Tana/Teno Monitoring and Research Group

Status of the Tana/Teno River salmon populations in 2023

Report from the Tana/Teno Monitoring and Research Group 1/2024

Status of the Tana/Teno River salmon populations in 2023

Report from the Tana/Teno Monitoring and Research Group

THE REPORT CITES AS:
Anon. 2024. Status of the Tana/Teno River salmon populations in 2023. Report from the Tana/Teno Monitoring and Research Group nr 1/2024.

Tromsø/Trondheim/Oulu, January 2024

ISSN: 2535-4701
ISBN: 978-82-93716-14-3

EDIT
1

AVAILABILITY
Open

PUBLICATION TYPE
Digital document (pdf)

KEY WORDS
exploitation, fisheries management, management targets, mixed-stock fishery, monitoring, overexploitation, pre-fishery abundance, Salmo salar, spawning targets, status assessment, status evaluation, stock recovery, stock status

Contact:
Report from The Tana/Teno Monitoring and Research Group
Morten Falkegård, NINA, morten.falkegard@nina.no
Jaakko Erkinaro, Luke, jaakko.erkinaro@luke.fi

Summary

Anon. 2024. Status of the Tana/Teno River salmon populations in 2023. Report from the Tana/Teno Monitoring and Research Group nr 1/2024.

This report is the seventh 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 thirteen stocks/areas of the Tana/Teno river system. All stocks were 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, 2022 and 2023, 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, 2022 and 2023 because of the absence of salmon catches.

The map below summarizes the 2020-2023 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)

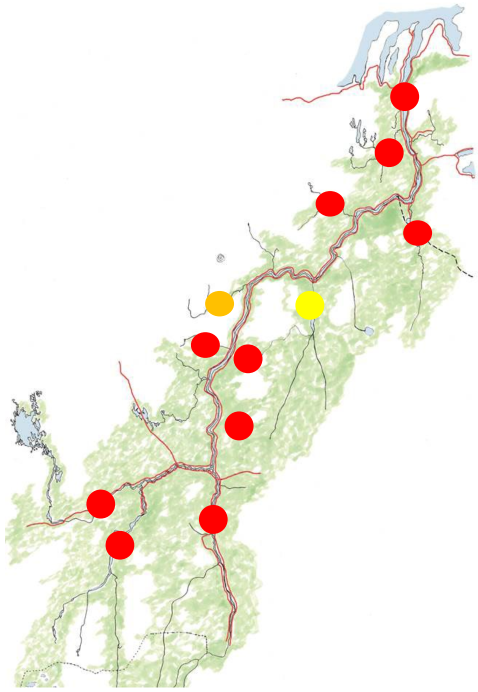
Based on the status assessment, eleven of the thirteen evaluated areas had a management target below 40 %, and ten of the areas were placed in the worst (red) status category with no exploitable surplus in at least two of the last four years.

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 and of the Tana/Teno main stem. These areas, which constitute 80.5 % of the total Tana/Teno spawning target, have had consistently low target attainment and low to no exploitable surplus over several years.

To conclude, the situation for different salmon stocks of the Tana/Teno system in 2023 continued to show an overall negative status with exceptionally low spawning stocks and low estimates of pre-fishery abundance. The numbers of large MSW salmon were still low, in line with what was predicted for 2023. 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 2024 and that there likely will not be any sustainable surplus available.

Given the critical red status category for ten of twelve 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 2023 and previous four years, and the probability for reaching the spawning target over the previous 4 years (=the management target).

	2023 target attainment	2023 probability	4-year target attainment	Management target
Tana/Teno MS	69 %	1 %	64 %	0 %
Máskejohka	-	-	67 %	0 %
Buolbmátjohka/Pulmankijoki	89 %	24 %	61 %	0 %
Lákšjohka	30 %	0 %	22 %	0 %
Ohcejohka/Utsjoki (+tributaries)	90 %	22 %	103 %	55 %
Leavvajohka	61 %	2 %	112 %	59 %
Báišjohka	20 %	0 %	66 %	1 %
Njiljohka/Nilijoki	63 %	0 %	54 %	0 %
Ástejohka	116 %	67 %	-	-
Áhkojohka/Akujoki	67 %	1 %	56 %	0 %
Kárášjohka (+tributaries)	59 %	0 %	55 %	0 %
Iešjohka	-	-	29 %	0 %
Anárjohka/Inarijoki	35 %	0 %	26 %	0 %

Jaakko Erkinaro, Natural Resources Institute Finland (Luke), Paavo Havaksen tie 3, 90570 Oulu, Finland (jaakko.erkinaro@luke.fi)
Panu Orell, Natural Resources Institute Finland (Luke), Paavo Havaksen tie 3, 90570 Oulu, Finland (panu.orell@luke.fi)
Morten Falkegård, Norwegian Institute for Nature Research (NINA), Fram Centre, 9296 Tromsø, Norway (morten.falkegard@nina.no)
Anders Foldvik, Norwegian Institute for Nature Research (NINA), P.O. Box 5685 Torgard, 7485 Trondheim, Norway (anders.foldvik@nina.no)

Contents

1 Introduction

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

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

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

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

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

Based on advice from the International Council for the Exploration of the Sea (ICES), salmon fisheries should only 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 an important lower threshold, 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 salmon stock in some way is depending on the number of eggs spawned and that each salmon river has a maximum potential production of recruits. The number of eggs necessary to produce this maximum number of recruits is called the spawning target of a river. See Falkegård *et al*. (2014) for further information on spawning targets in Tana/Teno.

1.2 Knowledge-based stock evaluations and different sources of information

Within the Precautionary Approach, there is an emphasis on utilizing all available information when developing management advice. This is reflected in point 3 of the MRG mandate, which tasks the MRG with integrating local and traditional knowledge of the stocks in the evaluations. All provided evaluations should account explicitly for various sources of uncertainty, and the resulting assessment procedure should provide the most likely assessment of the salmon stock situation within the Tana/Teno. According to point 1 of the MRG mandate, this is an annually repeated procedure with each new year adding new points to the assessments and using any new sources of information to update/revise assumptions and parameters and thereby potentially also revise previous assessments. This is an adaptive process that is illustrated conceptually in Figure 1.

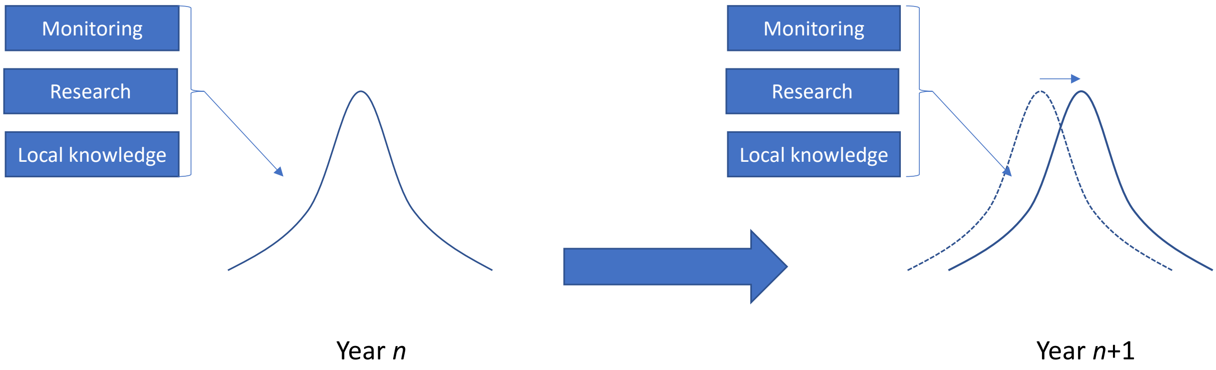


Figure 1. A conceptual representation of the adaptive process that is used for the annual assessment of Tana/Teno salmon stocks. In this repeated procedure, an assessment in a new year (n+1) is made based on the results of the preceding year (n), amended by any new sources of information (monitoring, research, local/traditional knowledge) that has become available.

At its most simple, the procedure illustrated in Figure 1 involves getting new information in the form of a new fish count, adding a new year with a spawning stock estimate to the assessment and updating the management target. At other times, however, there are sources of information that necessitates more significant changes.

To better understand the conceptual representation in Figure 1 and how different sources of information affect the assessment, it is useful to look at some practical examples from recent years. One practical starting point might be a salmon stock that is exploited through fishing. In order to evaluate such a stock, it is necessary to have knowledge about fishing efficiency. The best way to achieve this is through factual information, for instance the relation between a fish count and catch statistics. If a fish count is missing, other sources of information is necessary to estimate fishing efficiency. One example was the description of historic catch rates in rivers such as Máskejohka and Ánarjohka/Inarijoki. In the initial years of assessing these rivers, we used data from other rivers to set what was judged to be the most likely catch rates of Máskejohka and Ánarjohka/Inarijoki. These catch rates were then adjusted on an annual basis, for instance based on local knowledge about fishing conditions. For both areas, the availability of fish counts (2018 in Ánarjohka/Inarijoki and 2020 in Máskejohka) necessitated re-evaluating the catch rate estimates throughout the assessment period.

Other examples of significant changes were the revised spawning target of Leavvajohka in 2019, which changed the target attainment and probabilities throughout the assessment period, and the revised female proportions and average sizes of the Ohcejohka/Utsjoki assessment in 2022 which led to significant changes in the spawning stock estimates throughout the assessment period.

In all examples above, new knowledge is gained, models are updated, and optimal management strategies can be derived accordingly. This illustrates a core strength of an adaptive knowledge-based approach. Because it is based on a learning process, it improves the probability of a positive long-term management outcome. Examples of the latter are successful stock recoveries and sustainable exploitation of the salmon stocks.

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) **Combining 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) **Combining 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) **Combining 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 can be 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. Microsatellite markers were used to analyse catch samples from 2006-2008, 2011-2012, whilst single-nucleotide polymorphism (SNP) markers 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.

1.4 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 ten out of fifty 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 number 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/Teno 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.

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 (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 several years 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, 2017-2023)
- Ascending adult salmon by a sonar in Anárjohka/Inarijoki (in 2018-2019, 2021, 2023)
- Ascending adult salmon by a sonar in the Tana/Teno main stem (2018-2023)

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).

More recently, single-year fish counts have also been carried out in some tributaries, e.g. Váljohka (video, 2015 and some snorkelling counts), Veahčajohka/Vetsijoki (sonar+video, 2016 and 2021), Iešjohka (sonar, 2022), Máskejohka (sonar, 2020 and 2022), Gálddašjohka/Kalddasjoki (video, 2023), and six Norwegian tributary areas snorkelled in 2023 (detailed in Table 1). These pieces of information from individual tributaries are useful as reference levels for estimating their stock status, which in most other years make use of catch data only or are not evaluated at all.

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

2.1 Catch and fisheries data in 2023

The Tana/Teno salmon fisheries were totally closed in 2023, third year in a row, because of poor stock status. Catch and fisheries data from earlier years can be found from an older report (Anon. 2020). Overall, some illegal salmon fisheries operated in the Tana system in 2023 but its volume was impossible to estimate.

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 abundances are not straightly used in assessing stock status for individual populations (chapter 3), information on juvenile abundance is still a valuable 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 2023 mean densities of juvenile salmon at the permanent electrofishing sites increased from 2022 in the Tana/Teno mainstem and in Ohcejohka/Utsjoki but slightly decreased in Anárjohka/Inarijoki (Figure 2). Densities of older (≥1+) parr were, however, still among the lowest observed throughout the time series and especially low in Anárjohka/Inarijoki (Figure 2).

Overall, the rather low 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. The salmon fishing ban in 2021-2023 have, however, increased spawning stock sizes and probably helped in maintaining the juvenile production.

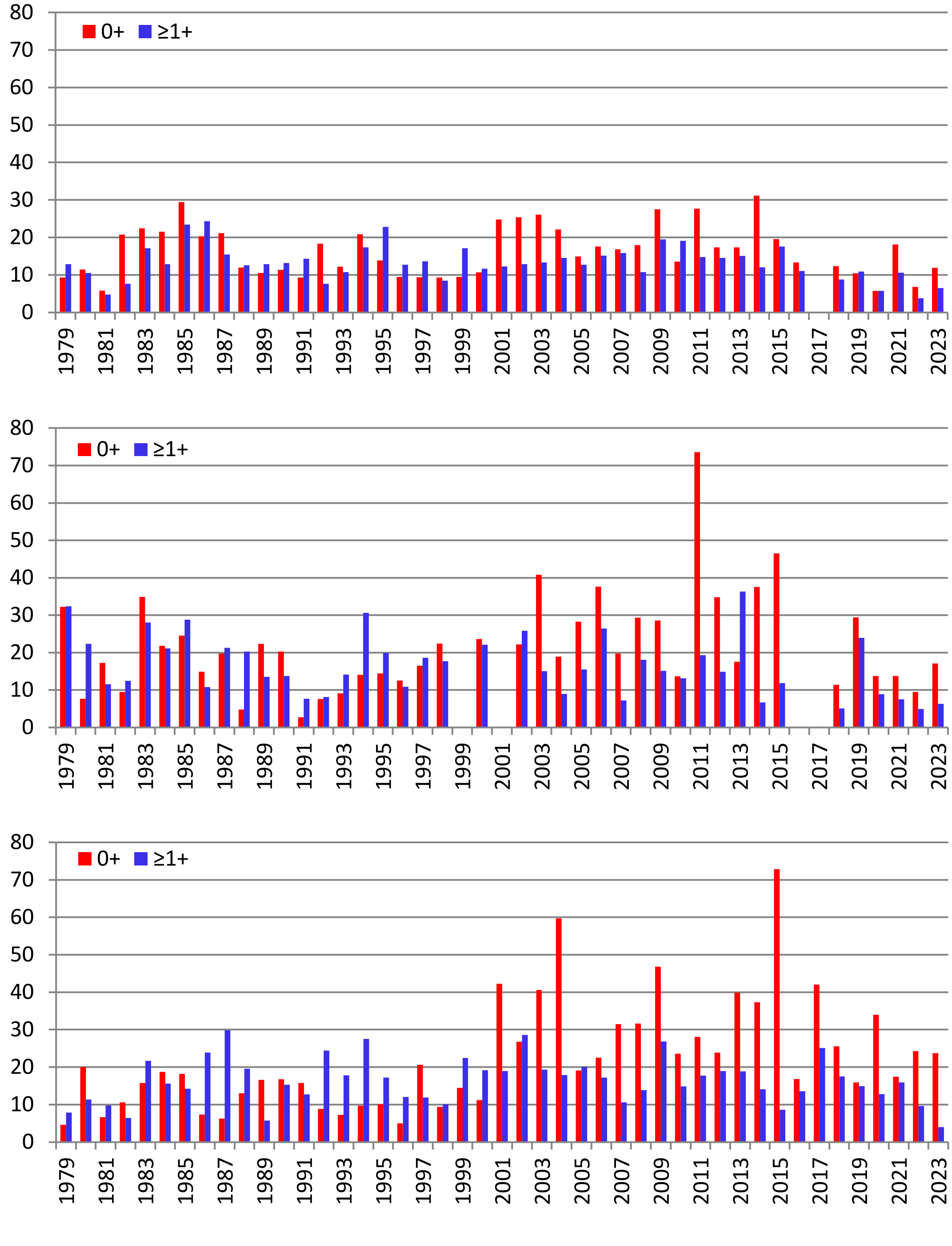


Figure 2. Mean densities (fish/100 m^2; one pass, uncorrected) of salmon fry (0+) and parr (≥1+) at permanent electrofishing sites in the rivers Tana/Teno (uppermost panel), Ohcejohka/Utsjoki (middle panel) and Anárjohka/Inarijoki (lowermost panel) in the years 1979-2023. Note: this data only includes 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.

In addition to the electrofishing of long-term monitoring sites, a survey in the river Čársejohka/Tsarsjoki, a major tributary of Ohcejohka/Utsjoki, was conducted in 2023, including 26 sampling sites (Figure 3). The aim of this electrofishing is to get an updated overview on the juvenile densities of the river Čársejohka/Tsarsjoki on c. four-year intervals and compare these densities to earlier surveys conducted in 2004, 2009, 2014 and 2019 (Figure 3).

The juvenile densities of Čársejohka/Tsarsjoki in 2023 were within the limits observed in earlier years, but the overall density of all age-classes was the lowest observed since 2004 (Figure 3). The production of fry (0+) is mostly concentrated to areas above the waterfall (sites 11-26) situated close to the outlet of the Njidgu river. Production areas of parr (≥1+) are more evenly distributed throughout the surveyed sites. Overall, the mean densities of fry in Čársejohka/Tsarsjoki were lower than in Ohcejohka/Utsjoki main stem but parr densities were significantly higher in Čársejohka/Tsarsjoki (Figures 1-2).

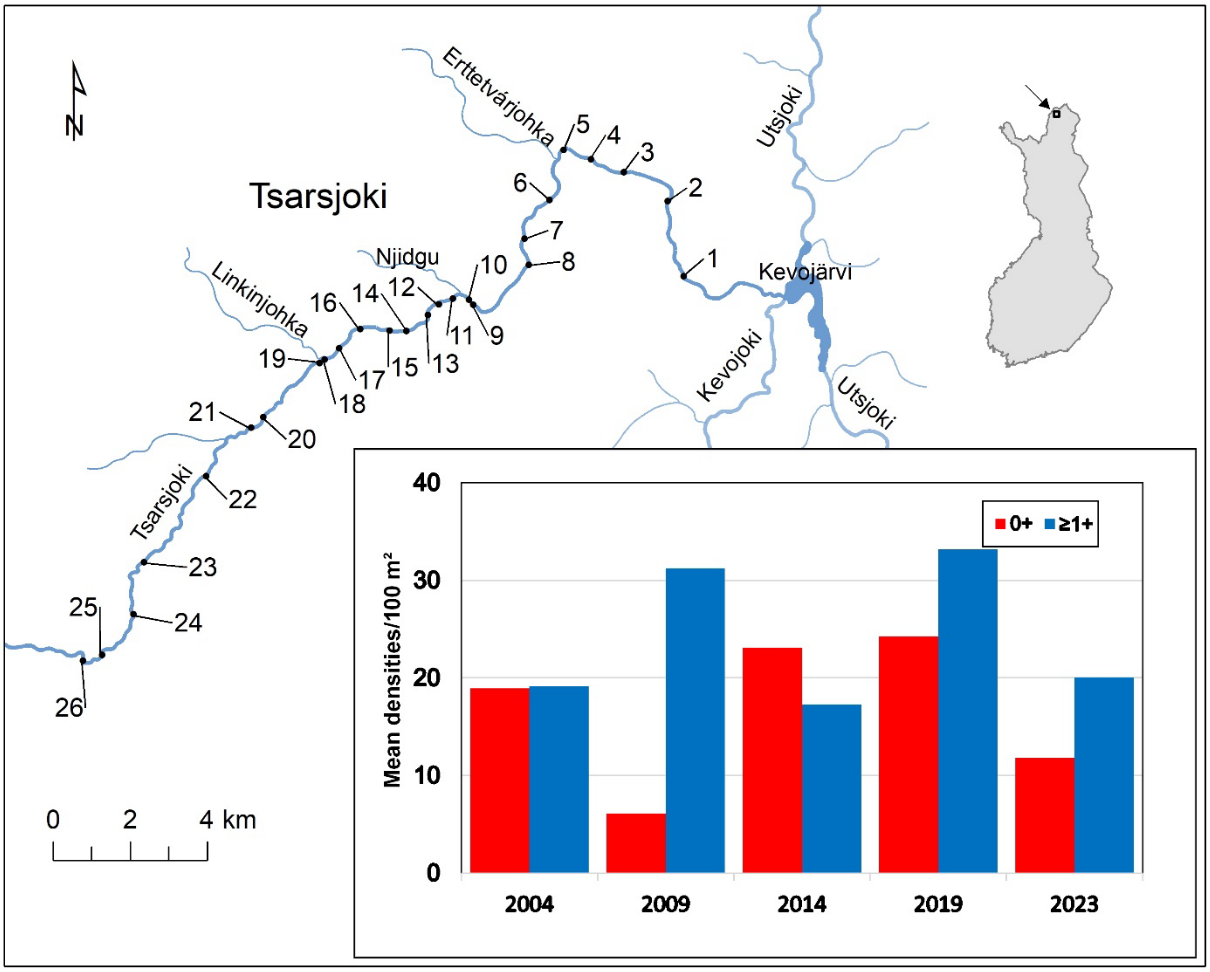


Figure 3. Mean densities (fish/100m2; one pass) of salmon fry (0+) and parr (≥1+) of the 26 sampling sites in the river Čársejohka /Tsarsjoki in 2004, 2009, 2014, 2019 and 2023.

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 rivers using multiple methods, including video monitoring, sonar counts and snorkelling counts (Figure 4).

In 2023 adult salmon counts were performed at the following sites (Figure 4): Tana/Teno main stem (sonar), Ohcejohka/Utsjoki (video), Kárášjohka (sonar), Anárjohka/Inarijoki (sonar), Gálddašjohka/Kalddasjoki (video), Buolbmátjohka/Pulmankijoki (snorkelling), Njiljohka/Nilijoki (snorkelling) and Áhkojohka/Akujoki (snorkelling).

Additional adult salmon counts by snorkelling came also available from several Norwegian tributaries of the Tana through the Tanavassdragets Fiskeforvalting (TF, Pierre Fagard). These rivers included: Geaimmejohka (a tributary of Karasjohka), Ástejohka (a tributary of Valljohka), Báišjohka, Leavvajohka, Lákšjohka, Deavvkehanjohka (a tributary of Lákšjohka) and Geasis (a tributary of Maskejohka).

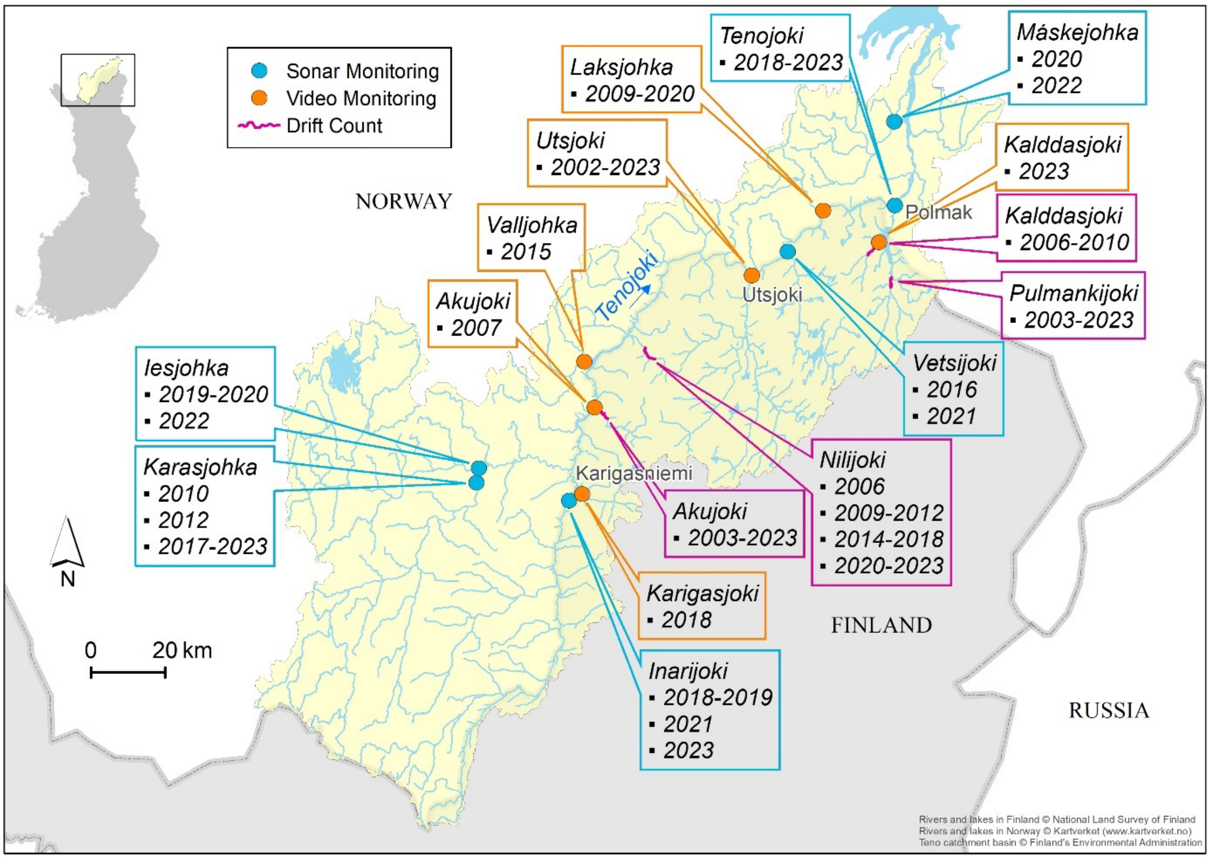


Figure 4. Map of the Tana/Teno river system indicating the most important adult salmon counting sites and counting methods between 2002 and 2023. Note that the Iešjohka sonar counts in 2019-2020 produced unreliable low-quality data and were not used in the spawning stock assessments.

