Tana/Teno Monitoring and Research Group

Status of the Tana/Teno River salmon populations in 2024

Report from the Tana/Teno Monitoring and Research Group 1/2025

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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. 2025. Status of the Tana/Teno River salmon populations in 2024. Report from the Tana/Teno Monitoring and Research Group nr 1/2025.

This report is the eighth 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 fourteen 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 2021-2024, 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 2021-2024 because of the absence of salmon catches.

The map below summarizes the 2021-2024 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, thirteen of the fourteen evaluated areas had a management target below 40 %, and all of these areas were placed in the worst (red) status category due to no exploitable surplus in at least two of the last four years.

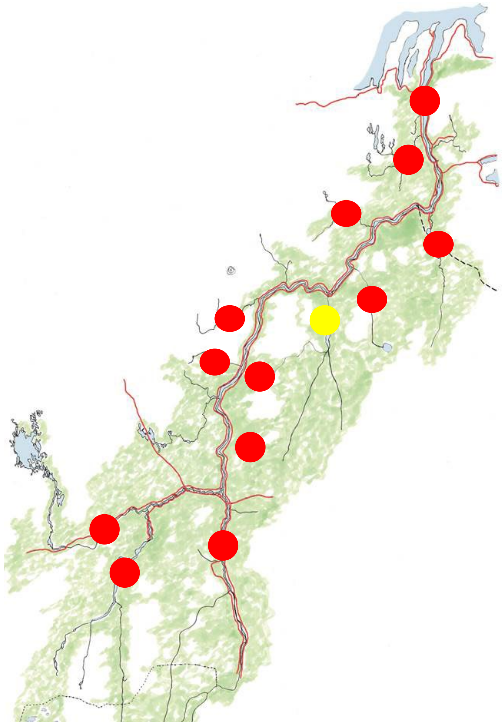
Of the stocks with poor status, the most important thing to note is the status of the upper main headwater areas of Kárášjohka, Iešjohka and Anárjohka/Inarijoki and of the Tana/Teno main stem. These areas, which constitute 80.5 % of the total Tana/Teno spawning target, have had consistently low target attainment and low to no exploitable surplus over several years.

To conclude, the situation for different salmon stocks of the Tana/Teno system in 2024 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 2024.

The return of 1SW salmon in Tana/Teno has been low since 2019. This situation turned significantly worse in 2024, with the overall 1SW run size being by far the lowest we have seen. This happened despite relatively good smolt numbers found in the monitoring in 2023. The low 1SW numbers in 2024 has critical implications for the return of 2SW salmon in 2025, which, given the long-term relation

between 1SW one year and 2SW the year after, are now expected to be catastrophically bad. Most 2SW salmon are female, and consequently, the overall spawning stock size and resulting egg deposition in 2025 can be expected to be well below the levels from 2024.

Given the critical red status category for thirteen of fourteen assessed areas (the Tana/Teno total not shown in the figure below), 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 target attainment and probability for enough spawners for 2024, and the average target attainment and probability for reaching the spawning target over the last 4 years (=the management target).

	2024 target attainment	2024 probability	4-year target attainment	Management target
Tana/Teno MS	57 %	0 %	71 %	1 %
Máskejohka	23 %	0 %	41 %	0 %
Buolbmátjohka/Pulmankijoki	34 %	0 %	60 %	0 %
Lákšjohka	3 %	0 %	23 %	0 %
Veahčajohka/Vetsijoki	49 %	0 %	96 %	38 %
Ohcejohka/Utsjoki (+tributaries)	37 %	0 %	98 %	43 %
Leavvajohka	45 %	0 %	64 %	3 %
Báišjohka	1 %	0 %	15 %	0 %
Njiljohka/Nilijoki	21 %	0 %	52 %	0 %
Ástejohka	82 %	17 %	-	-
Áhkojohka/Akujoki	9 %	0 %	54 %	0 %
Kárášjohka (+tributaries)	32 %	0 %	51 %	0 %
Iešjohka	32 %	0 %	37 %	0 %
Anárjohka/Inarijoki	17 %	0 %	29 %	0 %
Tana/Teno (total)	45 %	0 %	67 %	0 %

A key task for the MRG is identifying knowledge gaps and give advice on relevant monitoring and research. The declining stock situation and apparent downward trend in mortality from smolt to adult, which was considerably more pronounced from 2023 to 2024 in Tana/Teno compared to neighbouring rivers, has led to a collapse in 1SW salmon in 2024. This collapse has possible connections to either, or both, climate change and the 2023 pink salmon trap. It is crucial that this knowledge gap is prioritized in 2025. We strongly advise prioritizing resources towards an individual-based telemetry study in 2025 with a study design that allows for gathering data on downstream smolt migration and the cost of any delays at the 2025 trap site. Another crucial question, which could be studied simultaneously, is the upstream migration of adult Atlantic salmon and the possible delays and problems the pink salmon trap may cause.

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.

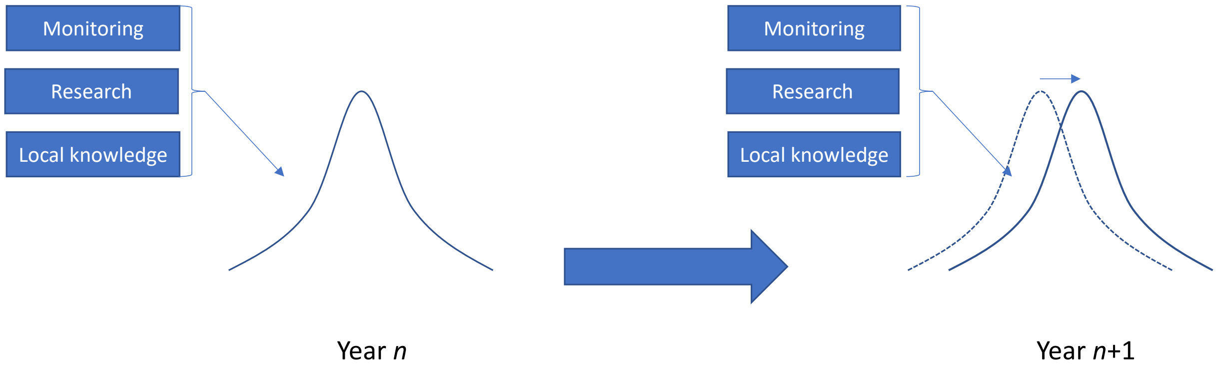


Figure 1. A conceptual representation of the adaptive process that is used for the annual assessment of Tana/Teno salmon stocks. In this repeated procedure, an assessment in a new year (n+1) is made based on the results of the preceding year (n), amended by any new sources of information (monitoring,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

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, 2017-2024)
- 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 (2018-2024)

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, 2021 and 2024), Iešjohka (sonar, 2022 and 2024), Máskejohka (sonar, 2020 and 2022), Gálddašjohka/Kalddasjoki (video, 2023-2024), and six Norwegian tributary areas snorkelled in 2023-2024 (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 2024

The Tana/Teno salmon fisheries were generally closed in 2024, fourth year in a row, because of poor stock status. A very small-scale salmon fisheries operated on the Finnish side of the Tana/Teno. Two days fishing was allowed in tributaries Veahčajohka/Vetsijoki and Ohcejohka/Utsjoki and nine fishermen used a symbolic traditional fishing opportunity in the Tana/Teno main stem. Overall, these fisheries may have yielded a catch on c. 50-100 salmon in 2024, but no catch estimates were done. In addition some illegal salmon fisheries operated in the Tana/Teno system in 2024 too but its volume is impossible to estimate. Catch and fisheries data from earlier years can be found from an older report (Anon. 2020).

2.2 Juvenile salmon monitoring

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

Although the juvenile salmon 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. Juvenile density data is also one of the longest time series on Tana/Teno salmon.

In 2024 surprisingly high densities of fry (0+) were observed in Ohcejohka/Utsjoki and Anárjohka/Inarijoki and fry densities in the Tana/Teno mainstem also increased compared to years 2022-2023 (Figure 2). Densities of older (≥1+) parr also increased significantly in Ohcejohka/Utsjoki and Anárjohka/Inarijoki and were close to the long-term means (Figure 2).

The heavy increase of both fry and older parr densities in 2024 is somewhat unexpected as adult salmon populations have heavily decreased in recent years. The salmon fishing ban has, however, enabled high survival of adults to spawn, which may partly explain the results. Environmental conditions in 2024 were also exceptional, discharges were very low, and water temperatures were high. When the water volume lessens salmon juveniles are packed to smaller areas which increases the density per area. Environmental conditions may also have affected electrofishing catchability. It will be very interesting to see how the juvenile densities develop in 2025 after extremely bad adult salmon season.

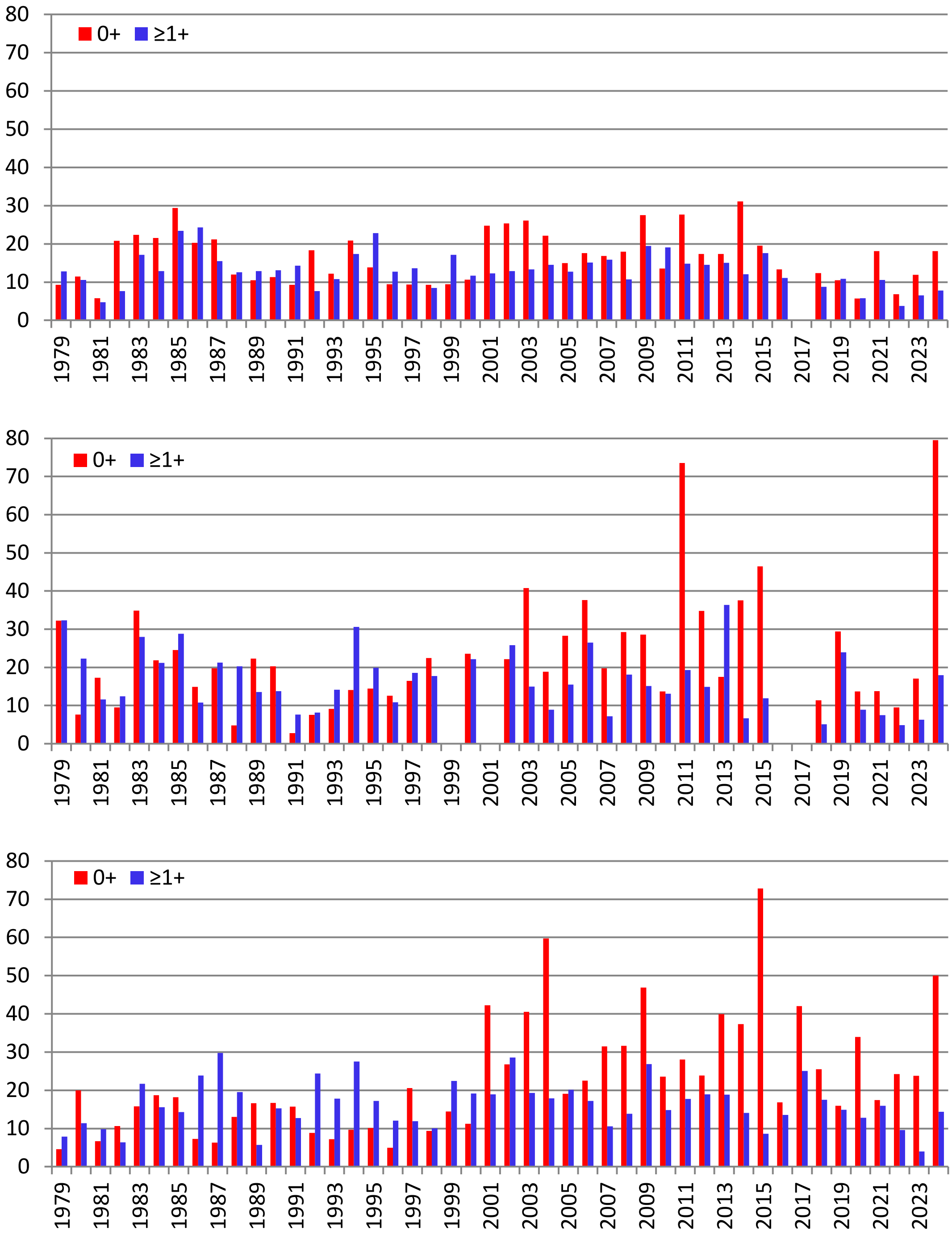


Figure 2. Mean densities (fish/100 m^2; one pass, uncorrected) of salmon fry (0+) and parr (≥1+) at permanent electrofishing sites in the rivers Tana/Teno (uppermost panel), Ohcejohka/Utsjoki (middle panel) and Anárjohka/Inarijoki (lowermost panel) in the years 1979-2024. Note: this data only includes electrofishing sites (Tana/Teno 16-22 sites, Ohcejohka/Utsjoki 11-12 sites and Anárjohka/Inarijoki 5-7 sites) that have been the same throughout the monitoring period.

2.3 Adult salmon counting

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

In 2024 adult salmon counts were performed at the following sites (Figure 3): Tana/Teno main stem (sonar), Veahčajohka/Vetsijoki (sonar) Ohcejohka/Utsjoki (video), Kárášjohka (sonar), Iešjohka (sonar) Gálddašjohka/Kalddasjoki (video), Buolbmátjohka/Pulmankijoki (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 Kárášjohka), Ástejohka (a tributary of Valljohka), Báišjohka, Leavvajohka, Lákšjohka, Deavvkehanjohka (a tributary of Lákšjohka) and Luovttejohka (Figure 3). The river Geasis (a tributary of Maskejohka) was also snorkelled but the data quality was too poor for reliable spawning stock assesment.

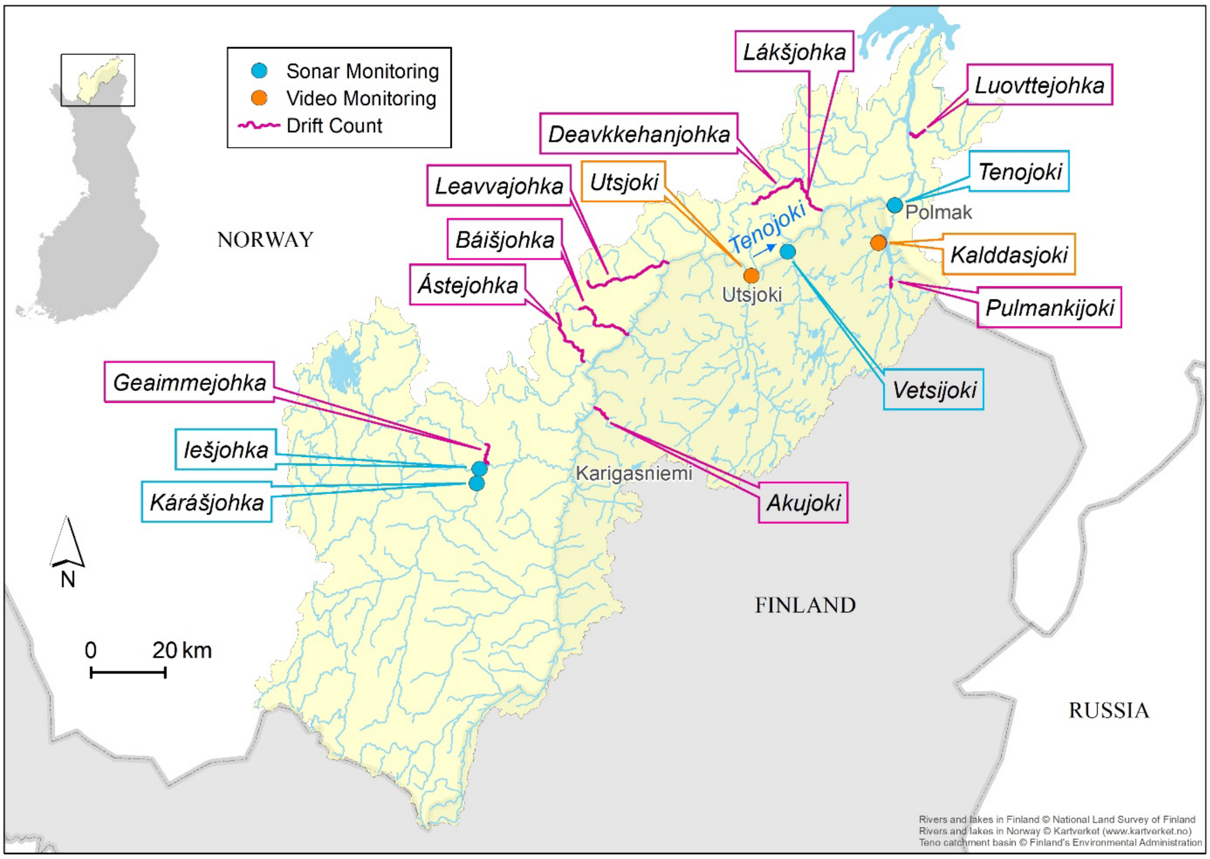


Figure 3. Map of the Tana/Teno river system indicating the most important adult salmon counting sites and counting methods in 2024.

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 500 and 6 700 in 2002-2024 (Figure 4).

In 2024 the video counting was performed in rather good environmental conditions without any significant technical problems. The adult salmon count was only c. 500, being more than 60 % lower than year before and clearly the lowest observed during the monitoring time series (Figure 4). Bearing in mind the salmon fishing ban in the Tana/Teno system and in the coastal area around Tanafjord the salmon count in 2024 was extremely alarming. The count in 2024 was only 16 % from the long-term average (3 110 fish).

The migration activity in 2024 was overall very low and no clear activity peaks were observed (Figure 5).

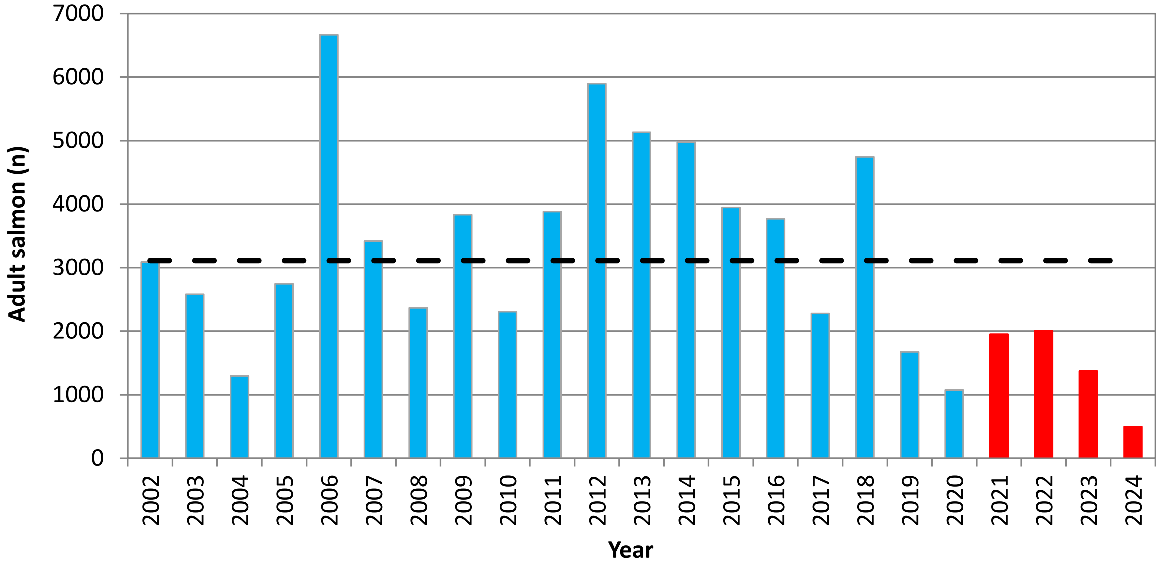


Figure 4. Video counts of ascending adult salmon at the river mouth of Ohcejohka/Utsjoki in 2002-2024. Red bars indicate the years when salmon fishing has been banned and the dashed black line indicates the long-term average between 2002-2024. All sea-age groups are combined.

