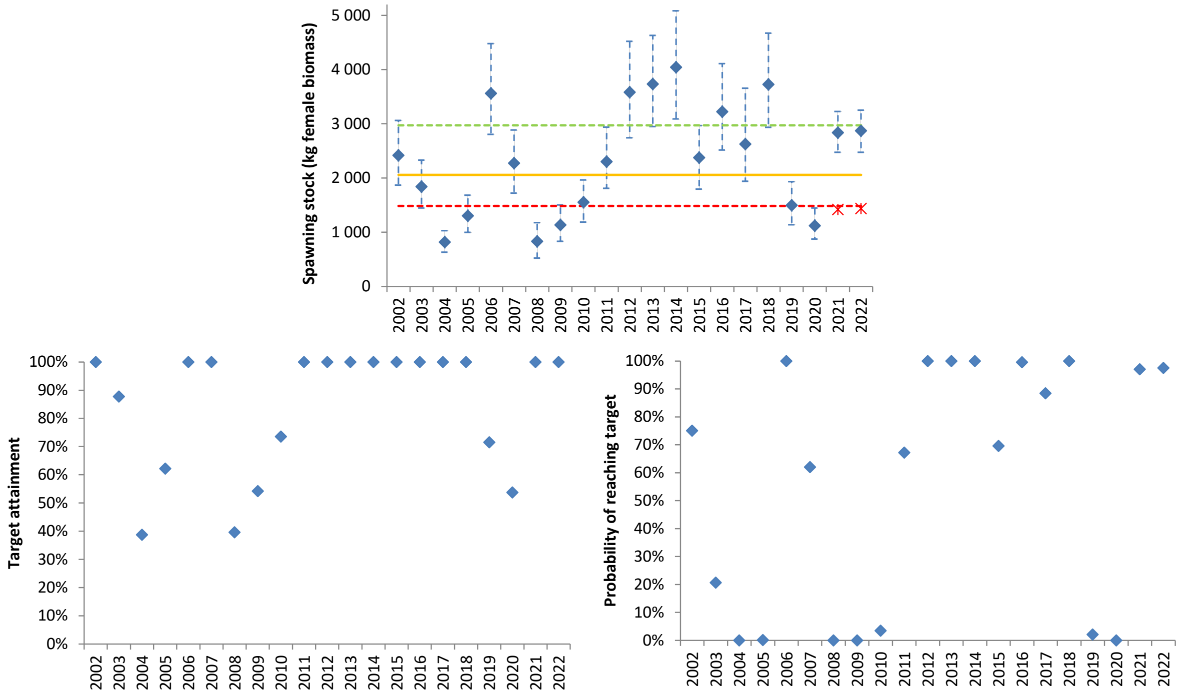


*Figure 21. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2002-2022 in the Finnish tributary Ohcejohka/Utsjoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 and 2022 if fishing had continued.*

### 3.4.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Ohcejohka/Utsjoki stock complex has varied from a maximum of 16 372 kg in 2006 down to 5 255 kg in 2021 (Figure 22; Table 10).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Ohcejohka/Utsjoki stock complex is 2 059 kg. The female PFA has varied between a maximum of 8 805 kg in 2014 down to a minimum of 3 143 kg in 2021 (Figure 22; Table 10).

With the management target at 42 %, the Ohcejohka/Utsjoki stock complex has to be put in the yellow status category. All years of the period 2006-2022 have had an exploitable surplus of salmon belonging to the Ohcejohka/Utsjoki stock complex. The estimated sustainable exploitation rate was 34 % in 2021 and 37 % in 2022 (Table 10).

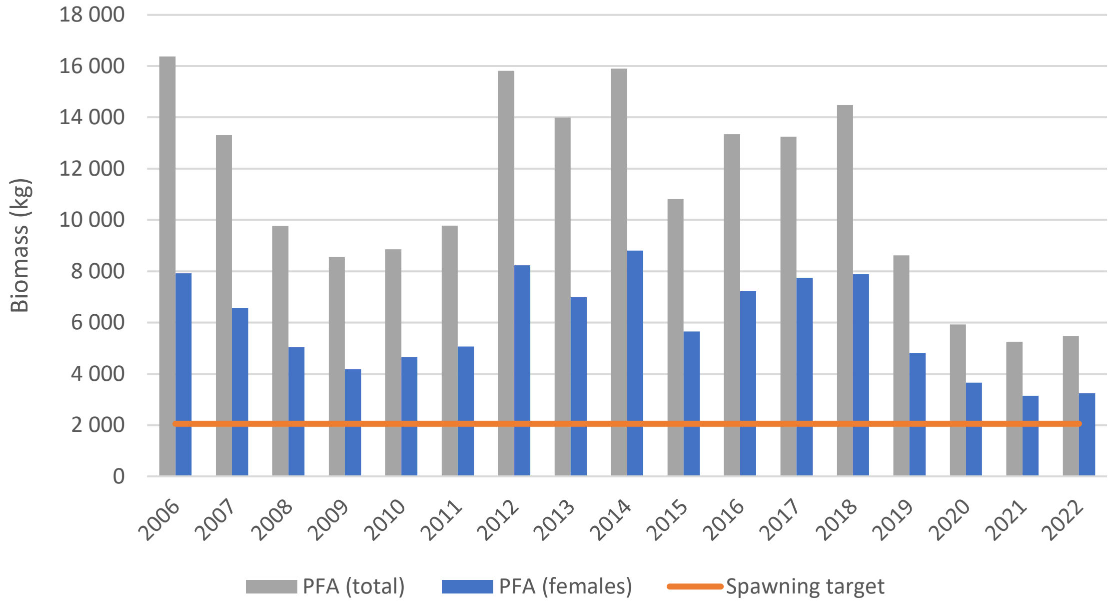


*Figure 22. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock complex in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 10. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock complex in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 2 631 | 4 008 | 2 373 | 3 562 | 0.48 | 16 372 | 7 924 | 0.74 |
| **2007** | 2 283 | 4 475 | 1 943 | 2 272 | 0.49 | 13 310 | 6 563 | 0.69 |
| **2008** | 1 336 | 4 218 | 2 603 | 834 | 0.52 | 9 773 | 5 041 | 0.59 |
| **2009** | 1 826 | 2 309 | 2 093 | 1 135 | 0.49 | 8 552 | 4 177 | 0.51 |
| **2010** | 1 342 | 3 255 | 1 304 | 1 552 | 0.53 | 8 856 | 4 651 | 0.56 |
| **2011** | 1 633 | 2 082 | 1 624 | 2 301 | 0.52 | 9 780 | 5 066 | 0.59 |
| **2012** | 2 172 | 4 160 | 2 603 | 3 583 | 0.52 | 15 815 | 8 235 | 0.75 |
| **2013** | 1 878 | 2 952 | 1 694 | 3 731 | 0.50 | 13 994 | 6 990 | 0.71 |
| **2014** | 2 048 | 3 599 | 2 953 | 4 043 | 0.55 | 15 901 | 8 805 | 0.77 |
| **2015** | 1 297 | 2 820 | 2 147 | 2 376 | 0.52 | 10 815 | 5 648 | 0.64 |
| **2016** | 2 164 | 3 146 | 2 088 | 3 221 | 0.54 | 13 346 | 7 229 | 0.72 |
| **2017** | 2 569 | 4 336 | 1 851 | 2 627 | 0.58 | 13 251 | 7 744 | 0.73 |
| **2018** | 2 738 | 2 983 | 1 922 | 3 724 | 0.54 | 14 481 | 7 888 | 0.74 |
| **2019** | 1 275 | 3 121 | 1 556 | 1 495 | 0.56 | 8 626 | 4 823 | 0.57 |
| **2020** | 1 032 | 2 198 | 884 | 1 120 | 0.62 | 5 931 | 3 658 | 0.44 |
| **2021** | 511 | 0 | 0 | 2 837 | 0.60 | 5 255 | 3 143 | 0.34 |
| **2022** | 640 | 0 | 0 | 2 871 | 0.59 | 5 484 | 3 250 | 0.37 |

## 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 Spawning stock

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 2006-2022, 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 | 0.80 | 0.7 | 0.29 | 0.86 |
| 2021 | 102 | 8 | 1.3 | 3.6 | 0.80 | 0.7 | 0.50 | 0.50 |
| 2022 | 85 | 16 | 1.3 | 3.6 | 0.80 | 0.7 | 0.44 | 0.56 |

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 |
|---|---|---|---|---|
| 2007 | 751 | 0.0085 | 0.45 | 0.78 |
| 2008 | 500 | 0.0048 | 0.45 | 0.63 |
| 2013 | 538 | 0.0079 | 0.45 | 0.58 |
| 2019 | 567 | 0.0160 | 0.35 | 0.58 |

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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 63 % and the probability of meeting the spawning target was 0 % (Figure 23). The management target was not reached as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 4 % with an overall attainment of 71 %.