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 2002-2023 (Figure 5).

In 2023 the video counting was performed in good environmental conditions without any significant technical problems. The adult salmon count was less than 1 400 fish, being more than 30 % lower than year before and among the lowest observed during the monitoring time series (Figure 5). Bearing in mind the salmon fishing ban in the Tana/Teno system and in the Tanafjord the salmon count in 2023 was very disappointing. The count in 2023 was almost 60 % lower than the long-term average (3 300 fish).

The migration activity in 2023 was peaking at late-June early-July (Figure 6) coinciding with the normal migration window observed in Ohcejohka/Utsjoki. A surprising migration peak was, however, observed after mid-August, soon after the pink salmon fence was removed at Tana Bru (Figure 6). This may indicate possible delays in salmon migration caused by the fence system.

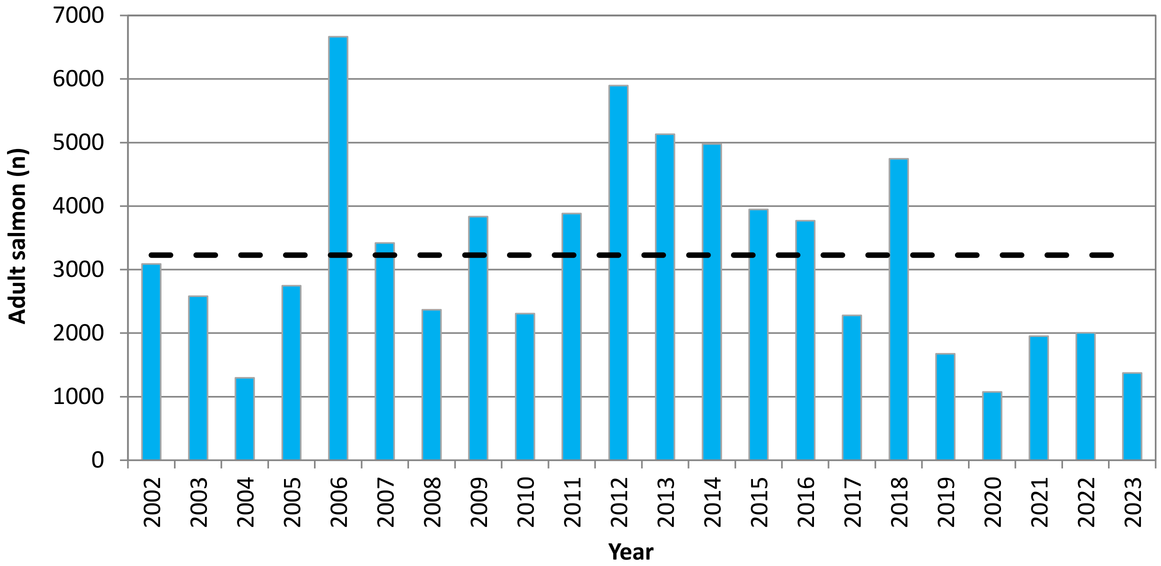


Figure 5. Video counts of ascending adult salmon at the river mouth of Ohcejohka/Utsjoki in 2002-2023. The dashed black line indicates the long-term average between 2002-2023. All sea-age groups are combined.

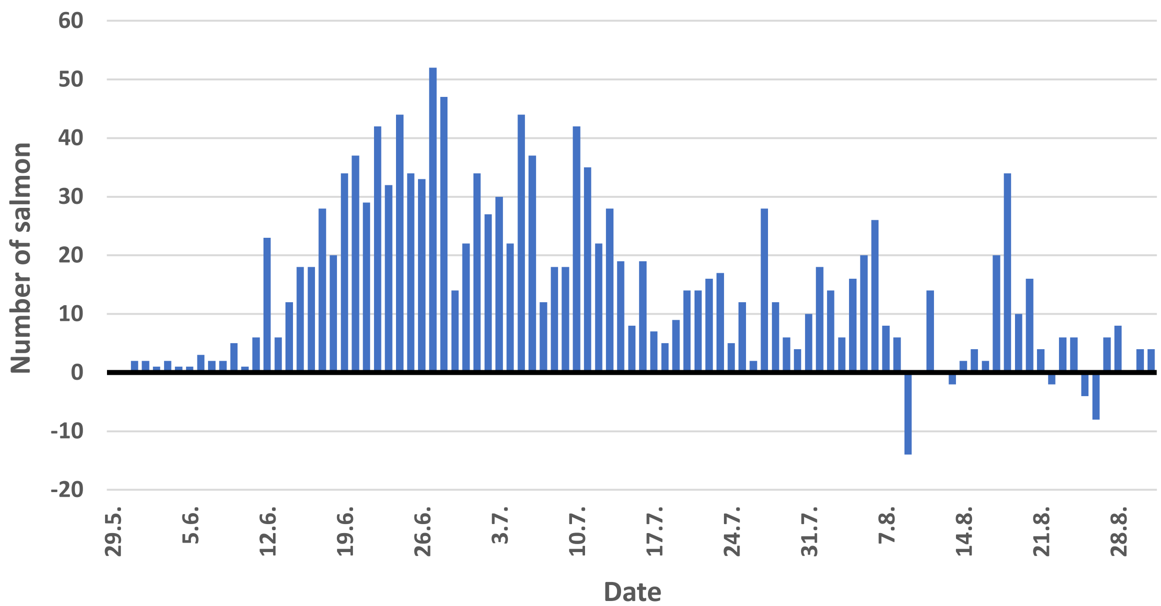


Figure 6. Estimated daily numbers of ascending salmon in the River Ohcejohka/Utsjoki in 29.5.-31.8.2023. Negative values indicate that during those days more salmon migrated downstream than upstream. All sea-age groups are combined.

2.3.2 Gálddašjohka/Kalddasjoki video counting

An automatic Simsonar FC stereo camera system was used in the lower reaches of the River Gálddašjohka/Kalddasjoki in 2023. The unit was located c. 650 m upstream from the river outlet. Guiding fences from both shores were used to guide the fish to swim trough the counter unit tunnel

(Figure 7). The counter was installed on 8th June 2023, but due to technical problems full data (24/7) was available between 13.6. and 20.9.

The system automatically observed fish, their swimming direction, species, and size. These automatic observations were, however, manually checked and corrected if clear mistakes were evident. Overall, the system worked reliably throughout the monitoring period. During August there were two short (c. 24 h) summer flood periods when the guiding fence connections to the tunnel unit were slightly broken, and some fish may have been able to pass the site without moving through the counting tunnel.

The total salmon count during the monitoring period was 196 fish (Figure 8). From these, 165 (84 %) individuals were measured to be ≤65 cm and 31 (16 %) individuals ≥65 cm long. The largest salmon was measured as 93 cm long. In addition to the salmon, three pink salmon individuals ascended the Gálddašjohka/Kalddasjoki system, one during 1st August and two on 13th August. The salmon migration was rather scattered and two peaks in migration activity were observed, during mid-July and during late July early-August (Figure 8).

Figure 7. Simsonar FC stereo camera system installed to the River Gálddašjohka/Kalddasjoki. The white box in the middle of the river is the camera tunnel unit. Guiding fences goes from the tunnel unit downstream to both shores. Data recording and solar power systems are situated on the shore (left hand side). Photo: Mikko Kytökorpi.

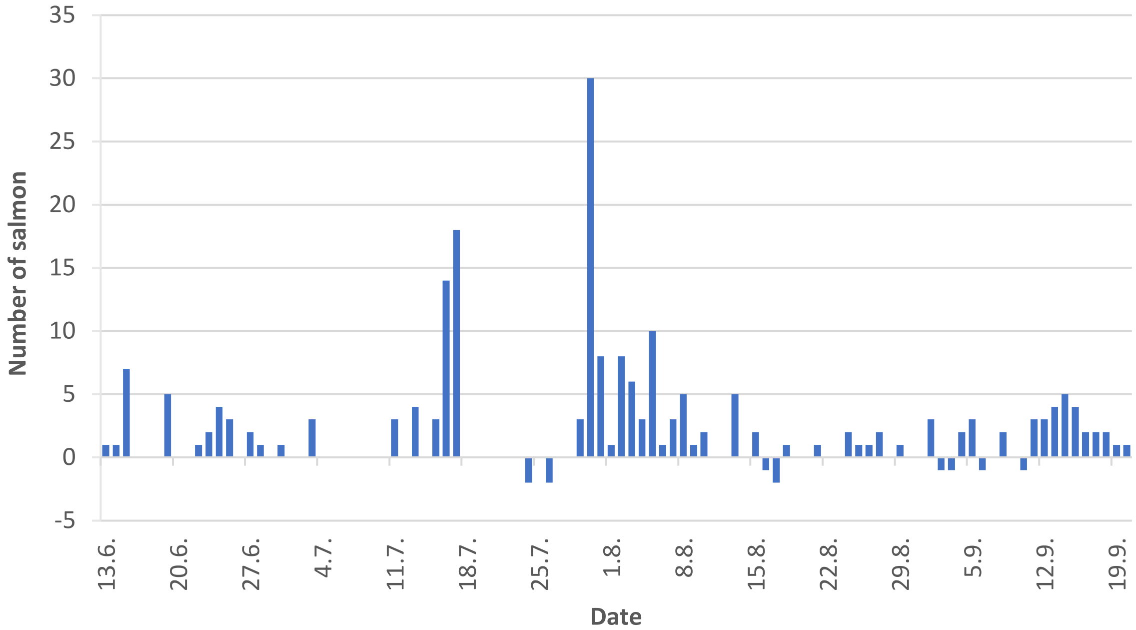


Figure 8. Estimated daily numbers of ascending salmon in the River Gálddašjohka/Kalddasjoki in 13.6-20.9.2023 based on video monitoring (Simsonar FC stereo camera). All sea-age groups are combined. Negative values indicate that during those days more salmon migrated downstream than upstream.

2.3.3 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 9). In 2023 these snorkelling counts were performed in rather good environmental conditions and the results are comparable to other years.

Numbers of spawning salmon in the snorkelling rivers in 2023 mostly followed the decreasing trend observed in the Ohcejohka/Utsjoki video monitoring (Figure 9). in Áhkojohka/Akujoki and Njiljohka/Nilijoki spawner numbers decreased considerably (52 % and 32 %) from 2022 but somewhat increased (28 %) in Buolbmátjohka/Pulmankijoki. The decreasing counts were mostly caused by low grilse numbers as numbers of larger multi-sea-winter (MSW) salmon stayed at the levels observed in 2022.

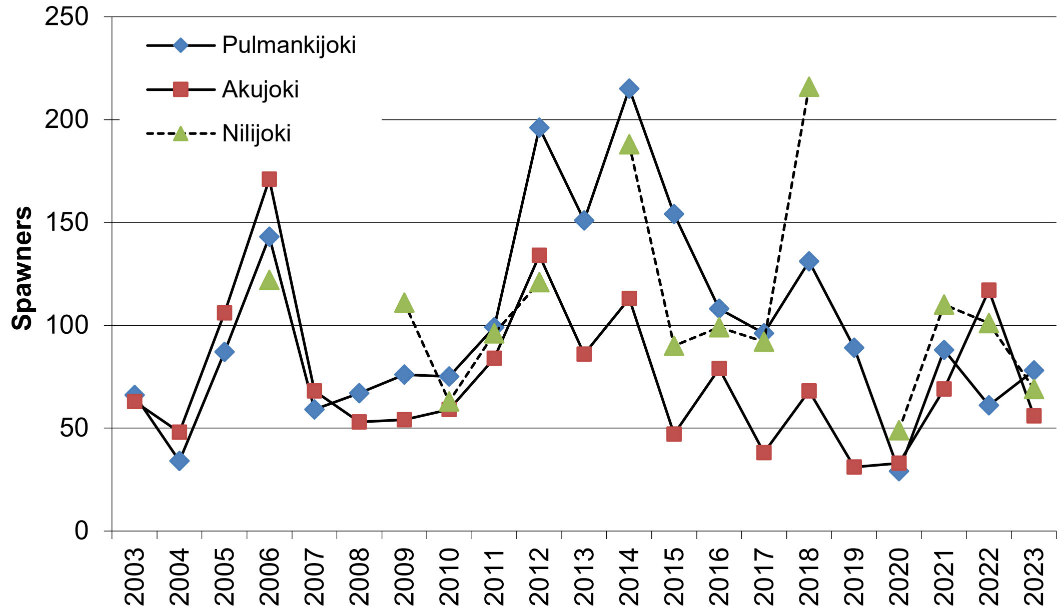


Figure 9. Snorkelling counts of spawning salmon in the rivers Buolbmátjohka/Pulmankijoki, Áhkojohka/Akujoki and Njiljohka/Nilijoki in 2003-2023. All sea-age groups are combined.

In addition to the long-term snorkelling counts on the Finnish tributaries an extra seven tributaries were snorkelled on the Norwegian side in 2023 (Table 1). The count results indicated rather low salmon abundance compared to the lengths of rivers snorkelled. The salmon/km parameter varied from 1.65 (Deavvkehanjohka) to 9.09 salmon/km (Leavvajohka) depending on the river. In the Finnish tributaries values of this parameter was mostly much higher (9.33-18.14), which is partly explained by the fact that in Buolbmátjohka/Pulmankijoki and Njiljohka/Nilijoki only the best river stretches are counted annually, considerably increasing their salmon/km values.

Table 1. Snorkelling count results (numbers of salmon) from seven Norwegian tributaries of Tana/Teno in 2023 divided to sea-age/sex groups (1SW=small salmon, 2SW=medium sized salmon and MSW=large salmon). Counts were performed throughout the anadromous lengths of the rivers, i.e., in areas that are included in the Tana/Teno spawning targets. 1SW? and 2SW? means small and medium sized salmon without confirmed sexes. Source: Pierre Fagard, TF.

River	Counting date	1SW ♂	1SW ♀	2SW ♂	2SW ♀	MSW ♂	MSW ♀	1SW ?	2SW ?	In total
Geaimmejohka	1.9.2023	18	20	14	14	2	2			70
Ástejohka	29.8.2023	14	14	24	30		1	20		103
Báišjohka	28.8.2023	33	26	10	10					79
Leavvajohka	23.-25.8.2023	105	43	28	62	1	2			241
Lákšjohka (main stem)	14.-15.09.2023	8	28	4	16	8	5	2	6	77
Deavvkehanjohka	13.-14.9.2023	5	13	2	5			3		28
Geasis	21.9.2023	4	2	8	13	6	19		1	53

2.3.4 Sonar counts

During the last 10 years sonar monitoring have been actively used in counting the numbers ascending salmon. In 2023 sonar counts were performed in the Tana/Teno main stem, in Kárášjohka and in Anárjohka/Inarijoki (Figure 4). 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 cut-off 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 sixth year in the Tana/Teno main stem in 2023, at Polmak, c. 55 km upstream from the river mouth (Figure 10). The aim of this survey is to estimate the total salmon run size of the Tana/Teno system on annual basis and nowadays also the pink salmon ascendance during odd years. 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 10).

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. However, since 2021 the Tana/Teno salmon fisheries has been closed and no catch data has been available. In 2021 the salmon run (and pink salmon run) estimate was based on three different data sources: sonar length frequency data (all ≥65 cm fish regarded as salmon), earlier years (2018-2020) daily salmon proportions in relation to the whole season and video data from four underwater cameras installed within the sonar window. In 2022 a combined Tana bru-national border catch data from years 2017-2020 were used to correct the species distribution of the 50-65 cm long sonar fish observations in 2022. This correction was done throughout the counting season using 5-day intervals.

In 2023 the species distribution was estimated based on video data collected during the sonar monitoring period from four underwater cameras installed within the northernmost sonar window (see Figure 10-11). Analysis of sonar data was also slightly changed in 2023 compared to earlier years and all ≥40 cm long fish were measured and counted. This change was done because of a large amount of 40-50 cm pink salmon were ascending to Tana in 2023 and there was a need to estimate the run size of pink salmon too.

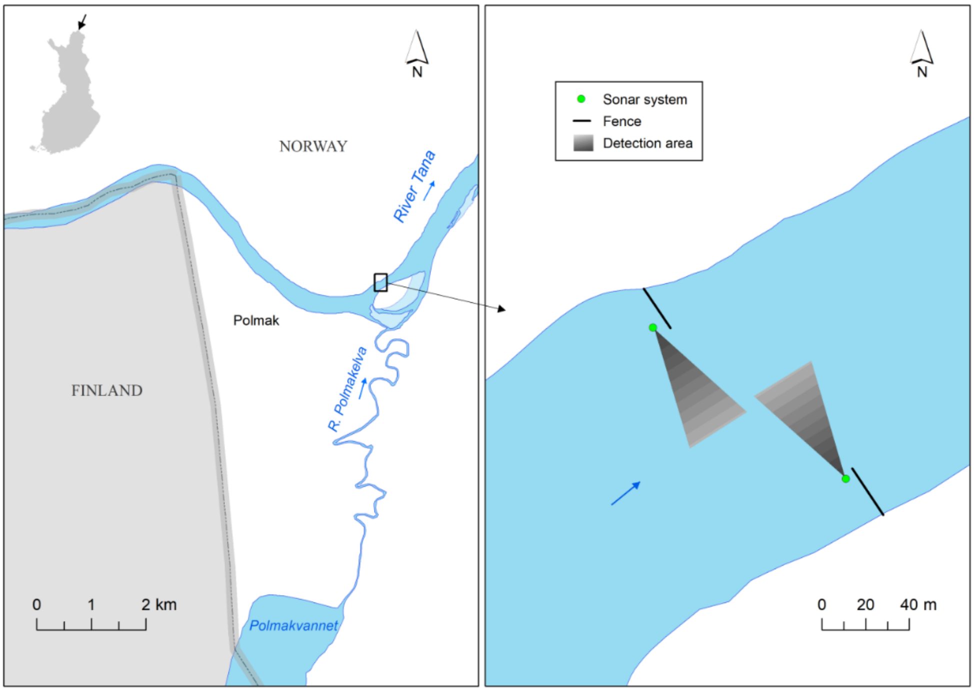


Figure 10. Schematic map of the Tana/Teno main stem sonar counting site including the locations of the two sonar units and guiding fences in 2018-2023.

Figure 11. Still image from the underwater cameras installed to the sonar counting window in Polmak. There is a large school of pinks and an individual Atlantic salmon (up in the middle) migrating upstream. Photo: Panu Orell.

The total 2023 sonar count of ≥40 cm fish was 142 028 individuals (Figure 12). Clearly over 90% of these fish observations belonged to size groups 40-50 cm and 50-65 cm (Figure 13) and based on video data were mostly (91%) pink salmon.

The preliminary (before full-scale Bayesian modelling approach) salmon run estimate in 2023 was 18 700 individuals (Table 2). Salmon numbers divided to size groups were 9 230 (40-65 cm), 7 570 (65-90 cm) and 1 910 (>90 cm). 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.

The salmon run size at Polmak counting site in 2023 was at the same low level observed during the last five years (Table 2). No positive indications of increasing small salmon (<65 cm, 1SW) numbers were found in 2023 which was in line with the observations from the several Tana tributary counts.

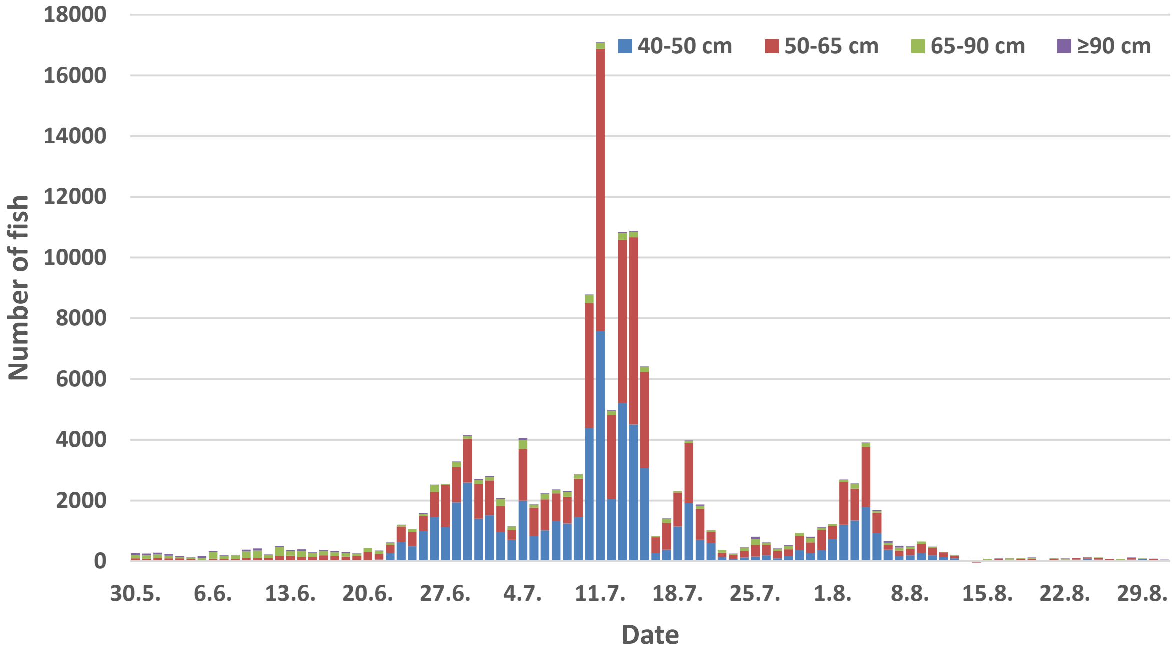


Figure 12. Estimated daily numbers of ascending fish passing the Polmak sonar counting site in 30.5.-31.8.2023 divided to four distinct size groups. The total sonar count was 142 028 fish individuals.