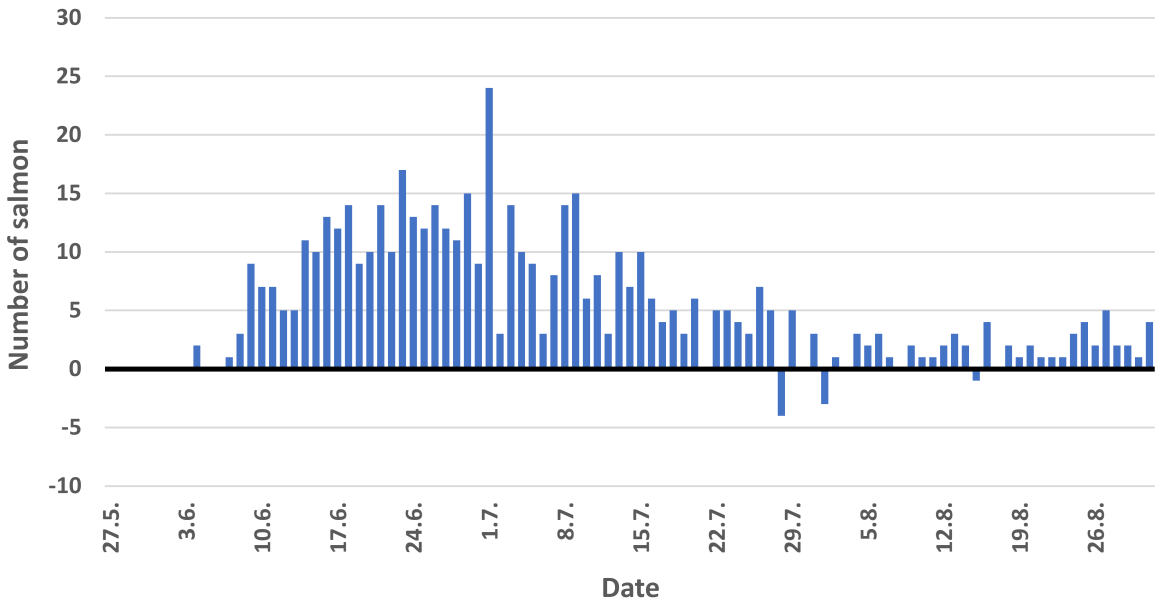


Figure 5. Estimated daily numbers of ascending salmon in the River Ohcejohka/Utsjoki in 27.5.-31.8.2024. Negative values indicate that during those days more salmon migrated downstream than upstream. All sea-age groups are combined.

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 2023-2024. 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 6). The counter was installed on 5th June 2024, but due to technical problems full data (24/7) was analysed between 11.6. and 29.9.

The system automatically observed fish, their swimming direction, species, and size. These automatic observations were, however, manually checked and corrected if mistakes were evident. Overall, the system and guiding fences worked reliably throughout the monitoring period.

The total salmon count during the monitoring period in 2024 was only 47 salmon (Figure 7). This was 76 % less than in 2023. From these, 42 (89 %) individuals were measured to be ≤65 cm and 5 (11%) individuals ≥65 cm long. Kalddasjohka salmon migration was rather scattered and no peaks in migration activity were observed (Figure 7). No salmon ascended past the monitoring site during the first three weeks of August, when discharge was extremely low and water temperatures very high (Figure 7).

Figure 6. Simsonar FC stereo camera system installed to the River Gálddašjohka/Kalddasjoki in 2024. 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.

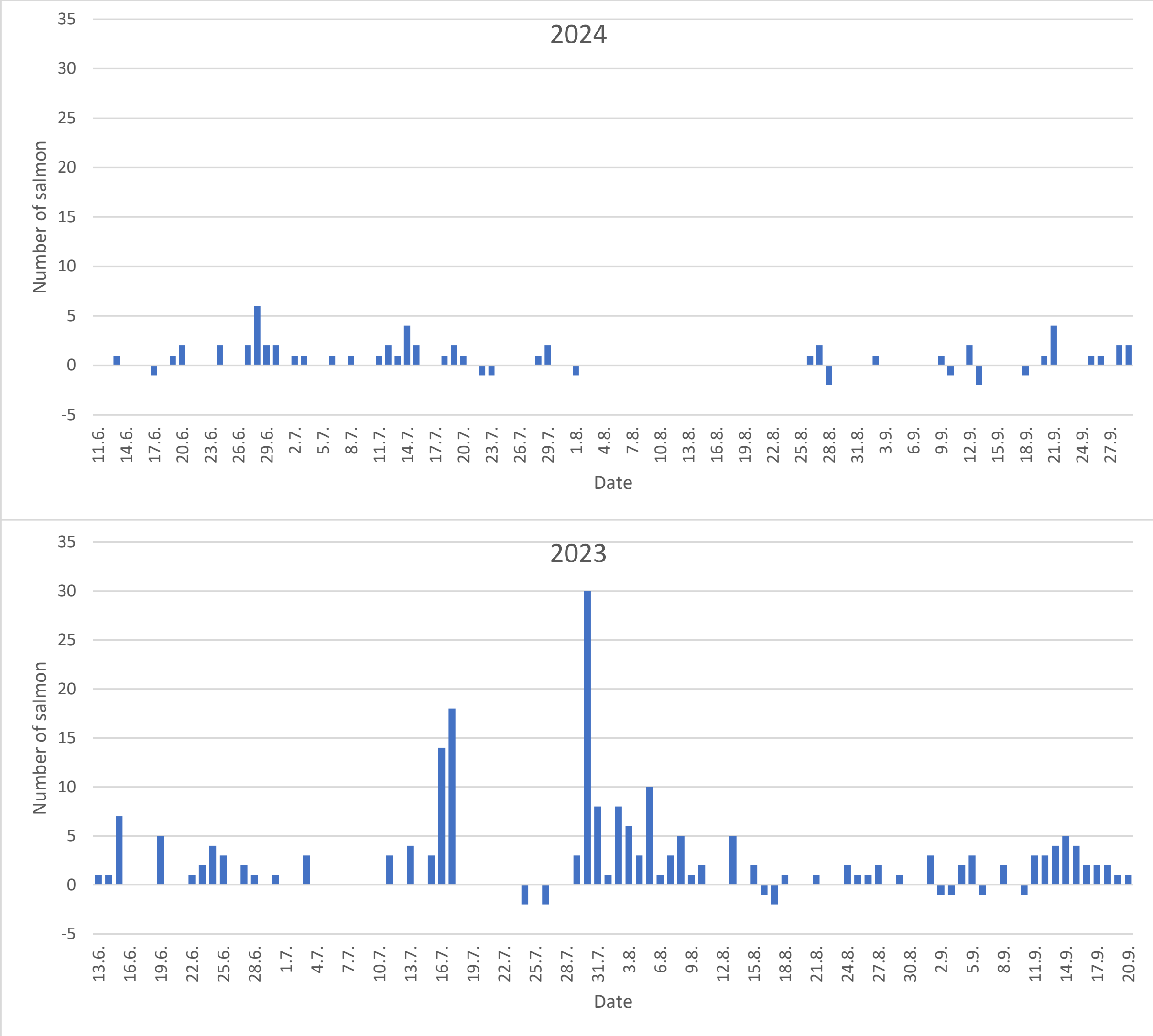


Figure 7. Estimated daily numbers of ascending salmon in the River Gálddašjohka/Kalddasjoki in 2023-2024 based on video monitoring (Simsonar FC stereo camera). All sea-age groups are combined. Negative values indicate that during those days more salmon migrated downstream than upstream. Monitoring periods were 13.6.-20.9.2023 and 11.6.-29.9.2024.

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 8). In 2024 only Áhkojohka/Akujoki and Buolbmátjohka/Pulmankijoki were counted. Water level was too low for performing snorkelling in Njiljohka/Nilijoki.

Numbers of spawning salmon in both Áhkojohka/Akujoki and Buolbmátjohka/Pulmankijoki were extremely low in 2024 and decreased considerably (79 % and 56 %) from 2023. In Áhkojohka/Akujoki the snorkelling count resulted only 12 salmon which is clearly the lowest record during the long-term monitoring period. The decreasing counts were mostly caused by both very low grilse numbers and low number of larger multi-sea-winter (MSW) salmon.

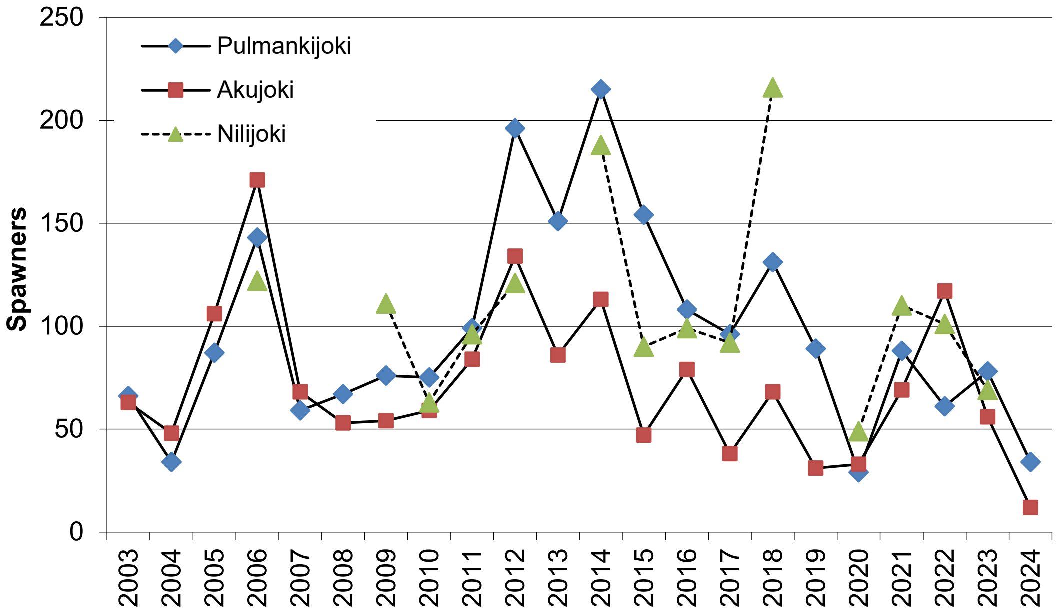


Figure 8. Snorkelling counts of spawning salmon in the rivers Buolbmátjohka/Pulmankijoki, Áhkojohka/Akujoki and Njiljohka/Nilijoki in 2003-2024. All sea-age groups are combined.

In addition to the long-term snorkelling counts on the Finnish tributaries an extra six tributaries were snorkelled on the Norwegian side in 2024 (Table 1). As in the Finnish tributaries the salmon numbers decreased heavily in most of the Norwegian tributaries too and were extremely low in Geaimmejohka, Báišjohka, Lákšjohka and Deavvkehanjohka (Table 1). The only positive exception was the river Ástejohka, where salmon numbers decreased only slightly from 2023 (Table 1).

Table 1. Snorkelling count results (numbers of salmon) from seven Norwegian tributaries of Tana/Teno in 2024 divided to sea-age/sex groups (1SW=small salmon, 2SW=medium sized salmon and MSW=large salmon). The count results from 2023 are also shown. Counts were performed throughout the anadromous lengths of the rivers, i.e., in areas that are included in the Tana/Teno spawning targets. 1SW?, 2SW? and MSW? means small, medium and large sized salmon without confirmed sexes. Source: Pierre Fagard, Tanavassdragets fiskeforvalting (TF).

River	Counting date	1SW ♂	1SW ♀	2SW ♂	2SW ♀	MSW ♂	MSW ♀	1SW ?	2SW ?	MSW ?	In total	2023
Geaimmejohka	10.9.2024		6	2	4		1				13	70
Ástejohka	9.9.2024	31	50	1	6			4			92	103
Báišjohka	6.9.2024	2	1		1						4	79
Leavvajohka	4.-5.9.2024	40	27	13	48	2	2				132	241
Lákšjohka	17.9.2024	1	8	2	1			2			14	77
Deavvkehanjohka	16.-17.9.2024				1						1	28
Luovttejohka	3.9.2024	4	2	3	3	1				1	14	no count

2.3.4 Sonar counts

During the last 10 years sonar monitoring have been actively used in counting the numbers ascending salmon. In 2024 sonar counts were performed in the Tana/Teno main stem, in Veahčajohka/Vetsijoki, in Kárášjohka and in Iešjohka (Figure 3). 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 earlier estimated based on nearby catch information or recently by video monitoring within sonar windows.

Tana/Teno main stem sonar

Sonar counting of ascending salmon numbers was continued for seventh year in the Tana/Teno main stem in 2024, at Polmak, c. 55 km upstream from the river mouth (Figure 9). 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 9).

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 several different data sources (sonar data, underwater videodata from the sonar window, catch data from pink salmon fishermen) and bayesian modelling. 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 2023 salmon and pink salmon run estimates were based on sonar data, video data collected during the sonar monitoring period from four underwater cameras installed within the northernmost sonar window (see Figure 9) and bayesing modelling. 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.

In 2024 salmon run estimate was based on sonar data of ≥45 cm fish and video data collected during the sonar monitoring period from four underwater cameras installed within the northernmost sonar window (see Figure 9).

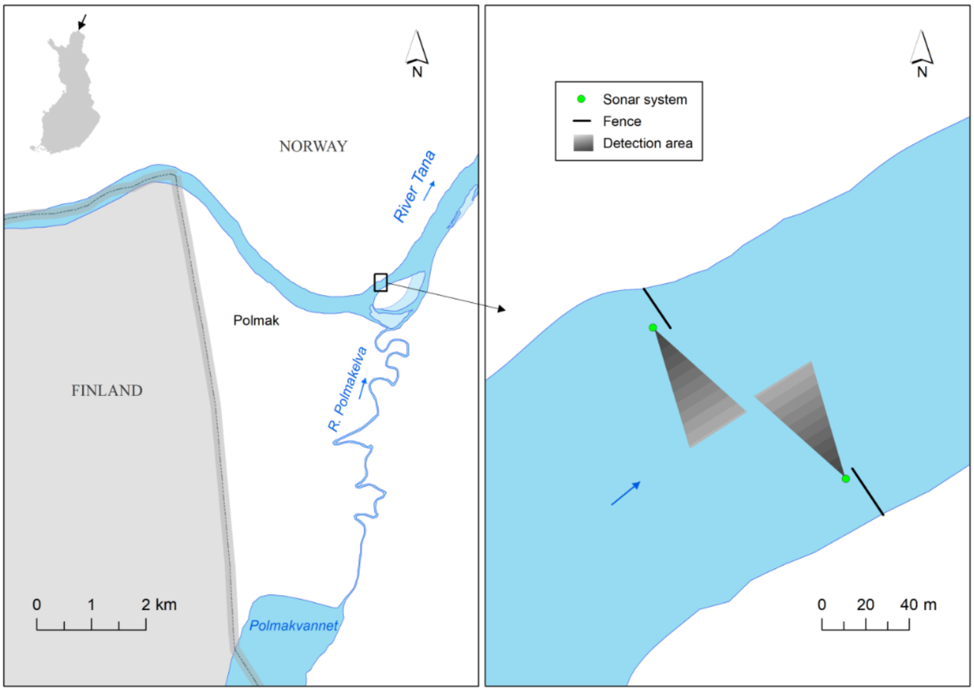


Figure 9. Schematic map of the Tana/Teno main stem sonar counting site including the locations of the two sonar units and guiding fences in 2018-2024.

The salmon migration past the Polmak monitoring site was extremely low in 2024 and the total salmon estimate was less than 8500 individuals (Table 2). The count decreased 56 % compared to 2023. Most striking decreasing trend (68 %) was observed in small (45-65 cm) salmon numbers and rather significant decrease (52 %) was also evident in medium (65-90 cm) sized salmon. The numbers of large (≥90 cm) salmon were at the level observed also in 2021-2023 (Table 2).

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 2018-2024. The salmon estimates in 2021 and 2023 were re-evaluated in 2024 by using Bayesian modelling. This re-evaluation was made to size classes 45-65 cm (2021, 2023) and 65-90 cm (2023).

			Number of salmon			%-distribution		
Year	Time period	Salmon estimate	45-65 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	27.5.-31.8.	20008	11685	6665	1658	58 %	33 %	8 %
2022	30.5.-31.8.	19943	9473	8747	1723	48 %	44 %	9 %
2023[a]	30.5.-31.8.	18717	8557	8245	1914	46 %	44 %	10 %
2024	31.5.-31.8.	8241	2897	3607	1737	35 %	44 %	21 %

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

Kárášjohka sonar

In the River Kárášjohka, sonar counting of ascending salmon has been used in 2010, 2012 and 2017-2024. 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 six years the monitored river width has been c. 30-35 m. During the past four years (2021-2024), 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. 850 salmon were estimated to pass the sonar counting station in Kárášjohka in 30.5.-11.9.2024 (Figure 10). Overall, the run size decreased 60 % from 2023 (Figure 10, Table 3) and was clearly the lowest observed in the Kárášjohka sonar monitoring surveys. One small migration peak was observed on 19th June (Figure 10).

The estimated sea-age distribution of 1SW (<65 cm), 2SW (65-90 cm) and MSW (≥90 cm) salmon was 42 %, 45 % and 13 %, respectively. The length distribution data includes some uncertainty because of a rather long (30-35 m) sonar window used in the survey.

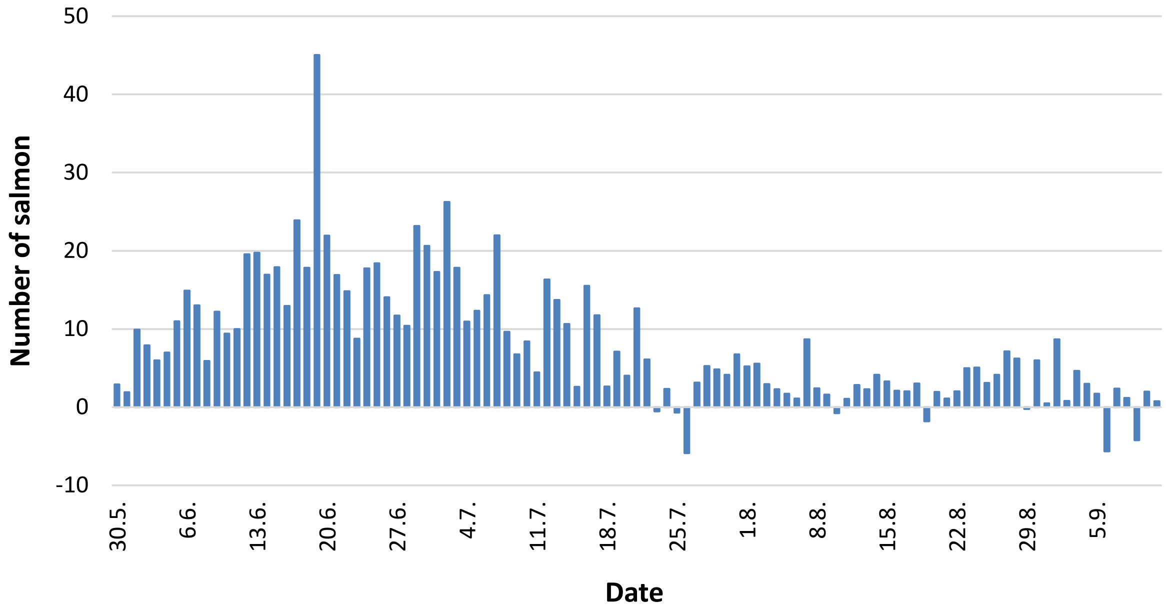


Figure 10. Estimated daily numbers of ascending salmon (≥45 cm) in the Kárášjohka sonar count in 2024 Negative values indicate that during those days more salmon migrated downstream than upstream. All sea-age groups are combined. The estimate of the total ascendance through the site was 844 salmon.

Table 3. Sonar count results of ascending salmon numbers in the River Kárášjohka in 2010, 2012, and 2017-2024 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
30.5.-11.9.2024	358	486	844	Missing time estimated	Aris

Iešjohka sonar

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

A more reliable sonar counting at the same location was performed in 2022 by using Aris sonar. This counting was repeated in 2024. Sonar data was collected in 5.6.-31.8.2024. For species determination purposes four underwater videocameras were also installed to the sonar window. Environmental-technical problems, however, decreased the video data usability and only data collected in August were available for later analysis. This means that salmon numbers during June-July are somewhat more uncertain compared to those in August.