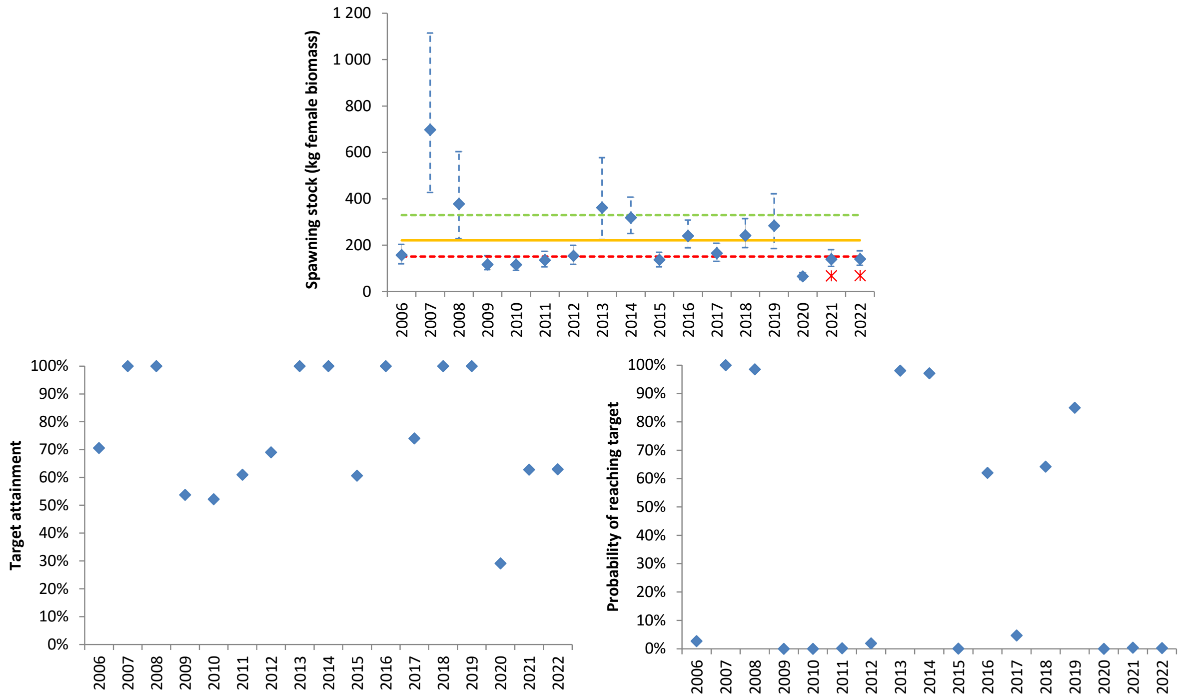


*Figure 23. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2022 in the Finnish tributary Njiljohka/Nilijoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 and 2022 if fishing had continued.*

### 3.5.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Njiljohka/Nilijoki stock has varied from a maximum of 2 117 kg in 2007 down to 344 kg in 2021 (Figure 24; Table 13).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Njiljohka/Nilijoki stock is 221 kg. The female PFA has varied between a maximum of 1 646 kg in 2007 down to a minimum of 171 kg in 2021 (Figure 24; Table 13).

Of the years 2006-2022, an exploitable surplus has been missing in 2021 and 2022. As an exploitable surplus has been missing in two of the last four years, the Njiljohka/Nilijoki stock is placed in the red status category, meaning that no exploitation should take place and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in recent years is reflected in the estimated sustainable exploitation rate that was estimated at 0 % in 2021-2022 (Table 13). In contrast, as much as 87 % of the female PFA could have been exploited sustainably as recently as 2007.

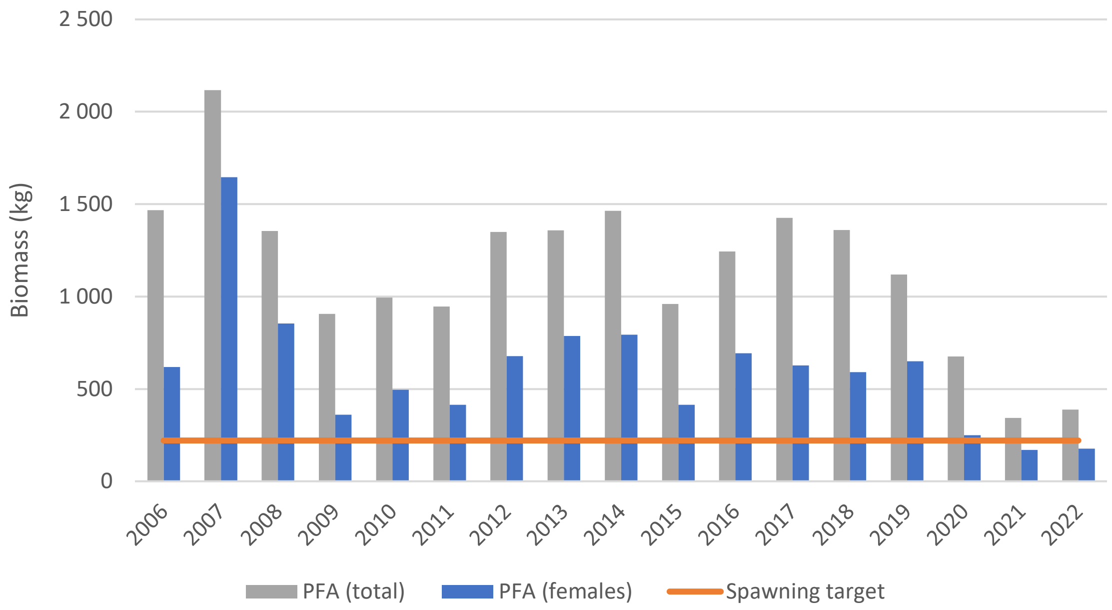


*Figure 24. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 13. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 243 | 853 | 0 | 157 | 0.42 | 1 468 | 619 | 0.64 |
| **2007** | 461 | 752 | 0 | 703 | 0.78 | 2 117 | 1 646 | 0.87 |
| **2008** | 254 | 502 | 0 | 377 | 0.63 | 1 355 | 854 | 0.74 |
| **2009** | 190 | 422 | 0 | 117 | 0.40 | 907 | 361 | 0.39 |
| **2010** | 165 | 595 | 0 | 117 | 0.50 | 994 | 496 | 0.55 |
| **2011** | 157 | 485 | 0 | 134 | 0.44 | 947 | 415 | 0.47 |
| **2012** | 173 | 871 | 0 | 154 | 0.50 | 1 350 | 678 | 0.67 |
| **2013** | 206 | 540 | 0 | 354 | 0.58 | 1 358 | 786 | 0.72 |
| **2014** | 216 | 658 | 0 | 320 | 0.54 | 1 464 | 794 | 0.72 |
| **2015** | 124 | 516 | 0 | 138 | 0.43 | 959 | 414 | 0.47 |
| **2016** | 234 | 575 | 0 | 243 | 0.56 | 1 245 | 693 | 0.68 |
| **2017** | 281 | 767 | 0 | 166 | 0.44 | 1 425 | 627 | 0.65 |
| **2018** | 297 | 508 | 0 | 241 | 0.43 | 1 360 | 591 | 0.63 |
| **2019** | 372 | 268 | 0 | 278 | 0.58 | 1 120 | 649 | 0.66 |
| **2020** | 114 | 389 | 0 | 64 | 0.37 | 676 | 250 | 0.12 |
| **2021** | 65 | 0 | 0 | 139 | 0.50 | 344 | 171 | 0.00 |
| **2022** | 82 | 0 | 0 | 140 | 0.46 | 389 | 177 | 0.00 |

## 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 Spawning stock

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 2003-2022. 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 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 | - |
| 2022 | 100 | 17 | 1.3 | 3.6 | 0.85 | 1 | 0.46 | 0.76 | - |

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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 94 % in 2022 and the probability of meeting the spawning target was 32 %. The management target was not reached, as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 0 % with an overall attainment of 48 % (Figure 25).