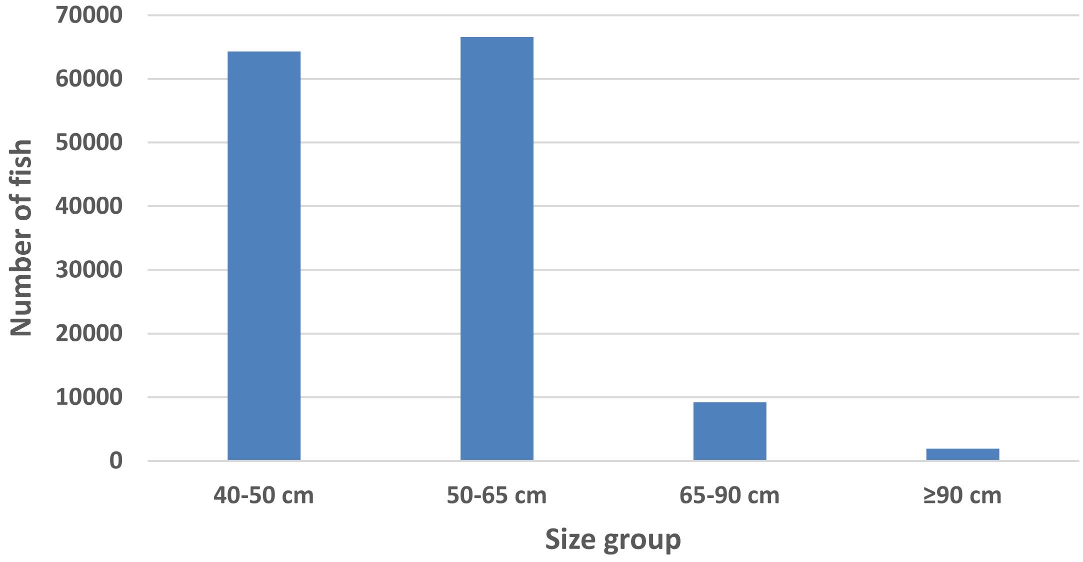


Figure 13. Estimated numbers of ascending fish passing the Polmak sonar counting site in 30.5.-31.8.2023 divided to four distinct size groups.

Table 2. Annual estimated numbers of salmon and their size distribution (n, %) divided to three size classes in the Tana/Teno main stem sonar count in 2018-2023. The small salmon (50-65 cm) estimate in 2021 is most probably an overestimate because of the large pink salmon run. The estimates in 2021 and 2023 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.	32445	20272	10378	1795	62 %	32 %	6 %
2019	22.5.-17.9.	21013	7447	9920	3646	35 %	47 %	17 %
2020	5.6.-14.9.	14656	7122	4827	2707	49 %	33 %	18 %
2021[a]	27.5.-31.8.	26348	18025	6665	1658	68 %	25 %	6 %
2022	30.5.-31.8.	19943	9473	8747	1723	48 %	44 %	9 %
2023[b]	30.5.-31.8.	18710	9229	7566	1914	49 %	40 %	10 %

[a] Numbers and proportion of small (50-65 cm) salmon propably overestimated, because of a large pink salmon run

[b] Size group 40-65 cm was used in 2023 because of the large pink salmon run

Kárášjohka sonar

In the River Kárášjohka, sonar technology to count ascending salmon has been used in 2010, 2012 and 2017-2023. 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. 2 090 salmon were estimated to pass the sonar counting station in Kárášjohka in 27.5.-9.9.2023 (Figure 14). Overall, the run size in 2023 was rather similar to those observed in 2021-2022, but numbers of small salmon (<65 cm) were decreasing (Figure 14, Table 3), as was observed in many other tributaries of the Tana in 2023.

The length distribution data of salmon passing the sonar site in 2023 indicated that 53 % of salmon were <65 cm fish, 30 % were fish between 65 and 90 cm and 16% 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.

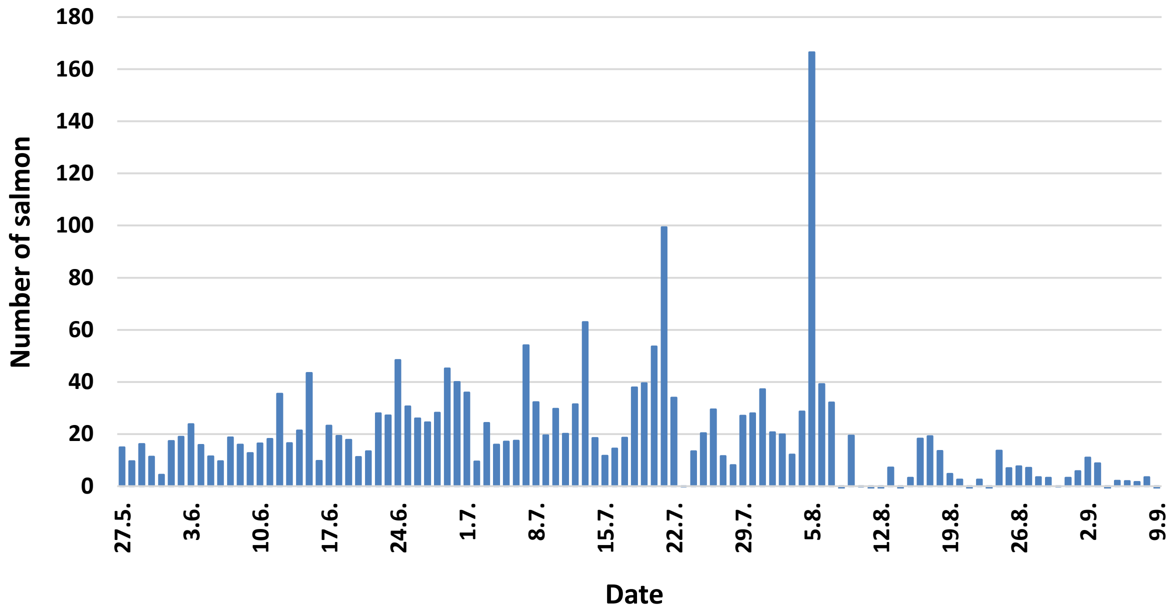


Figure 14. Estimated daily numbers of ascending salmon (≥45 cm) in the Kárášjohka sonar count in 2023. The estimate of the total ascendance through the site was 2088 salmon.

Table 3. Sonar count results of ascending salmon numbers in the River Kárášjohka in 2010, 2012, and 2017-2023 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	1016	661	1677	Missing time estimated	Didson
6.6.-27.8.2012	1038	1589	2627	Missing time not estimated	Simsonar
7.6.-31.8.2017	371	492	863	Missing time not estimated	Aris/Simsonar
1.6.-3.9.2018	1786	1176	2962	Missing time not estimated	Aris
29.5.-3.9.2019	569	774	1343	Missing time estimated	Aris
29.5.-15.9.2020	426	815	1241	Missing time estimated	Aris
28.5.-12.9.2021	1616	807	2423	Missing time estimated	Aris
1.6.-14.9.2022	1304	957	2261	Missing time estimated	Aris
27.5.-9.9.2023	1118	970	2088	Missing time estimated	Aris

Anárjohka/Inarijoki sonar

In the River Anárjohka/Inarijoki, sonar counting of ascending salmon have been performed in 2018-2019, 2021 and in 2023. The counting site is located just above the Gáregasjohka/Karigasjoki confluence, c. 220 km upstream from the Tana/Teno river mouth. The monitoring is done with one sonar unit, which is pointing from the Norwegian side to the Finnish side. Guiding fences are installed on both shores to narrow the river (c. 30 m) for full sonar coverage. Species distribution and proportion of salmon of the sonar count is estimated based on data from four underwater cameras installed within the sonar counting line. The camera data in 2023 was, however, incomplete because of rather late installation of cameras (24.6.) and because of some technical problems during the monitoring period. This caused some extra uncertainty to the species distribution estimation.

In total c. 1 900 salmon were estimated to pass the sonar counting site in Anárjohka/Inarijoki in 29.5.-21.9.2023 (Figure 15). The run size was slightly smaller than in 2021 but larger than in 2019 (Table 4). Compared to the year 2018 the grilse (1SW) numbers have been low in recent years, especially when considering the salmon fishing ban starting in 2021 (Table 4).

The length distribution data of salmon passing the Anárjohka/Inarijoki sonar site in 2023 indicated that 58 % of salmon were <65 cm fish, 38 % were fish between 65 and 90 cm and 4 % were fish ≥90 cm. The length distribution data includes some uncertainty because of the rather long (30-35 m) sonar window used in the survey.

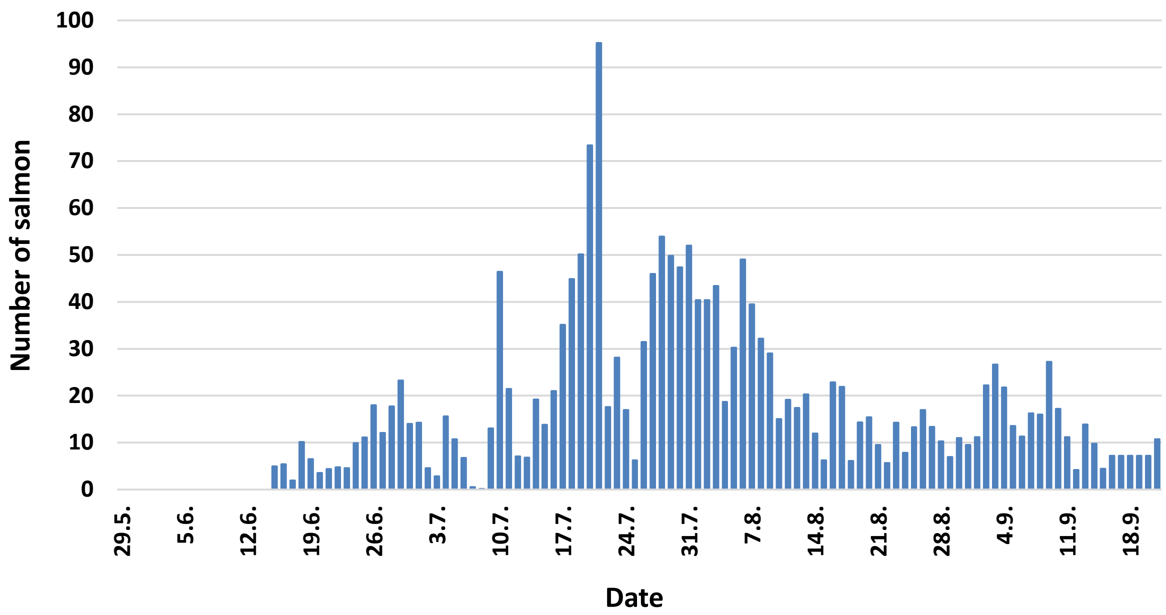


Figure 15. Estimated daily numbers of ascending salmon (≥45 cm) in the Anárjohka/Inarijoki sonar count in 2023. The estimate of the total ascendance through the site was 1 898 salmon.

Table 4. Sonar count results of ascending salmon numbers in the River Anárjohka/Inarijoki in 2018, 2019, 2021 and 2023 divided to 1SW (<65 cm) and MSW (≥65 cm) salmon.

Year	Time period	1SW	MSW	All	Note	Equipment
2018	26.5.-10.9.2018	2227	621	2848	Missing time estimated	ARIS
2019	4.6.-18.9.2019	921	671	1592	Missing time estimated	ARIS
2021	2.6.-13.9.2021	1450	630	2080	Missing time estimated	ARIS
2023	29.5.-21.9.2023	1105	793	1898	Missing time estimated	ARIS

2.4 Pink salmon occurrence and stock size development

Pink salmon, an invasive species originating from the Pacific area, has since 2017 occurred in much higher numbers in the Tana/Teno system than earlier. Overall, abundance of this odd-year pink salmon stock has increased substantially within large areas of the North Atlantic. A new peak in pink salmon occurrence in the Tana/Teno system took place in 2023 despite of the use of a fence-trap system spanning from shore to shore at Tana bru (Figure 16).

Figure 16. The fence-trap system in the eastern channel of the Tana at Seidaholmen (Tana bru). A second fence (flexible fence) was utilized in the western channel. Photo: Panu Orell.

In the Tana/Teno mainstem a raw sonar count estimate of the pink salmon run in 2023 was c. 120 000 individuals. It was, however, observed that the sonar counts largely underestimated pink salmon numbers because they were migrating in very large and dense schools that could not be counted precisely from sonar data. When using a school size correction factor derived from the four underwater cameras situated at the sonar window (see Figure 11) the pink salmon run estimate past the Polmak counting site was c. 170 000 individuals. The corresponding estimate in 2021 was c. 50 000 pink salmon. The first pink salmon at Polmak sonar site was observed on the 18th of June but pink salmon numbers remained low until 23rd June. Since then, active pink salmon migration continued until c. 5th of August.

The pink salmon catch at the Seidaholmen pink salmon fence in Tana bru was only 7 700 individuals (source: Miljødirektoratet). It is less than 5 % compared to the Polmak sonar count estimate c. 20 km upstream from the trapping site.

In the river Maskejohka c. 2 570 pink salmon were removed by using a trap in the lower reaches of the river (source: Miljødirektoratet).

In the River Ohcejohka/Utsjoki pink salmon net numbers above the video site increased to c. 1 140 individuals from c. 470 counted in 2021. First pinks in Utsjoki were observed on 28th of June which was more than a week earlier compared to 2021. The active pink salmon migration continued until c. 10th of August. Overall, the Utsjoki pink salmon estimate contains some uncertainty as pink salmon moved back and forth through the camera line. In addition, pink salmon may have been using the shoreline migration routes (between shores and bridge pillars) to a larger extent than Atlantic salmon, and the Utsjoki camera set-up does not produce data from these areas. Therefore, the pink salmon run size may be somewhat underestimated.

In the Finnish snorkelling tributaries, no pink salmon were observed either alive or dead. Neither sign of pink salmon spawning redds were observed.

In the River Gálddašjohka/Kalddasjoki three pink salmon individuals were observed to the river during the migration period (see chapter 2.3.2 for more information).

In the River Kárášjohka the estimated pink salmon count in 2023 was very low, only c. 140 individuals. This was c. 85 % less compared to 2021 (950 pinks). The first pinks were observed on 1st of July and the upstream migration continued until early-August.

In the River Anárjohka/Inarijoki c. 4 000 pink salmon were estimated to ascend past the sonar monitoring site. This estimate is multiple times larger than in 2021, when c. 800 pinks were counted. The first pinks in Anárjohka/Inarijoki were observed already on the 24th of June and the active migration continued until c. 10th of August.

2.5 Summary of counting results

Adult salmon numbers in different parts of the Tana/Teno system mostly decreased compared to the two earlier salmon fishing closure seasons but was larger than in 2020 (Figure 17). The increase in salmon numbers in 2021-2023 compared to 2020 is 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 fifth successive season, indicating continued poor sea conditions and low sea-survival of salmon. The low sea-survival situation also seems to affect other Finnmark rivers in 2023.

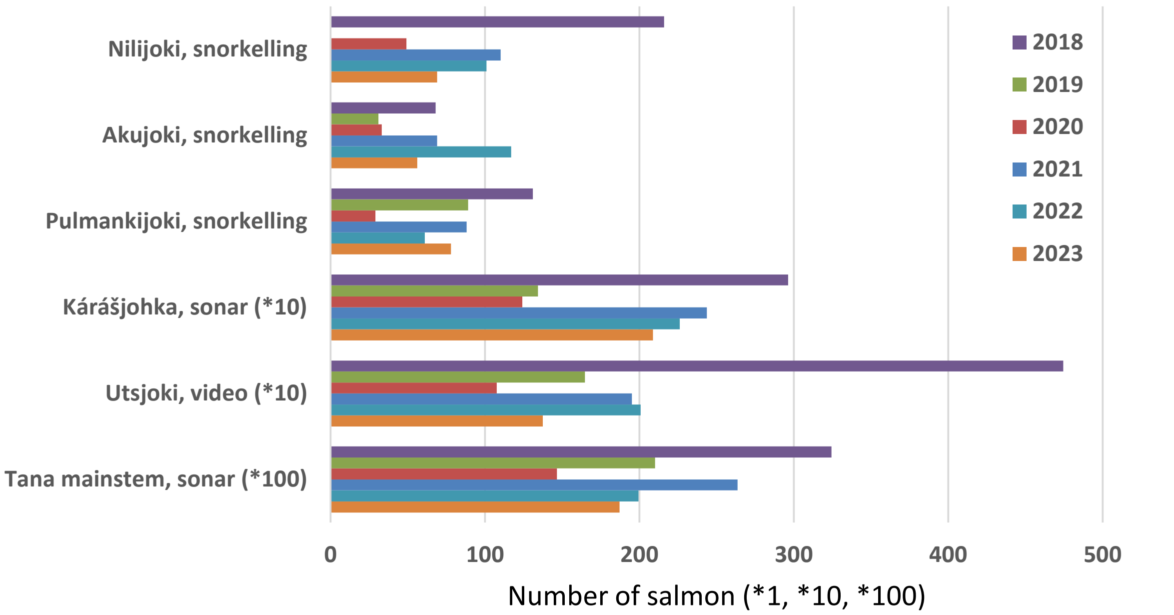


Figure 17. Counting results (number of adult salmon) in different parts of the Tana/Teno system in 2018-2023. Note: Kárášjohka sonar and Ohcejohka/Utsjoki video counts are divided by a factor of 10 and the Tana/Teno mainstem sonar numbers by a factor of 100.

3 Stock status assessment

In this chapter we do a status assessment of 12 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 5. Female proportions in Table 5 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 5).

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 5). 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 %.

Table 5. 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

The 2021-2023 closure 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 an average of the stock-identified fish caught above the Polmak counting site in the Genmix project years 2006-2008 and 2011-2012. 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. The counts used in 2023 were 9 229 salmon <65 cm, 7 566 salmon between 65-90 cm and 1 914 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, in combination with the size-specific Tana/Teno MS proportions above, 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. Numbers in 2023 were 2 504 salmon <65 cm, 1 822 salmon between 65-90 cm and 1 406 salmon ≥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 22 189 kg as the mode, 16 642 kg as the minimum and 33 284 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The 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 2023 and the probability of meeting the spawning target was 1 % (Figure 18). The management target was not reached as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 64 %.

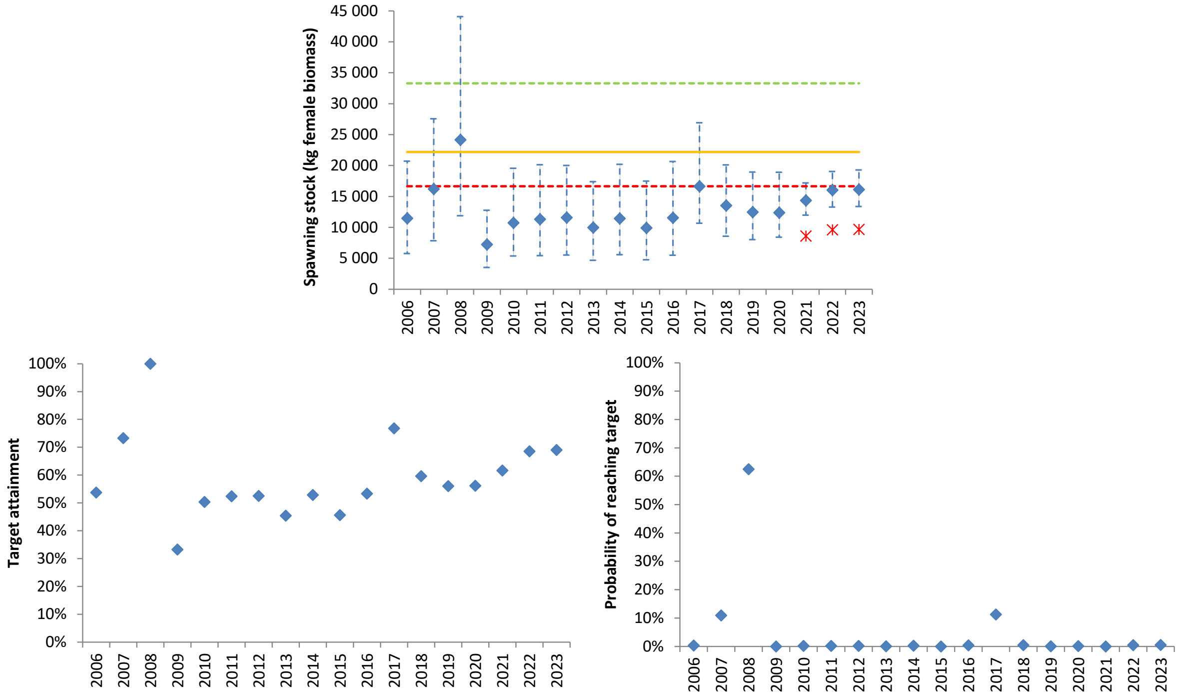


Figure 18. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2023 for the Tana/Teno MS stock. The red symbol in the upper panel show what the spawning stock size would have been in 2021-2023 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 (males and females) of salmon belonging to the Tana/Teno MS stock has varied from a maximum of 124 621 kg in 2008 down to 29 973 kg in 2023 (Figure 19; Table 6).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 15 274 kg in 2021 (Figure 19; Table 6).

Of the years 2006-2023, an exploitable surplus has been missing in the last five years (2019-2023). Therefore, 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 2019-2023 (Table 6). In contrast, as much as 72 % of the female PFA could have been exploited sustainably as recent as 2008.

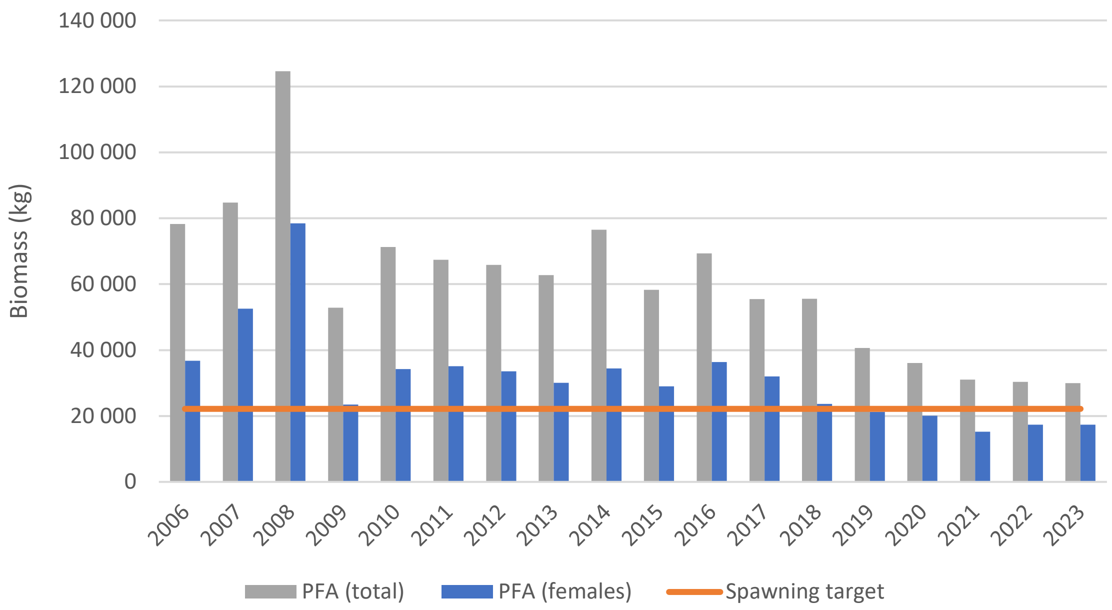


Figure 19. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 6. Numbers involved in the calculation of pre-fishery abundance (PFA, kg) of salmon belonging to the Tana/Teno MS stock in 2006-2023.

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	-	14 359	0.49	31 027	15 274	0.00
2022	2 327	0	-	16 026	0.57	30 366	17 357	0.00
2023	2 166	0	-	16 128	0.58	29 973	17 384	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 few 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 7. Female proportions in Table 7 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are 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 7).