Slightly more than 600 salmon were estimated to ascend to Iešjohka in 2024 (Figure 11). This is c. 41 % less compared to the Iešjohka salmon count in 2022. A small peak in migration activity was observed after mid-June (Figure 11). Migration activity during August was very low.

The estimated sea-age distribution of 1SW (<65 cm), 2SW (65-90 cm) and MSW (≥90 cm) salmon was 29 %, 40 % and 31 %, respectively. The length distribution data includes some uncertainty because of a rather long (30-35 m) sonar window used in the survey.

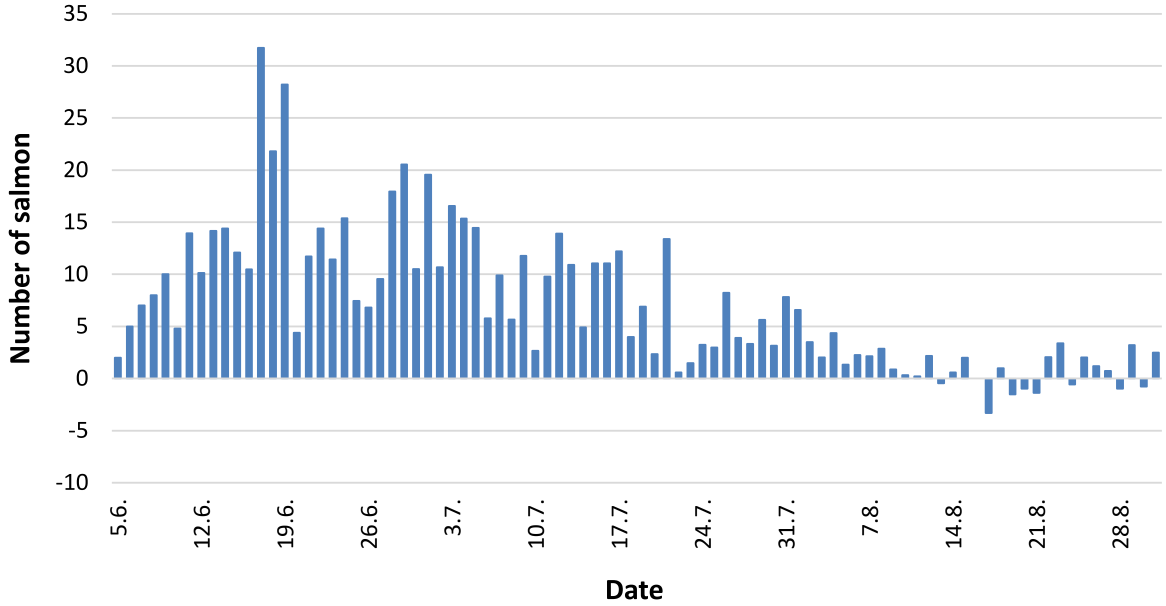


Figure 11. Estimated daily numbers of ascending salmon (≥45 cm) in the Iešjohka sonar count in 2024 Negative values indicate that during those days more salmon migrated downstream than upstream. All sea-age groups are combined. The estimate of the total ascendance through the site was 614 salmon.

Veahčajohka/Vetsijoki sonar

Sonar (and video) counting of salmon has been conducted in the river mouth of Veahčajohka/Vetsijoki in 2016 and 2021 and was repeated in 2024. Data was collected in 3.6.-31.8.2024. For species determination purposes four underwater videocameras were also installed to the sonar window. Cameras were run in 4.6.-31.8.2024.

The salmon run estimate in 2024 was only c. 360 salmon (Figure 12). The salmon run size in 2024 decreased 66 % compared to 2021 and 84 % compared to 2016 (Figure 13).

The estimated sea-age distribution of 1SW (<65 cm), 2SW (65-90 cm) and MSW (≥90 cm) salmon was 57 %, 38 % and 5 %, respectively. The Veahčajohka/Vetsijoki length distribution data includes less uncertainty compared to other sonar monitoring sites because of the use of a short (10-15 m) sonar window.

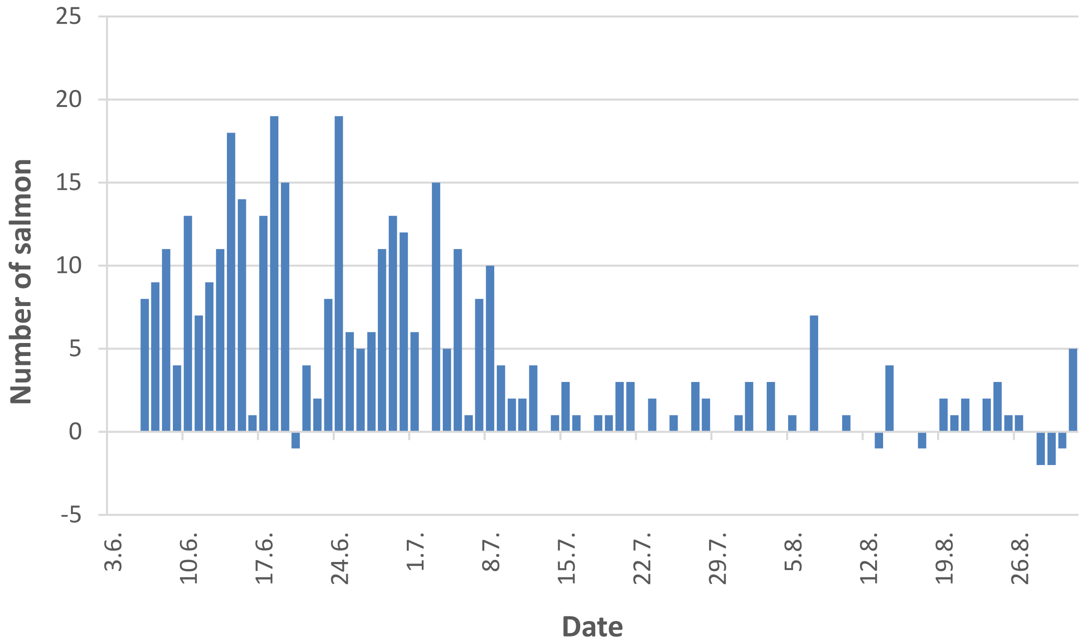


Figure 12. Estimated daily numbers of ascending salmon (≥45 cm) in the Veahčajohka/Vetsijoki sonar count in 2024. Negative values indicate that during those days more salmon migrated downstream than upstream. All sea-age groups are combined. The estimate of the total ascendance through the site was 356 salmon.

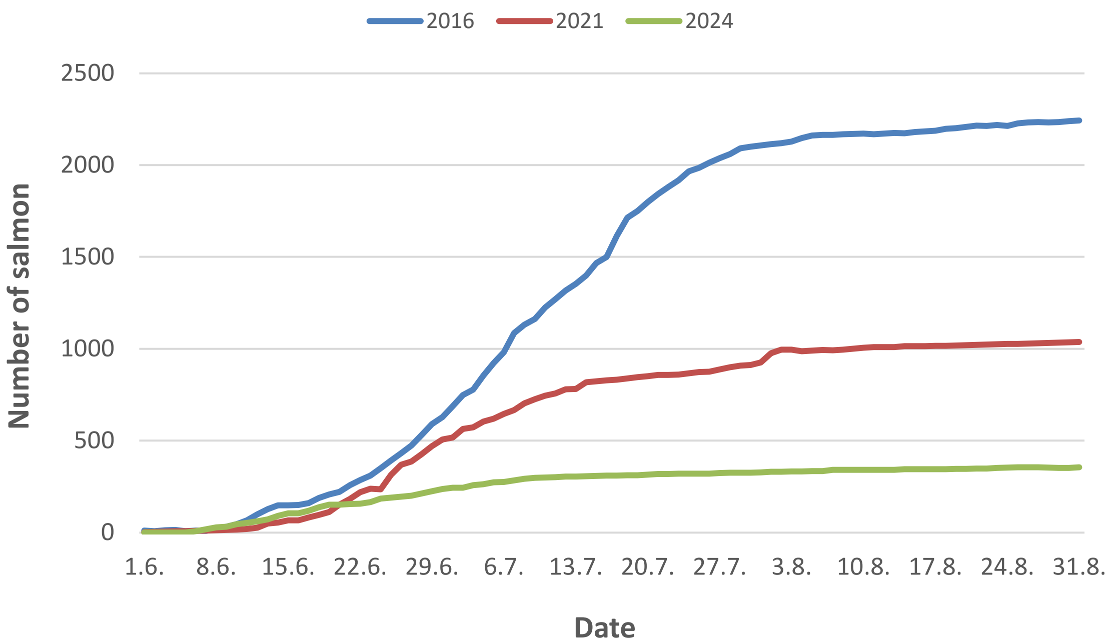


Figure 13. Cumulative estimated salmon numbers in the River Veahčajohka/Vetsijoki in 2016, 2021 and 2024. All sea-age groups are combined.

2.4 Summary of counting results

Adult salmon numbers in different parts of the Tana/Teno system decreased heavily in 2024 compared to the three earlier salmon fishing closure seasons and were mostly the lowest observed during the time series (Figure 14). The increase in salmon numbers in 2021-2023 compared to 2020 were probably 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. The very low salmon numbers observed in 2024 indicate that salmon sea-survival rates have dropped to even lower levels than in few earlier years.

One sea-winter (1SW) salmon abundance was extremely poor throughout the Tana/Teno system in 2024. Overall, the season 2024 was the sixth successive poor 1SW season, indicating continued poor sea conditions and low sea-survival of salmon. The low sea-survival situation seems to affect many other rivers in Finnmark too.

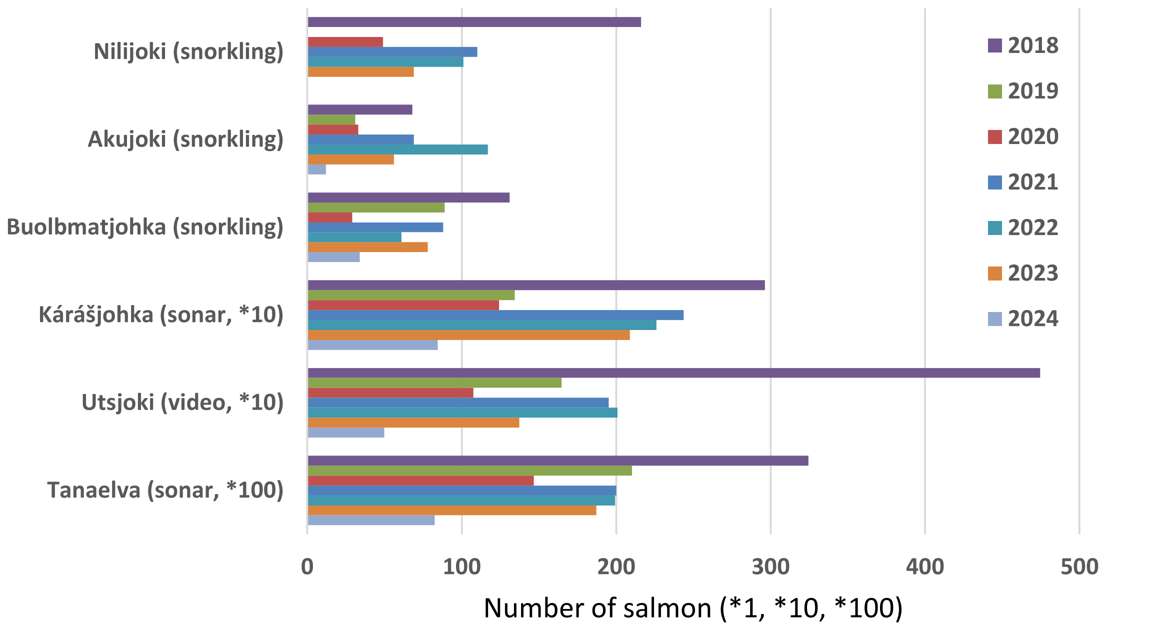


Figure 14. Counting results (number of adult salmon) in different parts of the Tana/Teno system in 2018-2024. Note: Kárášjohka sonar and Ohcejohka/Utsjoki video counts are divided by a factor of 10 and the Tana/Teno mainstem sonar numbers by a factor of 100. The River Nilijoki was not counted in 2024.

3 Stock status assessment

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 4. Female proportions in Table 4 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 4).

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 55 %. 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 4). 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 4. 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	0.55	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 2021-2024 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 11 685 salmon <65 cm, 6 665 salmon between 65-90 cm and 1 658 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 8 557 salmon <65 cm, 8 245 salmon between 65-90 cm and 1 914 salmon ≥90 cm. The 2024 estimate was based on a count of 2 897 salmon <65 cm, 3 607 salmon between 65-90 cm and 1 737 salmon >7 kg. Note that the sonar counts from 2021 and 2023 were revised from earlier reports based on a recently developed Bayesian model for separating different species in the sonar counts.

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 14.2 %[1] of the total main stem production areas, and the Polmak count were adjusted with this percentage in the evaluation. These adjustments, in combination with the size-specific Tana/Teno MS proportions above, result in an estimated run size of Tana/Teno MS salmon in 2021 of 3 577 salmon <65 cm, 1 810 salmon between 65-90 cm and 1 374 salmon ≥90 cm. The total run of Tana/Teno MS salmon in 2022 was estimated at 2 900 salmon <65 cm, 2 376 salmon between 65-90 cm and 1 428 salmon ≥90 cm. Numbers in 2023 were 2 619 salmon <65 cm, 2 240 salmon

[11] Revised up significantly from 1.22 % used in previous reports. The revision was done to include potentially productive fringe habitat areas in the lower main stem outside of the defined riffle sections. The fringe habitats were defined as 10 % of the sandy areas in Falkegård *et al*. (2014).

between 65-90 cm and 1 586 salmon ≥90 cm. Estimations for 2024 were 887 salmon <65 cm, 980 salmon between 65-90 cm and 1 439 salmon >90 cm.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 4 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 57 % in 2024 and the probability of meeting the spawning target was 0 % (Figure 15). The management target was not reached as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 1 % with an overall attainment of 71 %.

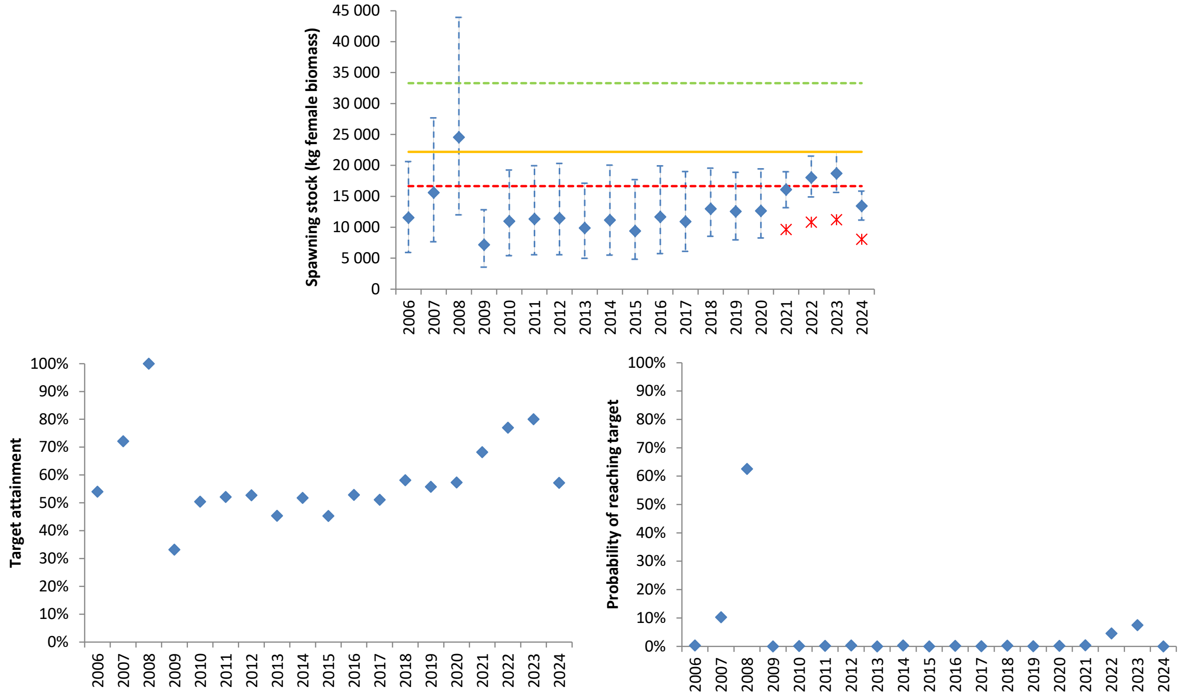


Figure 15. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 for the Tana/Teno MS stock. The red symbols in the upper panel show what the spawning stock sizes would have been in 2021-2024 if fishing had continued.

3.1.2 Pre-fishery abundance

The pre-fishery abundance (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 123 242 kg in 2008 down to 22 607 kg in 2024 (Figure 16; Table 5).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Tana/Teno MS stock is 22 189 kg. 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 then be overexploitation. The female PFA has varied between a maximum of 77 642 kg in 2008 down to a minimum of 14 560 kg in 2024 (Figure 16; Table 5).

Of the years 2006-2024, an exploitable surplus has been missing in the last six years (2019-2024). 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 2019-2024 (Table 5). In contrast, as much as 71 % of the female PFA could have been exploited sustainably as recently as 2008.

In the years 2006-2020, significant overexploitation of Tana/Teno MS salmon took place, averaging at a level of 43 % with a maximum of 68 % in 2009 (Table 5). The estimated average exploitation rate in 2006-2020 was 61 %. In the years 2021-2024, Tana/Teno MS salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 8 % and an average overexploitation of 6 % (Table 5).

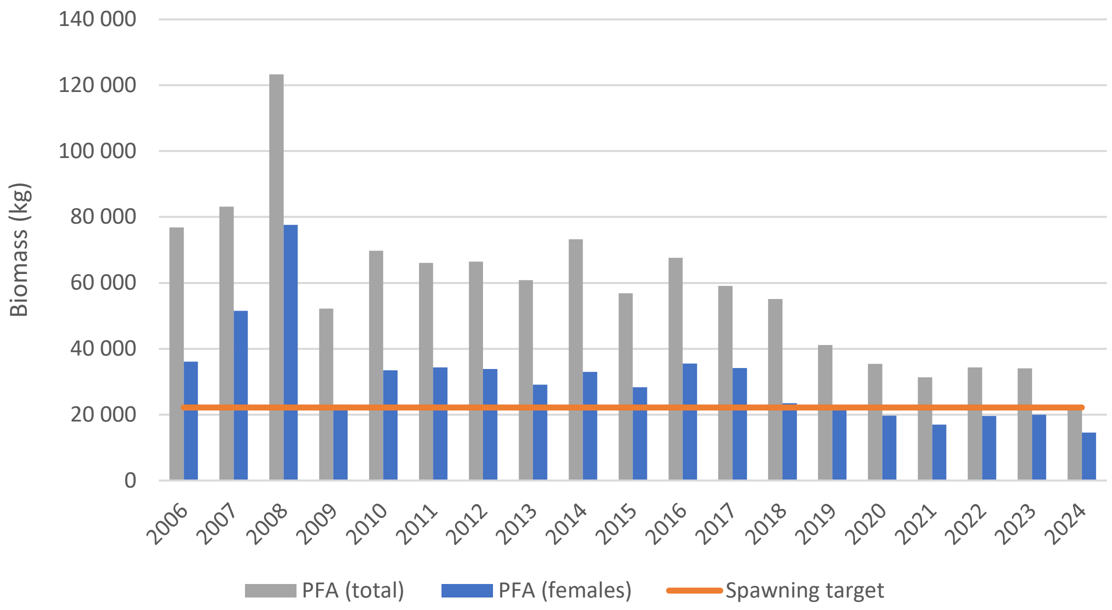


Figure 16. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Tana/Teno MS stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 5. Numbers involved in the calculation of pre-fishery abundance (PFA, kg) of salmon belonging to the Tana/Teno MS stock in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	12 948	38 731	-	11 816	0.47	76 819	36 105	0.39	0.67	0.47
2007	19 574	39 298	-	15 024	0.62	83 105	51 525	0.57	0.71	0.32
2008	24 699	60 907	-	23 711	0.63	123 242	77 642	0.71	0.69	0.00
2009	11 426	24 945	-	7 010	0.44	52 175	23 144	0.04	0.70	0.68
2010	11 738	35 161	-	10 967	0.48	69 734	33 490	0.34	0.67	0.51
2011	11 988	33 457	-	10 751	0.52	66 121	34 383	0.35	0.69	0.52
2012	9 487	34 550	-	11 422	0.51	66 433	33 881	0.35	0.66	0.49
2013	8 264	31 896	-	9 881	0.48	60 817	29 090	0.24	0.66	0.55
2014	9 412	38 881	-	11 242	0.45	73 277	32 972	0.33	0.66	0.49
2015	6 836	30 469	-	9 746	0.50	56 881	28 319	0.22	0.66	0.56
2016	11 467	33 982	-	11 637	0.52	67 620	35 492	0.37	0.67	0.48
2017	12 985	16 684	-	16 982	0.58	59 053	34 129	0.35	0.50	0.23
2018	11 448	13 741	-	12 745	0.43	55 126	23 468	0.05	0.46	0.43
2019	6 741	10 201	-	12 621	0.52	41 106	21 470	0.00	0.41	0.40
2020	5 068	8 455	-	12 206	0.56	35 390	19 754	0.00	0.38	0.34
2021	2 117	0	-	15 861	0.54	31 327	17 011	0.00	0.07	0.05
2022	2 663	0	-	18 137	0.57	34 394	19 659	0.00	0.08	0.07
2023	2 526	0	-	18 493	0.59	34 101	19 973	0.00	0.07	0.07
2024	2 032	0	-	13 251	0.64	22 607	14 560	0.00	0.09	0.06

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 6. Female proportions in Table 6 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 6).