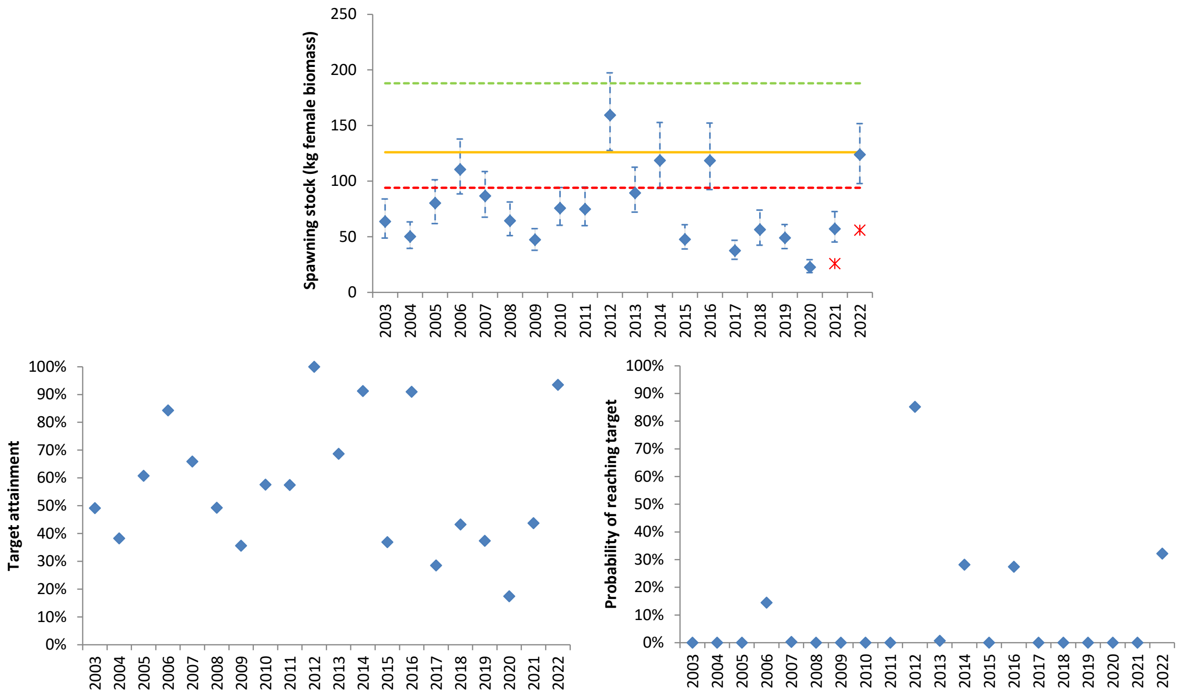


*Figure 25. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2022 in the Finnish tributary Áhkojohka/Akujoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021 and 2022 if fishing had continued.*

### 3.6.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Áhkojohka/Akujoki stock has varied from a maximum of 1 041 kg in 2017 down to 163 kg in 2021 (Figure 26; Table 15).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Áhkojohka/Akujoki stock is 126 kg. The female PFA has varied between a maximum of 653 kg in 2019 down to a minimum of 73 kg in 2021 (Figure 26; Table 15).

Of the years 2006-2022, an exploitable surplus were missing in 2021. As the management target was 0 % but an exploitable surplus were missing in only one of the last four years, the Áhkojohka/Akujoki stock is placed in the orange status category. This means that exploitation should be strictly controlled and a formal stock recovery plan should be implemented. It is worth noting that the target attainment of Áhkojohka/Akujoki varies considerably from year to year. This is reflected in the estimated sustainable exploitation rate that has varied between 0 % (2021) and 81 % (2019) in the last four years (Table 15).

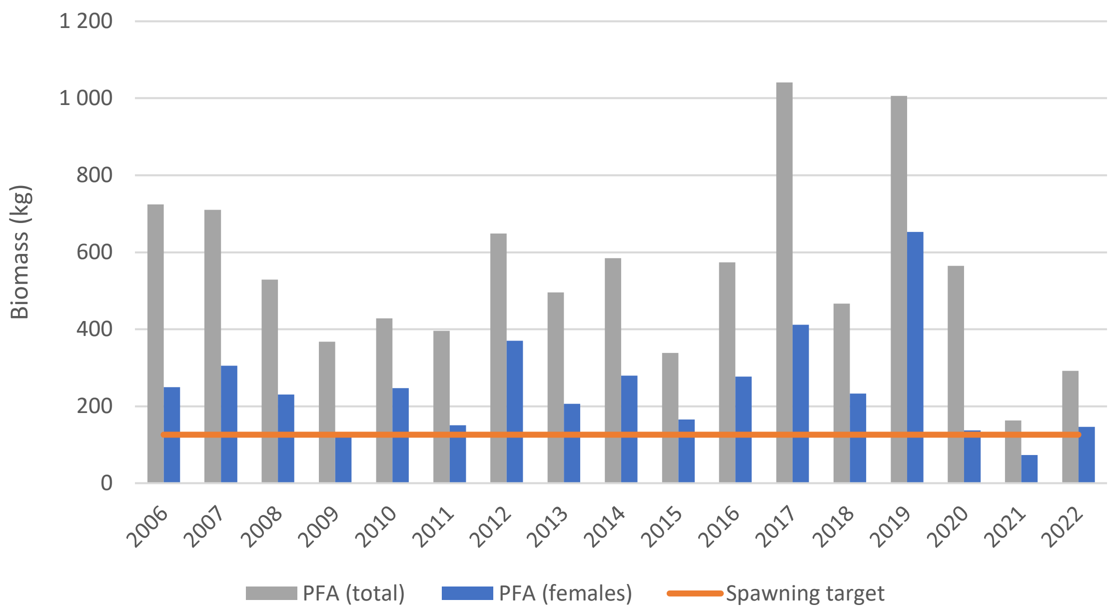


*Figure 26. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation. Note: The Akujoki PFA estimates are highly uncertain because of the problems in estimating genetic proportions of the Akujoki salmon in mixed stock fisheries.*

*Table 15. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in 2006-2022. Note: The Akujoki PFA estimates are highly uncertain because of the problems in estimating genetic proportions of the Akujoki salmon in mixed stock fisheries (coastal catch and Tana main stem catch).*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 121 | 284 | 0 | 110 | 0.34 | 724 | 250 | 0.50 |
| **2007** | 155 | 354 | 0 | 87 | 0.43 | 710 | 305 | 0.59 |
| **2008** | 99 | 283 | 0 | 64 | 0.44 | 529 | 231 | 0.45 |
| **2009** | 77 | 160 | 0 | 47 | 0.36 | 368 | 132 | 0.04 |
| **2010** | 71 | 226 | 0 | 76 | 0.58 | 428 | 247 | 0.49 |
| **2011** | 66 | 137 | 0 | 74 | 0.38 | 396 | 151 | 0.16 |
| **2012** | 83 | 284 | 0 | 160 | 0.57 | 649 | 370 | 0.66 |
| **2013** | 74 | 205 | 0 | 90 | 0.42 | 496 | 206 | 0.39 |
| **2014** | 87 | 250 | 0 | 118 | 0.48 | 585 | 279 | 0.55 |
| **2015** | 44 | 196 | 0 | 48 | 0.49 | 338 | 165 | 0.24 |
| **2016** | 108 | 218 | 0 | 119 | 0.48 | 574 | 277 | 0.55 |
| **2017** | 206 | 740 | 0 | 38 | 0.40 | 1 041 | 412 | 0.69 |
| **2018** | 102 | 252 | 0 | 56 | 0.50 | 467 | 233 | 0.46 |
| **2019** | 193 | 738 | 0 | 49 | 0.65 | 1 006 | 653 | 0.81 |
| **2020** | 95 | 375 | 0 | 23 | 0.24 | 565 | 137 | 0.08 |
| **2021** | 37 | 0 | 0 | 57 | 0.45 | 163 | 73 | 0.00 |
| **2022** | 47 | 0 | 0 | 123 | 0.50 | 292 | 147 | 0.14 |

## 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 Spawning stock

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 countings of fish in 2010, 2012 and 2017-2022 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 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, particularly in 2020 (Table 16). Note that the 2020 exploitation rates were reduced in this report compared to previous assessments as a consequence of revisions to revised localization of parts of the 2020 Kárášjohka catch.

Because the Tana/Teno salmon fisheries were closed in 2021 and in 2022, the spawning stocks in these two years were estimated based solely on the sonar counts 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 | 0.12 | 0.15 | 0.20 | 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 | 0.15 | 0.15 | 0.09 | 0.71 | 0.73 | 0.1001 |
| 2021 | - | - | - | - | - | - | 0.09 | 0.71 | 0.73 | - |
| 2022 | - | - | - | - | - | - | 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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 56 % in 2022 and the probability for meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 0 % with an overall attainment of 50 % (Figure 27). In terms of spawning stock development, it is worth noting an overall positive trend with the target attainment in 2020-2022 being the best throughout the entire 17-year period that have been assessed. This positive development can be traced back to a significant decline in overall exploitation (Table 16), especially with the closed fisheries of 2021-2022.