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 Máskejohka in 2021, and as all salmon fisheries were closed, no status assessment could be done. A new sonar count was however conducted in 2022. The assessment in 2022 were based on 767 salmon <3 kg (<65 cm), 173 salmon 3-7 kg (65-90 cm), and 18 salmon >7 kg (≥90 cm). There was no sonar count in 2023, only a partial count of the salmon run from a pink salmon trap that was operated for parts of the summer. This trapping has so far not been reported to the MRG. The only assessment for the Máskejohka river system that we are able to include in this report is therefore a partial assessment for the tributary Geasis, based on a snorkelling count.

Table 7. 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	-

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 1 521 kg as the mode, 1 100 kg as the minimum and 2 000 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 latest year with counting of ascending salmon in Máskejohka was 2022. In this year, 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 20).

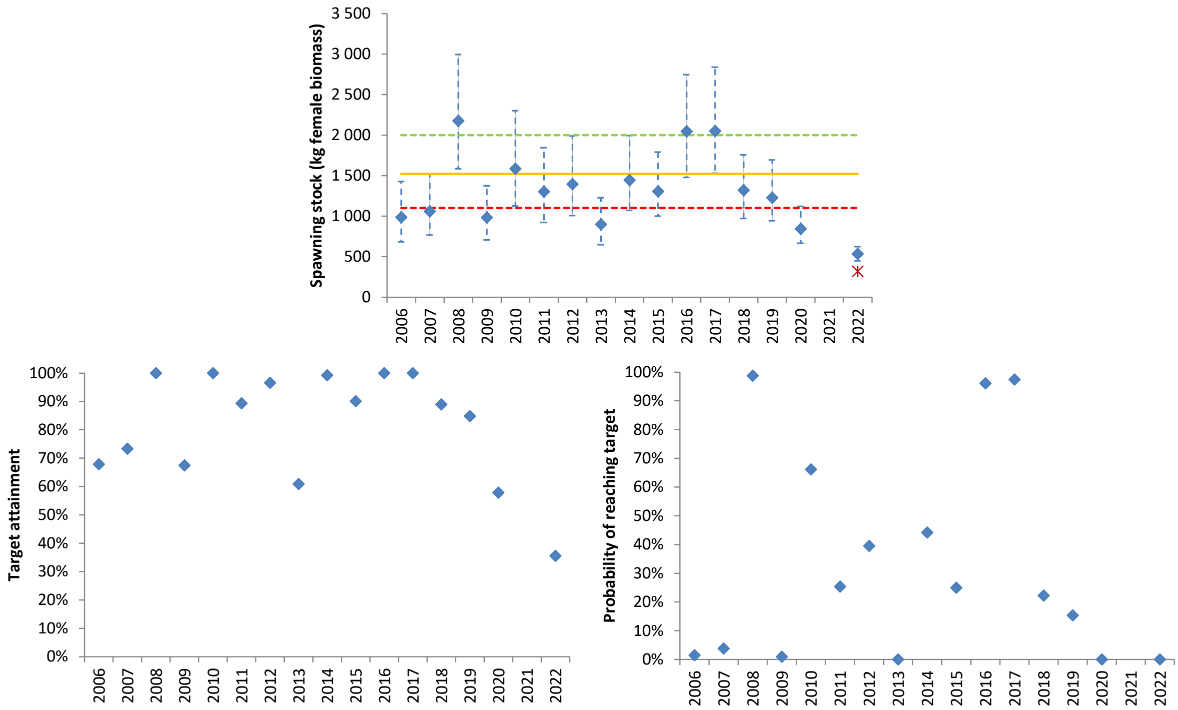


Figure 20. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2022 for the Máskejohka stock. The red symbol in the upper panel shows what the spawning stock size would have been in 2022 if fishing had continued.

The 2023 Geasis snorkelling yielded a count of 6 small-sized (2 females), 22 medium-sized (13 females and 1 uncertain) and 25 large-sized (19 females) salmon. Average sizes of the three size groups were based on five-year averages (2006-2008, 2011-2012) from the Genmix project (Falkegård *et al*. 2023): 1.9 kg for the small-sized, 4.5 kg for the medium-sized and 7.8 kg for the large-sized group. The spawning target of Geasis is approximately 233 kg (175-350 kg). Snorkelling detection rate was subjectively set by the snorkellers to 75 %.

The 2023 estimated Geasis spawning stock was 286 kg (237-332 kg), with a target attainment of 115 % and the probability of meeting the spawning target was 77 %.

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 21; Table 8).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 21; Table 8).

Of the years 2006-2023, an exploitable surplus was 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. Due to lack of data, a PFA estimate cannot be provided for 2023. However, the spawning target attainment of the tributary Geasis indicates that the Máskejohka target attainment was improved in 2023. However, the situation of the preceding years still mean that an exploitable surplus was missing in more than one of the last four years and the Máskejohka stock should therefore still 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 8). In contrast, as much as 66 % of the female PFA could have been exploited sustainably as recently as 2008.

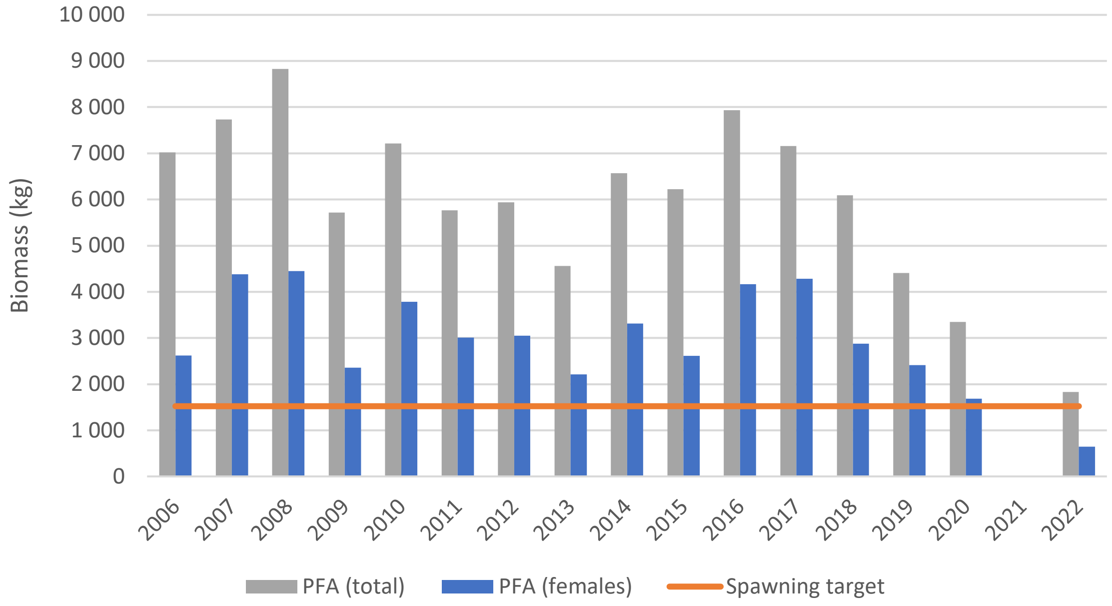


Figure 21. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Máskejohka stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon 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 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	0	0	-	-	-	-	-
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 The River 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 major gillnet salmon fishery with accurate catch statistics operating in the lake Pulmankijärvi, 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 9. Female proportions in Table 9 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 Lake Pulmankijärvi 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 9 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 511 kg as the mode, 383 kg as the minimum and 767 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The 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 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	-
2023	0	78	0.70	0.2	-	0.60	-

The spawning target attainment was 89 % in 2023 and the probability of meeting the spawning target was 24 % (Figure 22). The management target was not reached, as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 61 %.

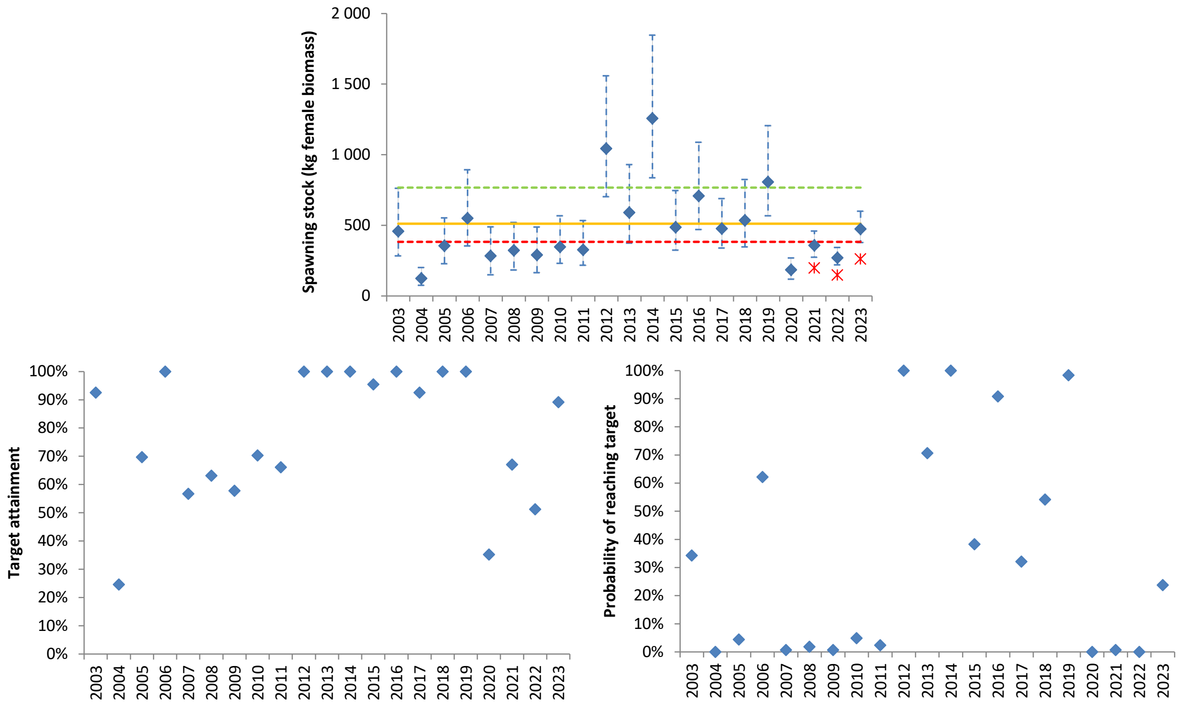


Figure 22. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2023 in the Norwegian/Finnish tributary Buolbmátjohka/Pulmankijoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021-2023 if fishing had continued.

The 2023 video monitoring of the tributary Gálddašjohka/Kalddasjoki allows for a separate spawning target assessment. There were 165 salmon <65 cm and 31 salmon ≥65 cm ascending the tributary, of which 47 and 23 individuals were females in the two size groups. Based on The Lake Pulmankijärvi scale data from 2010-2020, average female sizes <65 cm and ≥65 cm salmon were 1.29 and 2.94 kg, respectively. The Gálddašjohka/Kalddasjoki specific spawning target (Falkegård *et al*. 2014) is 110 kg (82-165 kg).

The 2023 estimated Gálddašjohka/Kalddasjoki spawning stock was 127 kg (109-149 kg), with a target attainment of 110 % and the probability of meeting the spawning target was 70 %.

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 (males and females) PFA of salmon belonging to the Buolbmátjohka/Pulmankijoki stock has varied from a maximum of 4 178 kg in 2014 down to 695 kg in 2022 (Figure 23; Table 10).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 23; Table 10).

Of the years 2006-2023, an exploitable surplus was 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 10). In contrast, as much as 77 % of the female PFA could have been exploited sustainably as recently as 2014.

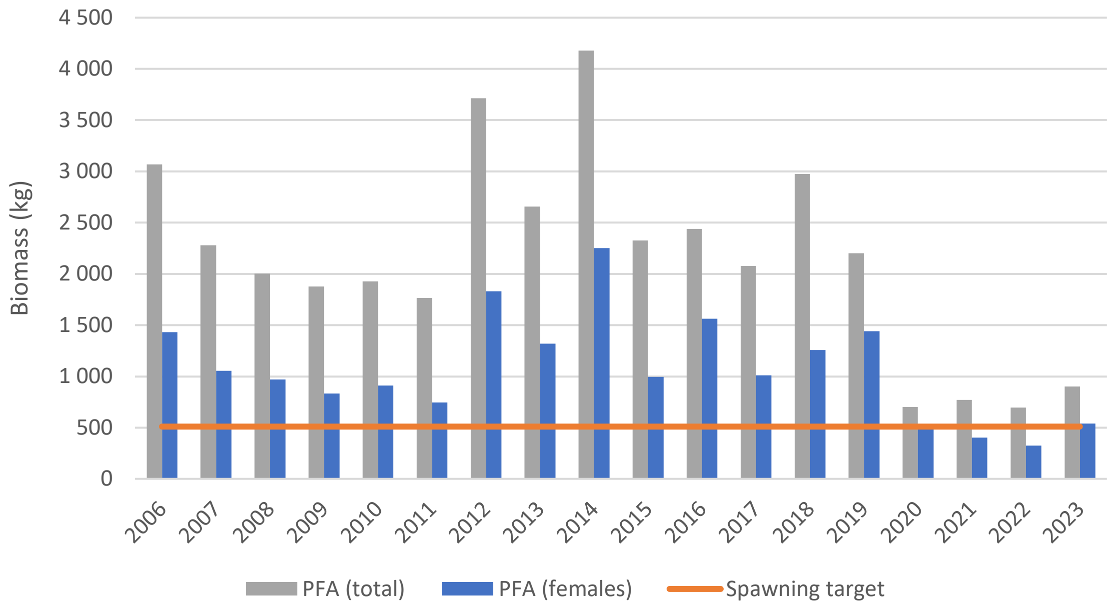


Figure 23. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female 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 Buolbmátjohka/Pulmankijoki stock in 2006-2023.

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	770	404	0.00
2022	119	0	0	270	0.47	695	325	0.00
2023	111	0	0	474	0.60	902	541	0.06

3.4 Lákšjohka

Lákšjohka is a small- to medium-sized tributary that enters the Tana 77 km upstream from the Tana/Teno river mouth. There is a 3-m high vertical waterfall with a fish ladder approximately 9 km from the Lákšjohka river mouth. There are few spawning grounds available for salmon below the waterfall, while the river habitat above the waterfall is well-suited both for spawning and juvenile production. Any functional problems with the ladder will therefore directly limit salmon production in Lákšjohka.

The total river length used by salmon in the Lákšjohka system is estimated to be at least 41 km. There are no further waterfalls limiting salmon distribution above the fish ladder. The main Lákšjohka is close to 14 km long. Further up the salmon can use two smaller tributaries, over 17 km in Deavkkehanjohka and 11 km in Gurtejohka.

The salmon in Lákšjohka are relatively small-sized, with 1SW fish weighing around 1-1.5 kg and 2SW fish 2-3.5 kg. Fish larger than 7 kg are rarely caught.

3.4.1 Spawning stock

The Lákšjohka spawning target is 2 969 946 eggs (2 203 525-4 454 919 eggs). The female biomass needed to obtain this egg deposition is 1 165 kg (864-1 747 kg) when using a stock-specific fecundity of 2 550 eggs kg^{-1}.

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

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

The data input for the variables in this formula are summarized in Table 11. Female proportions in Table 11 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.

A video camera setup has counted ascending salmon in Lákšjohka since 2009, allowing us to accurately estimate the annual exploitation rate in Lákšjohka. The exploitation rate was around 30 % in 2009-2011 and around 20 % in 2012-2013. We used a total exploitation of around 30 % also for the years preceding 2009. Beginning in 2014, the proportions of released salmon increased significantly in Lákšjohka. This led to decreased exploitation rates, and the combined exploitation rate of all size classes in 2014-2018 have been in the range 6-14 %. There were problems with the video monitoring in 2017, so the video counts were treated as a minimum estimate of the number of ascending salmon, 50 % was added as the most likely estimate of ascending salmon and 100 % as an estimate of the maximum number. In 2018 conditions for video monitoring were good and the counting results indicate an overall exploitation of 6 %. Conditions for video monitoring were again good in 2019, and results indicated that exploitation increased with an overall exploitation of 16 %. Monitoring conditions were challenging in 2020 with suboptimal video coverage and the video counts must therefore be treated as minimum estimates. Both counts and catches were relatively low and an overall exploitation estimate of 11 % (10 % for grilse and 15 % for MSW salmon) was used in the simulation (Table 11).

The annual video counting of Lákšjohka ended in 2020, and the combination of no counting and closed fisheries in 2021 and 2022 meant that no assessment could be done for these two years. Parts of the Lákšjohka system were snorkelled in 2023, forming the basis for a new assessment. Areas covered were Lákšjohka main stem and the tributary river Deavkehanjohka, together covering 66 % of the Lákšjohka salmon production area. Detection rates were set to 0.85 for Deavkehanjohka and 0.70 for Lákšjohka. A total of 105 salmon were observed, 28 of which were in Deavkehanjohka and 77 in Lákšjohka. Of the observations in Deavkehanjohka, 21 were 1SW-sized (13 females, 3 uncertain) while 7 were 2SW-sized (5 females). In Lákšjohka, 38 were 1SW-sized (28 females, 2 uncertain). 26 2SW-sized (16 females, 6 uncertain) and 13 3SW-sized (5 females).

Table 11. Summary of stock data used to estimate annual spawning stock sizes in Lákšjohka.

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	609	91	0	0.30	0.30	0.20	0.72	0.39	0.50	0.0073
2007	357	63	20	0.30	0.30	0.20	0.78	0.58	0.50	0.0197
2008	385	51	22	0.30	0.30	0.20	0.57	0.82	0.50	0.0062
2009	266	70	0	0.35	0.37	0.37	0.71	0.61	0.50	0.0077
2010	208	29	0	0.29	0.29	0.29	0.71	0.61	0.50	0.0077
2011	173	31	14	0.36	0.42	0.42	0.64	0.75	0.50	0.0024
2012	185	44	0	0.17	0.15	0.15	0.55	0.64	0.50	0.0029
2013	155	28	0	0.28	0.13	0.13	0.71	0.61	0.50	0.0077
2014	84	15	0	0.08	0.06	0.06	0.71	0.61	0.50	0.0077
2015	118	16	0	0.18	0.06	0.06	0.71	0.61	0.50	0.0077
2016	99	56	0	0.17	0.06	0.06	0.71	0.61	0.50	0.0077
2017	42	19	0	0.08	0.05	0.05	0.71	0.61	0.50	0.0125
2018	39	26	0	0.06	0.06	0.06	0.71	0.61	0.50	0.0070
2019	74	35	0	0.18	0.15	0.15	0.71	0.61	0.50	0.0180
2020	28	7	0	0.10	0.15	0.15	0.71	0.61	0.50	0.0125

To account for uncertainty, the exploitation rate and female proportion estimates in Table 11 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. Due to water level conditions in 2017, the monitoring numbers had a higher uncertainty than usual. Because of this, a 20 % uncertainty was used on the lower side of the exploitation rate and 35 % on the upper side. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 1 165 kg as the mode, 864 kg as the minimum and 1 747 kg as the maximum value.

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

The spawning target attainment was 30 % in 2023 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 22 % (Figure 24).

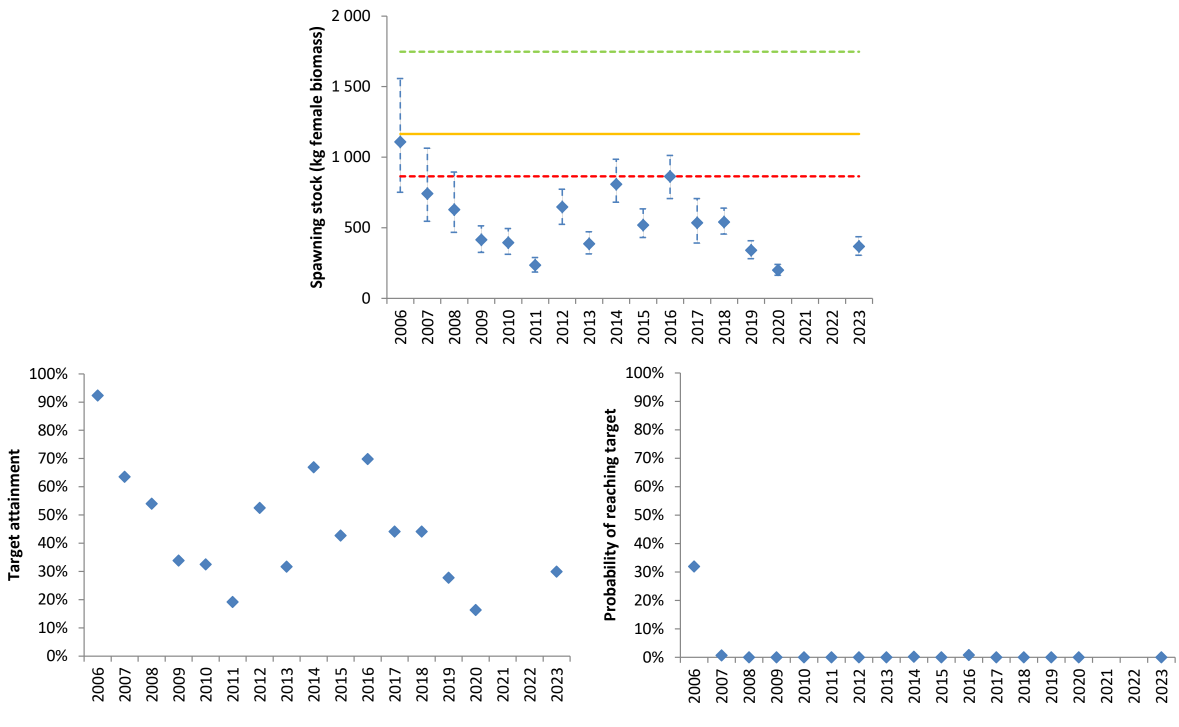


Figure 24. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2023 in the Norwegian tributary Lákšjohka.

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 (males and females) PFA of salmon belonging to the Lákšjohka stock has varied from a maximum of 3 716 kg in 2007 down to 607 kg in 2023 (Figure 25; Table 12).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 Lákšjohka stock is 1 165 kg. The female PFA has varied between a maximum of 2 745 kg in 2007 down to a minimum of 367 kg in 2023 (Figure 25; Table 12).

Of the years 2006-2023, an exploitable surplus was missing in several years, and most recently in 2018-2023. As an exploitable surplus has been missing in more than two of the last four years, the Lákšjohka 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 2018-202 (Table 12). In contrast, as much as 58 % of the female PFA could have been exploited sustainably as recently as 2007.

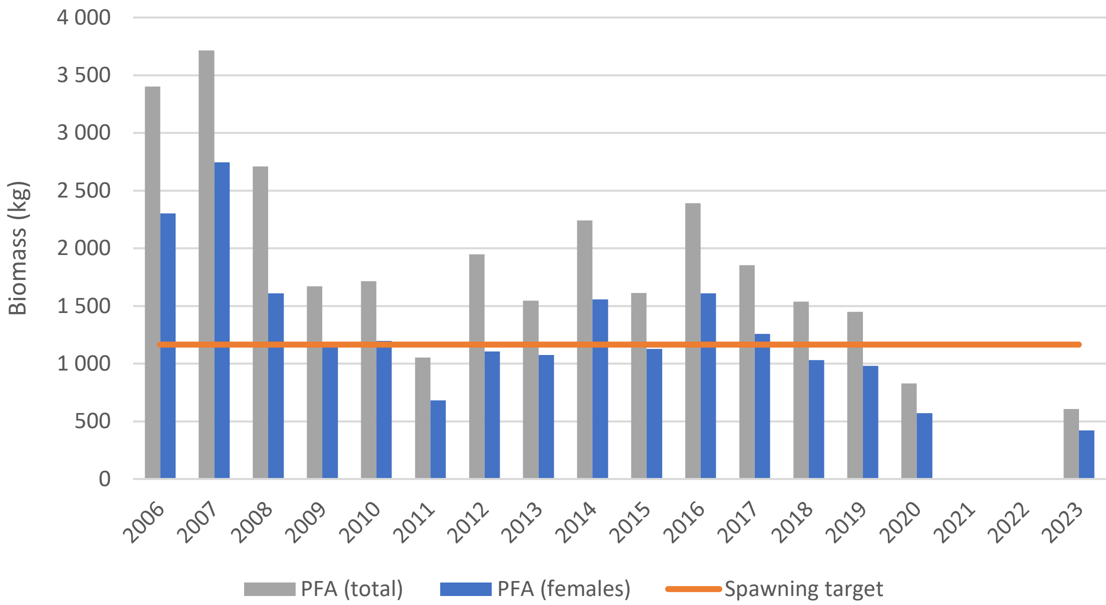


Figure 25. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Lákšjohka stock in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 12. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Lákšjohka stock in 2006-2023.