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.

Table 6. Summary of stock data used to estimate annual spawning stock sizes in Máskejohka in years with catch statistic.

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

Since salmon fisheries closed in 2021, the assessment approach had to be changed for Máskejohka. A new sonar count were done in 2022, meaning that we have two years of counting data (2020, 2022) that can be used as a basis for assessing 2021, 2023, and 2024. In this alternative approach, it is assumed that the run size of Máskejohka is relatively correlated with the overall run of the Tana/Teno river system and that the variation of this overall run is reflected in the Polmak sonar count. We can then use the proportion between the Máskejohka counts and the Polmak counts in 2020 and 2022 to infer the Máskejohka run in 2021, 2023, and 2024. The resulting numbers are given in Table 7.

Table 7. Summary of data used to estimate annual spawning stock sizes in Máskejohka in the years with either counting (2022) or an estimate based on the average ratio between Máskejohka and Polmak (2021, 2023, 2024).

Year	Number of salmon(<3 kg)	Number of salmon (3-7 kg)	Number of salmon (>7 kg)	Average size (<3 kg)	Average size (3-7 kg)	Average size (>7 kg)	Weight (<3 kg)	Weight (3-7 kg)	Weight (>7 kg)
2021	770	132	17	1.9	3.8	8.9	1 462	501	154
2022	624	173	18	1.9	3.8	8.9	1 186	657	160
2023	564	163	20	1.9	3.8	8.9	1 071	620	178
2024	191	71	18	1.9	3.8	8.9	363	271	161

To account for uncertainty, the exploitation rate and female proportion estimates in Table 6 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 spawning target attainment was 23 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 41 % (Figure 17).

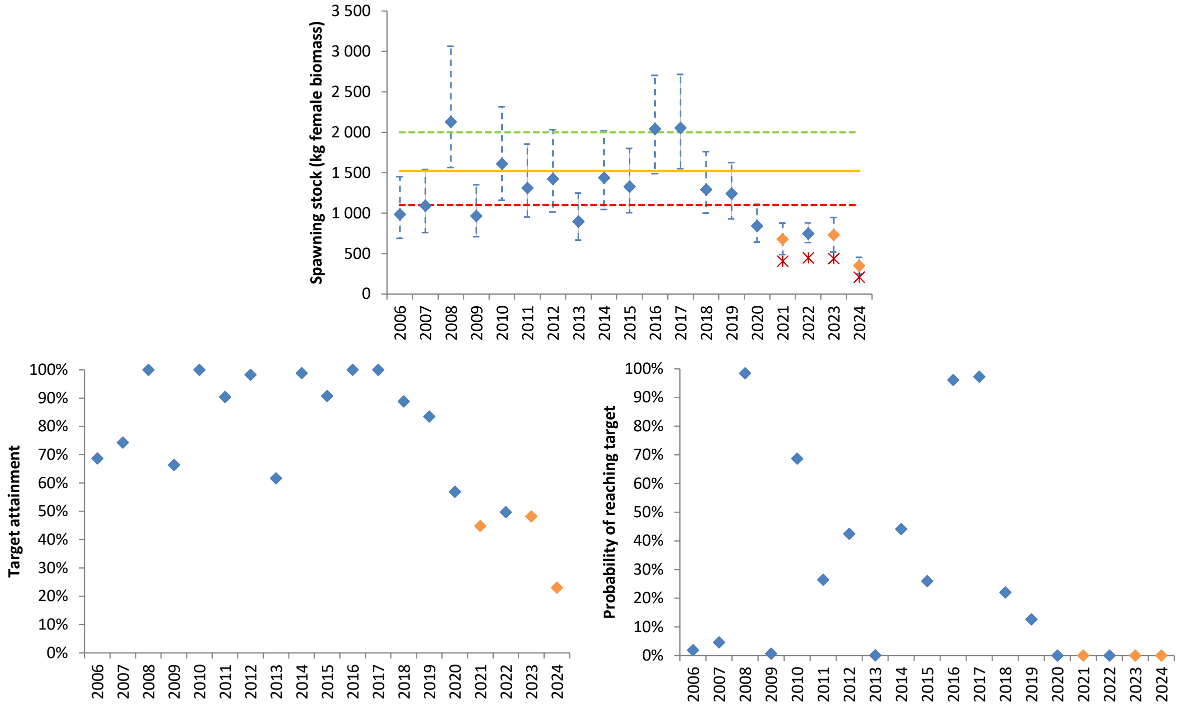


Figure 17. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 for the Máskejohka stock. The red symbols in the upper panel shows what the spawning stock size would have been in 2021-2024 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 %.

Geasis was surveyed twice in 2024. No salmon were observed during a first survey on the 19.9. that covered most of the anadromous area under low water conditions. Two small-sized females and two small-sized males were observed in the sidebranch Uvjálatnjá on the same day. A second count was done in Geasis on the 4.10., with one small-sized female and two medium-sized females observed. Based on this, salmon spawning in these upper parts of Máskejohka were likely negligible in 2024.

3.2.2 Pre-fishery abundance

The pre-fishery abundance (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 9 567 kg in 2008 down to 877 kg in 2024 (Figure 18; Table 8).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Máskejohka stock is 1 521 kg. 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 then be overexploitation. The female PFA has varied between a maximum of 4 825 kg in 2008 down to a minimum of 381 kg in 2024 (Figure 18; Table 8).

Of the years 2006-2024, an exploitable surplus was missing in 2021-2024 and nearly missing in 2020 with an exploitable surplus of only 6 %. As an exploitable surplus has been missing in the last four years, the Máskejohka 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 0 % (Table 8). In contrast, as much as 68 % of the female PFA could have been exploited sustainably as recently as 2008.

In the years 2006-2020, Máskejohka salmon were overexploited at an average level of 17 % with a maximum of 45 % in 2020 (Table 8). The estimated average exploitation rate in 2006-2020 was 58 %. In the years 2021-2024, Máskejohka salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 5 % and an average overexploitation of 2 % (Table 8).

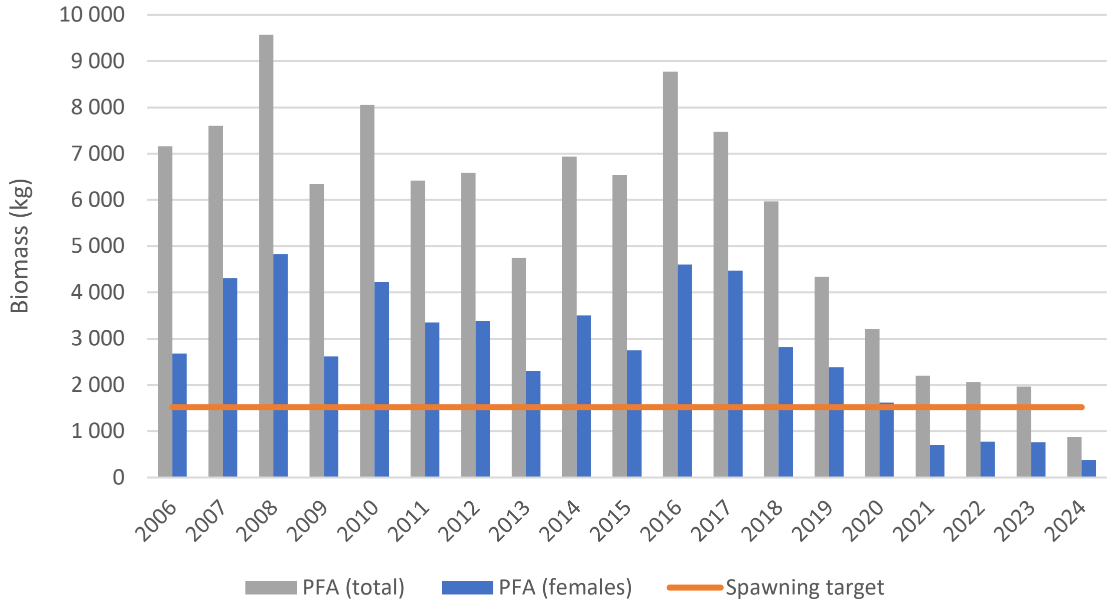


Figure 18. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Máskejohka stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon 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 2006-2024.

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	Actual expl. rate	Over-expl.
2006	1 062	1 555	1 911	983	0.37	7 161	2 675	0.43	0.63	0.35
2007	1 325	3 060	1 290	1 091	0.57	7 602	4 303	0.65	0.75	0.28
2008	2 125	900	2 318	2 130	0.50	9 567	4 825	0.68	0.56	0.00
2009	1 612	903	1 486	966	0.41	6 341	2 617	0.42	0.63	0.36
2010	1 743	1 273	1 968	1 610	0.52	8 056	4 223	0.64	0.62	0.00
2011	1 405	1 058	1 441	1 311	0.52	6 415	3 348	0.55	0.61	0.14
2012	1 172	871	1 768	1 425	0.51	6 583	3 384	0.55	0.58	0.06
2013	767	1 155	978	896	0.49	4 747	2 304	0.34	0.61	0.41
2014	1 187	1 408	1 495	1 438	0.50	6 940	3 501	0.57	0.59	0.05
2015	956	1 103	1 317	1 328	0.42	6 535	2 747	0.45	0.52	0.13
2016	2 112	1 231	1 537	2 043	0.52	8 774	4 602	0.67	0.56	0.00
2017	1 568	1 322	1 150	2 052	0.60	7 470	4 469	0.66	0.54	0.00
2018	1 158	1 219	855	1 292	0.47	5 968	2 819	0.46	0.54	0.15
2019	664	705	708	1 242	0.55	4 343	2 380	0.36	0.48	0.18
2020	341	670	528	842	0.50	3 212	1 616	0.06	0.48	0.45
2021	80	0	0	676	0.32	2 198	702	0.00	0.04	0.02
2022	78	0	0	746	0.38	2 061	776	0.00	0.04	0.02
2023	67	0	0	730	0.38	1 965	756	0.00	0.03	0.02
2024	76	0	0	348	0.43	877	381	0.00	0.09	0.02

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	-
2024	0	34	0.80	0.2	-	0.62	-

The spawning target attainment was 34 % in 2024 and the probability of meeting the spawning target was 0 % (Figure 19). The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 61 %.

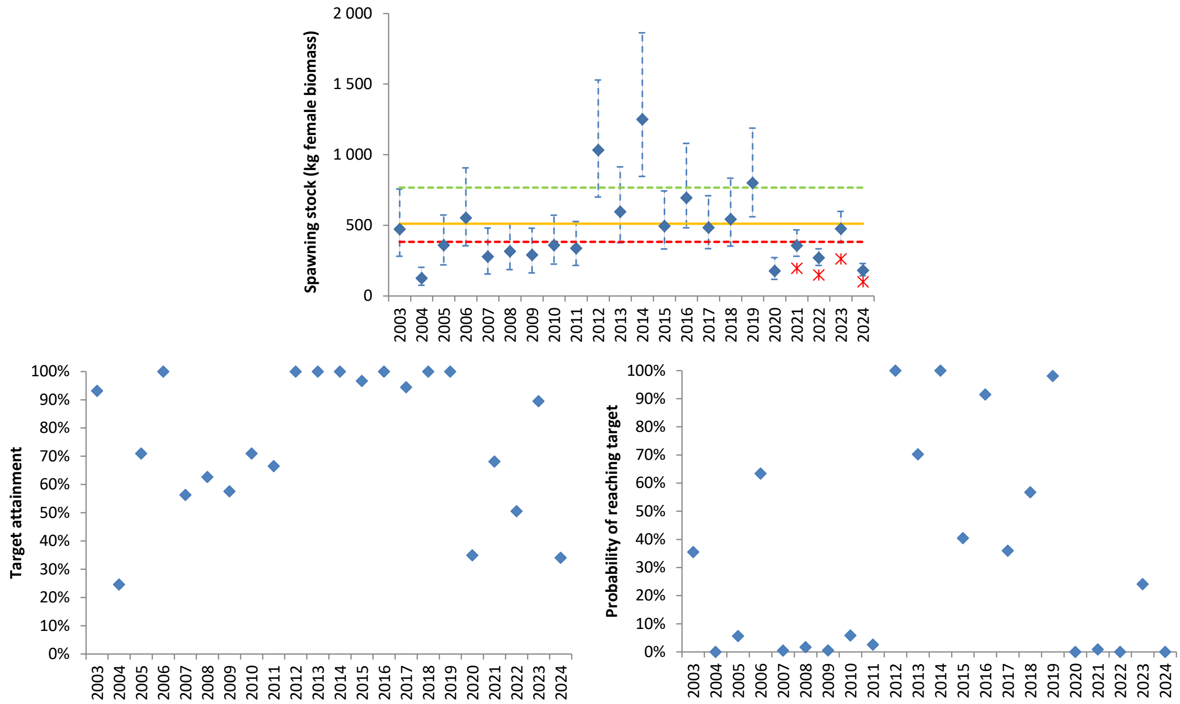


Figure 19. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2024 in the Norwegian/Finnish tributary Buolbmátjohka/Pulmankijoki. The red symbols in the upper panel show what the spawning stock sizes would have been in 2021-2024 if fishing had continued.

The 2023 video monitoring of the tributary Gálddašjohka/Kalddasjoki allowed for a separate spawning target assessment. There were 165 salmon <65 cm and 31 salmon ≥65 cm ascending the tributary in 2023, of which 47 and 23 individuals were females in the two size groups. Based on the 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).

Based on the above data, the 2023 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 %.

The salmon run of Gálddašjohka/Kalddasjoki was counted again in 2024. The total salmon count in 2024 was only 47 salmon, of which 42 were <65 cm and 5 were >65 cm. The estimated spawning stock was 26 kg (22-31 kg), with a target attainment of 23 % and a zero probability of enough spawners in 2024.

3.3.2 Pre-fishery abundance

The pre-fishery abundance (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 4 238 kg in 2014 down to 373 kg in 2024 (Figure 20; Table 10).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Buolbmátjohka/Pulmankijoki stock is 511 kg. 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 then be overexploitation. The female PFA has varied between a maximum of 4 786 kg in 2014 down to a minimum of 319 kg in 2024 (Figure 20; Table 10).

Of the years 2006-2024, an exploitable surplus was missing in 2020, 2021, 2022, and 2024, and very close to missing in 2023. As an exploitable surplus has been missing in three 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, 2021, 2022, and 2024, and just 1 % in 2023 (Table 10). In contrast, as much as 80 % of the female PFA could have been exploited sustainably as recently as 2014.

In the years 2006-2020, Buolbmátjohka/Pulmankijoki salmon were overexploited at an average level of 17 % with a maximum of 61 % in 2020 (Table 10). The estimated average exploitation rate in 2006-2020 was 60 %. In the years 2021-2024, Buolbmátjohka/Pulmankijoki salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 7 % and an average overexploitation of 5 % (Table 10).

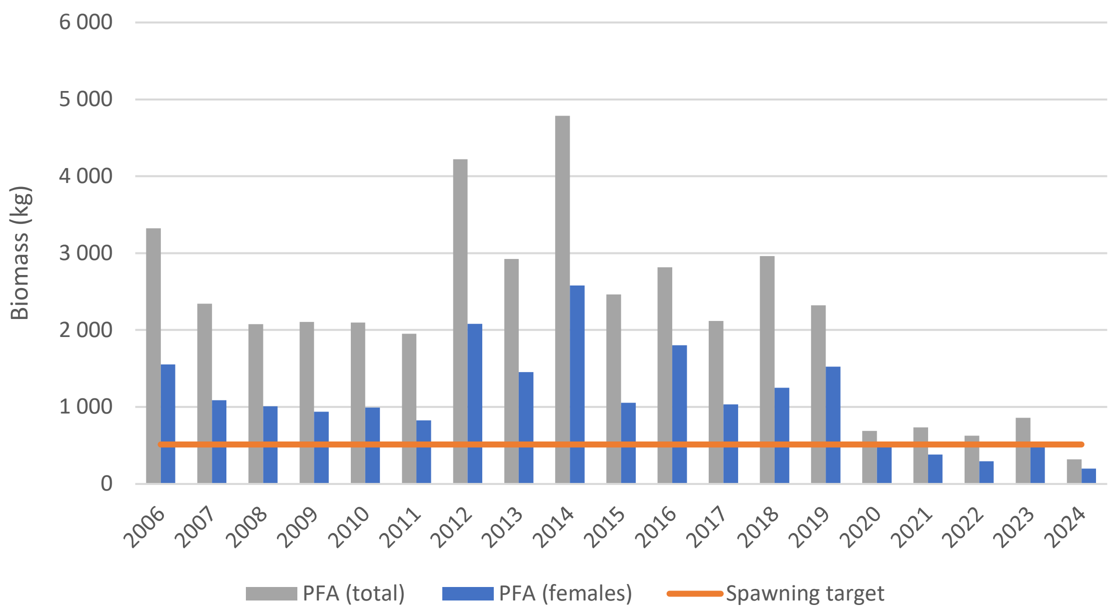


Figure 20. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Buolbmátjohka/Pulmankijoki stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any 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 2006-2024.

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	Actual expl. rate	Over-expl.
2006	596	551	1 009	545	0.47	3 323	1 551	0.67	0.65	0.00
2007	349	557	804	293	0.46	2 344	1 086	0.53	0.73	0.43
2008	309	471	649	314	0.48	2 077	1 007	0.49	0.69	0.39
2009	475	257	744	280	0.44	2 107	937	0.45	0.70	0.45
2010	395	362	590	354	0.47	2 096	991	0.48	0.64	0.31
2011	364	184	609	335	0.42	1 950	824	0.38	0.59	0.34
2012	868	376	934	1 007	0.49	4 222	2 080	0.75	0.52	0.00
2013	508	328	889	595	0.50	2 923	1 452	0.65	0.59	0.00
2014	1 027	400	1 089	1 223	0.54	4 786	2 579	0.80	0.53	0.00
2015	362	313	629	497	0.43	2 464	1 056	0.52	0.53	0.03
2016	717	350	664	695	0.64	2 817	1 803	0.72	0.61	0.00
2017	370	423	348	476	0.49	2 116	1 032	0.50	0.54	0.07
2018	476	378	853	529	0.42	2 962	1 250	0.59	0.58	0.00
2019	433	235	435	800	0.66	2 323	1 522	0.66	0.47	0.00
2020	71	214	148	182	0.72	686	494	0.00	0.63	0.61
2021	48	0	0	357	0.52	732	382	0.00	0.07	0.05
2022	39	0	0	273	0.47	625	292	0.00	0.06	0.04
2023	64	0	0	478	0.60	857	517	0.01	0.07	0.06
2024	27	0	0	180	0.62	319	197	0.00	0.09	0.03

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).