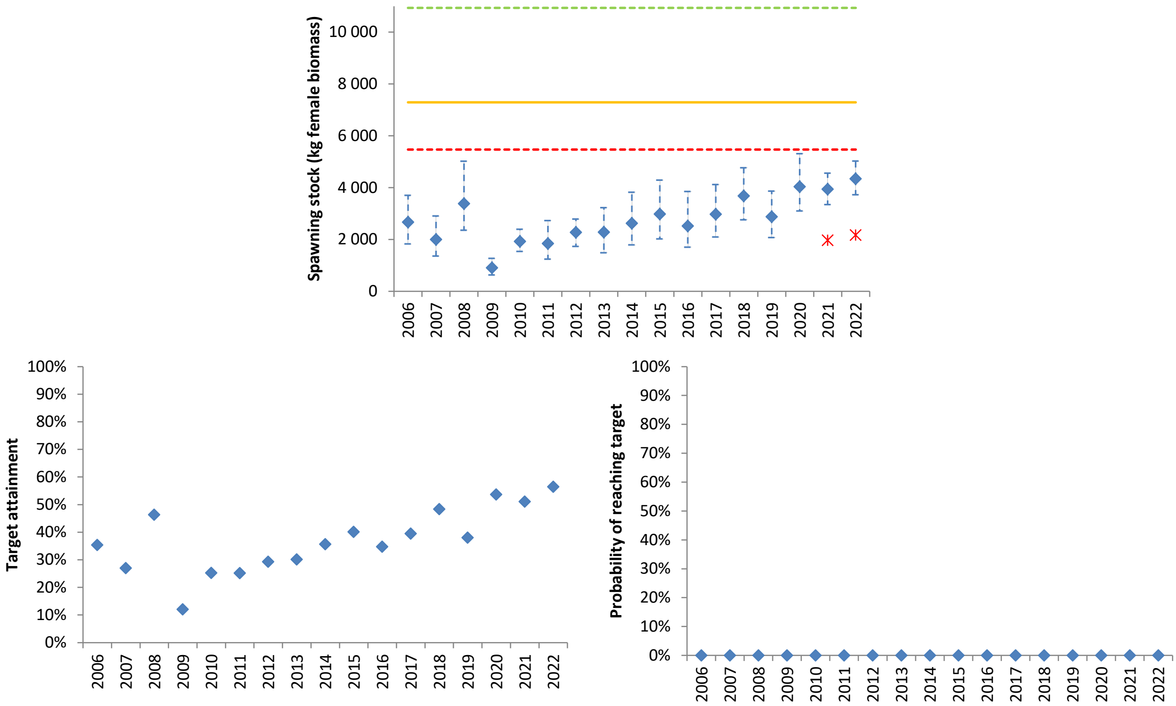


*Figure 27. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2022 in the Norwegian tributary Káráŝjohka. The red symbol in the upper panel show what the spawning stock size would have been in 2021 and 2022 if fishing had continued.*

### 3.7.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Káráŝjohka stock complex has varied from a maximum of 25 818 kg in 2008 down to 9 214 kg in 2022 (Figure 28; Table 17).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Kárášjohka stock complex is 7 290 kg. The female PFA has varied between a maximum of 17 649 kg in 2008 down to a minimum of 4 186 kg in 2021 (Figure 28; Table 17).

Of the years 2006-2022, an exploitable surplus has been missing in three of the latest four years (2019, 2021-2022). As an exploitable surplus has been missing in three out of four years, the Kárášjohka stock complex is placed in the red status category, meaning that no exploitation should take place and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in recent years is reflected in the estimated sustainable exploitation rate that was estimated at 0 % in 2019 and 2021-2022 (Table 17). In contrast, as much as 59 % of the female PFA could have been exploited sustainably as recently as 2008.

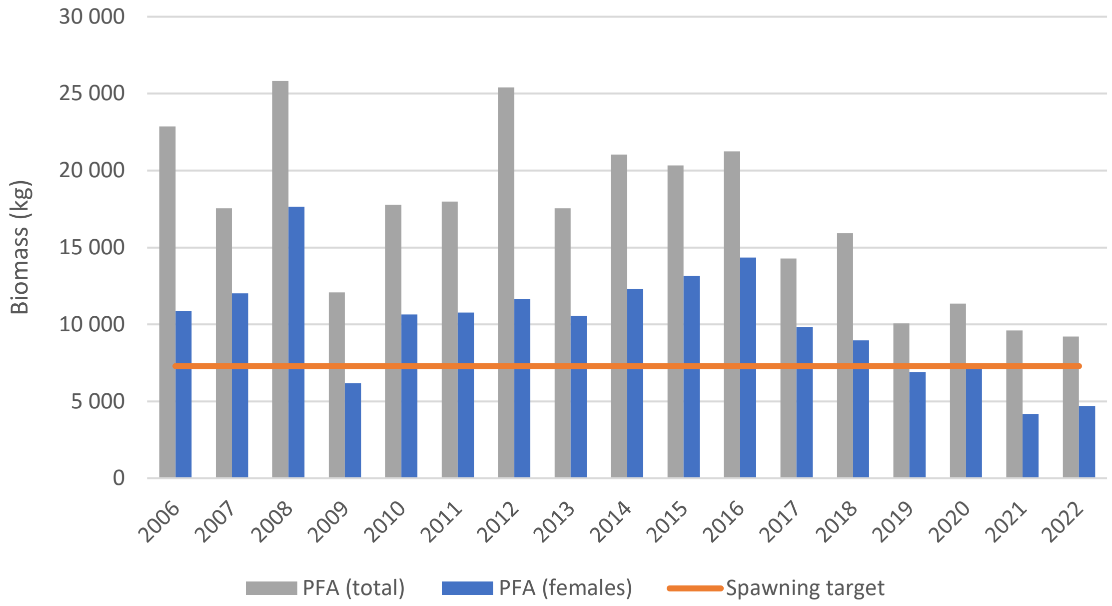


*Figure 28. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock complex in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 17. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock complex in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 3 309 | 9 776 | 4 158 | 2 671 | 0.48 | 22 859 | 10 871 | 0.33 |
| **2007** | 3 572 | 8 747 | 2 312 | 1 998 | 0.68 | 17 551 | 12 009 | 0.39 |
| **2008** | 4 390 | 12 360 | 4 118 | 3 384 | 0.68 | 25 818 | 17 649 | 0.59 |
| **2009** | 2 393 | 6 548 | 1 365 | 907 | 0.51 | 12 077 | 6 184 | 0.00 |
| **2010** | 2 728 | 9 229 | 2 608 | 1 927 | 0.60 | 17 781 | 10 652 | 0.32 |
| **2011** | 2 750 | 9 590 | 2 569 | 1 841 | 0.60 | 17 979 | 10 782 | 0.32 |
| **2012** | 3 001 | 13 525 | 3 910 | 2 272 | 0.46 | 25 395 | 11 635 | 0.37 |
| **2013** | 2 341 | 8 372 | 3 032 | 2 284 | 0.60 | 17 540 | 10 561 | 0.31 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **2014** | 2 773 | 10 206 | 3 569 | 2 627 | 0.58 | 21 040 | 12 304 | 0.41 |
| **2015** | 2 346 | 9 597 | 3 784 | 2 983 | 0.65 | 20 333 | 13 167 | 0.45 |
| **2016** | 3 672 | 10 704 | 3 144 | 2 516 | 0.68 | 21 246 | 14 346 | 0.49 |
| **2017** | 2 569 | 5 293 | 2 115 | 2 970 | 0.69 | 14 291 | 9 839 | 0.26 |
| **2018** | 2 953 | 5 043 | 1 392 | 3 681 | 0.56 | 15 932 | 8 961 | 0.19 |
| **2019** | 1 781 | 2 691 | 1 400 | 2 875 | 0.69 | 10 062 | 6 905 | 0.00 |
| **2020** | 1 388 | 2 683 | 1 103 | 4 040 | 0.65 | 11 351 | 7 424 | 0.02 |
| **2021** | 559 | 0 | 0 | 3 943 | 0.44 | 9 606 | 4 186 | 0.00 |
| **2022** | 700 | 0 | 0 | 4 338 | 0.51 | 9 214 | 4 694 | 0.00 |

## 3.8 Iešjohka

Iešjohka is one of the three large rivers that together form the Tana main stem. Iešjohka flows into the Kárášjohka at Skáidegeahči, and the Kárášjohka then flows close to 40 km before meeting Anárjohka, thereby forming the Tana main stem. The Iešjohka is a relatively fast-flowing river, with riffles and rapids of varying lengths spaced out by large slow flowing pools. The only major obstacle for salmon is a waterfall approximately 75 km upstream. Salmon can pass this waterfall, at least at low water levels.

### 3.8.1 Spawning stock

The Iešjohka spawning target is 11 536 009 eggs (8 127 759-17 304 014 eggs). The female biomass needed to obtain this egg deposition is 6 072 kg (4 278-9 107 kg) when using a stock-specific fecundity of 1 900 eggs $kg^{-1}$.

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

*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 the 5-year average from Genmix.

The run timing and size composition of salmon belonging to Kárášjohka and Iešjohka is very similar, and it is therefore reasonable to expect that salmon from both stocks are subject to the same exploitation in the Tana main stem. Given this assumption, the ratio of salmon entering Iešjohka and salmon entering upper Kárášjohka should equal the ratio of Iešjohka and Kárášjohka salmon in the main stem indicated by the respective main stem genetic proportions. The results of the sonar counting in Kárášjohka are therefore also relevant for Iešjohka and this is valuable in the historic assessments of Iešjohka.

In the years 2006-2008, the relative catch in Iešjohka was significantly higher than the catch in upper Kárášjohka, given the indication from their relative proportions in the Tana main stem fisheries remain. This indicates a higher exploitation rate in Iešjohka than Kárášjohka during these three years (Table 18 vs. Table 16). The estimated main stem proportions and the proportional catch in Iešjohka and Kárášjohka were relatively equal in the years 2009-2016. Exploitation rates in Iešjohka were therefore set equal to the Kárášjohka rates in this period.