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	416	649	700	1 108	0.68	3 402	2 304	0.49
2007	531	1 742	439	741	0.74	3 716	2 745	0.58
2008	545	649	459	629	0.59	2 710	1 611	0.28
2009	323	412	336	414	0.69	1 672	1 152	0.00
2010	335	580	237	394	0.70	1 717	1 198	0.03
2011	307	164	218	235	0.65	1 052	681	0.00
2012	312	266	229	647	0.57	1 948	1 105	0.00
2013	281	526	183	387	0.69	1 547	1 074	0.00
2014	340	642	99	808	0.69	2 243	1 558	0.25
2015	233	503	134	520	0.70	1 614	1 127	0.00
2016	395	561	155	863	0.67	2 391	1 611	0.28
2017	344	661	61	535	0.68	1 853	1 258	0.07
2018	371	294	65	541	0.67	1 537	1030	0.00
2019	234	604	109	340	0.68	1 449	982	0.00
2020	169	335	35	200	0.69	829	572	0.00
2021	68	0	0	-	-	-	-	-
2022	85	0	0	-	-	-	-	-
2023	79	0	0	367	0.70	607	422	0.00

3.5 Ohcejohka/Utsjoki + tributaries

Ohcejohka/Utsjoki is one of the largest tributaries of the Tana/Teno with a catchment area of 1 665 km^2. The river flows 66 km in a mountain valley before connecting to the Tana/Teno 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.

3.5.1 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 13. Female proportions were estimated 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 used to convert the video counts 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 high water level conditions.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 13 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 13. 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	-
2023	-	850	523	2.35	-	0.59	-

The spawning target attainment was 90 % in 2023 and the probability of meeting the spawning target was 22 %. The management target was not reached as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 55 % with an overall attainment of 103 % (Figure 26).

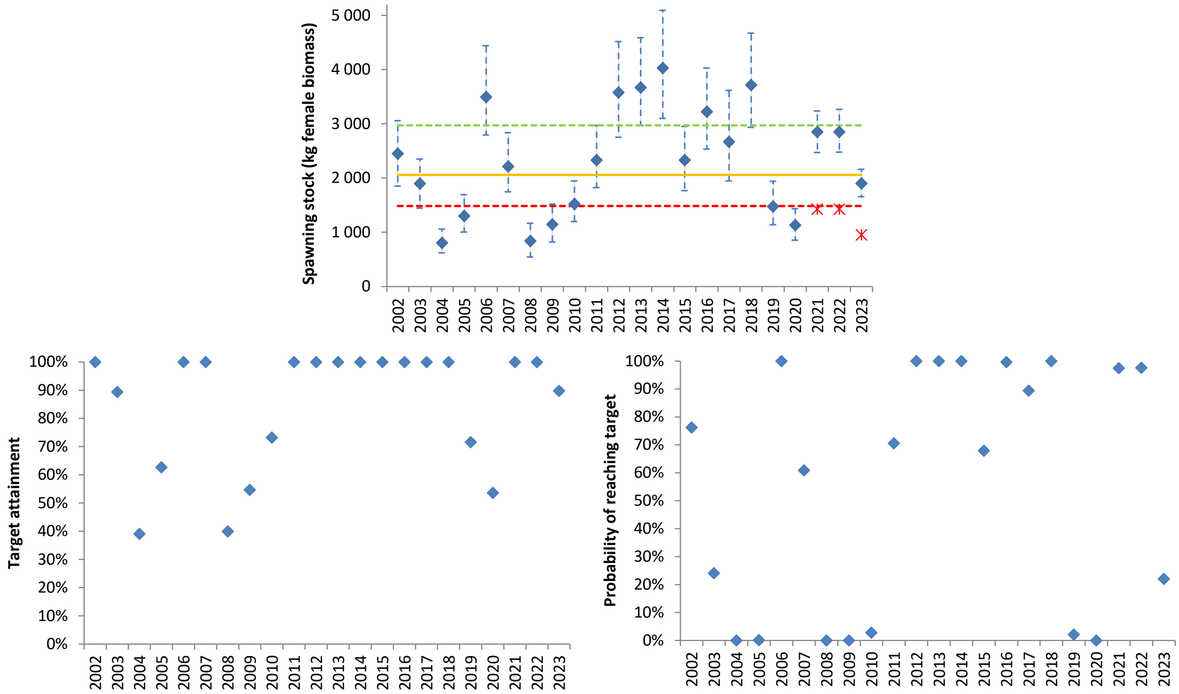


Figure 26. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2002-2023 in the Finnish tributary Ohcejohka/Utsjoki. The red symbol in the upper panel shows what the spawning stock size would have been in 2021-2023 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 (males and females) PFA of salmon belonging to the Ohcejohka/Utsjoki stock complex has varied from a maximum of 16 372 kg in 2006 down to 3 839 kg in 2023 (Figure 27; Table 14).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 2 251 kg in 2023 (Figure 27; Table 14).

With the management target at 55 %, the Ohcejohka/Utsjoki stock complex has to be put in the yellow status category. There have been an exploitable surplus of salmon belonging to the Ohcejohka/Utsjoki stock complex in all years of the period 2006-2023. The estimated sustainable exploitation rate was however at its lowest observed level in 2023 with 9 % (Table 14).

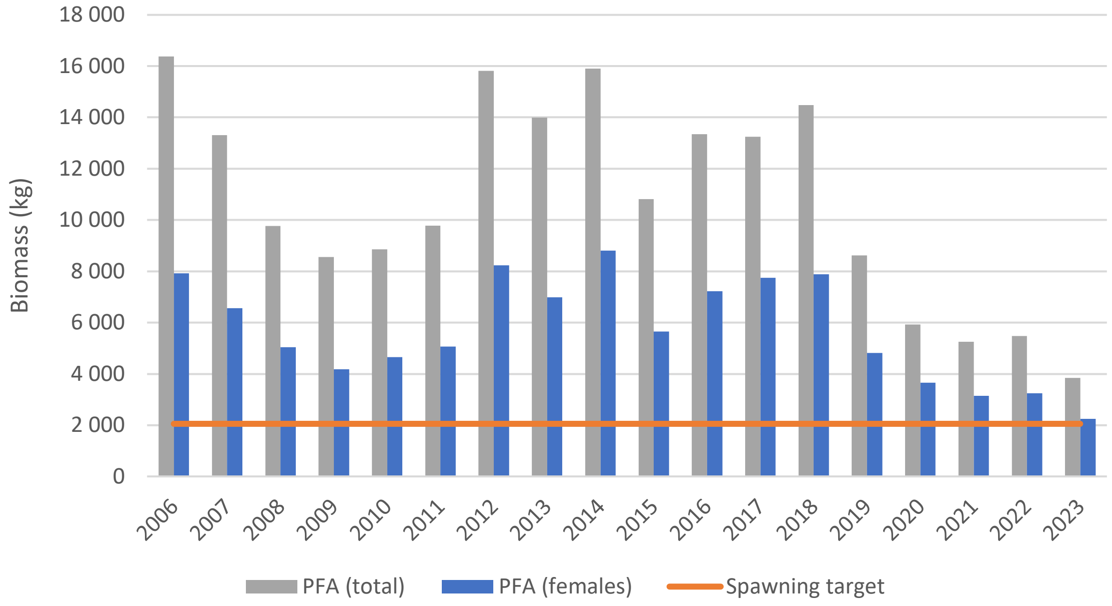


Figure 27. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock complex in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 14. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock complex in 2006-2023.

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
2023	595	0	0	1 902	0.59	3 839	2 251	0.09

3.6 Leavvajohka

Leavvajohka is a middle-sized tributary (catchment area 313 km^2) running into the Tana/Teno main stem almost 140 km from the Tana/Teno estuary. It is a relatively long and fast-running river with no tributaries and relatively few pools. For this reason, Leavvajohka is not considered an attractive fishing place for anglers, and there are only a few fishermen visiting each year. The salmon stock is small-sized, dominated by 1SW and small 2SW salmon.

3.6.1 Spawning stock

Before 2019, Leavvajohka was evaluated using a spawning target calculated from a salmon distribution area that was too restricted. A new salmon distribution area (based on local knowledge and a survey) was therefore established in 2019. This new area covered Leavvajohka all the way up to a point between Suonjirgáisá and Uhcagáisá. The resulting revised Leavvajohka spawning target is 1 119 162 eggs (559 581-1 678 743 eggs). The female biomass needed to obtain this egg deposition is 466 kg (233-699 kg) when using a stock-specific fecundity of 2 400 eggs kg^{-1}.

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

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

The data input for the variables in this formula are summarized in Table 15. Female proportions in Table 15 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 the other years are the 5-year average from Genmix weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project. Newer SNP-based proportions were used in 2017-2020.

There are limited catches of salmon from Leavvajohka and no monitoring or fish counting either. The status must therefore be evaluated by alternative means. One feasible approach is to use the proportion of salmon belonging to Leavvajohka that are found in the main stem fisheries and an estimate of the main stem exploitation rate. We have direct estimates of the main stem proportion of Leavvajohka salmon in 2006-2008 and 2011-2012 and can use the average from these five years to cover the remaining years in the period 2006-2016.

Before 2017, the main stem exploitation rate was estimated to be 45 %. This estimate was based on the location of Leavvajohka along the Tana/Teno main stem and the main stem exploitation of other stocks. The main stem exploitation rate estimate was reduced by 10 % from previous years in 2017 due to the implementation of new fishing rules in Tana/Teno. The exploitation estimate was further reduced by 20 % in 2018 as indicated by the combined main stem and tributary fish counting (Table 15).

We were unable to calculate spawning stocks for Leavvajohka in 2021 and 2022 as all salmon fisheries were closed in the Tana/Teno river system and no alternative monitoring information for Leavvajohka was available. In 2023, however, the entire Leavvajohka was snorkelled, thus providing the basis for a status assessment. A total of 241 salmon were counted by the snorkellers, distributed into 148 small-sized (43 females), 90 medium-sized (62 females) and 3 large-sized (2 females) salmon. Average sizes used for the assessment were based on five-year averages (2006-2008, 2011-2012) from the Genmix project (Falkegård *et al*. 2023) and set to 1.4 kg for the small-sized, 2.7 kg for the medium-sized and 3.8 kg for the large-sized groups. The snorkelling detection rate was estimated to 0.85.

When interpreting the results of the Leavvajohka status assessment, it is important to acknowledge that the snorkelling in 2023 represents the first year with more reliable data from Leavvajohka itself while the assessments in earlier years were based on less certain assumptions about main stem exploitation rates and catch proportions that might have led to an overestimate of the Leavvajohka spawning stock. This possible problem is well illustrated by the Njiljohka/Nilijoki assessment and further discussed in chapter 4.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 15 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 the female proportions in Table 15. 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 466 kg as the mode, 233 kg as the minimum and 699 kg as the maximum value.

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

Table 15. Summary of stock data used to estimate annual spawning stock sizes in Leavvajohka in 2006-2020.

Year	Estimated main stem catch (kg)	Main stem proportion	Main stem exploitation rate	Female proportion
2006	1 167	0.0131	0.45	0.50
2007	1 863	0.0211	0.45	0.80
2008	1 364	0.0130	0.45	0.62
2009	696	0.0130	0.45	0.52
2010	981	0.0130	0.45	0.56
2011	415	0.0061	0.45	0.59
2012	1 037	0.0113	0.45	0.48
2013	890	0.0130	0.45	0.56
2014	1 085	0.0130	0.45	0.52
2015	850	0.0130	0.45	0.57
2016	948	0.0130	0.45	0.56
2017	1 296	0.0245	0.40	0.58
2018	756	0.0180	0.35	0.52
2019	1 040	0.0310	0.35	0.56
2020	657	0.0245	0.35	0.57

The spawning target attainment was 61 % in 2023 and the probability of meeting the spawning target was 2 % (Figure 28). The management target, calculated based on the two last years of data (2020 and 2023), was not reached as the probability was 59 % with an overall attainment of 112 % (Figure 28).

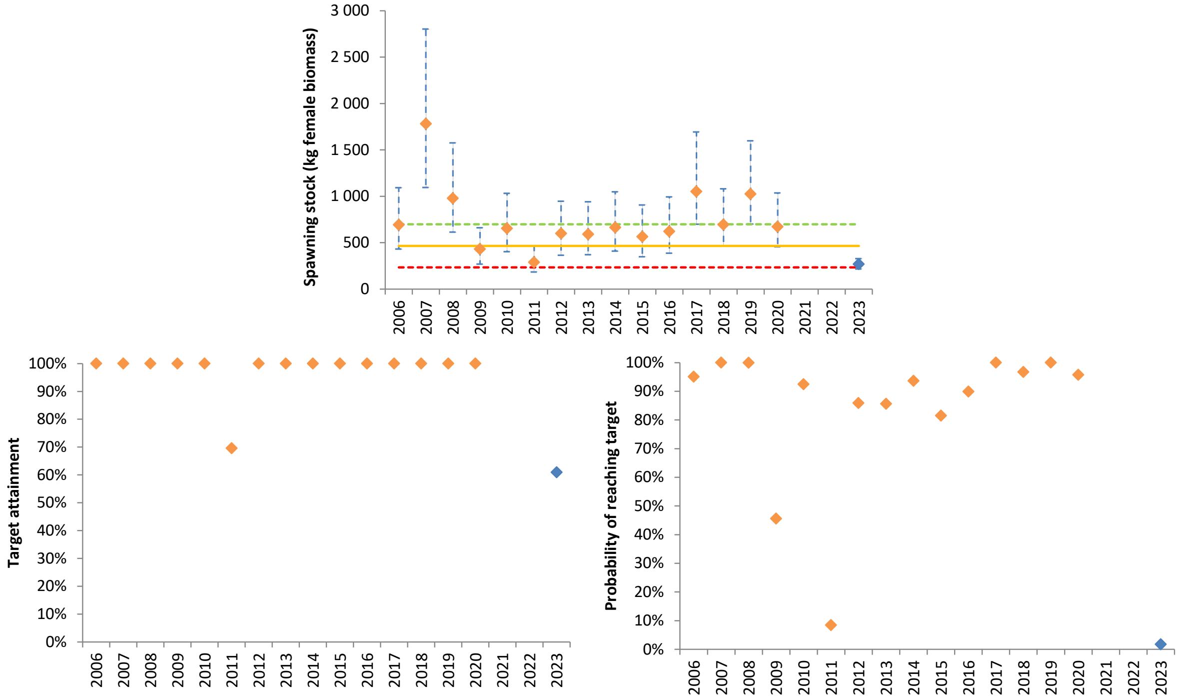


Figure 28. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2023 in the Norwegian tributary Leavvajohka. The orange symbols in the panels show the years with the alternative assessment approach based on genetic proportions of main stem catch.

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 (males and females) PFA of salmon belonging to the Leavvajohka stock has varied from a maximum of 5 269 kg in 2007 down to 703 kg in 2023 (Figure 29; Table 16).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 Leavvajohka stock is 466 kg. The female PFA has varied between a maximum of 4 215 kg in 2007 down to a minimum of 269 kg in 2023 (Figure 29; Table 16).

Of the years 2006-2023, an exploitable surplus was missing in 2023. Over the last four years, spawning stocks and PFAs were only estimated for 2020 and 2023. The relatively low spawning stock in Leavvajohka in 2023 compared to earlier years corresponds well to the negative development seen elsewhere in the Tana/Teno river system over the last four years, and it is likely that the two years with missing estimates (2021, 2022) were at a low level corresponding with other Tana/Teno stocks. It is also worth noting that 2023 was the first year with reliable adult data collected from the Leavvajohka itself, whilst the assessment in earlier years relied on more uncertain main stem stock proportions and estimates of exploitation rates, which may have given too positive results.

Based on this, the Leavvajohka stock should be placed at least at an orange status category, meaning that exploitation should be strictly controlled, and a formal stock recovery plan should be implemented. The lack of an exploitable surplus in 2023 is reflected in the sustainable exploitation rate that was estimated at 0 % (Table 16). In contrast, as much as 89 % of the female PFA could have been exploited sustainably as recently as 2007.

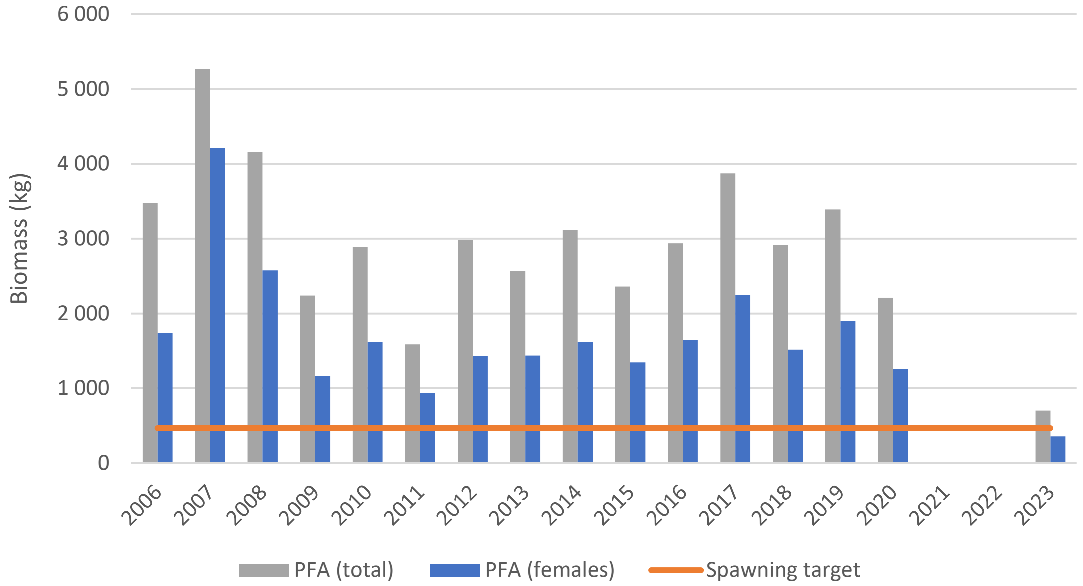


Figure 29. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Leavvajohka stock in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 16. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Leavvajohka stock in 2006-2023.

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	926	1 167	0	692	0.50	3 477	1 738	0.73
2007	1 180	1 863	0	1 780	0.80	5 269	4 215	0.89
2008	1 212	1 364	0	978	0.62	4 154	2 576	0.82
2009	718	696	0	430	0.52	2 241	1 165	0.60
2010	744	981	0	653	0.56	2 891	1 619	0.71
2011	683	415	0	289	0.59	1 587	936	0.50
2012	694	1 037	0	599	0.48	2 979	1 430	0.67
2013	624	890	0	591	0.56	2 570	1 439	0.68
2014	755	1 085	0	664	0.52	3 117	1 621	0.71
2015	518	850	0	565	0.57	2 360	1 345	0.65
2016	877	948	0	622	0.56	2 936	1 644	0.72
2017	764	1 296	0	1 052	0.58	3 873	2 246	0.79
2018	824	756	0	693	0.52	2 914	1 515	0.69
2019	521	1 040	0	1 026	0.56	3 393	1 900	0.75
2020	376	657	0	671	0.57	2 210	1 260	0.63
2021	150	0	0	-	-	-	-	-
2022	188	0	0	-	-	-	-	-
2023	175	0	0	269	0.51	703	358	0.00

3.7 Báišjohka

Báišjohka is a small-sized tributary entering the Tana main stem from the west approximately 160 km from the estuary. We have few catch records from Báišjohka, and there are few anglers visiting the river each summer. Báišjohka flows very broadly and shallow at places in its lowermost part, so salmon migration into the river is likely water-level dependent.

3.7.1 Spawning stock

The Báišjohka spawning target is 946 688 eggs (711 516-1 423 032 eggs). The female biomass needed to obtain this egg deposition is 395 kg (296-593 kg) when using a stock-specific fecundity of 2 400 eggs kg^{-1}.

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

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

The data input for the variables in this formula are summarized in Table 17. Female proportions in Table 17 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix weighted with 50 % of the up or down variation of the annual female proportion observed in the Tana scale sampling project.

There is no catch statistics from Báišjohka and no monitoring or fish counting either. The status therefore must be evaluated by alternative means. One feasible approach is to use the proportion of salmon belonging to Báišjohka that are found in the main stem fisheries and an estimate of the main stem exploitation rate. We have microsatellite-based estimates of the main stem proportion of Báišjohka salmon in 2006-2008 and 2011-2012 and can use the average from these five years to cover the remaining years in the period 2006-2016. Newer SNP-based estimates were used for 2018 and 2019, and an average SNP proportion was used in 2017 and 2020.

The main stem exploitation is estimated at 45 % based on the location along the Tana main stem and the main stem exploitation of other stocks. The main stem exploitation rate estimate in 2017 was reduced by 10 % from previous years in 2017 due to the implementation of new fishing rules in Tana. The exploitation estimate was reduced to 0.35 % in 2018-2020 as indicated by the combined main stem and tributary fish counting (Table 17).

We were unable to calculate spawning stocks for Báišjohka in 2021 and 2022 as all salmon fisheries were closed in the Tana/Teno river system and no alternative monitoring information for Báišjohka was available. In 2023, however, the entire Báišjohka was snorkelled, thus providing the basis for a status assessment. A total of 79 salmon were observed in the snorkelling, distributed into 59 small-sized (26 females) and 20 medium-sized (10 females) salmon. Snorkelling detection rate was set to 0.85. Average sizes used for the assessment were based on five-year averages (2006-2008, 2011-2012) from the Genmix project (Falkegård *et al*. 2023) and set to 1.5 kg for the small-sized and 3.3 kg for the medium-sized groups.

When interpreting the results of the Báišjohka status assessment, it is important to acknowledge that the snorkelling in 2023 represents the first year with more reliable data from Báišjohka itself while the assessments in earlier years were based on less certain assumptions about main stem exploitation rates and catch proportions that might have led to an overestimate of the Báišjohka spawning stock. This possible problem is well illustrated by the Njiljohka/Nilijoki assessment and further discussed in chapter 4.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 17 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 395 kg as the mode, 296 kg as the minimum and 593 kg as the maximum value.

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

Table 17. Summary of stock data used to estimate annual spawning stock sizes in Báišjohka.

Year	Estimated main stem catch (kg)	Main stem proportion	Main stem exploitation rate	Female proportion
2006	473	0.0053	0.45	0.49
2007	1 026	0.0116	0.45	0.77
2008	813	0.0078	0.45	0.75
2009	381	0.0071	0.45	0.57
2010	536	0.0071	0.45	0.61
2011	207	0.0030	0.45	0.44
2012	701	0.0077	0.45	0.57
2013	487	0.0071	0.45	0.61
2014	593	0.0071	0.45	0.57
2015	465	0.0071	0.45	0.62
2016	518	0.0071	0.45	0.62
2017	529	0.0130	0.40	0.64
2018	546	0.0130	0.35	0.57
2019	507	0.0160	0.35	0.62
2020	348	0.0130	0.35	0.62

The spawning target attainment was 20 % in 2023 and the probability of meeting the spawning target was 0 % (Figure 30). The management target, calculated based on the two last years of data (2020 and 2023), was not reached as the probability was 1 % with an overall attainment of 66 % (Figure 30).