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

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 and 2024, 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.

In 2023, 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).

In the 2024 snorkelling survey, detection rates were set to 0.85 for Deavkehanjohka and 0.75 for Lákšjohka. A total of 15 salmon were observed, one of which were in Deavkehanjohka and 14 in

Lákšjohka. The Deavkehanjohka observation was one medium-sized male. In Lákšjohka, 9 small-sized salmon (8 female) and 3 medium-sized salmon (1 female) were observed.

Final estimated salmon numbers, based salmon observations, detection rates and area covered, are summarized in Table 12.

Table 12. Summary of data used to estimate annual spawning stock sizes in Lákšjohka in the years with either counting (2023, 2024) or an estimate based on the average ratio between Lákšjohka and Polmak (2021, 2022).

Year	Estimated number of salmon (small sized)	Estimated number of salmon (middle sized)	Estimated number of salmon (large sized)	Avg. size (small)	Avg. size (middle)	Avg. size (large)	Female prop. (small)	Female prop. (medium)	Female prop. (large)
2021	163	56	24	1.6	2.6	3.1	0.76	0.78	0.63
2022	132	73	25	1.6	2.6	3.1	0.76	0.78	0.63
2023	120	69	28	1.6	2.6	3.1	0.76	0.78	0.63
2024	22	8	0	1.6	2.6	3.1	0.88	0.50	0.00

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 3 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 23 % (Figure 21).

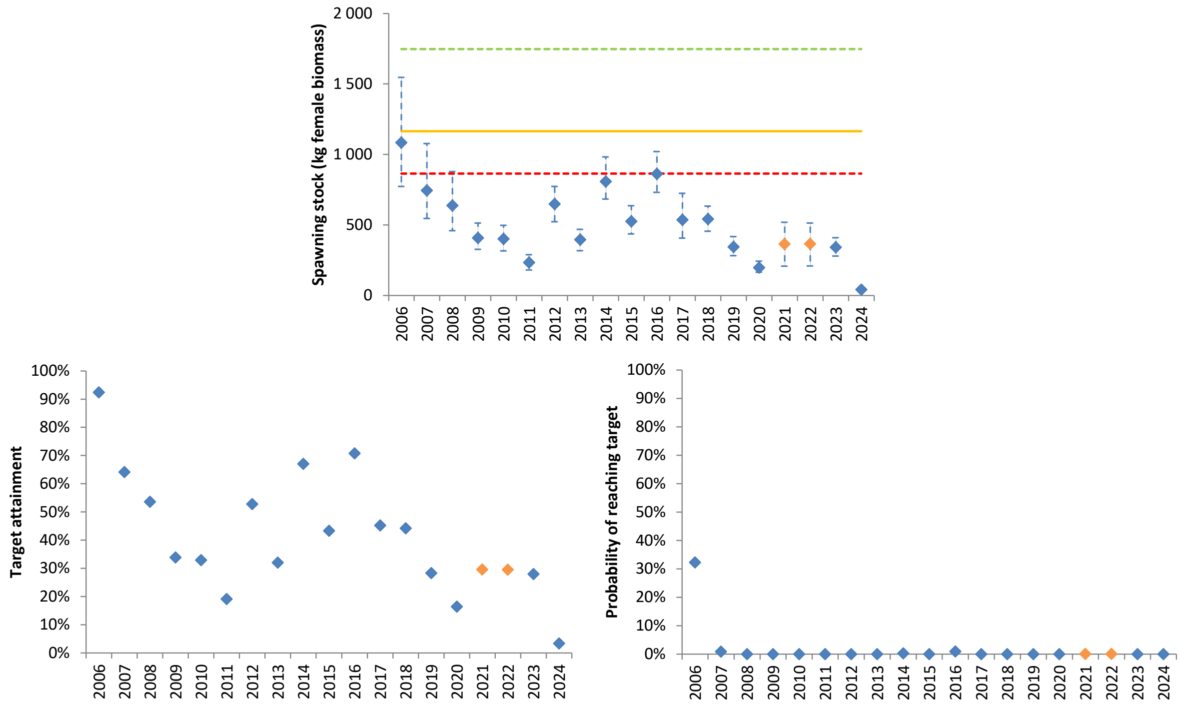


Figure 21. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the Norwegian tributary Lákšjohka. The orange symbols in the panels show the years (2021, 2022) with the alternative approach, using the ratio between counts in Lákšjohka and Polmak in 2023 on the Polmak counts in 2021 and 2022 to estimate a run size in Lákšjohka.

3.4.2 Pre-fishery abundance

The pre-fishery abundance (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 4 144 kg in 2006 down to 63 kg in 2024 (Figure 22; Table 13).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Lákšjohka stock is 1 165 kg. 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 then be overexploitation. The female PFA has varied between a maximum of 3 042 kg in 2007 down to a minimum of 47 kg in 2024 (Figure 22; Table 13).

Of the years 2006-2024, an exploitable surplus was missing in several years, and most recently in 2018-2024. As an exploitable surplus has been missing in all 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 2018-2024 (Table 13). In contrast, as much as 62 % of the female PFA could have been exploited sustainably as recently as 2007.

In the years 2006-2020, Lákšjohka salmon were overexploited at an average level of 44 % with a maximum of 66 % in 2010 (Table 13). The estimated average exploitation rate in 2006-2020 was 61 %. In the years 2021-2024, Lákšjohka salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 9 % and an average overexploitation of 2 % (Table 13).

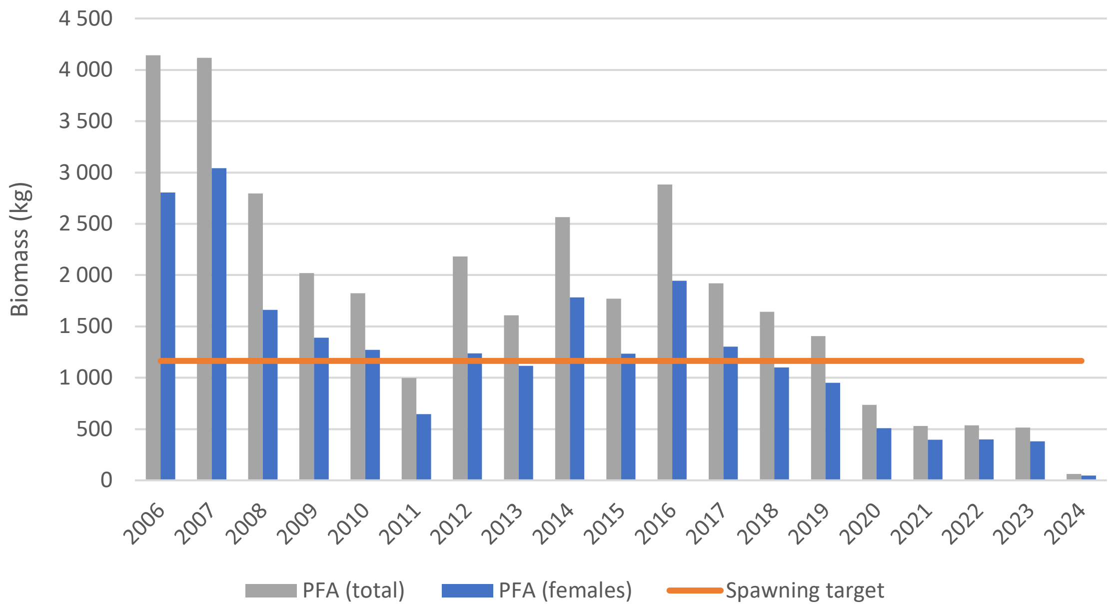


Figure 22. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Lákšjohka stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 13. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Lákšjohka stock in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	1 195	649	700	1 084	0.68	4 144	2 806	0.58	0.61	0.07
2007	928	1 742	439	745	0.74	4 117	3 042	0.62	0.76	0.36
2008	614	649	459	638	0.59	2 795	1 662	0.30	0.62	0.45
2009	679	412	336	408	0.69	2 019	1 391	0.16	0.71	0.65
2010	433	580	237	401	0.70	1 825	1 273	0.09	0.69	0.66
2011	253	164	218	234	0.65	997	645	0.00	0.64	0.35
2012	544	266	229	649	0.57	2 184	1 239	0.06	0.48	0.44
2013	330	526	183	395	0.69	1 608	1 117	0.00	0.65	0.62
2014	663	642	99	808	0.69	2 566	1 783	0.35	0.55	0.31
2015	380	503	134	526	0.70	1 771	1 236	0.06	0.57	0.55
2016	891	561	155	862	0.67	2 885	1 944	0.40	0.56	0.26
2017	409	661	61	536	0.68	1 920	1 304	0.11	0.59	0.54
2018	475	294	65	541	0.67	1 642	1 100	0.00	0.51	0.48
2019	184	604	109	345	0.68	1 405	953	0.00	0.64	0.52
2020	81	335	35	198	0.69	737	509	0.00	0.61	0.27
2021	41	0	0	365	0.74	532	395	0.00	0.08	0.03
2022	45	0	0	365	0.74	535	399	0.00	0.08	0.03
2023	52	0	0	342	0.74	514	381	0.00	0.10	0.03
2024	7	0	0	41	0.74	63	47	0.00	0.11	0.00

3.5 Veahčajohka/Vetsijoki

Veahčajohka/Vetsijoki is a middle-sized river flowing into the Tana main stem approximately 95 km from the Tana estuary. It is one of the most important salmon tributaries flowing to the Tana from the Finnish side, with a sizeable proportion of MSW salmon. Vetsijoki itself has a salmon-producing length of around 42 km. In addition, approximately 6 km is available in the small tributary Vaisjoki.

3.5.1 Spawning stock

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

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

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

The data input for the variables in this formula are summarized in Table 14. Female proportions in Table 14 in the years 2006-2008 and 2011-2012 were based on Tana main stem stock-identified samples from the Genmix project, while female proportions in the other years were 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.

The salmon run was counted for the first time in Vetsijoki in 2016 using an acoustic counting system (ARIS). The estimated run size was 1 673 1SW salmon and 570 MSW salmon, indicating an exploitation rate of under 15 % in Vetsijoki in 2016. However, catch estimates from Vetsijoki are among the most uncertain on the Finnish side of Tana/Teno. It is known that Vetsijoki is a popular fishing site, but accurate information on fishing activity is partly missing and, consequently, catch estimation is very challenging and it is likely that there is significant unreported catch. We therefore selected 20 % as the median exploitation estimate in 2016. The same median exploitation was used also in 2017 and 2020 because of relatively low in-river catch estimates in those years compared with the overall Tana/Teno catch, while a median exploitation of 25 % was used in all other years (Table 14).

The salmon migration was again counted in 2021, yielding an estimated run size of 695 1SW salmon and 342 MSW salmon. Due to the fisheries being closed in 2021, the assessment was based solely on the fish count results. The long-term Vetsijoki scale data series (1972-2020) indicates average female proportions of 0.16 for 1SW salmon and 0.88 for MSW salmon. Average sizes were 1.40 kg for 1SW salmon and 4.02 kg for MSW salmon.

The salmon run was not counted in 2022 and 2023. We used the relation between the Vetsijoki and Utsjoki counts in 2016 and 2021 and the Utsjoki counts in 2022 and 2023 to estimate run sizes for Vetsijoki. For 2022, the salmon run size was estimated to 699 1SW salmon and 445 MSW salmon. For 2023, the estimate was 496 1SW salmon and 287 MSW salmon.

Ascending salmon was again counted in 2024 with sonar and video. The final estimated run size from the count was 202 1SW salmon and 154 MSW salmon.

Table 14. Summary of stock data used to estimate annual spawning stock sizes in Veahčajohka/Vetsijoki in the years with catch statistics (2006-2020).

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

To account for uncertainty, the exploitation rates and female proportion estimates in Table 14 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation for all years except 2016 when a 10 % uncertainty was used due to the fish counting. In all years, 10 % uncertainty was used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 1 165 kg as the mode, 864 kg as the minimum and 1 747 kg as the maximum value.

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

The spawning target attainment was 49 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 38 % with an overall attainment of 96 % (Figure 23).

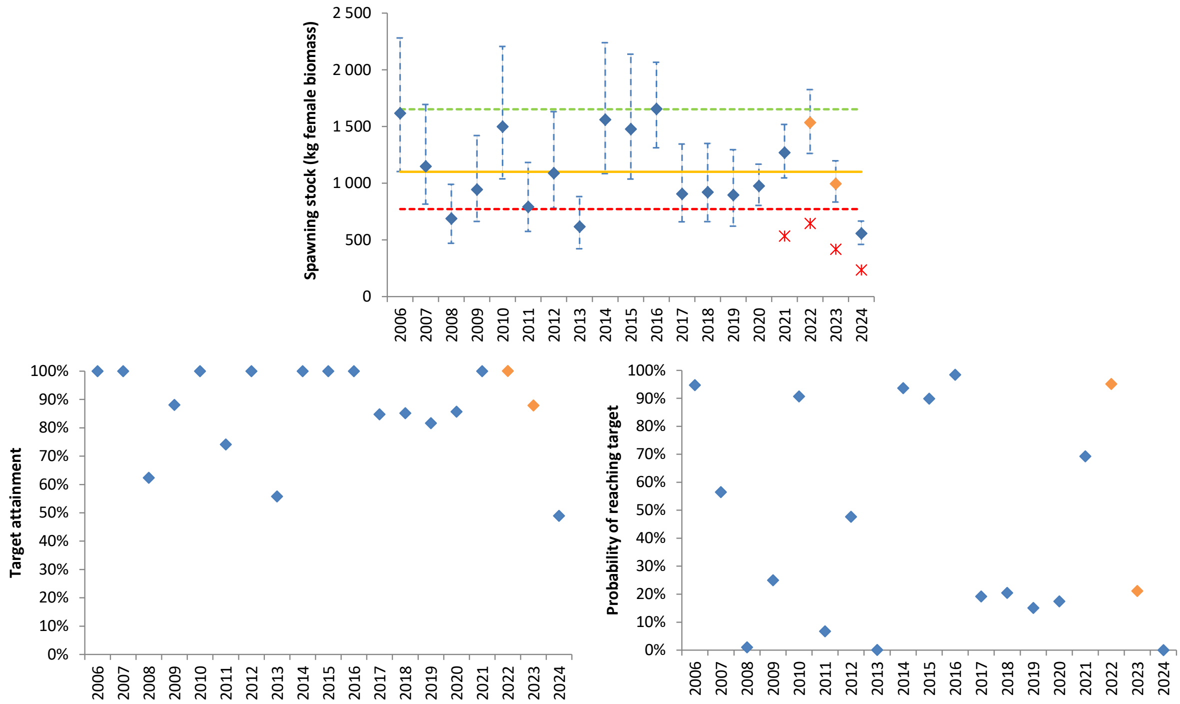


Figure 23. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the Finnish tributary Veahčajohka/Vetsijoki. The orange symbols in the panels show the years with the alternative assessment approach based on the relation between counts in Vetsijoki and Utsjoki in 2016 and 2021.The red symbols in the upper panel show what the spawning stock sizes would have been in 2021-2024 if fishing had continued.

3.5.2 Pre-fishery abundance

The pre-fishery abundance (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 Veahčajohka/Vetsijoki stock has varied from a maximum of 8 578 kg in 2006 down to 1 141 kg in 2024 (Figure 22; Table 13).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Veahčajohka/Vetsijoki stock is 1 101 kg. 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 then be overexploitation. The female PFA has varied between a maximum of 5 404 kg in 2006 down to a minimum of 601 kg in 2024 (Figure 20; Table 15).

Of the years 2006-2024, an exploitable surplus was missing in 2023 and 2024. As an exploitable surplus were missing in two of the latest four years, the Veahčajohka/Vetsijoki 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 estimated sustainable exploitation rate was estimated at 0 % in 2023 and 2024 (Table 15). In contrast, as much as 80 % of the female PFA could have been exploited sustainably as recently as 2006.

In the years 2006-2020, Veahčajohka/Vetsijoki salmon were overexploited at an average level of 13 % with a maximum of 46 % in 2013 (Table 15). The estimated average exploitation rate in 2006-2020 was 68 %. In the years 2021-2024, Veahčajohka/Vetsijoki salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 6 % and overexploitation of 2 % (Table 15).

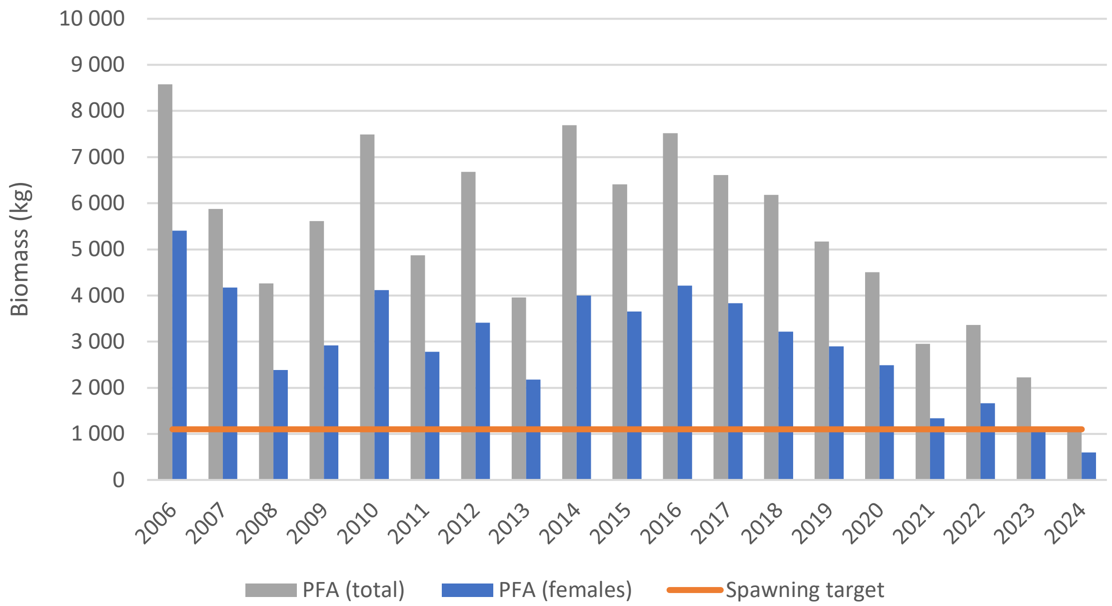


Figure 24. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Veahčajohka/Vetsijoki stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 15. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Veahčajohka/Vetsijoki stock in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	1 743	3 466	859	1 581	0.63	8 578	5 404	0.80	0.71	0.00
2007	1 437	2 264	560	1 146	0.71	5 875	4 171	0.74	0.73	0.00
2008	672	2 009	415	654	0.56	4 263	2 387	0.54	0.73	0.41
2009	1 545	1 550	629	981	0.52	5 610	2 917	0.62	0.66	0.11
2010	1 648	2 185	929	1 499	0.55	7 488	4 119	0.73	0.64	0.00
2011	852	2 123	485	806	0.57	4 874	2 778	0.60	0.71	0.27
2012	915	2 795	754	1 131	0.51	6 681	3 407	0.68	0.67	0.00
2013	525	1 982	375	591	0.55	3 957	2 176	0.49	0.73	0.46
2014	1 281	2 416	1 019	1 548	0.52	7 693	4 001	0.72	0.61	0.00
2015	1 081	1 893	884	1 453	0.57	6 408	3 653	0.70	0.60	0.00
2016	1 708	2 112	754	1 649	0.56	7 519	4 211	0.74	0.61	0.00
2017	692	3 940	406	911	0.58	6 608	3 833	0.71	0.76	0.17
2018	808	3 026	602	907	0.52	6 180	3 213	0.66	0.72	0.18
2019	484	2 584	545	873	0.56	5 172	2 896	0.62	0.70	0.21
2020	394	1 997	358	970	0.55	4 506	2 488	0.56	0.61	0.12
2021	170	0	0	1 266	0.45	2 957	1 343	0.18	0.06	0.00
2022	225	0	0	1 554	0.50	3 364	1 666	0.34	0.07	0.00
2023	134	0	0	1 001	0.48	2 223	1 065	0.00	0.06	0.06
2024	85	0	0	557	0.53	1 141	601	0.00	0.07	0.04

3.6 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.