In 2017, very few fishermen were active and fishing conditions in Iešjohka were severe, especially during the first half of the fishing season. A comparison of the catches in Iešjohka and Kárášjohka indicated lower efficiency in Iešjohka and the exploitation rates were set 5 percent points lower than the Kárášjohka rates for salmon >3 kg (Table 18).

In 2018, acoustic counting from the neighbouring Kárášjohka indicated continued low exploitation and the exploitation estimate in Iešjohka was set equal to the Kárášjohka rates (Table 18).

The first attempts at counting salmon in Iešjohka were made in 2019 and 2020. There were, however, significant issues both years with the reliability and performance of the counts that make them difficult to use for estimating exploitation rates. In line with the approach taken in earlier years, the 2019 exploitation rates were set equal to the Kárášjohka (Table 18).

The catch statistics in 2020 indicated that large MSW salmon were heavily exploited in Iešjohka. Unfortunately, the sonar counts were not helpful in setting an exploitation level for 2020, due to high water levels, a late starting date and unknown reliability of the sonar in a situation with long sonar window and a less than ideal bottom profile. The Iešjohka catch of salmon >7 kg was, however, almost twice the catch of Kárášjohka. The catches of salmon <7 kg in Iešjohka compared to Kárášjohka were approximately at the same ratio as earlier years. For this reason, exploitation rates of salmon <7 kg were set equal to the Kárášjohka rates. For salmon >7 kg, the relative size of the catches in the two rivers indicated that the Iešjohka exploitation was three times higher than the Kárášjohka (Table 18).

Due to closed fisheries and no counting, Iešjohka was not assessed in 2021.

In 2022, a new attempt was made at counting the run size of Iešjohka, this time with a changed sonar setup using ARIS and a guiding fence setup similar to the one used for Kárášjohka.

*Table 18. Summary of stock data used to estimate annual spawning stock sizes in Iešjohka.*

| 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 | 1 531 | 1 110 | 1 573 | 0.30 | 0.50 | 0.50 | 0.09 | 0.69 | 0.64 | 0.0864 |
| 2007 | 184 | 749 | 1 389 | 0.30 | 0.50 | 0.50 | 0.17 | 0.77 | 0.76 | 0.0777 |
| 2008 | 227 | 933 | 2 943 | 0.30 | 0.50 | 0.50 | 0.18 | 0.50 | 0.73 | 0.0928 |
| 2009 | 329 | 205 | 636 | 0.25 | 0.45 | 0.45 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2010 | 227 | 404 | 782 | 0.25 | 0.45 | 0.45 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2011 | 365 | 456 | 1 149 | 0.25 | 0.45 | 0.45 | 0.02 | 0.61 | 0.66 | 0.1104 |
| 2012 | 505 | 694 | 1 169 | 0.25 | 0.45 | 0.45 | 0.12 | 0.65 | 0.64 | 0.1159 |
| 2013 | 240 | 632 | 1 330 | 0.25 | 0.45 | 0.45 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2014 | 363 | 700 | 1 580 | 0.25 | 0.45 | 0.45 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2015 | 138 | 566 | 1 183 | 0.25 | 0.45 | 0.45 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2016 | 112 | 280 | 1 423 | 0.25 | 0.45 | 0.45 | 0.10 | 0.66 | 0.69 | 0.0963 |
| 2017 | 62 | 204 | 794 | 0.15 | 0.28 | 0.28 | 0.10 | 0.66 | 0.69 | 0.0834 |
| 2018 | 287 | 221 | 394 | 0.12 | 0.15 | 0.2 | 0.10 | 0.66 | 0.69 | 0.1000 |
| 2019 | 34 | 218 | 443 | 0.15 | 0.25 | 0.25 | 0.10 | 0.66 | 0.69 | 0.0668 |
| 2020 | 40 | 102 | 1 305 | 0.15 | 0.15 | 0.45 | 0.10 | 0.66 | 0.69 | 0.0834 |
| 2021 | - | - | - | - | - | - | - | - | - | - |
| 2022 | - | - | - | - | - | - | 0.10 | 0.66 | 0.69 | - |

To account for uncertainty, the exploitation rate and female proportion estimates in Table 18 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 6 072 kg as the mode, 4 278 kg as the minimum and 9 107 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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 36 % in 2022 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 0 % with an overall attainment of 29 % (Figure 29).

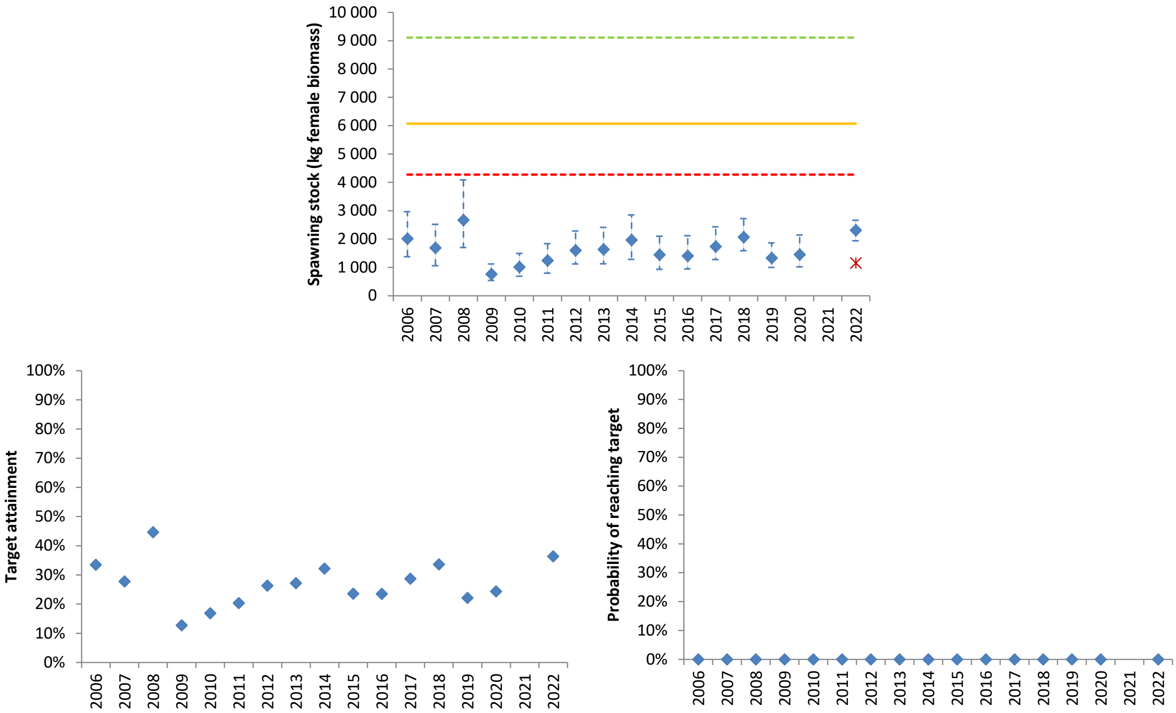


*Figure 29. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2022 in the Norwegian tributary Iešjohka. The red symbol in the upper panel show what the spawning stock size would have been in 2022 if fishing had continued.*

### 3.8.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the Iešjohka stock has varied from a maximum of 21 366 kg in 2008 down to 4 727 kg in 2022 (Figure 30; Table 19).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the Iešjohka stock is 6 072 kg. The female PFA has varied between a maximum of 13 829 kg in 2008 down to a minimum of 2 570 kg in 2022 (Figure 30; Table 19).

Of the years 2006-2022, an exploitable surplus has been missing in all the latest four assessed years (2018-2020 and 2022). As an exploitable surplus has been missing in all the last four years, the Iešjohka stock is placed firmly in the red status category, meaning that no exploitation should take place and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in recent years is reflected in the estimated sustainable exploitation rate that was estimated at 0 % in 2018-2022 (Table 19). In contrast, as much as 56 % of the female PFA could have been exploited sustainably as recently as 2008.