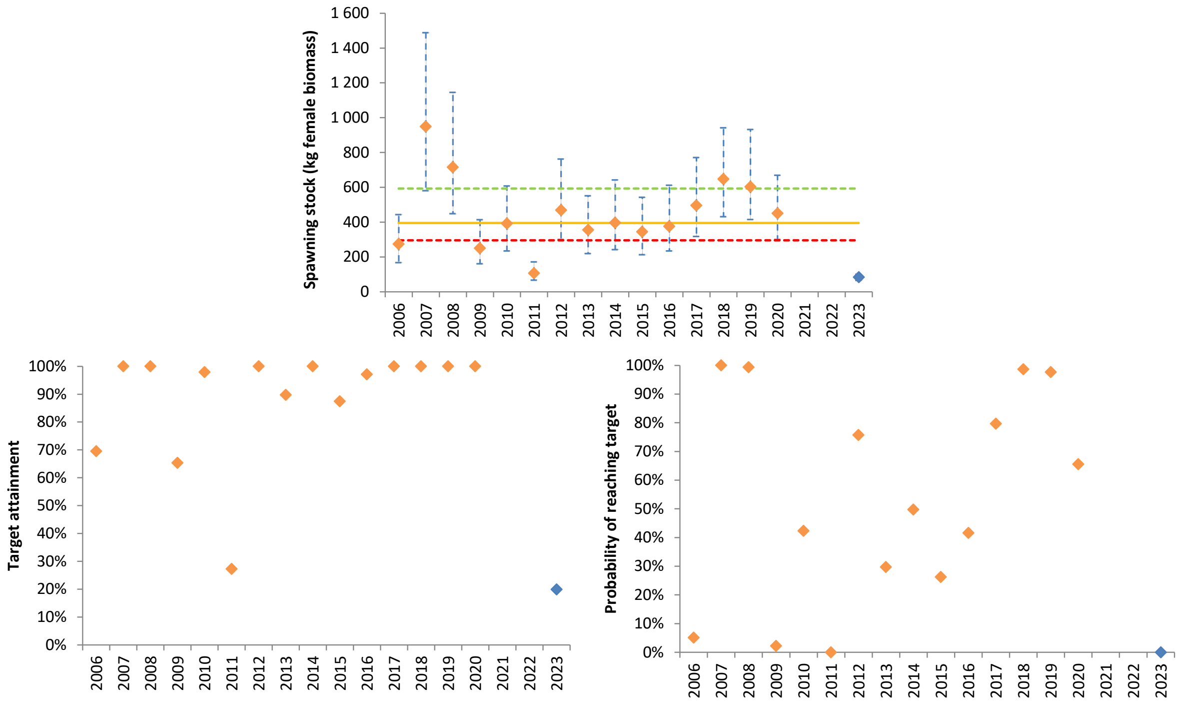


Figure 30. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2023 in the Norwegian tributary Báišjohka. The orange symbols in the panels show the years with the alternative assessment approach based on genetic proportions of main stem catch.

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 (males and females) PFA of salmon belonging to the Báišjohka stock has varied from a maximum of 2 928 kg in 2007 down to 279 kg in 2023 (Figure 32; Table 19).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 Báišjohka stock is 395 kg. The female PFA has varied between a maximum of 2 255 kg in 2007 down to a minimum of 130 kg in 2023 (Figure 32; Table 19).

Of the years 2006-2023, an exploitable surplus was missing in 2023. Over the last four years, spawning stocks and PFAs were only estimated for 2020 and 2023. The relatively low spawning stock in Báišjohka in 2023 compared to earlier years corresponds well to the negative development seen elsewhere in the Tana/Teno river system over the last four years, and it is likely that the two years with missing estimates (2021, 2022) also were at a low level with missing exploitable surplus, corresponding with other Tana/Teno stocks. It is also worth noting that 2023 was the first year with reliable adult data collected from the Báišjohka itself, whilst the assessment in earlier years relied on more uncertain main stem stock proportions and estimates of exploitation rates, which may have given too positive results.

Based on this, the Báišjohka stock should be placed at a 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 2023 is reflected in the sustainable exploitation rate that was estimated at 0 % (Table 19). In contrast, as much as 82 % of the female PFA could have been exploited sustainably as recently as 2007.

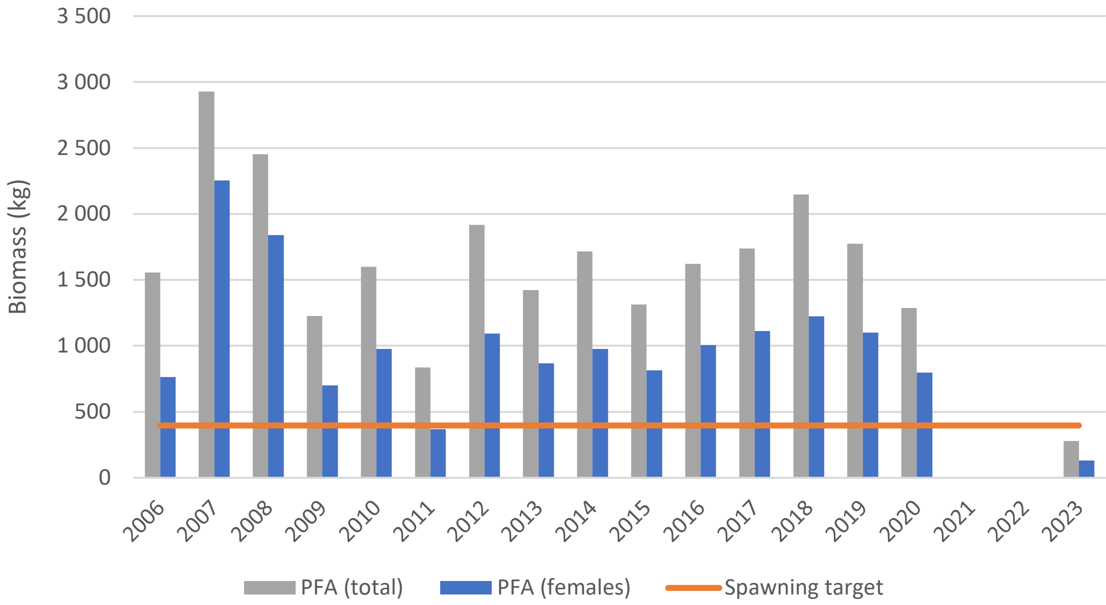


Figure 31. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Báišjohka stock in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 18. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Báišjohka stock in 2006-2023.

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	525	473	0	273	0.49	1 556	763	0.48
2007	669	1 026	0	949	0.77	2 928	2 255	0.82
2008	687	813	0	716	0.75	2 454	1 841	0.79
2009	407	381	0	250	0.57	1 227	699	0.44
2010	422	536	0	392	0.61	1 600	976	0.60
2011	387	207	0	106	0.44	836	368	0.00
2012	393	701	0	469	0.57	1 917	1 093	0.64
2013	354	487	0	355	0.61	1 422	868	0.54
2014	428	593	0	396	0.57	1 716	978	0.60
2015	294	465	0	344	0.62	1 313	814	0.51
2016	497	518	0	376	0.62	1 622	1 006	0.61
2017	433	529	0	496	0.64	1 737	1 112	0.64
2018	467	546	0	647	0.57	2 148	1 225	0.68
2019	295	507	0	603	0.62	1 775	1 100	0.64
2020	213	348	0	450	0.62	1 288	798	0.51
2021	85	0	0	-	-	-	-	-
2022	107	0	0	-	-	-	-	-
2023	99	0	0	84	0.47	279	130	0.00

3.8 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 Báišjohka. 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.

3.8.1 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 19. Female proportions in Table 19 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 19 are based on a combination of main stem Genmix samples from 2006-2008 and 2011-2012.

Table 19. 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
2023	55	14	1.3	3.6	0.75	0.7	0.49	0.86

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 Tana/Teno main stem fisheries and an estimate of the main stem exploitation rate (Table 20). 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.

When interpreting the results of the Njiljohka/Nilijoki status assessment, it is evident that the current approach based on less certain assumptions about main stem exploitation rates and catch proportions likely overestimates the Njiljohka/Nilijoki spawning stock compared to the assessment approach based on more reliable snorkelling counts. See chapter 4 for a further discussion.

Table 20. 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 19 and Table 20 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 in 2023 was 63 % and the probability of meeting the spawning target was 0 % (Figure 32). The management target was not reached as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 54 %.

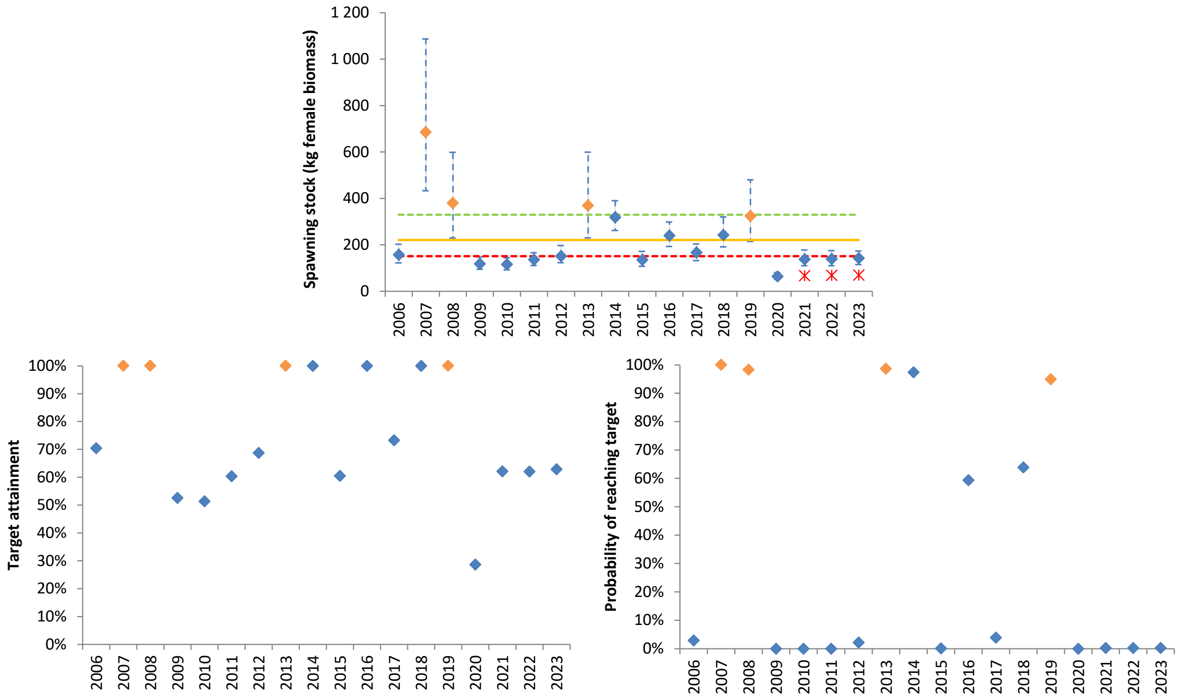


Figure 32. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2023 in the Finnish tributary Njiljohka/Nilijoki. The orange symbols in the panels show the years with the alternative assessment approach based on genetic proportions of main stem catch. The red symbols in the upper panel show what the spawning stock size would have been in 2021-2023 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 (males and females) PFA of salmon belonging to the Njiljohka/Nilijoki stock has varied from a maximum of 2 117 kg in 2007 down to 327 kg in 2023 (Figure 33; Table 21).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 33; Table 21).

Of the years 2006-2023, an exploitable surplus was missing in 2021-2023. As an exploitable surplus has been missing in three 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 2021-2023 (Table 21). In contrast, as much as 87 % of the female PFA could have been exploited sustainably as recently as 2007.

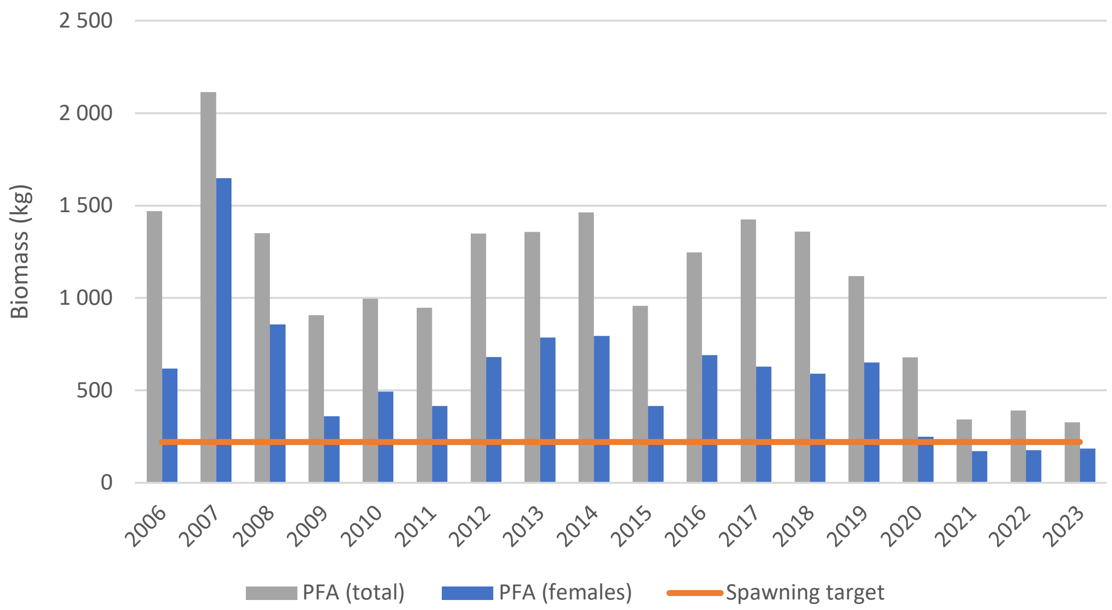


Figure 33. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female 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 Njiljohka/Nilijoki stock in 2006-2023.

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	0.45	389	177	0.00
2023	76	0	0	142	0.57	327	185	0.00

3.9 Ástejohka

The river Ástejohka is a tributary of Váljohka, a relatively small-sized river flowing into the Tana/Teno main stem approximately 175 km from the Tana/Teno estuary. The relatively fast-running Ástejohka has 18 km river length available for salmon production and enters Stuorrajávri, the lowermost lake in Váljohka, just to the west of where Váljohka enters.

The Ástejohka spawning target is 388 562 eggs (194 281-582 843 eggs). The female biomass needed to obtain this egg deposition is 159 kg (79-238 kg) when using a stock-specific fecundity of 2 450 eggs kg^{-1}.

Spawning salmon have been counted two times with autumn snorkelling, in 2015 and 2023. The count in 2015 was done relatively early (31.07.2015) and any salmon entering the river in August were therefore missed. In total, 85 small-sized and 15 medium-sized salmon were observed. The count in 2023 (see chapter 2.3.3) found 48 small-sized (14 females, 20 unknown), 54 medium-sized (30 females) and 1 large-sized female. Detection rate was set to 0.7 in 2015 and 0.8 in 2023. Female proportions, based on the 2023 count, were 0.5 for small-sized, 0.56 for medium-sized and 1.0 for large-sized salmon. Average female sizes (based on Genmix samples from 2006-2008 and 2011-2012) were 1.6 kg for the small-sized, 3.4 kg for the medium-sized and 4.6 for the large-sized group.

The spawning target attainment was 84 % in 2015 and 116 % in 2023. The probability of meeting the spawning target was 20 % in 2015 and 67 % in 2023 (Figure 34).

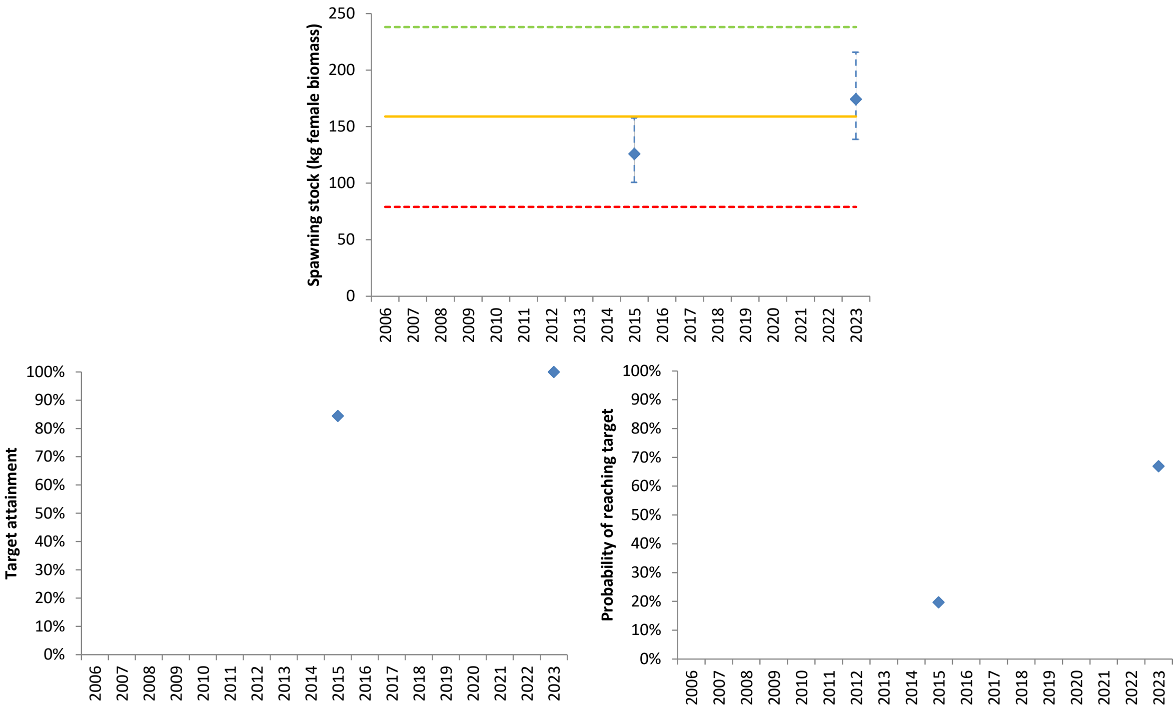


Figure 34. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the years 2015 and 2023 in the Norwegian river Ástejohka. Note that the 2015 target attainment estimate is based on snorkelling count conducted 31.7. and all salmon ascending to Ástejohka in August are missing. Therefore the 2015 attainment level is clearly a minimum estimate.

3.10 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.

3.10.1 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 2003-2023. 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 22. Female proportions in Table 22 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 22 are based on salmon samples from Áhkojohka/Akujoki in 2007 and 2011. Area covered under snorkelling is 100 % of the salmon distribution area in Áhkojohka/Akujoki each year.

Table 22. 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	-
2023	37	19	1.3	3.6	0.80	1	0.38	0.79	-

To account for uncertainty, the exploitation rate and female proportion estimates in Table 22 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 67 % in 2023 and the probability of meeting the spawning target was 1 %. The management target was not reached, as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 56 % (Figure 35).

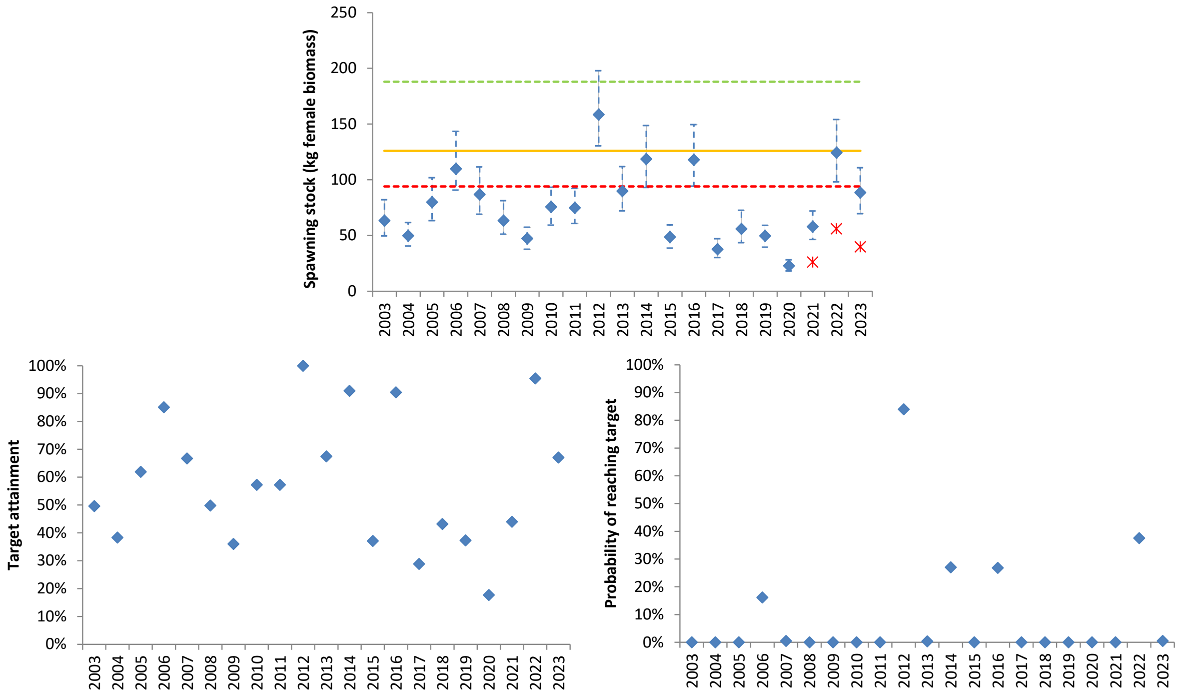


Figure 35. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2023 in the Finnish tributary Áhkojohka/Akujoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021-2023 if fishing had continued.

3.10.2 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 (males and females) 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 36; Table 23).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 36; Table 23).

Of the years 2006-2023, an exploitable surplus was missing in 2021 and 2023. As the management target was 0 % and an exploitable surplus were missing in two of the last four years, the Áhkojohka/Akujoki stock is placed in the red status category, meaning that no exploitation should take place 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, 2023) and 81 % (2019) in the last five years (Table 23).

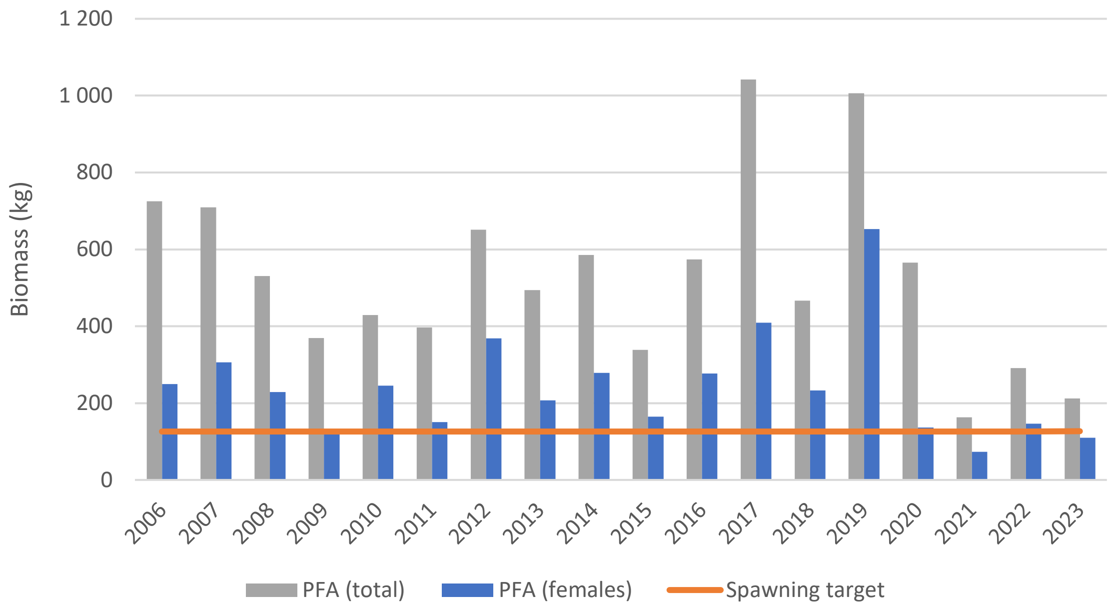


Figure 36. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female 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 23. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in 2006-2023. 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
2023	43	0	0	88	0.52	213	110	0.00

3.11 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 surveys, however, show 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.