3.6.1 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 16. 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 rates and female proportion estimates in Table 16 were treated as modal values, with a 10 % uncertainty used to estimate minimum and maximum values of exploitation 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 16. 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	-
2024	-	254	244	2.57	-	0.62	-

The spawning target attainment was 37 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 43 % with an overall attainment of 98 % (Figure 25).

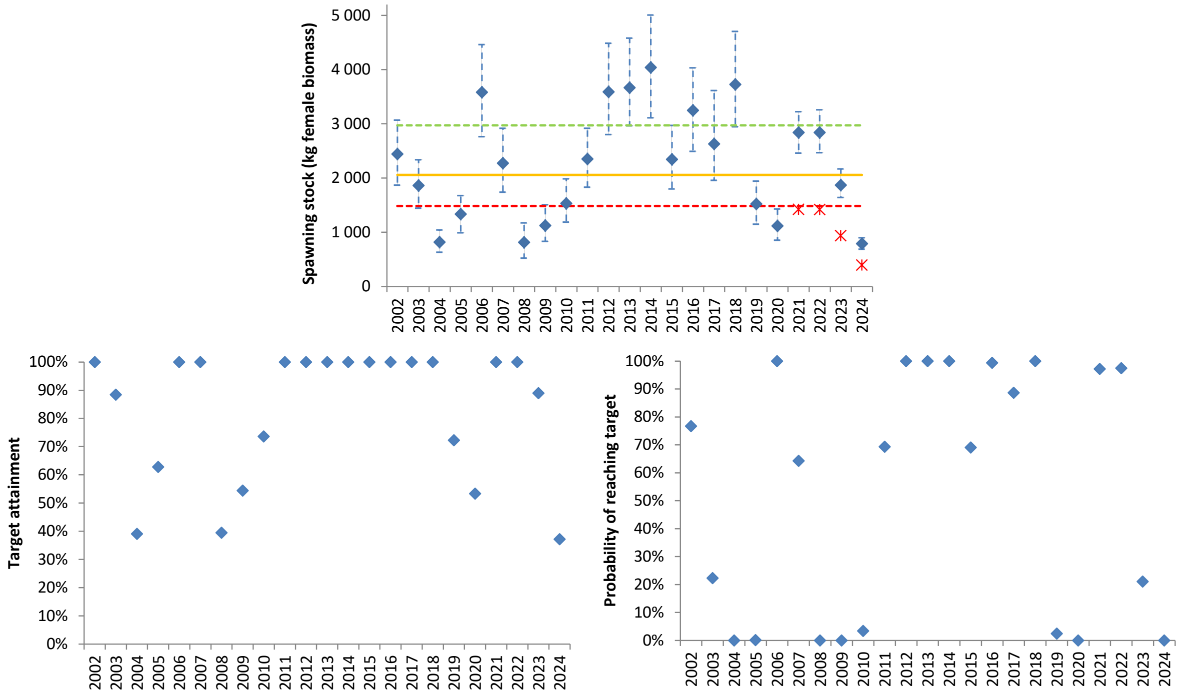


Figure 25. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2002-2024 in the Finnish tributary Ohcejohka/Utsjoki. The red symbol in the upper panel shows what the spawning stock size would have been in 2021-2024 if fishing had continued.

3.6.2 Pre-fishery abundance

The pre-fishery abundance (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 16 795 kg in 2006 down to 1 719 kg in 2024 (Figure 26; Table 17).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Ohcejohka/Utsjoki stock complex is 2 059 kg. 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 be overexploitation. The female PFA has varied between a maximum of 9 131 kg in 2014 down to a minimum of 1 060 kg in 2024 (Figure 26; Table 17).

With the management target at 43 %, the Ohcejohka/Utsjoki stock complex has to be placed in the yellow status category. However, it has to be noted that there was no exploitable surplus in 2024 and just barely a surplus in 2023 (8 %; Table 17). As the 1SW run size in 2024 was particularly bad, 2025 is expected to bring very few 2SW salmon and therefore expected to be especially bad in terms of female salmon. For this reason, no exploitation should take place in 2025, even though the river itself is in the yellow category. In contrast, as much as 77 % of the female PFA could have been exploited sustainably as recently as 2014.

In the years 2006-2020, Ohcejohka/Utsjoki salmon were overexploited at an average level of 13 % with a maximum of 60 % in 2008 (Table 17). The estimated average exploitation rate in 2006-2020 was 64 %. In the years 2021-2024, Ohcejohka/Utsjoki salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 16 % and an average overexploitation of 5 % (Table 17).

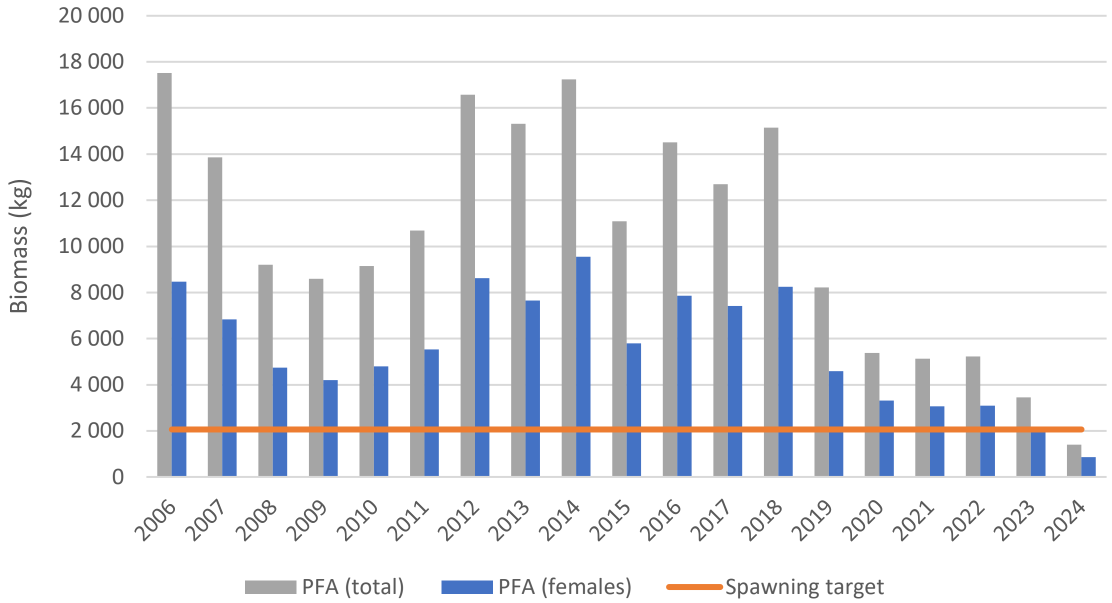


Figure 26. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock complex in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 17. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Ohcejohka/Utsjoki stock complex in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	3 860	4 008	2 373	3 518	0.48	17 509	8 474	0.76	0.58	0.00
2007	2 847	4 475	1 943	2 267	0.49	13 863	6 836	0.70	0.67	0.00
2008	797	4 218	2 603	820	0.52	9 208	4 749	0.57	0.83	0.60
2009	1 843	2 309	2 093	1 149	0.49	8 598	4 200	0.51	0.73	0.44
2010	1 683	3 255	1 304	1 526	0.53	9 148	4 805	0.57	0.68	0.26
2011	2 534	2 082	1 624	2 306	0.52	10 691	5 538	0.63	0.58	0.00
2012	3 016	4 160	2 603	3 534	0.52	16 567	8 627	0.76	0.59	0.00
2013	3 126	2 952	1 694	3 769	0.50	15 317	7 650	0.73	0.51	0.00
2014	3 317	3 599	2 953	4 082	0.55	17 240	9 547	0.78	0.57	0.00
2015	1 715	2 820	2 147	2 300	0.52	11 087	5 789	0.64	0.60	0.00
2016	3 350	3 146	2 088	3 212	0.54	14 514	7 861	0.74	0.59	0.00
2017	2 011	4 336	1 851	2 627	0.58	12 693	7 418	0.72	0.65	0.00
2018	3 270	2 983	1 922	3 795	0.54	15 143	8 249	0.75	0.54	0.00
2019	822	3 121	1 556	1 522	0.56	8 221	4 596	0.55	0.67	0.26
2020	451	2 198	884	1 135	0.62	5 374	3 314	0.38	0.66	0.45
2021	380	0	0	2 844	0.60	5 135	3 071	0.33	0.07	0.00
2022	416	0	0	2 852	0.59	5 228	3 098	0.34	0.08	0.00
2023	252	0	0	1 881	0.59	3 459	2 028	0.00	0.07	0.07
2024	120	0	0	790	0.62	1 400	864	0.00	0.09	0.04

3.7 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.

3.7.1 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 18. Female proportions in Table 18 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.

Table 18. Summary of stock data used to estimate annual spawning stock sizes in Leavvajohka in the years with catch statistics (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

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 18).

The stop in Tana/Teno salmon fisheries in 2021 made it necessary to assess the Leavvajohka stock through alternative means. The entire Leavvajohka was snorkelled in 2023 and 2024, which directly provide the basis for an assessment in those two years. The ratio between the snorkelling surveys and the Polmak sonar counts in 2023 and 2024 can then be used to give a rough estimate of the spawning stock situation in Leavvajohka in 2021 and 2022 (Table 19).

In 2023, 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.

A total of 132 salmon were observed in 2024, distributed into 67 small-sized (27 females), 61 medium-sized (48 females) and 4 large-sized salmon (2 females). The snorkelling survey was done 4-5. September under good conditions, and the detection rate was estimated to 0.85.

When interpreting the results of the Leavvajohka status assessment, it is important to acknowledge that the snorkelling surveys in 2023 and 2024 represents the first years with more reliable data from within the Leavvajohka. The assessments in the earlier years with catch statistics were based on assumptions about main stem exploitation rates and catch proportions that have unknown properties and are less certain.

Table 19. Summary of count data used to estimate annual spawning stock sizes in Leavvajohka in the years with either counting (2023, 2024) or an estimate based on the average ratio between Leavvajohka count and Polmak sonar count (2021, 2022).

Year	Count (small sized)	Count (middle sized)	Count (large sized)	Avg. size (small)	Avg. size (middle)	Avg. size (large)	Female prop. (small)	Female prop. (medium)	Female prop. (large)
2021	236	93	3	1.4	2.7	3.8	0.35	0.74	0.58
2022	191	122	3	1.4	2.7	3.8	0.35	0.74	0.58
2023	148	90	3	1.4	2.7	3.8	0.29	0.69	0.67
2024	67	61	4	1.4	2.7	3.8	0.40	0.79	0.50

To account for uncertainty, the exploitation rate and female proportion estimates in Table 18 were treated as modal values, with a 20 % uncertainty used to estimate minimum and maximum values of exploitation for all years. In all years, 10 % uncertainty was used for the female proportions in Table 18. 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.

The spawning target attainment was 45 % in 2024 and the probability of meeting the spawning target was 0 % (Figure 27). The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 3 % with an overall attainment of 64 % (Figure 27).

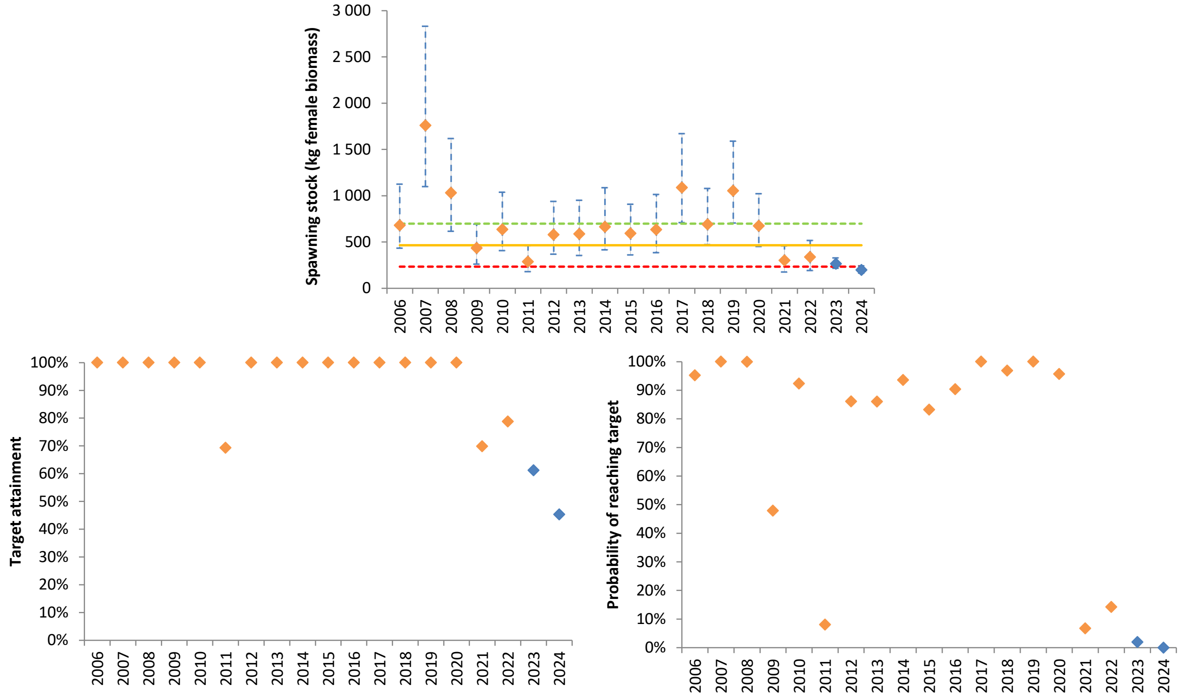


Figure 27. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the Norwegian tributary Leavvajohka. The orange symbols in the panels show the years with the alternative assessment approach based on genetic proportions of main stem catch (2006-2020) or proportion of the Polmak count (2021-2022).

3.7.2 Pre-fishery abundance

The pre-fishery abundance (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 6 265 kg in 2007 down to 340 kg in 2024 (Figure 28; Table 20).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Leavvajohka stock is 466 kg. 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 be overexploitation. The female PFA has varied between a maximum of 5 012 kg in 2007 down to a minimum of 218 kg in 2024 (Figure 28; Table 20).

Of the years 2006-2024, an exploitable surplus was missing in the latest four (2021-2024). Based on this, the Leavvajohka 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 2021-2024 is reflected in the sustainable exploitation rate that was estimated at 0 % (Table 20). In contrast, as much as 91 % of the female PFA could have been exploited sustainably as recently as 2007.

In the years 2006-2020, Leavvajohka salmon were overexploited at an average level of 3 % with a maximum of 38 % in 2011 (Table 20). The estimated average exploitation rate in 2006-2020 was 56 %. In the years 2021-2024, Leavvajohka salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 7 % and an average overexploitation of 5 % (Table 20).

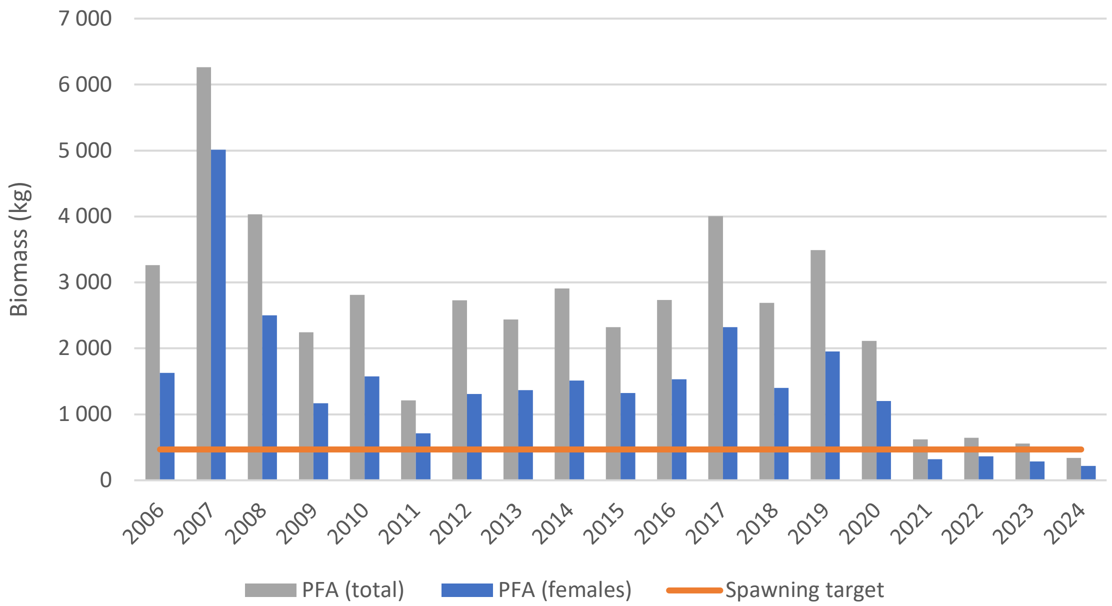


Figure 28. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Leavvajohka stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 20. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Leavvajohka stock in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	734	1 167	0	680	0.50	3 261	1 631	0.71	0.58	0.00
2007	2 202	1 863	0	1 760	0.80	6 265	5 012	0.91	0.65	0.00
2008	1 006	1 364	0	1 030	0.62	4 032	2 500	0.81	0.59	0.00
2009	713	696	0	435	0.52	2 245	1 167	0.60	0.63	0.07
2010	698	981	0	634	0.56	2 812	1 575	0.70	0.60	0.00
2011	309	415	0	287	0.59	1 210	714	0.35	0.60	0.38
2012	486	1 037	0	579	0.48	2 729	1 310	0.64	0.56	0.00
2013	501	890	0	587	0.56	2 439	1 366	0.66	0.57	0.00
2014	545	1 085	0	664	0.52	2 906	1 511	0.69	0.56	0.00
2015	434	850	0	592	0.57	2 323	1 324	0.65	0.55	0.00
2016	655	948	0	634	0.56	2 736	1 532	0.70	0.59	0.00
2017	832	1 296	0	1 089	0.58	4 005	2 323	0.80	0.53	0.00
2018	606	756	0	691	0.52	2 690	1 399	0.67	0.51	0.00
2019	570	1 040	0	1 053	0.56	3 491	1 955	0.76	0.46	0.00
2020	272	657	0	674	0.57	2 112	1 204	0.61	0.44	0.00
2021	40	0	0	301	0.52	619	322	0.00	0.06	0.04
2022	49	0	0	337	0.57	645	365	0.00	0.08	0.06
2023	36	0	0	266	0.51	557	284	0.00	0.06	0.04
2024	30	0	0	199	0.64	340	218	0.00	0.09	0.04

3.8 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.

3.8.1 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 21. Female proportions in Table 21 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 21).

Table 21. 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 stop in Tana/Teno salmon fisheries in 2021 made it necessary to assess the Báišjohka stock through alternative means. The entire Báišjohka was snorkelled in 2023 and 2024, which directly provide the basis for an assessment in those two years. The ratio between the snorkelling surveys and the Polmak sonar counts in 2023 and 2024 can then be used to give a rough estimate of the spawning stock situation in Báišjohka in 2021 and 2022 (Table 22).

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.

A new snorkelling survey was done in 2024 under good conditions. A total of 4 salmon was observed, 3 small-sized (1 female) and 1 medium-sized (female). Snorkelling detection rate was set to 0.85.