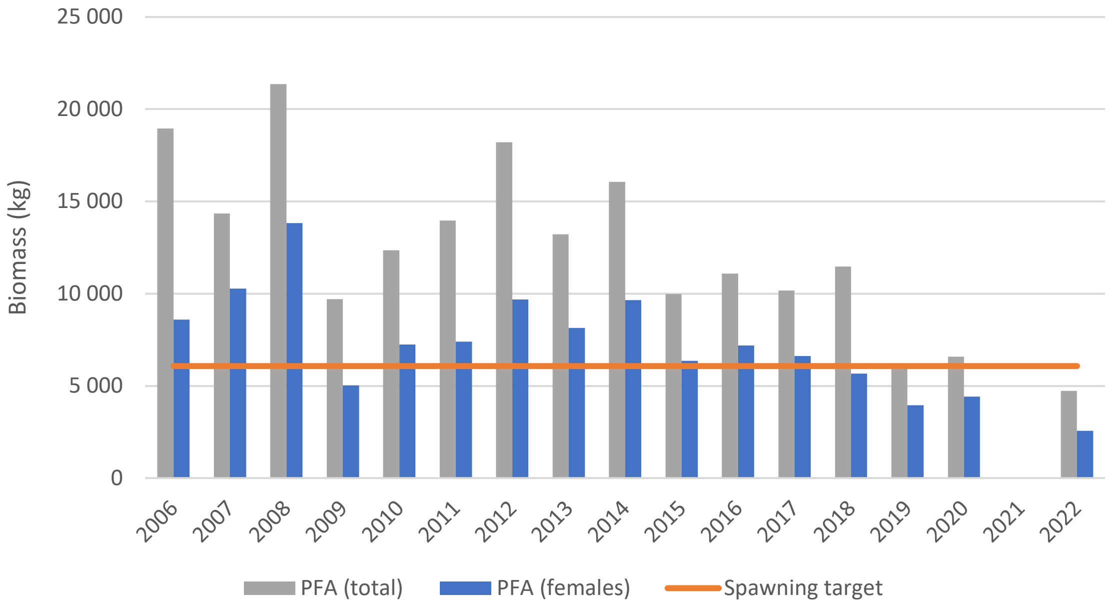


*Figure 30. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Iešjohka stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 19. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Iešjohka stock in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 2 632 | 7 679 | 4 210 | 2 010 | 0.45 | 18 955 | 8 593 | 0.29 |
| **2007** | 2 792 | 6 872 | 2 320 | 1 688 | 0.72 | 14 339 | 10 274 | 0.41 |
| **2008** | 3 429 | 9 712 | 4 100 | 2 670 | 0.65 | 21 366 | 13 829 | 0.56 |
| **2009** | 1 910 | 5 147 | 1 169 | 764 | 0.52 | 9 700 | 5 033 | 0.00 |
| **2010** | 1 965 | 7 255 | 1 412 | 1 012 | 0.59 | 12 356 | 7 248 | 0.16 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **2011** | 2 129 | 7 535 | 1 968 | 1 240 | 0.53 | 13 972 | 7 403 | 0.18 |
| **2012** | 2 203 | 10 621 | 2 366 | 1 602 | 0.53 | 18 201 | 9 684 | 0.37 |
| **2013** | 1 780 | 6 582 | 2 200 | 1 635 | 0.62 | 13 211 | 8 152 | 0.26 |
| **2014** | 2 112 | 8 023 | 2 641 | 1 969 | 0.60 | 16 053 | 9 648 | 0.37 |
| **2015** | 1 139 | 4 688 | 1 885 | 1 447 | 0.64 | 9 981 | 6 366 | 0.05 |
| **2016** | 1 883 | 5 228 | 1 813 | 1 404 | 0.65 | 11 088 | 7 196 | 0.16 |
| **2017** | 2 033 | 4 410 | 1 059 | 1 739 | 0.65 | 10 179 | 6 614 | 0.08 |
| **2018** | 2 186 | 4 202 | 901 | 2 069 | 0.49 | 11 470 | 5 677 | 0.00 |
| **2019** | 1 103 | 2 242 | 681 | 1 333 | 0.65 | 6 070 | 3 956 | 0.00 |
| **2020** | 701 | 2 235 | 1 483 | 1 454 | 0.67 | 6 584 | 4 422 | 0.00 |
| **2021** | - | - | - | - | - | - | - | - |
| **2022** | 481 | 0 | 0 | 2 309 | 0.54 | 4 727 | 2 570 | 0.00 |

## 3.9 Tana/Teno (total)

### 3.9.1 Spawning stock

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 the estimated biomass of females compared to the total biomass in the annual scale data. This approach is a minor change from earlier reports and all female proportions in Table 20 have been adjusted accordingly. The annual exploitation rates used in the 1993-2020 assessments were estimated based on the combined catch distribution estimates provided in previous status reports.

The 2021 and 2022 closures of the Tana/Teno salmon fisheries mean that we have to base the spawning stock estimate on the Tana/Teno main stem sonar count located at Polmak combined with average values for female proportions and sizes based on the 1993-2020 main stem scale data. Average female proportions for salmon <65 cm, 65-90 cm and ≥90 cm, respectively, were 0.18, 0.71 and 0.70. Corresponding average female sizes for the three size groups were 1.65 kg, 4.03 kg and 9.27 kg.

The 2021 estimate was based on a count of 18 025 salmon <65 cm, 6 814 salmon between 65-90 cm and 1 684 salmon ≥90 cm. The 2022 estimate was based on a count of 9 473 salmon <65 cm, 8 747 salmon between 65-90 cm and 1 723 salmon ≥90 cm. 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 lowermost part of the main stem were estimated by multiplying the estimated number of Tana/Teno MS salmon in the Polmak sonar count with the proportion of the total Tana main stem production area that are located in the lowermost part of the main stem. In 2021, salmon from Máskejohka were estimated based on the total Polmak sonar count multiplied with the proportion of total Tana/Teno production area that belong to Máskejohka, while in 2022, numbers from the Máskejohka sonar count were used. Salmon from the Buolbmátjohka/Pulmankijoki were added based on the status assessment of this stock. With these additions, the total Tana/Teno run of salmon in 2021 was estimated at 19 104 salmon <65 cm, 6 955 salmon between 65-90 cm and 1 713 salmon ≥90 cm. The total Tana/Teno run of salmon in 2022 was estimated at 10 539 salmon <65 cm, 9 072 salmon between 65-90 cm and 1 747 salmon ≥90 cm.

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.

*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 | 0.54 |
| 1994 | 131 878 | 0.60 | 0.62 |
| 1995 | 104 631 | 0.60 | 0.52 |
| 1996 | 88 832 | 0.60 | 0.49 |
| 1997 | 92 506 | 0.60 | 0.53 |
| 1998 | 102 627 | 0.60 | 0.49 |
| 1999 | 143 821 | 0.60 | 0.43 |
| 2000 | 209 532 | 0.60 | 0.51 |
| 2001 | 248 585 | 0.60 | 0.59 |
| 2002 | 190 107 | 0.60 | 0.60 |
| 2003 | 153 738 | 0.60 | 0.61 |
| 2004 | 69 994 | 0.60 | 0.60 |
| 2005 | 77 190 | 0.60 | 0.49 |
| 2006 | 108 596 | 0.60 | 0.44 |
| 2007 | 100 542 | 0.60 | 0.64 |
| 2008 | 121 860 | 0.60 | 0.62 |
| 2009 | 63 499 | 0.60 | 0.49 |
| 2010 | 87 058 | 0.60 | 0.56 |
| 2011 | 79 342 | 0.60 | 0.50 |
| 2012 | 108 794 | 0.60 | 0.48 |
| 2013 | 79 883 | 0.60 | 0.56 |
| 2014 | 99 236 | 0.60 | 0.49 |
| 2015 | 78 124 | 0.60 | 0.57 |
| 2016 | 84 744 | 0.60 | 0.57 |
| 2017 | 60 608 | 0.50 | 0.60 |
| 2018 | 49 530 | 0.45 | 0.42 |
| 2019 | 40 006 | 0.50 | 0.62 |
| 2020 | 31 591 | 0.50 | 0.60 |
| 2021 | 0 | 0 | 0.48 |
| 2022 | 0 | 0 | 0.58 |

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 two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then 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 74 % in 2022 and the probability of meeting the spawning target was 2 %. The management target was not reached, as the last 4 years' (2019-2022) overall probability of reaching the spawning target was 0 % with an overall attainment of 56 % (Figure 31).