3.11.1 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 24. Female proportions in Table 24 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are the 5-year average from Genmix.

There were sonar counting of fish in 2010, 2012 and 2017-2023 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 24). Note that the 2020 exploitation rates were reduced in this report compared to previous assessments because of revisions to the localization of parts of the 2020 Kárášjohka catch.

Because the Tana/Teno salmon fisheries were closed in 2021-2023, the spawning stocks in these three years were estimated based on the sonar counts at Heastanjárga. The counts are summarized in chapter 2.3.4.

Table 24. Summary of stock data used to estimate annual spawning stock sizes in Kárášjohka. The catch data are a combination of reported catches in upper Kárášjohka and an estimated Kárášjohka catch below the confluence with Iešjohka based on genetic proportions.

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	-
2023	-	-	-	-	-	-	0.09	0.71	0.73	-

To account for uncertainty, the exploitation rate and female proportion estimates in Table 24 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 59 % in 2023 and the probability for meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 55 % (Figure 37). In terms of spawning stock development, it is worth noting an overall positive trend with the target attainment in 2020-2023 being the best throughout the entire 18-year period that have been assessed. This positive development can be traced back to a significant decline in overall exploitation (Table 24), especially with the closed fisheries of 2021-2023.

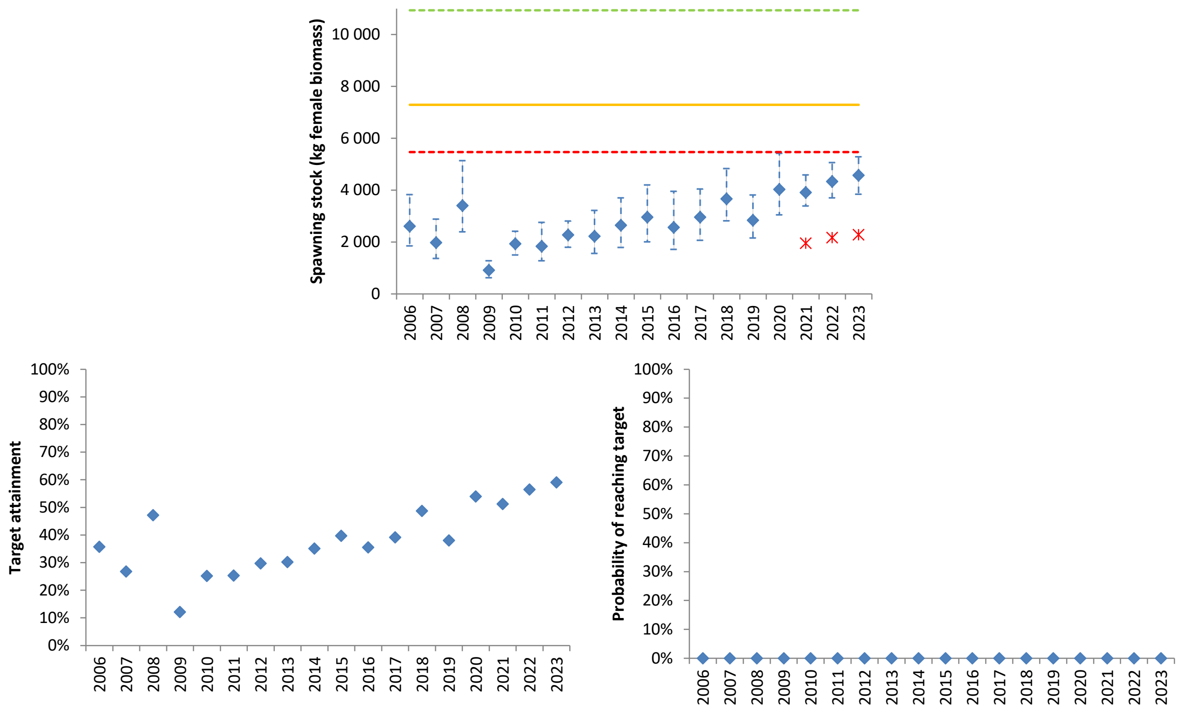


Figure 37. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2023 in the Norwegian tributary Kárášjohka. The red symbol in the upper panel show what the spawning stock size would have been in 2021-2023 if fishing had continued.

For 2023, snorkelling data from Geaimmejohka can be used to estimate the local spawning target attainment of this small tributary to the Kárášjohka. The spawning target of Geaimmejohka is 105 kg (78-157 kg). A total of 70 salmon were observed, of which 38 were 1SW-, 28 2SW- and 4 3SW-sized.

Female counts of the different size groups were 20, 14 and 2, respectively, and average sizes (based on five-year Genmix data) were 1.6 kg, 3.3 kg and 4.2 kg. Snorkelling detection rate was estimated at 0.75.

The 2023 spawning target attainment of Geaimmejohka was 106 % and the probability of meeting the spawning target was 62 %.

3.11.2 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 (males and females) PFA of salmon belonging to the Kárášjohka stock complex has varied from a maximum of 25 818 kg in 2008 down to 8 975 kg in 2023 (Figure 38; Table 25).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 38; Table 25).

Of the years 2006-2023, an exploitable surplus has been missing in three of the latest four years (2021-2023). 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 2021-2023 (Table 25). In contrast, as much as 59 % of the female PFA could have been exploited sustainably as recently as 2008.

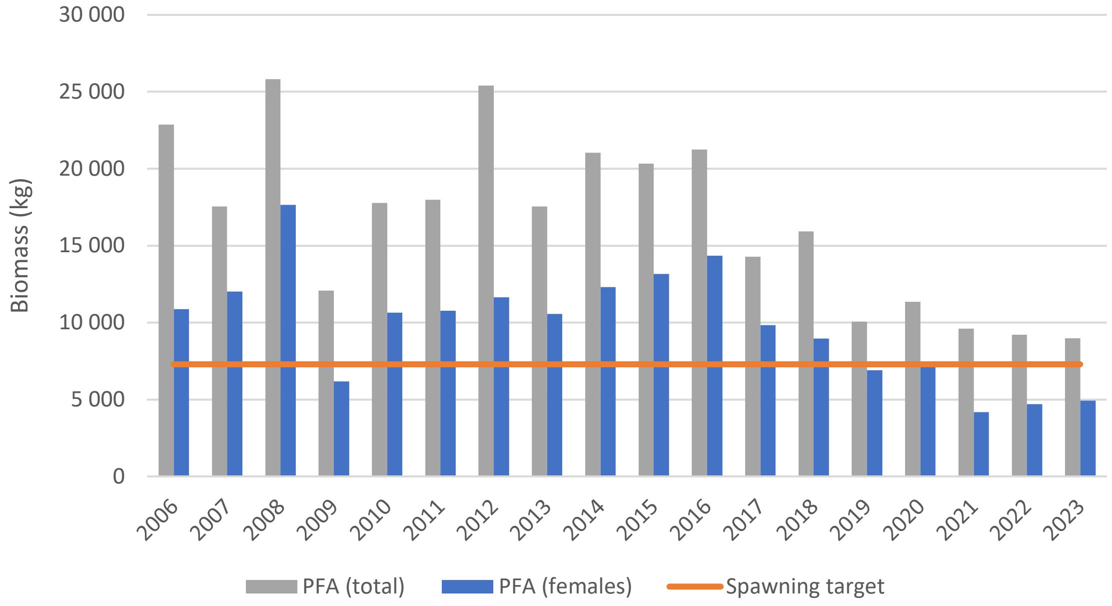


Figure 38. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock complex in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 25. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock complex in 2006-2023.

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
2023	651	0	0	4 571	0.55	8 975	4 928	0.00

3.12 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 from the river mouth. Salmon can pass this waterfall, at least at low water levels.

3.12.1 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 26. Female proportions in Table 26 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 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 26 vs. Table 24). 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 26).

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 26).

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 26).

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 26).

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 like the one used for Kárášjohka. The status assessment was based on a count of 471 salmon <65 cm, 428 salmon between 65 and 90 cm and 141 salmon ≥90 cm.

There was no fish counting in Iešjohka in 2023 so no spawning stock assessment was made for this year. However, the Iešjohka situation is likely to remain unchanged with a continuing low run size and low spawning stock.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 26 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.

Table 26. 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	-

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.

There was no counting in Iešjohka in 2023 so no updated spawning stock estimate can be provided. 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 39).

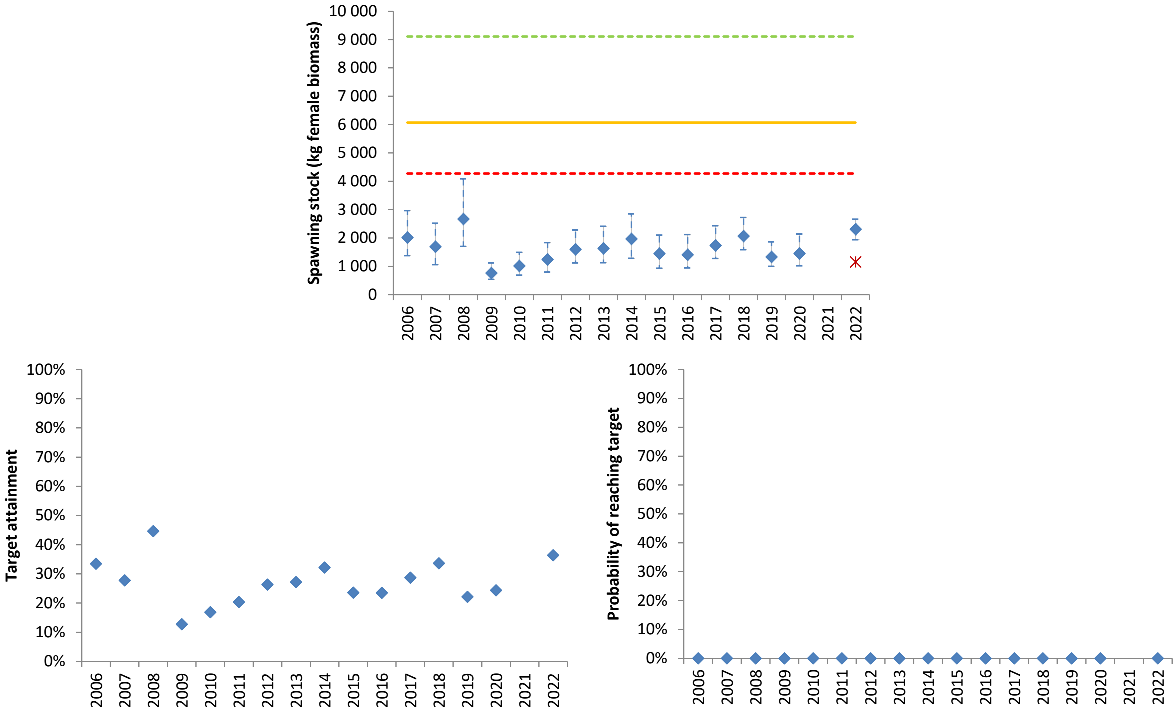


Figure 39. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2022 in the Norwegian tributary Iešjohka. The red symbol in the upper panel show what the spawning stock size would have been in 2022 if fishing had continued.

3.12.2 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 (males and females) 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 40; Table 27).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 40; Table 27).

Of the years 2006-2023, an exploitable surplus has been missing in all the latest four assessed years (2018-2020 and 2022). The situation was most likely similar also in 2021 and 2023. 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 27). In contrast, as much as 56 % of the female PFA could have been exploited sustainably as recently as 2008.

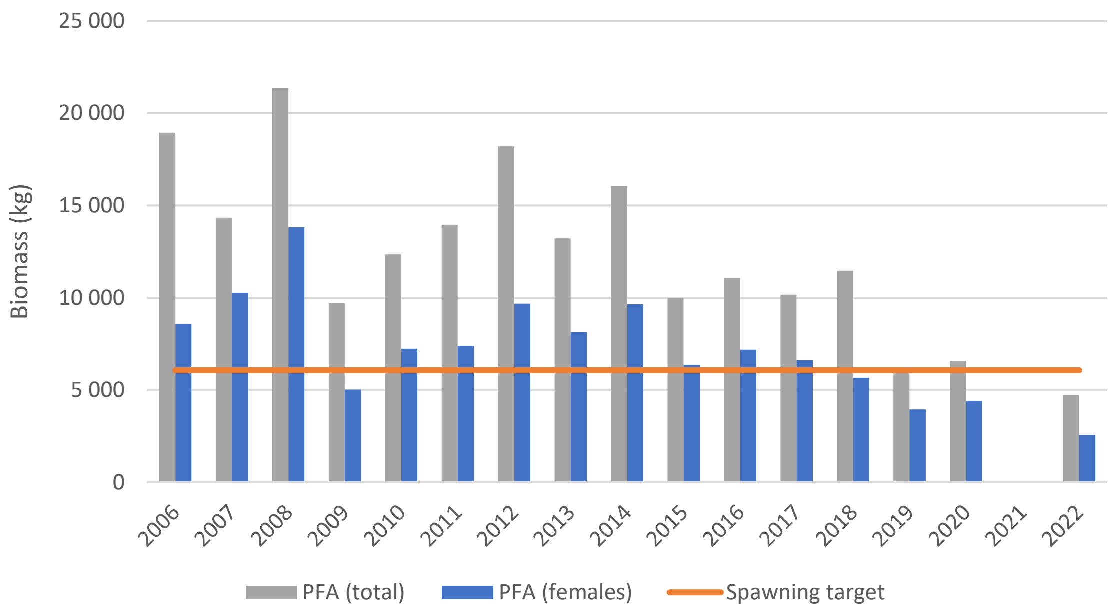


Figure 40. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Iešjohka stock in the period 2006-2022. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 27. 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

3.13 Anárjohka/Inarijoki + tributaries

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

3.13.1 Status assessment

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

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

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

The data input for the variables in this formula are summarized in Table 28. Female proportions in Table 28 in the years 2006-2008 and 2011-2012 are based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years are based on the size composition of the catch and the 5-year Genmix average female proportion of different size groups.

There have been no attempts at counting salmon in Anárjohka/Inarijoki before 2018. Sonar counting in Anárjohka/Inarijoki in 2018 indicate an exploitation rate of 0.14 and this estimate was used for 2018

(Table 28). A similar level of exploitation (0.15) was estimated from the counting in 2019. We used the same level of exploitation in 2017 and 2020, as a combination of difficult fishing conditions, few active fishermen and new regulatory measures aimed at decreasing exploitation likely led to significantly lower exploitation than previous years.

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

Because the Tana/Teno salmon fisheries were closed in 2021-2023, spawning stocks in these years had to be estimated based only on the Anárjohka/Inarijoki sonar counts in 2021 and 2023. These counts are summarized in chapter 2.3.4.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 28 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 6 072 kg as the mode, 4 278 kg as the minimum and 9 107 kg as the maximum value.

Table 28. Summary of stock data used to estimate annual spawning stock sizes in Anárjohka/Inarijoki.

Year	Catch (kg)	Exploitation rate	Female proportion	Main stem proportion
2006	4 137	0.40	0.47	0.1903
2007	2 266	0.40	0.74	0.1648
2008	2 323	0.40	0.64	0.0755
2009	2 005	0.40	0.45	0.1516
2010	2 442	0.40	0.62	0.1516
2011	1 908	0.40	0.45	0.1370
2012	4 285	0.40	0.50	0.1920
2013	1 986	0.40	0.62	0.1516
2014	2 832	0.40	0.60	0.1516
2015	1 881	0.40	0.65	0.1516
2016	1 654	0.40	0.57	0.1516
2017	639	0.15	0.64	0.1845
2018	788	0.14	0.51	0.1650
2019	564	0.15	0.62	0.2040
2020	326	0.15	0.58	0.1845
2021	-	-	0.46	-
2022	-	-	-	-
2023	-	-	0.50	-

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

The spawning target attainment was 35 % in 2023 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 26 % (Figure 41).

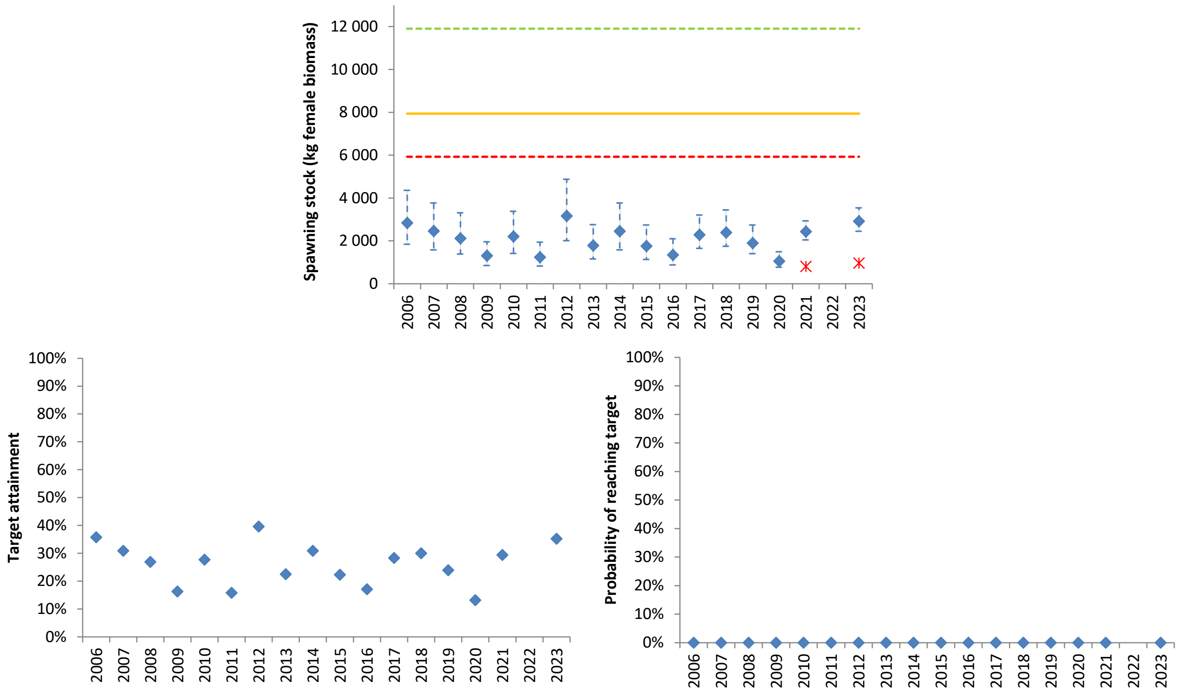


Figure 41. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2023 in the tributary Anárjohka/Inarijoki. The red symbols in the upper panel show what the spawning stock size would have been in 2021 and 2023 if fishing had continued.

3.13.2 Pre-fishery abundance

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 (males and females) PFA of salmon belonging to the Anárjohka/Inarijoki stock complex has varied from a maximum of 31 891 kg in 2006 and 31 888 kg in 2012 down to 5 913 kg in 2021 (Figure 42; Table 29).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The proportion of the annual female 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 Anárjohka/Inarijoki stock complex is 7 937 kg. The female PFA has varied between a maximum of 18 868 kg in 2007 down to a minimum of 2 720 kg in 2021 (Figure 42; Table 29).

Of the years 2006-2023, an exploitable surplus has been missing in three of the latest four years (2020-2021, 2023), and likely also in 2022 when the river was not assessed. As an exploitable surplus has been missing in three out of four years, the Anárjohka/Inarijoki 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 2020-2023 (Table 29). In contrast, as much as 58 % of the female PFA could have been exploited sustainably as recently as 2007.

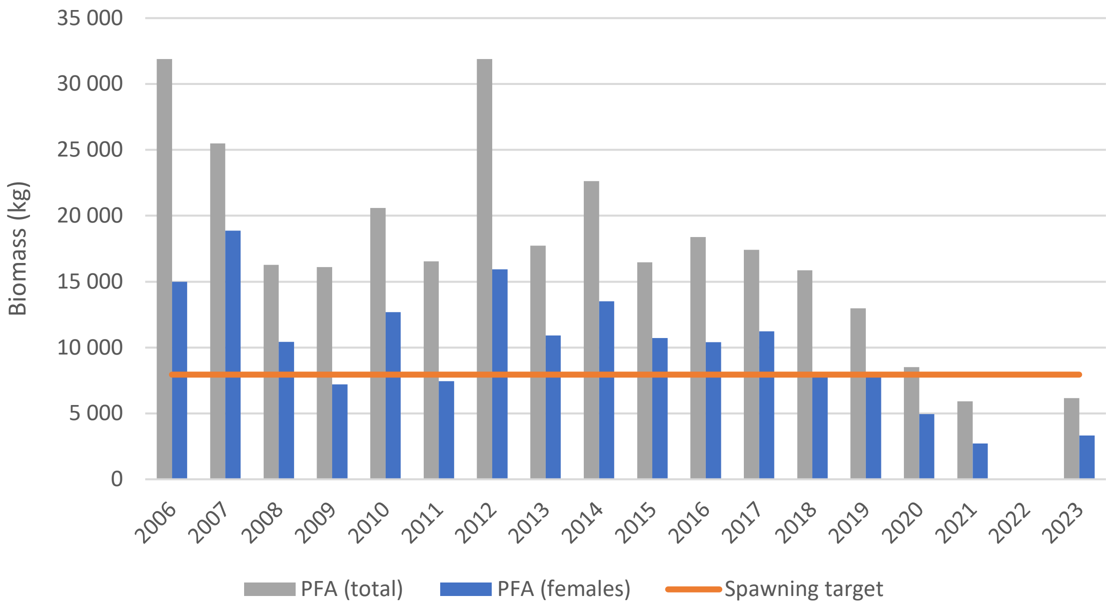


Figure 42. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock complex in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 29. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock complex in 2006-2023.

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	4 803	16 913	4 134	2 805	0.47	31 891	14 989	0.47
2007	5 333	14 575	2 264	2 450	0.74	25 497	18 868	0.58
2008	2 756	7 902	2 321	2 203	0.64	16 286	10 423	0.24
2009	3 084	8 103	2 003	1 292	0.45	16 116	7 198	0.00
2010	3 162	11 422	2 440	2 210	0.62	20 596	12 689	0.37
2011	2 531	9 351	1 906	1 219	0.45	16 548	7 447	0.00
2012	3 692	17 594	4 281	3 132	0.50	31 888	15 944	0.50
2013	2 482	10 361	1 984	1 810	0.62	17 724	10 908	0.27
2014	3 073	12 630	2 830	2 400	0.60	22 627	13 523	0.41
2015	2 004	9 898	1 879	1 780	0.65	16 481	10 720	0.26
2016	3 313	11 039	1 653	1 362	0.57	18 383	10 410	0.24
2017	3 477	9 756	638	2 230	0.64	17 419	11 229	0.29
2018	3 469	6 933	787	2 409	0.51	15 854	8 130	0.02
2019	2 507	6 845	564	1 936	0.62	12 983	8 038	0.01
2020	1 451	4 944	326	1 063	0.58	8 529	4 947	0.00
2021	661	0	0	2 416	0.46	5 913	2 720	0.00
2022	828	0	0	-	-	-	-	-
2023	771	0	0	2 920	0.54	6 178	3 336	0.00

3.14 Tana/Teno (total)

3.14.1 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 in 2019, the Tana/Teno total spawning target becomes 104 735 351 eggs (77 102 404-156 261 277 eggs). The female biomass needed to obtain this egg deposition is 52 105 kg (38 405-77 758 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 30. Female proportions in Table 30 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 30 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 2021-2023 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.