When interpreting the results of the Báišjohka status assessment, it is important to acknowledge that the snorkelling surveys in 2023 and 2024 represent the first years with more reliable data from Báišjohka itself while the assessments in 2006-2020 were based on less certain assumptions about main stem exploitation rates and catch proportions based on genetic stock identification that might have led to an overestimate of the Báišjohka spawning stock.

Table 22. Summary of count data used to estimate annual spawning stock sizes in Báišjohka in the years with either counting (2023, 2024) or an estimate based on the average ratio between Báišjohka count and Polmak sonar count (2021, 2022).

Year	Count (small sized)	Count (middle sized)	Count (large sized)	Avg. size (small)	Avg. size (middle)	Avg. size (large)	Female prop. (small)	Female prop. (medium)	Female prop. (large)
2021	81	16	0	1.7	4	0	0.44	0.5	0
2022	65	21	0	1.7	4	0	0.44	0.5	0
2023	59	20	0	1.7	4	0	0.44	0.5	0
2024	3	1	0	1.7	4	0	0.33	1	0

To account for uncertainty, the exploitation rate and female proportion estimates in Table 21 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.

The spawning target attainment was 1 % in 2024 and the probability of meeting the spawning target was 0 % (Figure 29). The management target, calculated based on the four last years (2021-2024), was not reached as the probability was 0 % with an overall attainment of 15 % (Figure 29).

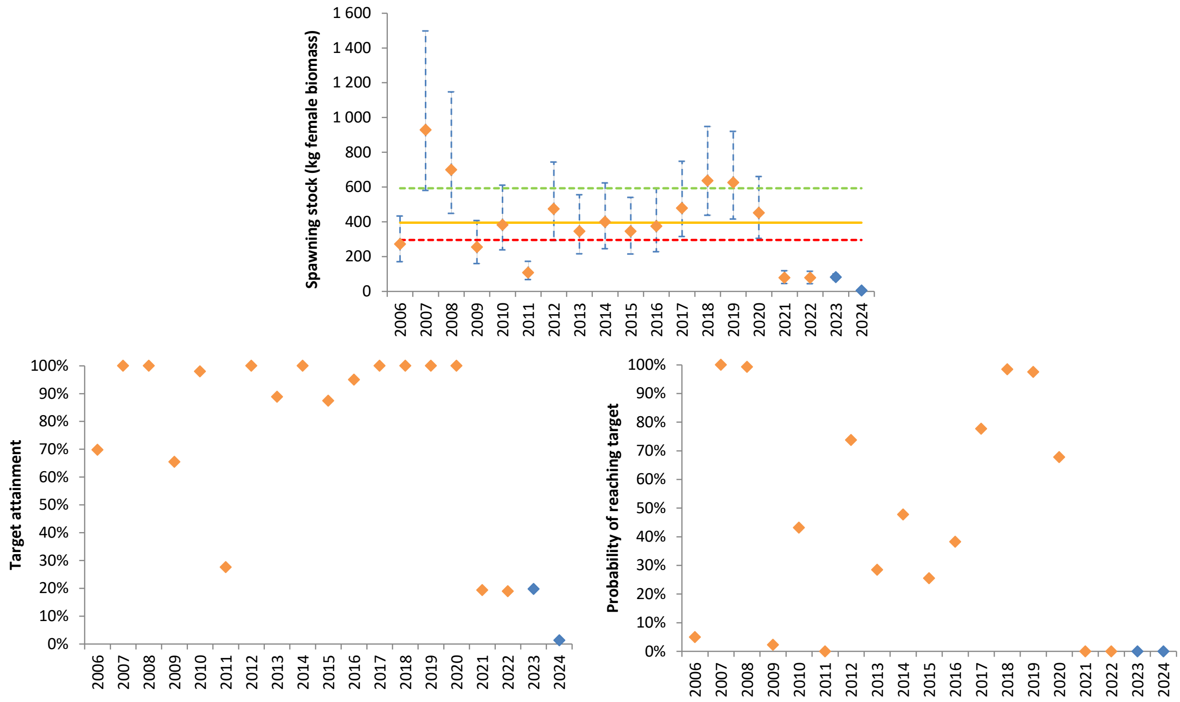


Figure 29. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the Norwegian tributary Báišjohka. The orange symbols in the panels show the years with the alternative assessment approach based on genetic proportions of main stem catch (2006-2020) or proportions of the Polmak count (2021-2022).

3.8.2 Pre-fishery abundance

The pre-fishery abundance (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 3 390 kg in 2007 down to 10 kg in 2024 (Figure 31; Table 24).

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 2 616 kg in 2007 down to a minimum of 6 kg in 2024 (Figure 31; Table 24).

Of the years 2006-2024, an exploitable surplus was missing over the last four years (2021-2024). Based on this, the Báišjohka stock should be 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 2021-2024 is reflected in the sustainable exploitation rate that was estimated at 0 % (Table 24). In contrast, as much as 85 % of the female PFA could have been exploited sustainably as recently as 2007.

In the years 2006-2020, Báišjohka salmon were overexploited at an average level of 9 % with a maximum of 36 % in 2011 (Table 24). The estimated average exploitation rate in 2006-2020 was 56 %. In the years 2021-2024, Báišjohka salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 7 % and an average overexploitation of 1 % (Table 24).

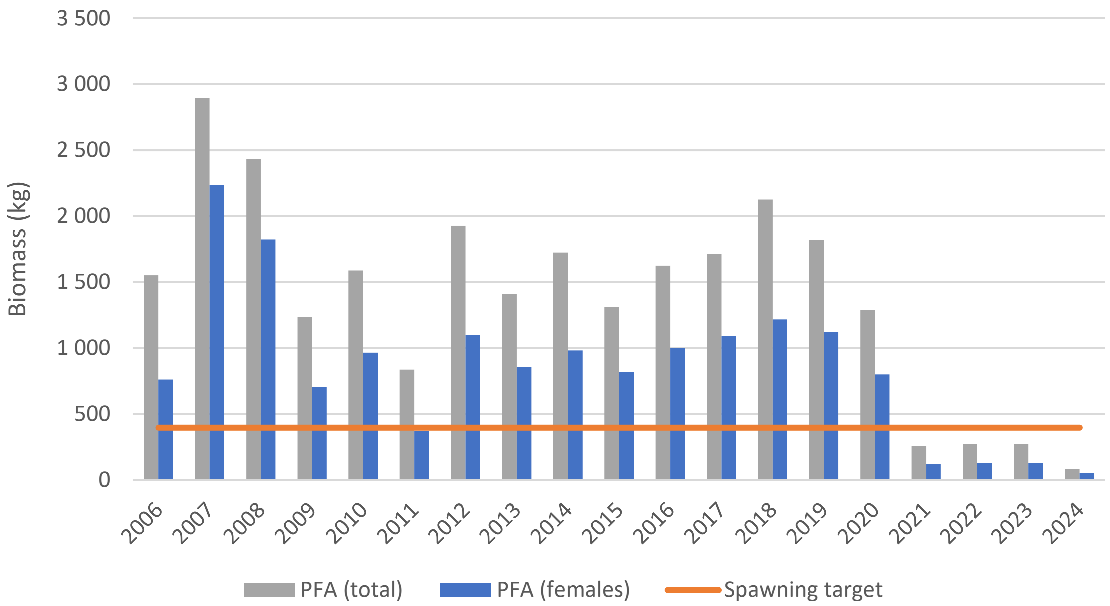


Figure 30. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Báišjohka stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 23. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Báišjohka stock in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	293	473	0	271	0.49	1 318	648	0.39	0.58	0.31
2007	1 161	1 026	0	928	0.77	3 390	2 616	0.85	0.65	0.00
2008	683	813	0	700	0.75	2 430	1 820	0.78	0.62	0.00
2009	417	381	0	255	0.57	1 245	709	0.44	0.64	0.36
2010	421	536	0	382	0.61	1 587	963	0.59	0.60	0.03
2011	116	207	0	107	0.44	564	251	0.00	0.57	0.36
2012	399	701	0	474	0.57	1 932	1 101	0.64	0.57	0.00
2013	294	487	0	345	0.61	1 350	819	0.52	0.58	0.13
2014	328	593	0	400	0.57	1 624	924	0.57	0.57	0.00
2015	252	465	0	345	0.62	1 270	793	0.50	0.56	0.13
2016	387	518	0	375	0.62	1 514	932	0.58	0.60	0.05
2017	366	529	0	479	0.64	1 646	1 049	0.62	0.54	0.00
2018	558	546	0	636	0.57	2 217	1 268	0.69	0.50	0.00
2019	338	507	0	626	0.62	1 862	1 146	0.66	0.45	0.00
2020	182	348	0	451	0.62	1 257	780	0.49	0.42	0.00
2021	11	0	0	79	0.46	182	83	0.00	0.06	0.01
2022	11	0	0	78	0.47	179	83	0.00	0.06	0.01
2023	11	0	0	82	0.47	186	87	0.00	0.06	0.01
2024	1	0	0	5	0.62	10	6	0.00	0.09	0.00

3.9 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.

3.9.1 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 2006-2024, with the exceptions of 2007, 2008, 2013, 2019 and 2024. 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 24. Female proportions in Table 24 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 24 are based on a combination of main stem Genmix samples from 2006-2008 and 2011-2012.

Table 24. 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 and with catch statistics (2007, 2008, 2013, 2019), an alternative approach were 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 25). 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.

Table 25. Summary of stock data used to estimate annual spawning stock sizes in Njiljohka/Nilijoki in the years without snorkelling data and with main stem catch 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

No snorkelling surveys were done in Njiljohka/Nilijoki in 2024, and an alternative approach based on the average ratio between the snorkelling surveys in Njiljohka/Nilijoki and the Polmak counts in 2021-2023. The average ratio was then used with the 2024 Polmak sonar count to estimate a run size for Njiljohka/Nilijoki.

To account for uncertainty, the exploitation rate and female proportion estimates in Table 24 and Table 25 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 2024 was 21 % and the probability of meeting the spawning target was 0 % (Figure 31). The management target was not reached as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 52 %.

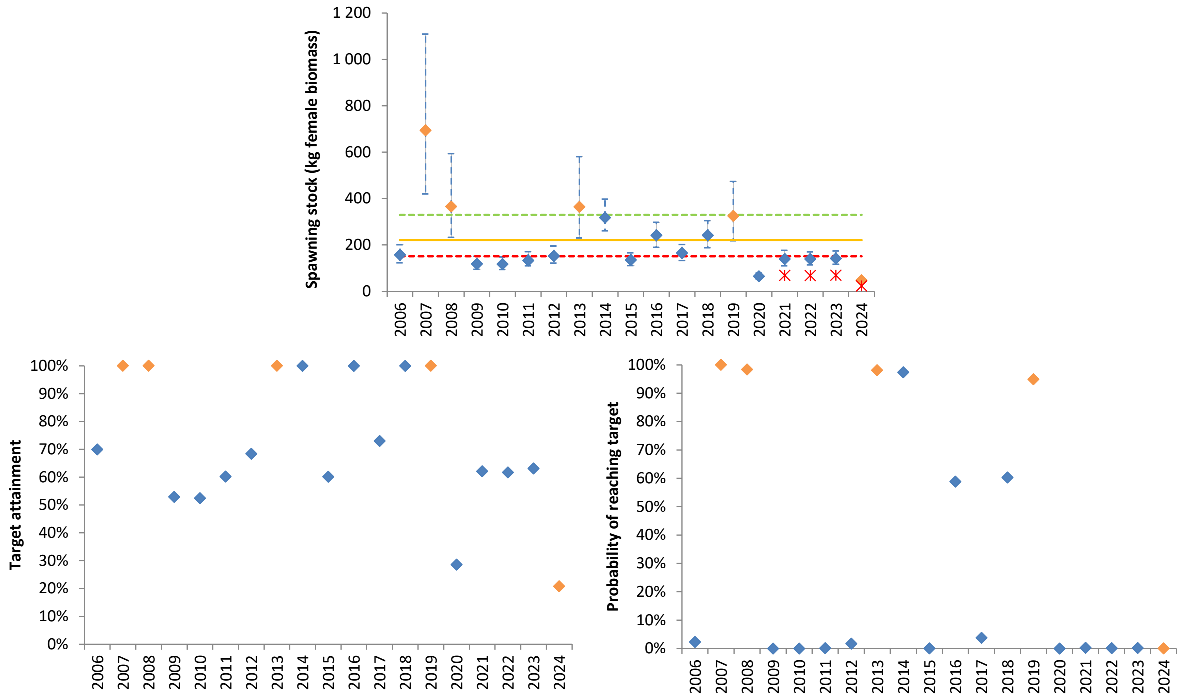


Figure 31. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the Finnish tributary Njiljohka/Nilijoki. The orange symbols in the panels show the years with 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 2021-2024 if fishing had continued.

3.9.2 Pre-fishery abundance

The pre-fishery abundance (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 2 501 kg in 2007 down to 108 kg in 2024 (Figure 32; Table 26).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Njiljohka/Nilijoki stock is 221 kg. 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 female PFA has varied between a maximum of 1 946 kg in 2007 down to a minimum of 55 kg in 2024 (Figure 32; Table 26).

Of the years 2006-2024, an exploitable surplus was missing in 2020-2024. As an exploitable surplus has been missing in all 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 2020-2024 (Table 26). In contrast, as much as 89 % of the female PFA could have been exploited sustainably as recently as 2007.

In the years 2006-2020, Njiljohka/Nilijoki salmon were overexploited at an average level of 22 % with a maximum of 69 % in 2020 (Table 26). The estimated average exploitation rate in 2006-2020 was 58 %. In the years 2021-2024, Njiljohka/Nilijoki salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 8 % and an average overexploitation of 4 % (Table 26).

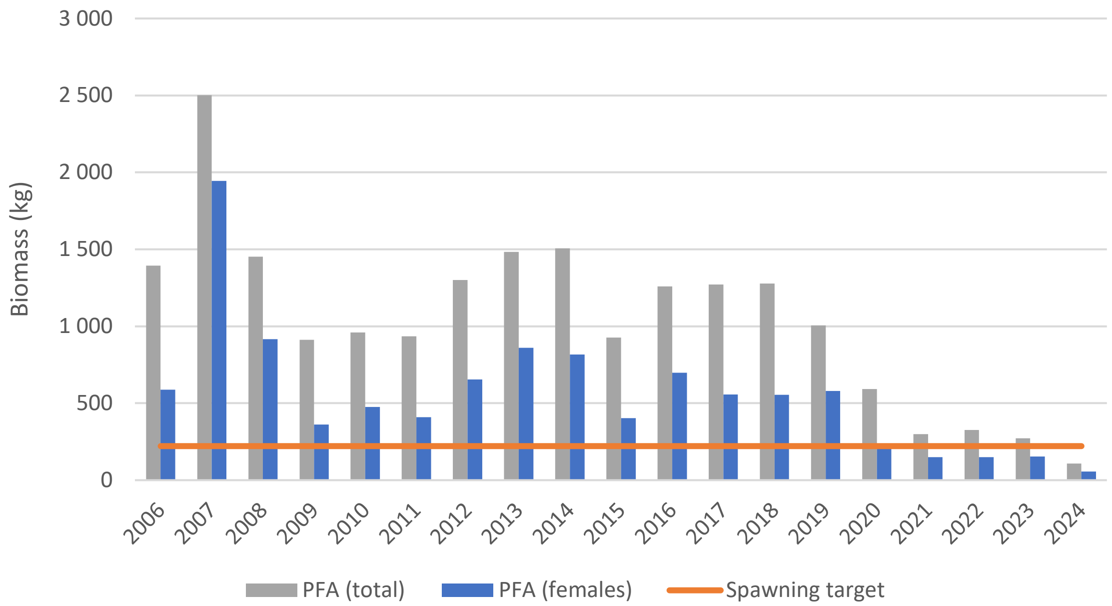


Figure 32. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 26. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Njiljohka/Nilijoki stock in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	169	853	0	157	0.42	1 394	589	0.62	0.73	0.29
2007	857	752	0	694	0.78	2 501	1 946	0.89	0.64	0.00
2008	371	502	0	365	0.63	1 452	917	0.76	0.60	0.00
2009	193	422	0	118	0.40	913	362	0.39	0.67	0.47
2010	127	595	0	118	0.50	959	476	0.54	0.75	0.47
2011	147	485	0	133	0.44	935	408	0.46	0.68	0.40
2012	127	871	0	152	0.50	1 300	654	0.66	0.77	0.31
2013	315	540	0	364	0.58	1 483	859	0.74	0.58	0.00
2014	262	658	0	318	0.54	1 506	817	0.73	0.61	0.00
2015	99	516	0	136	0.43	927	402	0.45	0.66	0.39
2016	248	575	0	242	0.56	1 258	699	0.68	0.65	0.00
2017	128	767	0	165	0.44	1 272	557	0.60	0.70	0.25
2018	213	508	0	242	0.43	1 278	555	0.60	0.56	0.00
2019	175	268	0	325	0.58	1 006	580	0.62	0.44	0.00
2020	26	389	0	65	0.37	591	217	0.00	0.70	0.69
2021	18	0	0	140	0.50	298	149	0.00	0.06	0.04
2022	20	0	0	139	0.46	326	148	0.00	0.06	0.04
2023	19	0	0	142	0.56	271	153	0.00	0.07	0.05
2024	15	0	0	47	0.51	108	55	0.00	0.14	0.03

3.10 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 three times with autumn snorkelling, in 2015, 2023, and 2024. The count in 2015 was done relatively early (31. July) and any salmon entering the river in August were therefore missed. In total, 85 small-sized and 15 medium-sized salmon were observed. Detection rate was set to 0.7.

The count in 2023 was done 29. August, and found 48 small-sized (14 females, 20 unknown), 54 medium-sized (30 females) and 1 large-sized female. Detection rate was set to 0.80.

The count in 2024 was done 6. September, and found 85 small-sized (50 females) and 7 medium-sized (6 females). Detection rate was set to 0.85.

Average female sizes (based on Genmix samples from 2006-2008 and 2011-2012) were set to 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 82 % in 2024. The probability of meeting the spawning target was 17 % in 2024 (Figure 33).

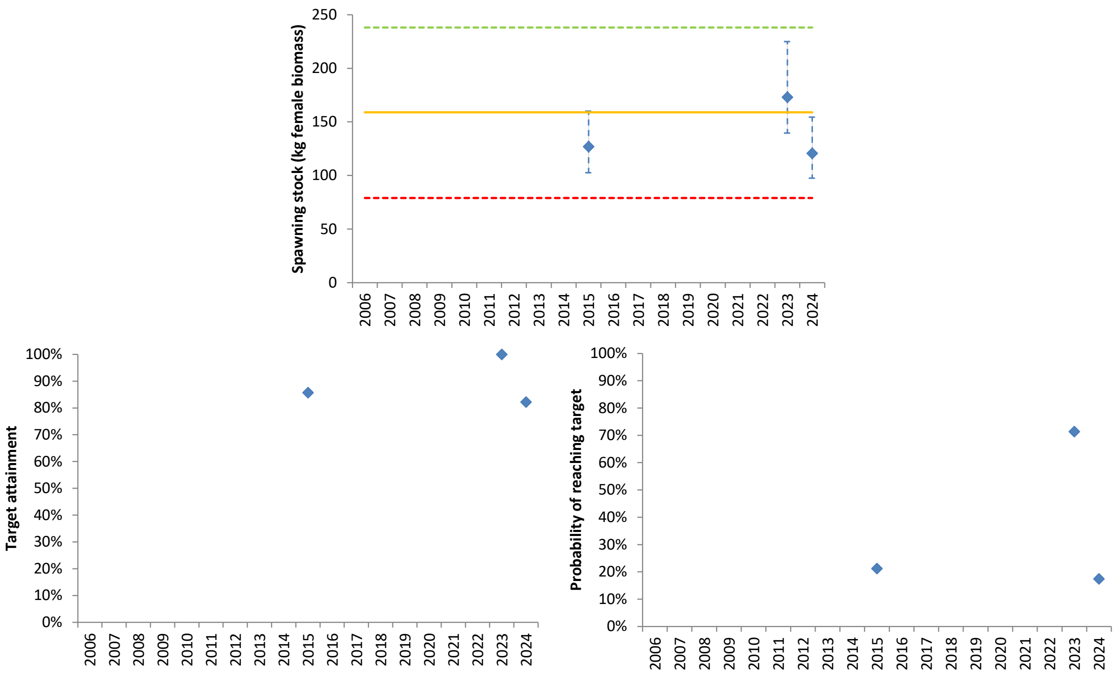


Figure 33. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the years 2015, 2023, and 2024 in the Norwegian river Ástejohka. Note that the 2015 target attainment estimate was based on snorkelling count conducted 31. July and all salmon ascending to Ástejohka in August were missing. Therefore the 2015 attainment level was clearly a minimum estimate.