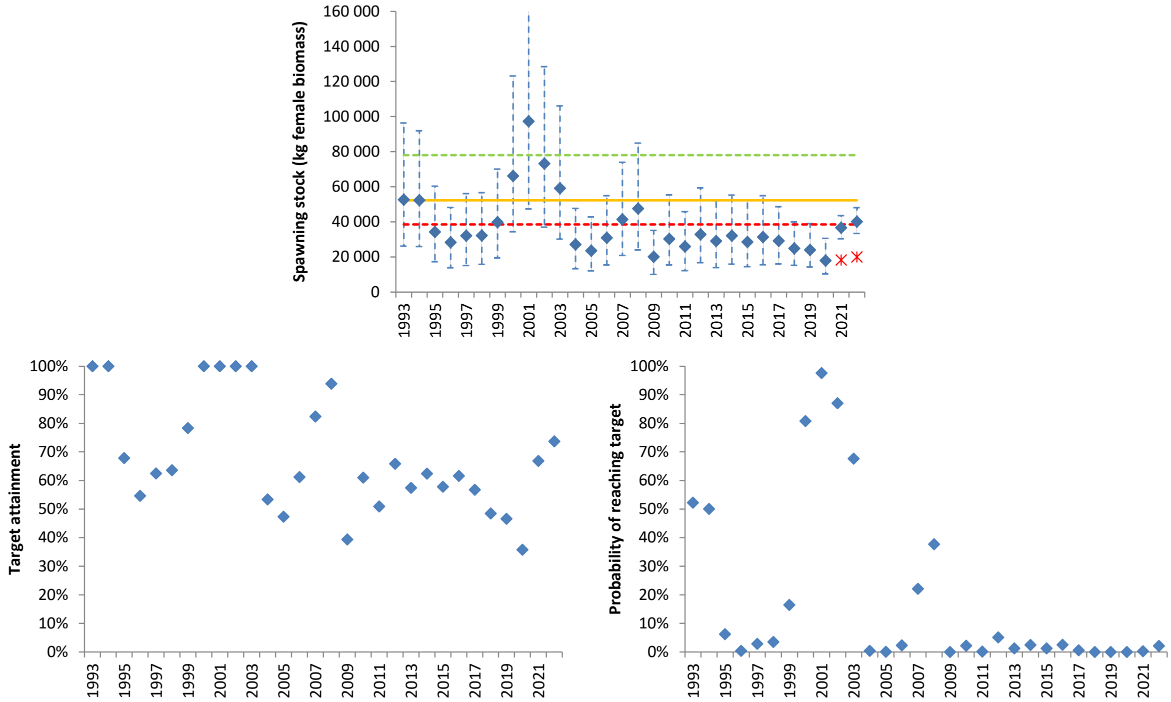


*Figure 31. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 1993-2022 for Tana/Teno (total). The red symbol in the upper panel show what the spawning stock size would have been in 2021 and 2022 if fishing had continued.*

### 3.9.2 Pre-fishery abundance (PFA)

The PFA is calculated by summing the amount of salmon that survive the fishing season and the amount of salmon caught in tributary, main stem, fjord and outer coastal fisheries. The PFA thus represents the size of the annual spawning run before any fishing takes place. The PFA can either be expressed as number of fish or fish biomass (kg). In order to facilitate comparison with the spawning target, we report the PFA as biomass.

The estimated total PFA of salmon belonging to the entire Tana/Teno river system has varied from a maximum of 240 252 kg in 2008 down to 74 371 kg in 2020 (Figure 32; Table 21).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual PFA above the spawning target thus represents the surplus that can be exploited sustainably, and any exploitation below the spawning target would represent overexploitation. The spawning target of the entire Tana/Teno is 52 312 kg. The female PFA has varied between a maximum of 148 746 kg in 2008 down to a minimum of 39 164 kg in 2021 (Figure 32; Table 21).

Of the years 2006-2022, an exploitable surplus has been missing in three of the latest four years (2020-2022). As an exploitable surplus has been missing in all the last three years, Tana/Teno overall is placed in the red status category, meaning that no exploitation should take place and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in recent years is reflected in the estimated sustainable exploitation rate that was estimated at 0 % in 2020-2022 (Table 21). In contrast, as much as 65 % of the female PFA could have been exploited sustainably as recently as 2008.

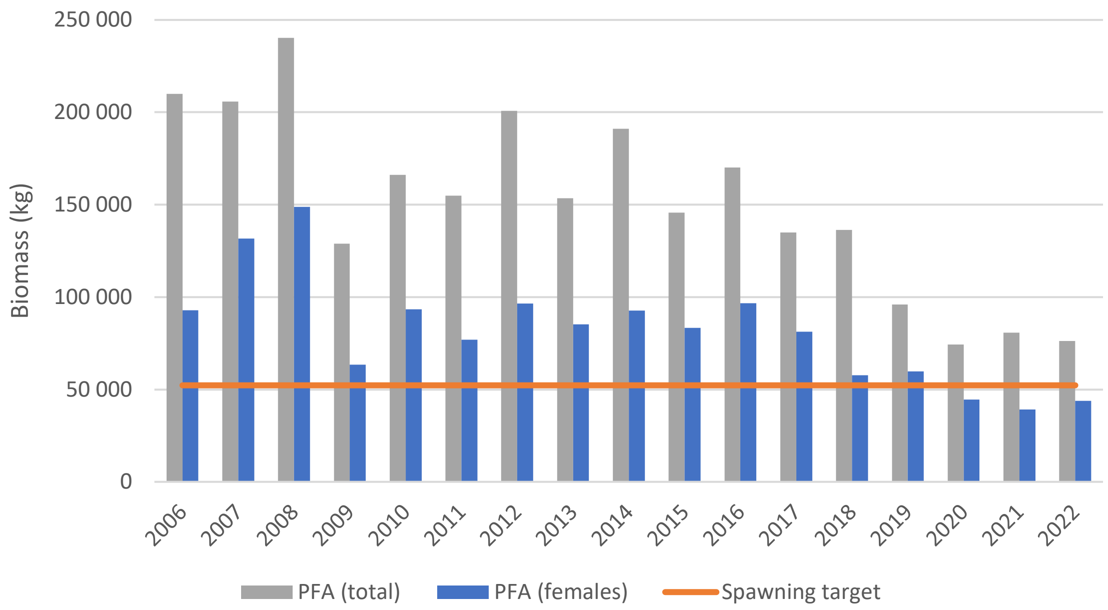


*Figure 32. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system in the period 2006-2022. The horizontal red line is the stock spawning target. Any biomass above the target is the exploitable surplus and any salmon caught below the target will all be overexploitation.*

*Table 21. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system in 2006-2022.*

| Year | Coastal catch (kg) | Main stem catch (kg) | Tributary catch (kg) | Spawning stock (kg) | Female prop. | Total PFA (kg) | Female PFA (kg) | Sustain. expl. rate |
|---|---|---|---|---|---|---|---|---|
| **2006** | 32 322 | 88 269 | 19 354 | 30 938 | 0.44 | 209 887 | 92 841 | 0.44 |
| **2007** | 41 199 | 87 836 | 11 933 | 41 455 | 0.64 | 205 754 | 131 656 | 0.60 |
| **2008** | 42 321 | 104 089 | 16 981 | 47 587 | 0.62 | 240 252 | 148 746 | 0.65 |
| **2009** | 25 074 | 53 193 | 9 826 | 20 057 | 0.49 | 128 834 | 63 426 | 0.18 |
| **2010** | 25 975 | 74 978 | 11 487 | 30 217 | 0.56 | 166 147 | 93 482 | 0.44 |
| **2011** | 23 840 | 68 015 | 10 820 | 25 903 | 0.50 | 154 845 | 76 883 | 0.32 |
| **2012** | 24 230 | 91 301 | 16 845 | 32 865 | 0.48 | 200 679 | 96 557 | 0.46 |
| **2013** | 21 780 | 68 016 | 11 335 | 29 117 | 0.56 | 153 500 | 85 347 | 0.39 |
| **2014** | 26 357 | 82 912 | 15 694 | 32 057 | 0.49 | 191 020 | 92 700 | 0.44 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **2015** | 18 086 | 64 973 | 12 660 | 28 538 | 0.57 | 145 615 | 83 286 | 0.37 |
| **2016** | 30 629 | 72 464 | 11 809 | 31 341 | 0.57 | 170 033 | 96 660 | 0.46 |
| **2017** | 26 671 | 52 193 | 7 629 | 29 156 | 0.60 | 134 929 | 81 219 | 0.36 |
| **2018** | 28 773 | 41 395 | 7 379 | 24 888 | 0.42 | 136 306 | 57 734 | 0.09 |
| **2019** | 18 186 | 33 254 | 5 997 | 23 972 | 0.62 | 95 950 | 59 723 | 0.12 |
| **2020** | 13 122 | 26 451 | 4 864 | 17 953 | 0.60 | 74 371 | 44 604 | 0.00 |
| **2021** | 5 246 | 0 | 0 | 36 621 | 0.48 | 80 774 | 39 164 | 0.00 |
| **2022** | 6 570 | 0 | 0 | 40 087 | 0.58 | 76 277 | 43 866 | 0.00 |

# 4 Conclusions and further insights into the status assessment

Stock status over the last four years (2019-2022) was poor in all the 8 areas that we evaluated (Figure 33). 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 33) should, following NASCO guidelines, automatically trigger the formulation of a recovery plan for the affected stock. All the evaluated areas fall below the 40 % management target threshold that indicates a need for stock recovery.