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 and 2023, 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 19 147 salmon <65 cm, 7 030 salmon between 65-90 cm and 1 852 salmon ≥90 cm. The total Tana/Teno run of salmon in 2022 was estimated at 10 561 salmon <65 cm, 9 170 salmon between 65-90 cm and 1 891 salmon ≥90 cm. Numbers in 2023 were estimated at 9 932 salmon <65 cm, 8 014 salmon between 65-90 cm and 2 138 salmon ≥90 cm.

Table 30. 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
2023	0	0	0.58

To account for uncertainty, the exploitation rate and female proportion estimates in Table 30 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 52 105 kg as the mode, 38 405 kg as the minimum and 77 758 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 72 % in 2023 and the probability of meeting the spawning target was 2 %. The management target was not reached, as the last 4 years' (2020-2023) overall probability of reaching the spawning target was 0 % with an overall attainment of 63 % (Figure 43).

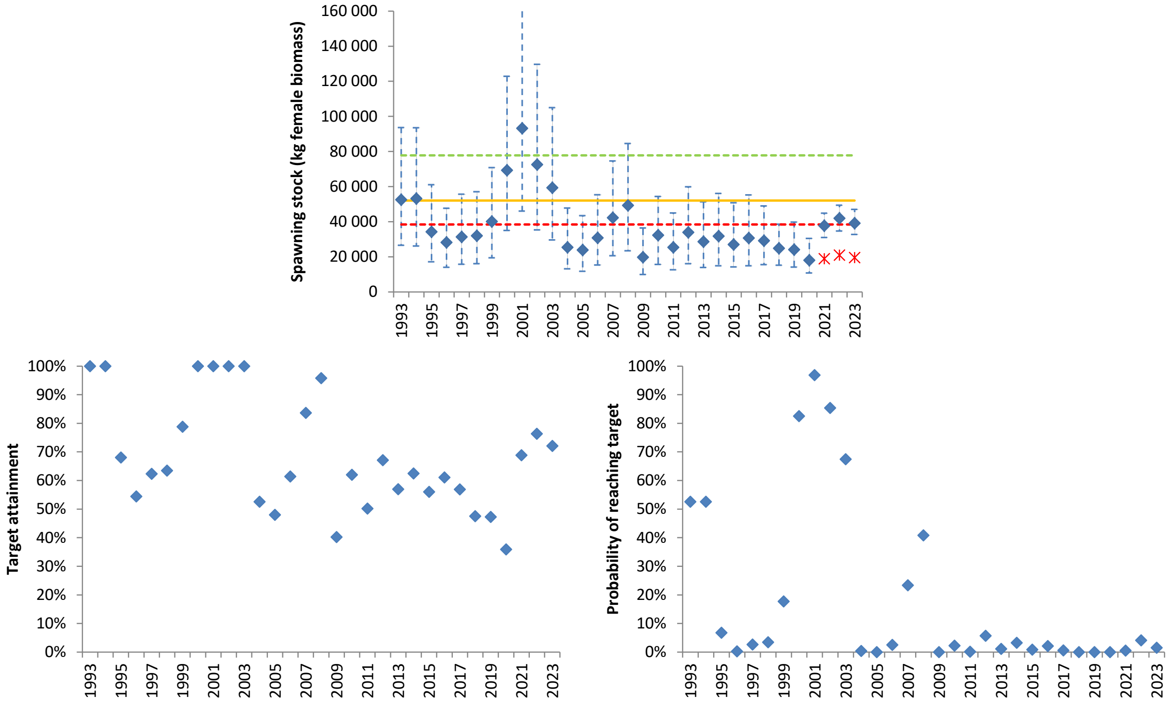


Figure 43. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 1993-2023 for Tana/Teno (total). The red symbols in the upper panel show what the spawning stock size would have been in 2021-2023 if fishing had continued.

3.14.2 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 (males and females) PFA of salmon belonging to the entire Tana/Teno river system has varied from a maximum of 243 106 kg in 2008 down to 74 075 kg in 2023 (Figure 44; Table 31).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential of the Tana/Teno river system. The proportion of the annual female 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 150 513 kg in 2008 down to a minimum of 40 319 kg in 2021 (Figure 44; Table 31).

Of the years 2006-2023, an exploitable surplus has been missing in the latest four years (2020-2023). As an exploitable surplus has been missing in all the last four 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 2020-2023 (Table 31). In contrast, as much as 65 % of the female PFA could have been exploited sustainably as recently as 2008.

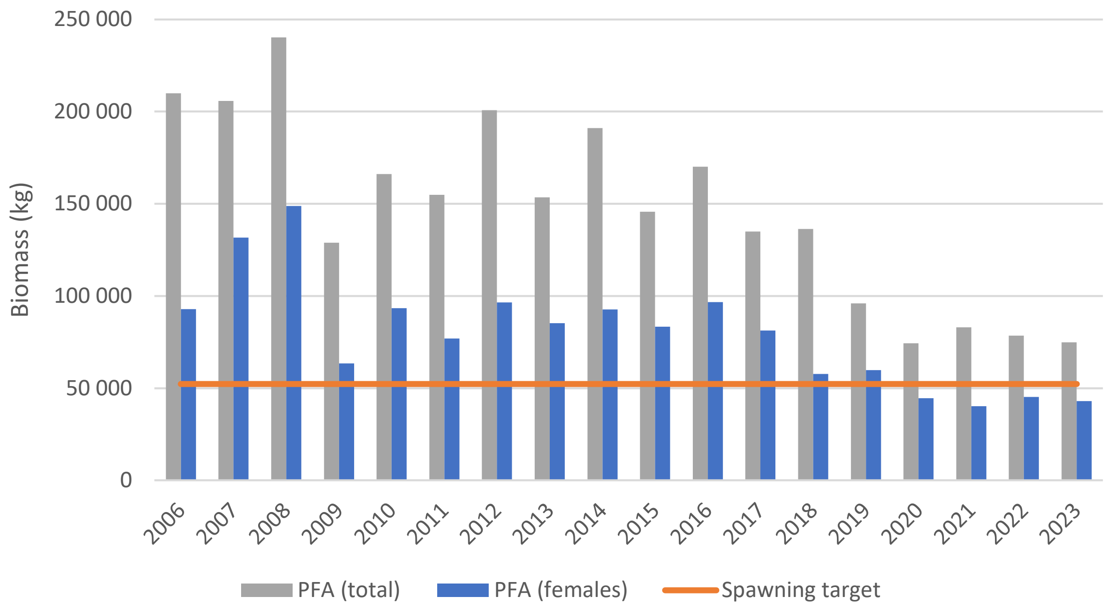


Figure 44. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system in the period 2006-2023. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 31. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system in 2006-2023.

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	30 860	0.44	209 710	92 763	0.44
2007	41 199	87 836	11 933	42 292	0.64	207 062	132 492	0.61
2008	42 321	104 089	16 981	49 354	0.62	243 106	150 513	0.65
2009	25 074	53 193	9 826	19 824	0.49	128 362	63 193	0.18
2010	25 975	74 978	11 487	32 275	0.56	169 803	95 539	0.45
2011	23 840	68 015	10 820	25 390	0.50	153 811	76 370	0.32
2012	24 230	91 301	16 845	33 995	0.48	203 029	97 688	0.47
2013	21 780	68 016	11 335	28 678	0.56	152 710	84 908	0.39
2014	26 357	82 912	15 694	31 805	0.49	190 500	92 447	0.44
2015	18 086	64 973	12 660	27 061	0.57	143 033	81 809	0.36
2016	30 629	72 464	11 809	30 742	0.57	168 980	96 062	0.46
2017	26 671	52 193	7 629	29 155	0.60	134 928	81 218	0.36
2018	28 773	41 395	7 379	24 907	0.42	136 350	57 753	0.10
2019	18 186	33 254	5 997	24 051	0.62	96 077	59 802	0.13
2020	13 122	26 451	4 864	18 039	0.60	74 514	44 689	0.00
2021	5 246	0	0	37 775	0.48	83 155	40 319	0.00
2022	6 570	0	0	41 906	0.58	79 439	45 684	0.00
2023	6 114	0	0	39 083	0.58	74 075	42 599	0.00

4 Conclusions and further insights into the status assessment

Stock status over the last four years (2020-2023) was poor in eleven of the thirteen areas that we evaluated (Figure 45). 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 45) should, following NASCO guidelines, automatically trigger the formulation of a recovery plan for the affected stock. Eleven of the evaluated areas fall below the 40 % management target threshold that indicates a need for stock recovery.

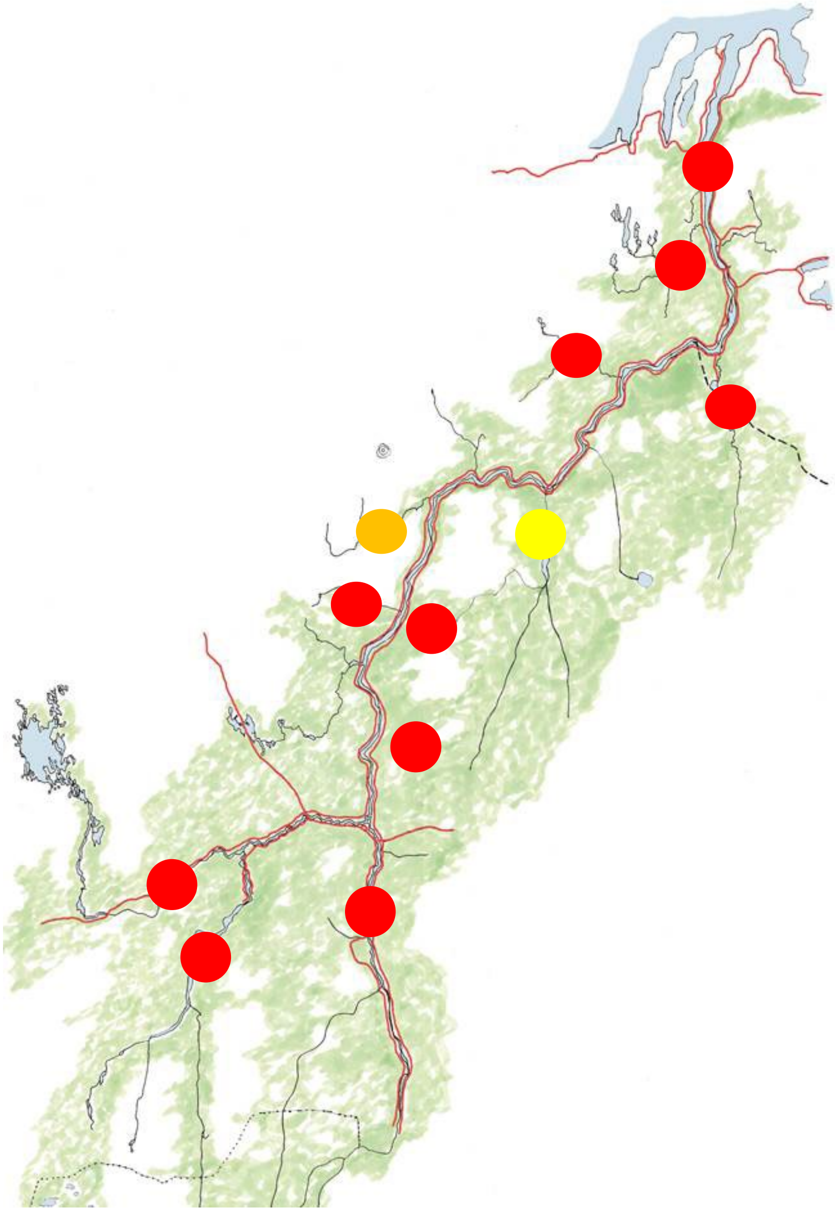


Figure 45. Map summary of the 2020-2023 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates stock status over the last four years. Possible colours are: Dark green = overall probability of attaining spawning target higher than 75 %, overall target attainment over 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.

Four of the evaluated areas are either completely (Tana/Teno MS) or partly (Leavvajohka, Báišjohka, Njiljohka/Nilijoki) assessed based on genetic proportions of salmon observed/caught in the main stem. In addition, all PFA estimates are also based on genetic proportions. A total of eight years with genetic stock identification of main stem catch samples have so far been analysed (2006-2008, 2011-2012, 2018-2020), forming a dataset that should enable relatively robust estimates of stock proportions from year to year, especially when combined with other data sources (sonar, video, and snorkelling counts) into a predictive model. Due to time and resource constraints, this model approach is still in its infancy. The main issues with the current simple approach to using genetic proportions can be traced to two factors: 1) problems with few catch samples in 2018-2020 which creates a possible bias in the proportion estimates, and 2) significant life history differences between stocks, which might lead to overestimates of small-sized stocks and underestimates of large-sized stocks. As an example, initial modelling work so far indicates that the current 2007 spawning estimate of Njiljohka/Nilijoki, a small population heavily dominated by 1SW salmon, overestimates the spawning stock with approximately 20 %.

It is important to note that this methodological issue does not affect the overall lack of spawners in the Tana/Teno river system, as summarized in Figure 45. However, improving the current approach to handling genetic proportions, especially in combination with other data sources, should have a high priority in the coming year. This is especially pertinent given the current poor stock status and need for stock recovery, meaning that access to new scale samples will be limited for several years.

On the positive side, establishing a more robust modelling approach based on a combination of counting and genetic proportions would allow for separating the estimated Tana/Teno run size into the complete stock complex on an annual basis, using any available counting data as a correcting factor to increase the accuracy of the annual model estimates.

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 four areas constitute 80.5 % of the total Tana/Teno production potential (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 46 % from the average of 2013-2020 to the average of 2021-2023 (Table 32). However, when looking at individual areas, some contrasts are evident. The most significant increases in average spawning stocks were estimated for the main stem and upper headwaters, increasing between 26 and 46 %. In contrast, the lowermost tributaries Máskejohka and Buolbmátjohka/Pulmankijoki saw decreases of 42-62 %. 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 salmon fishing closure in 2021-2023. However, the changes in female PFA from 2013-2020 to 2021-2023 are grim throughout the river system with decreases varying from 41 to 85 % (Table 32).

Table 32. Changes in spawning stock (female biomass, kg) and female pre-fishery abundance (PFA, kg) from the average of 2013-2020 to 2021-2023 in various areas of Tana/Teno evaluated in this and previous reports.

Area	Change in spawning stock from 2013-2020 to 2021-2023	Change in female PFA from 2013-2020 to 2021-2023
Tana/Teno MS	28 %	-41 %
Máskejohka	-62 %	-78 %
Buolbmátjohka/Pulmankijoki	-42 %	-67 %
Lákšjohka	-30 %	-63 %
Veahčajohka/Vetsijoki	15 %	-59 %
Ohcejohka/Utsjoki	-9 %	-56 %
Leavvajohka	-54 %	-73 %
Báišjohka	-79 %	-85 %
Njiljohka/Nilijoki	-38 %	-70 %
Áhkojohka/Akujoki	32 %	-63 %
Kárášjohka	43 %	-56 %
Iešjohka	42 %	-60 %
Anárjohka/Inarijoki	43 %	-69 %
Tana/Teno (total)	46 %	-43 %

To conclude, the situation for different salmon stocks of the Tana/Teno system in 2023 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 continued to be low, in line with what was predicted for 2023. Unfortunately, overall low returns of small salmon (grilse, 1SW) continued, and it is therefore expected that the return of MSW salmon will continue to be low in 2024 and that there still likely will not be any sustainable surplus available for exploitation within the Tana/Teno river system.

The majority of the evaluated areas were placed in the red status category in 2023. 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 at least orange.

5 References

Anon (2016) Status of the River Tana salmon populations 2016. Report of the Working Group on Salmon Monitoring and Research in the Tana River System.

Anon (2018) Status of the Tana/Teno River salmon populations in 2018. Report from the Tana/Teno Monitoring and Research Group 2/2018.

Anon (2020) Status of the Tana/Teno River salmon populations in 2020. Report from the Tana/Teno Monitoring and Research Group 1/2020.

Anon (2022) Tana/Teno salmon stock recovery and sustainable fisheries. Report from the Tana/Teno Monitoring and Research Group 1/2022.

Falkegård M, Foldvik A, Fiske P, Erkinaro J, Orell P, Niemelä E, Kuusela J, Finstad AG & Hindar K (2014) Revised first-generation spawning targets for the Tana/Teno river system. NINA Report, 1087, 68 pp.

Falkegård, M., Erkinaro, J., Vähä, J. & Kuusela, J. (2023) Genetisk bestandsidentifisering av skjellprøver fra fiske etter blandete laksebestander i Tana i 2006-2008 og 2011-2012 (Genmix). NINA Rapport, 2309.

Forseth T, Fiske P, Barlaup B, Gjøsæter H, Hindar K & Diserud OH (2013) Reference point based management of Norwegian Atlantic salmon populations. Environmental Conservation 40, 356-366.

NASCO (1998) Agreement on Adoption of a Precautionary Approach. North Atlantic Salmon Conservation Organization, Edinburgh, Scotland, UK. NASCO Council Document CNL(98)46, 4 pp.

NASCO (2002). Decision Structure for Management of North Atlantic Salmon Fisheries. North Atlantic Salmon Conservation Organization, Edinburgh, Scotland, UK. NASCO Council Document CNL31.332, 9 pp.

NASCO (2009) Guidelines for the Management of Salmon Fisheries. North Atlantic Salmon Conservation Organization, Edinburgh, Scotland, UK. NASCO Council Document CNL(09)43, 12 pp.

Orell P & Erkinaro J (2007) Snorkelling as a method for assessing spawning stock of Atlantic salmon, *Salmo salar*. Fisheries Management and Ecology, 14, 199-208.

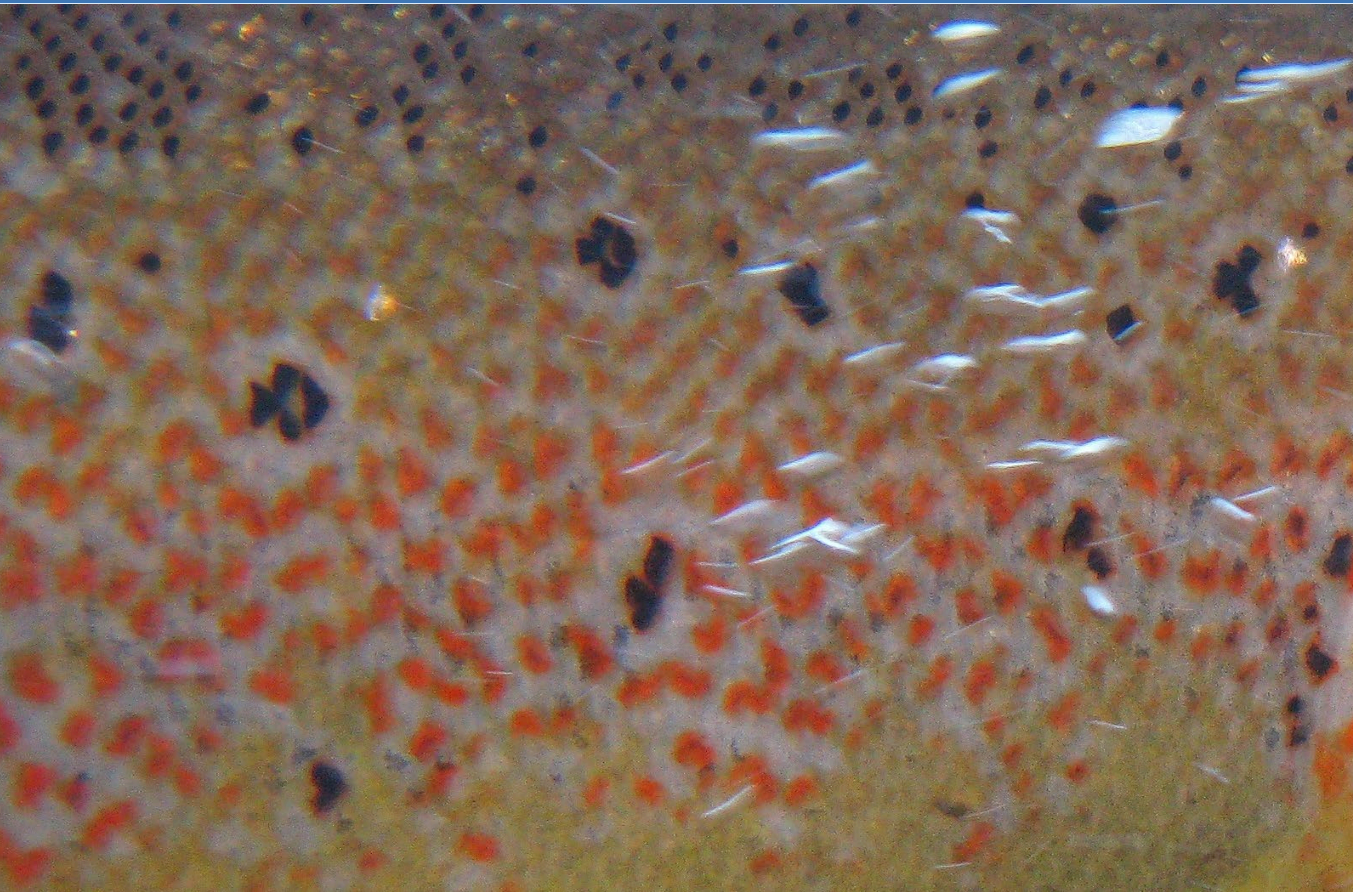
Orell P, Erkinaro J, Svenning MA, Davidsen JG & Niemelä E (2007) Synchrony in the downstream migration of smolts and upstream migration of adult Atlantic salmon in the subarctic River Utsjoki. Journal of Fish Biology, 71, 1735-1750.

Orell P, Erkinaro J & Karppinen P (2011) Accuracy of snorkelling counts in assessing spawning stock of Atlantic salmon, Salmo salar, verified by radio-tagging and underwater video monitoring. Fisheries Management and Ecology, 18, 392-399.

Pedersen SLK (2021). Evaluation and use of a monitoring method to estimate Atlantic salmon spawning run. An assessment of the use ARIS sonar in combination with Timespace underwater video in Máskejohka, a tributary of the River Tana. Master's thesis in Biology. Faculty of Biosciences, Fisheries and Economics, Department of Arctic and Marine Biology. The Arctic University of Norway. 49 p.

Pulkkinen H, Orell P, Erkinaro J & Mäntyniemi S (2020) Bayesian arrival model for passage counts powered by environmental covariates and expert knowledge. Canadian Journal of Fisheries and Aquatic Sciences 77, 462–474.

Tana/Teno Monitoring and Research Group



Contact:
Report from The Tana/Teno Monitoring and Research Group
Morten Falkegård, NINA, morten.falkegard@nina.no
Jaakko Erkinaro, Luke, jaakko.erkinaro@luke.fi

ISSN: 2535-4701
ISBN: 978-82-93716-14-3