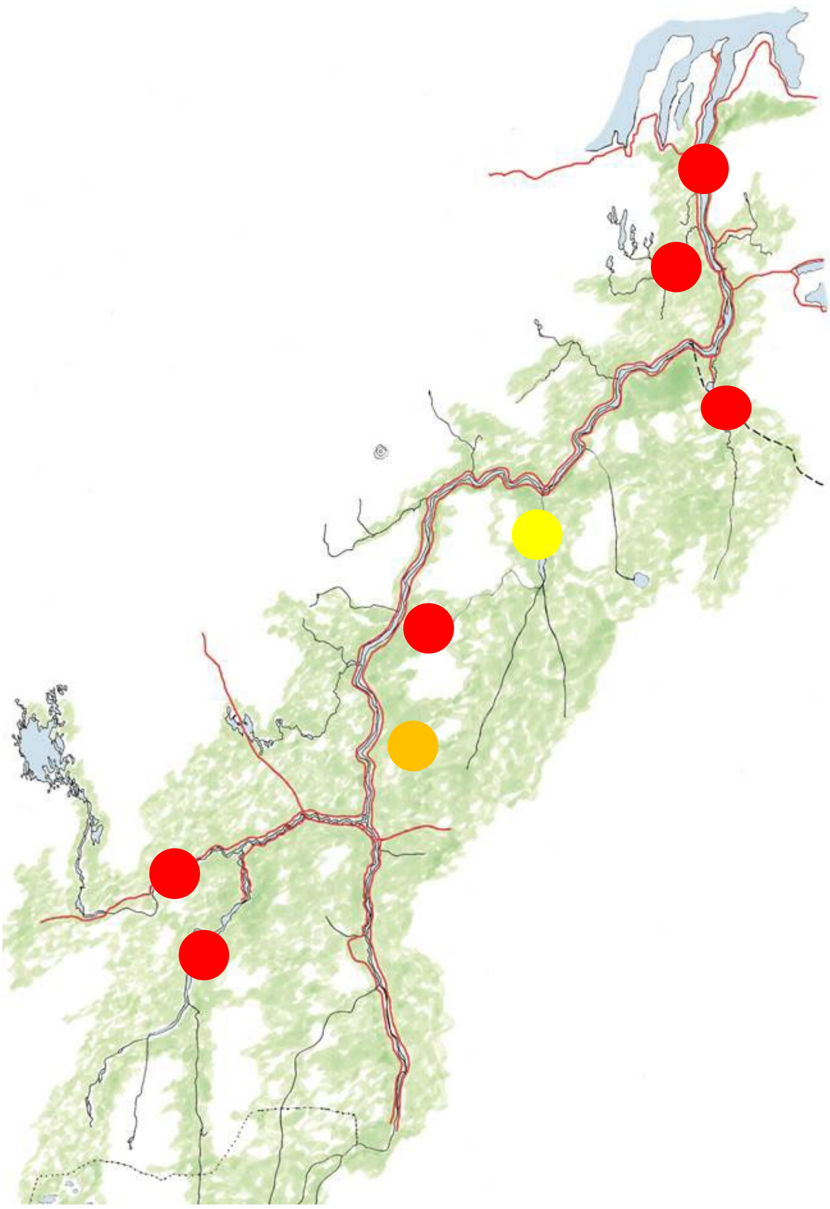

*Figure 33. Map summary of the 2019-2022 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates stock status over the last four years. Possible colours are: Dark green = overall probability of attaining spawning target higher than 75 %, overall target attainment over 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.*

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 not had an exploitable surplus.

The Tana/Teno overall spawning stock (female biomass) increased 41 % from the average of 2013-2020 to the average of 2021-2022 (Table 22). However, when looking at individual areas, some contrasts became evident. The most significant increases in average spawning stocks were the main stem and upper headwaters, increasing between 21 to 42 %. In contrast, lower tributaries such as Máskejohka and Buolbmátjohka/Pulmankijoki saw decreases of 50-62 %. This is likely a reflection of historic exploitation effects. The main stem and upper headwaters were the ones experiencing the highest accumulated exploitation rates, and these areas therefore saw the most female salmon saved through the stop in fisheries in 2021 and 2022. The changes in female PFA from 2013-2020 to 2021-2022 are grim, with decreases varying from 42 to 78 % (Table 22).

*Table 22. Changes in spawning stock (female biomass, kg) and female pre-fishery abundance (PFA, kg) from the average of 2013-2020 to 2021-2022 in various areas of Tana/Teno evaluated in this and last years report.*

| Area | Change in spawning stock from 2013-2020 to 2021-2022 | Change in female PFA from 2013-2020 to 2021-2022 |
|---|---|---|
| **Tana/Teno MS** | 26 % | -42 % |
| **Máskejohka** | -62 % | -78 % |
| **Buolbmátjohka/Pulmankijoki** | -50 % | -72 % |
| **Veahčajohka/Vetsijoki** | 15 % | -59 % |
| **Ohcejohka/Utsjoki** | 2 % | -52 % |
| **Njiljohka/Nilijoki** | -38 % | -71 % |
| **Áhkojohka/Akujoki** | 33 % | -63 % |
| **Kárášjohka** | 38 % | -57 % |
| **Iešjohka** | 42 % | -60 % |
| **Anárjohka/Inarijoki** | 21 % | -74 % |
| **Tana/Teno (total)** | 41 % | -45 % |

To conclude, the situation for different salmon stocks of the Tana/Teno system in 2022 show a continued overall negative status with rather low spawning stocks and extremely low PFA estimates and no exploitable surplus. The numbers of large MSW salmon were particularly low, in line with what was predicted for 2022. Overall low returns of grilse continued, and it is therefore expected that the return of MSW salmon will continue to be low in 2023 and that there likely will not be any sustainable surplus available.

The majority of the evaluated areas were placed in the red status category in 2022. This is a critical situation, and consequently, according to the procedure for setting stock-specific exploitation rates in the context of different status categories (summarized in Figure 3 of Anon. 2022), no exploitation should take place until the status categories increase to orange.

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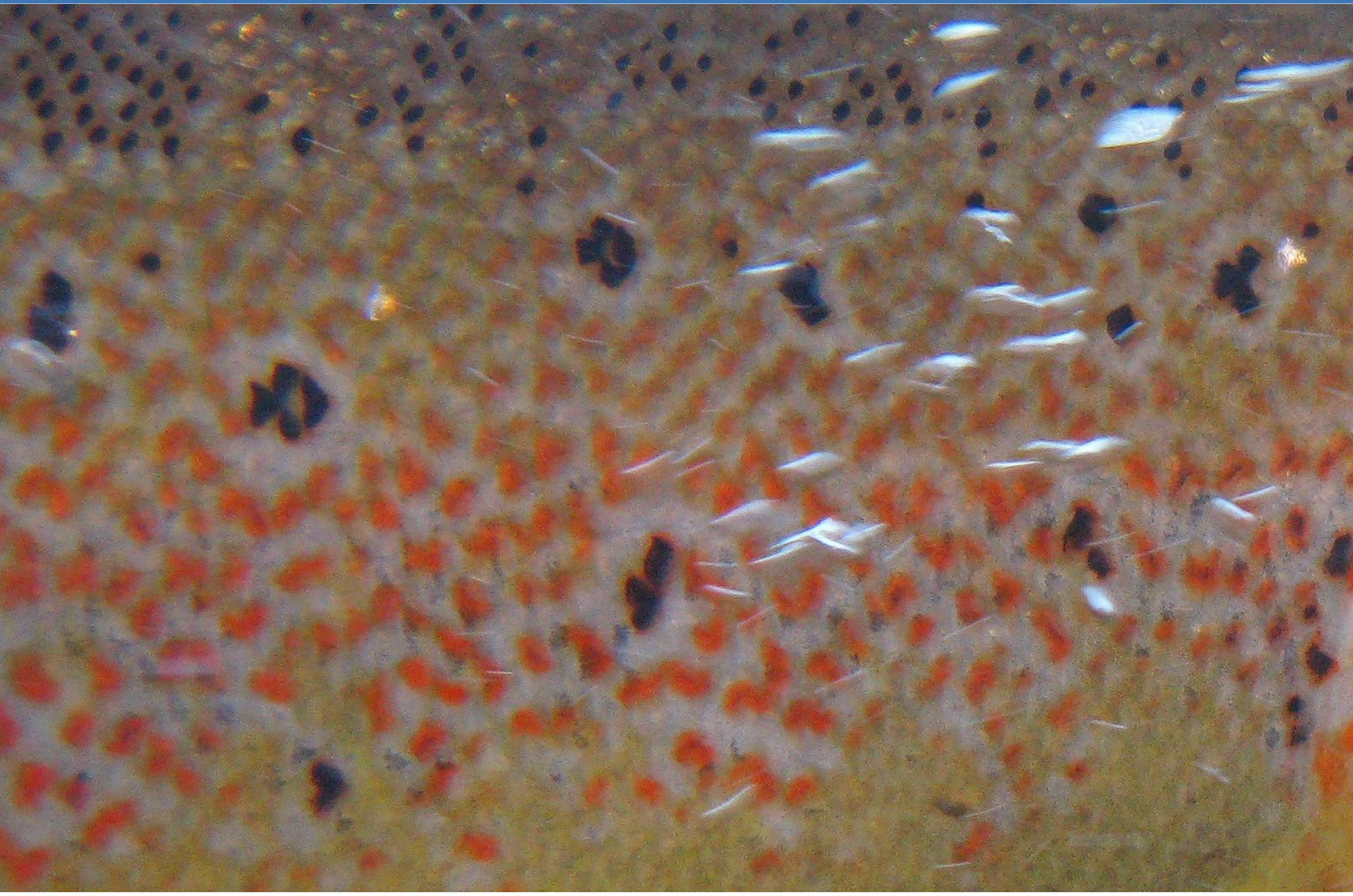

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