3.11 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.

3.11.1 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 27. Female proportions in Table 27 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 27 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 27. 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	-
2024	11	1	1.3	3.6	0.85	1	0.45	1.00	-

To account for uncertainty, the exploitation rate and female proportion estimates in Table 27 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 9 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 54 % (Figure 34).

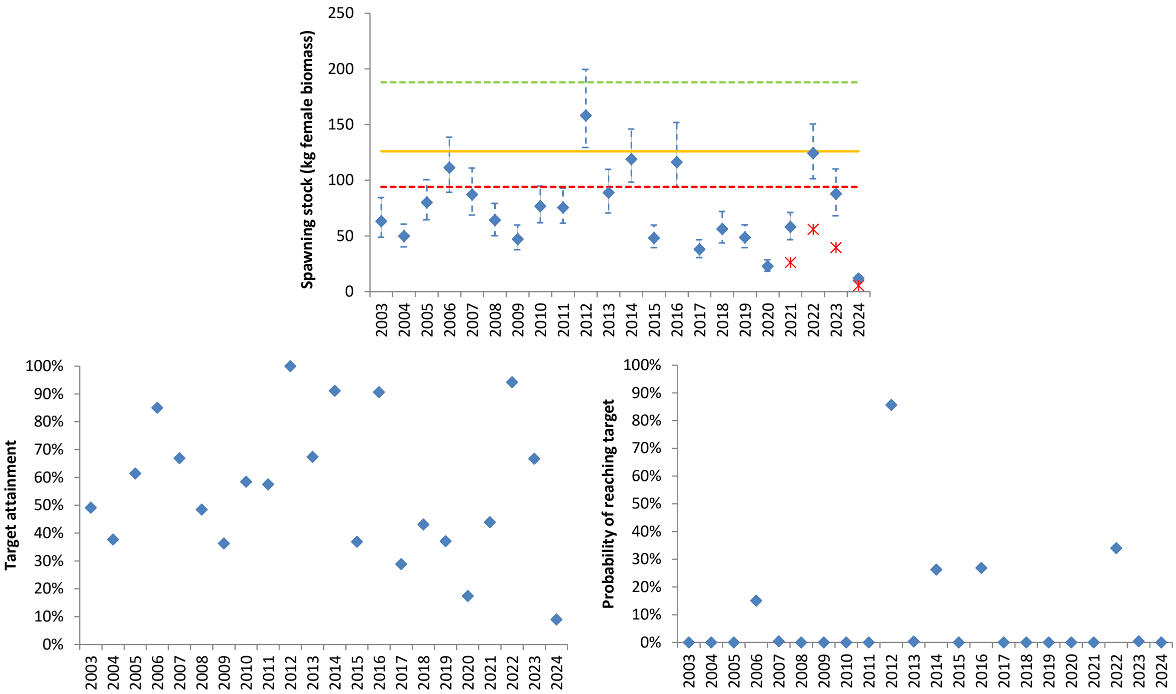


Figure 34. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2003-2024 in the Finnish tributary Áhkojohka/Akujoki. The red symbol in the upper panel show what the spawning stock size would have been in 2021-2024 if fishing had continued.

3.11.2 Pre-fishery abundance

The pre-fishery abundance (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 866 kg in 2017 down to 26 kg in 2024 (Figure 35; Table 28).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Áhkojohka/Akujoki stock is 126 kg. 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 female PFA has varied between a maximum of 541 kg in 2019 down to a minimum of 13 kg in 2024 (Figure 35; Table 28).

Of the years 2006-2024, an exploitable surplus was missing in 2020, 2021, 2023, and 2024. As the management target was 0 % and an exploitable surplus were missing in three 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 % (2020, 2021, 2023, 2024) and 77 % (2019) in the last six years (Table 28).

In the years 2006-2020, Áhkojohka/Akujoki salmon were overexploited at an average level of 40 % with a maximum of 74 % in 2020 (Table 28). The estimated average exploitation rate in 2006-2020 was 68 %. In the years 2021-2024, Áhkojohka/Akujoki salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 7 % and an average overexploitation of 2 % (Table 28).

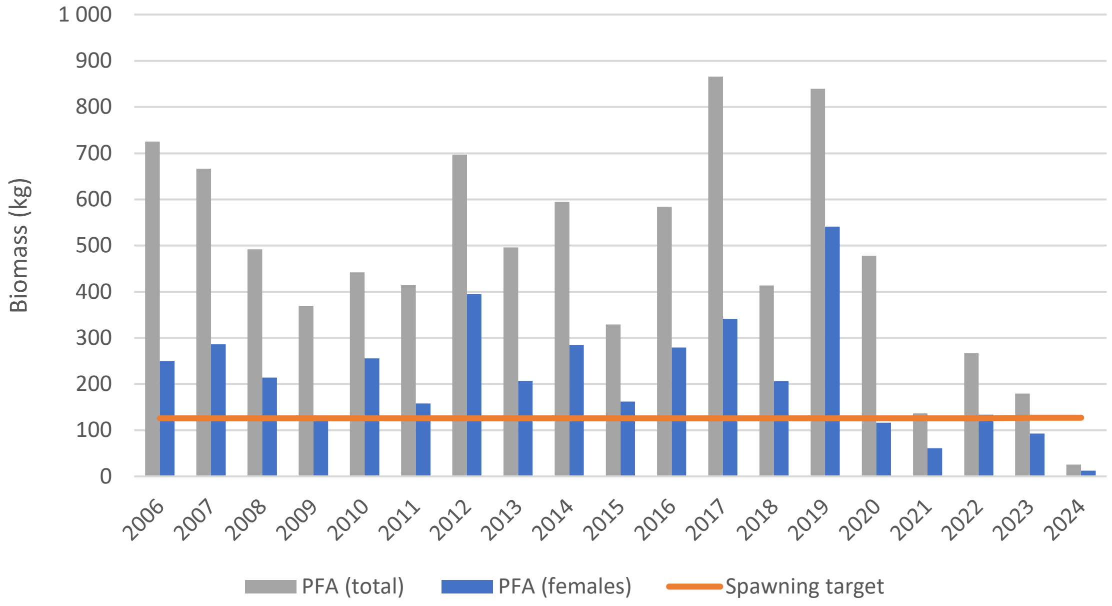


Figure 35. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female 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 28. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Áhkojohka/Akujoki stock in 2006-2024. 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	Actual expl. rate	Over-expl.
2006	120	284	0	111	0.34	725	250	0.50	0.56	0.12
2007	109	354	0	87	0.43	666	286	0.56	0.69	0.31
2008	63	283	0	64	0.43	492	214	0.41	0.70	0.49
2009	77	160	0	47	0.36	369	132	0.04	0.64	0.63
2010	84	226	0	76	0.58	442	255	0.51	0.70	0.40
2011	81	137	0	75	0.38	414	158	0.20	0.53	0.41
2012	133	284	0	159	0.57	697	395	0.68	0.60	0.00
2013	76	205	0	90	0.42	496	207	0.39	0.57	0.29
2014	98	250	0	118	0.48	594	285	0.56	0.59	0.06
2015	35	196	0	48	0.49	329	162	0.22	0.70	0.62
2016	120	218	0	117	0.48	584	279	0.55	0.58	0.07
2017	29	740	0	38	0.39	866	341	0.63	0.89	0.70
2018	49	252	0	56	0.50	413	207	0.39	0.73	0.56
2019	26	738	0	48	0.64	840	541	0.77	0.91	0.62
2020	9	375	0	23	0.24	478	116	0.00	0.80	0.74
2021	8	0	0	58	0.45	136	61	0.00	0.06	0.03
2022	18	0	0	125	0.50	267	134	0.06	0.07	0.01
2023	12	0	0	87	0.52	180	93	0.00	0.07	0.05
2024	2	0	0	12	0.50	26	13	0.00	0.07	0.01

3.12 Kárášjohka (+ Bávttajohka)

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, with only a few spots with higher water velocity and suitable conditions for salmon spawning. Above the confluence with Iešjohka, habitat conditions become better suited for salmon. There are several rapids and some waterfalls in Kárášjohka, with Šuorpmogorzi forming a partial obstacle for upstream migration. Electrofishing surveys show, however, that salmon can pass and spawn above this waterfall. There is one major tributary, Bávttajohka, approximately 98 km upstream from Skáidegeahči. In this tributary, close to 40 km is available for salmon. Just downstream of the confluence between Kárášjohka and Iešjohka, there is another smaller tributary, Geaimmejohka, with 10 km available for salmon. As Geaimmejohka is located below the sonar counting site, the status assessment in this chapter is a combined evaluation of Kárášjohka and the upper tributary Bávttajohka.

3.12.1 Spawning stock

The combined spawning target of Kárášjohka and Bávttajohka is 13 786 499 eggs (10 339 875-20 679 747 eggs). The female biomass needed to obtain this egg deposition is 7 186 kg (5 389-10 779 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 29. Female proportions in Table 29 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.

Table 29. Summary of stock data used to estimate annual spawning stock sizes in Kárášjohka in the years with catch statistics (2006-2020). 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

Sonar counts of migrating fish at Heastanjárga, close to the upper bridge over Kárášjohka and approximately 5 km upstream from Skáidegeahči, provide estimates of the number of salmon of different size groups that migrated into the upper part of Kárášjohka. Counts are available for the years 2010, 2012, and 2017-2024. The counts from 2010, 2012, and 2017-2020 can be used to estimate exploitation rates. 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 29).

Because the Tana/Teno salmon fisheries were closed in 2021-2024, salmon spawning stocks from these four years has to be estimated solely based on the Heastanjárga sonar counts. Note that the counts for 2021 and 2022 in the present report have been revised from previous assessments based on Domaas *et al*. (2024). The counts are summarised in Table 30.

Table 30. Summary of count data used to estimate annual spawning stock sizes in Kárášjohka in the years without catch statistics (2021-2024). The adjusted biomass in the rightmost three columns are obtained by multiplying the Heastanjárga count with the proportion of the productive area of Kárášjohka found below the counting site.

Year	Count (<3 kg)	Count (3-7 kg)	Count (>7 kg)	Avg. size (<3 kg)	Avg. size (3-7 kg)	Avg. size (>7 kg)	Weight (<3 kg)	Weight (3-7 kg)	Weight (>7 kg)	Adj. weight (<3 kg)	Adj. weight (3-7 kg)	Adj. weight (>7 kg)
2021	1 595	590	171	1.92	4.17	9.93	3 063	2 462	1 698	3 511	2 822	1 946
2022	1 201	701	185	1.98	4.78	8.99	2 379	3 354	1 663	2 726	3 844	1 906
2023	926	624	337	2.02	4.99	8.65	1 868	3 111	2 916	2 141	3 566	3 342
2024	358	376	110	2.01	5.02	8.64	722	1 889	950	827	2 165	1 089

To account for uncertainty, the exploitation rate and female proportion estimates in Table 29 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 7 186 kg as the mode, 5 389 kg as the minimum and 10 779 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 32 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 51 % (Figure 36).

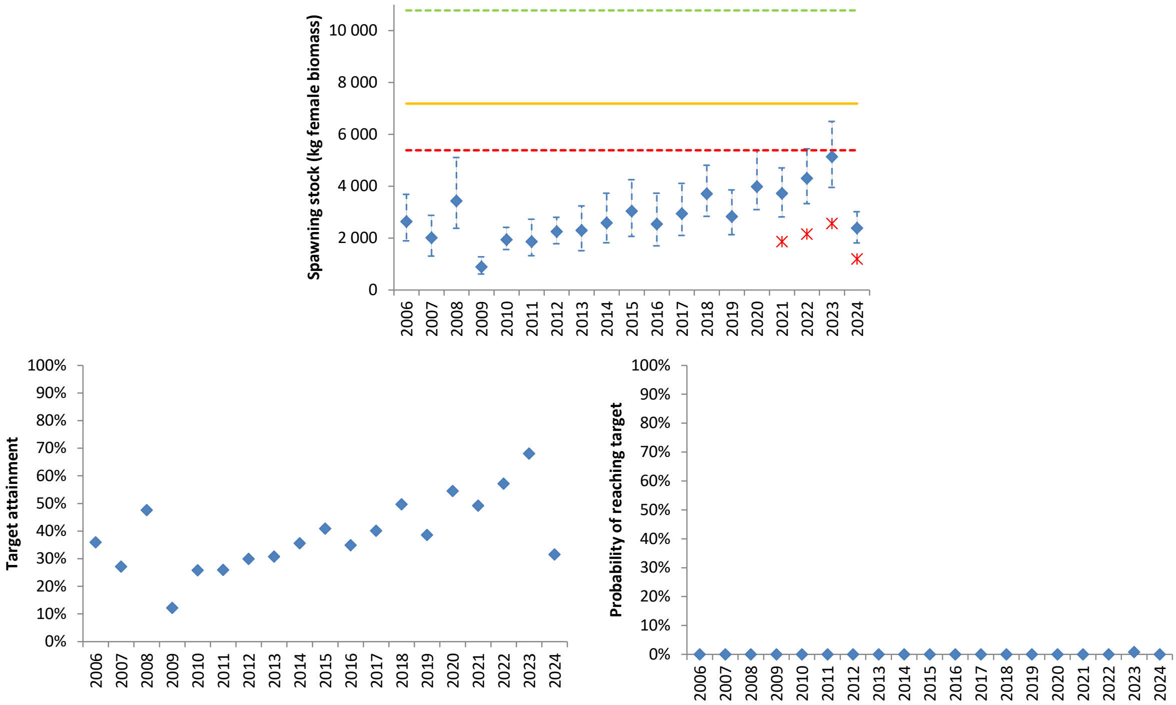


Figure 36. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the Norwegian tributary Kárášjohka. The red symbol in the upper panel show what the spawning stock size would have been in 2021-2024 if fishing had continued.

For 2023, snorkelling data from Geaimmejohka can be used to estimate the local spawning target attainment of this small tributary of 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 %.

Geaimmejohka was again snorkelled in 2024. A total of 13 salmon were observed, of which 6 were small-sized (6 females), 6 medium-sized (4 females) and 1 large-sized (1 female). The snorkelling detection rate was estimated at 0.80. The 2024 spawning target attainment of Geaimmejohka was 24 % with a 0 % probability of meeting the spawning target.

3.12.2 Pre-fishery abundance

The pre-fishery abundance (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 24 850 kg in 2008 down to 4 413 kg in 2024 (Figure 37; Table 31).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Kárášjohka stock complex is 7 186 kg. 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 female PFA has varied between a maximum of 16 988 kg in 2008 down to a minimum of 2 602 kg in 2024 (Figure 37; Table 31).

Of the years 2006-2024, an exploitable surplus has been missing in five of the latest six years (2019, 2021-2024). As an exploitable surplus has been missing in all latest 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 2021-2024 (Table 31). In contrast, as much as 58 % of the female PFA could have been exploited sustainably as recently as 2008.

In the years 2006-2020, Kárášjohka salmon were overexploited at an average level of 62 % with a maximum of 74 % in 2011 (Table 31). The estimated average exploitation rate in 2006-2020 was 74 %. In the years 2021-2024, Kárášjohka salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 7 % and an average overexploitation of 4 % (Table 31).

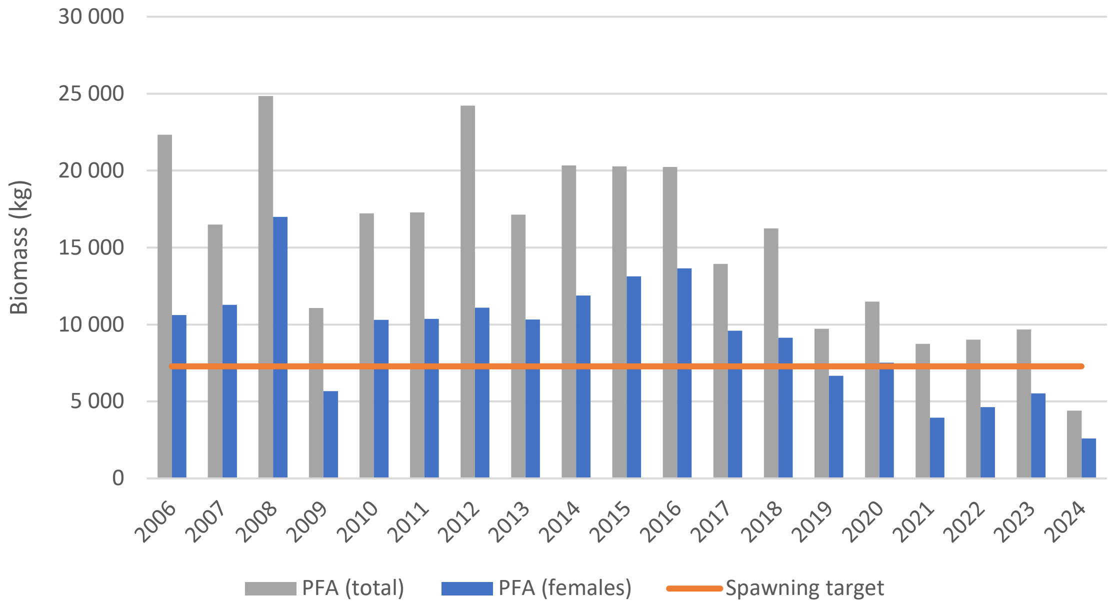


Figure 37. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Kárášjohka stock complex in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female 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 Kárášjohka stock complex in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	2 856	9 776	4 158	2 636	0.48	22 334	10 621	0.31	0.75	0.64
2007	2 486	8 747	2 312	2 017	0.68	16 493	11 285	0.35	0.82	0.72
2008	3 354	12 360	4 118	3 431	0.68	24 850	16 988	0.57	0.80	0.53
2009	1 427	6 548	1 365	891	0.51	11 078	5 673	0.00	0.84	0.66
2010	2 142	9 229	2 608	1 938	0.60	17 214	10 313	0.29	0.81	0.73
2011	2 019	9 590	2 569	1 866	0.60	17 289	10 368	0.30	0.82	0.74
2012	1 873	13 525	3 910	2 254	0.46	24 228	11 100	0.34	0.80	0.69
2013	1 912	8 372	3 032	2 297	0.60	17 132	10 316	0.29	0.78	0.68
2014	2 132	10 206	3 569	2 588	0.58	20 332	11 890	0.39	0.78	0.64
2015	2 216	9 597	3 784	3 038	0.65	20 288	13 138	0.45	0.77	0.58
2016	2 617	10 704	3 144	2 542	0.68	20 230	13 660	0.47	0.81	0.65
2017	2 263	5 293	2 115	2 944	0.69	13 948	9 603	0.24	0.69	0.60
2018	3 223	5 043	1 392	3 710	0.56	16 253	9 142	0.20	0.59	0.49
2019	1 506	2 691	1 400	2 831	0.69	9 723	6 672	0.00	0.58	0.53
2020	1 609	2 683	1 103	3 983	0.65	11 484	7 511	0.03	0.47	0.45
2021	500	0	0	3 727	0.45	8 748	3 952	0.00	0.06	0.03
2022	648	0	0	4 305	0.52	9 007	4 639	0.00	0.07	0.05
2023	682	0	0	5 134	0.57	9 678	5 523	0.00	0.07	0.05
2024	363	0	0	2 388	0.59	4 413	2 602	0.00	0.08	0.03

3.13 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.

3.13.1 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 32. Female proportions in Table 32 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 estimation of historic exploitation estimates in 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 32 vs. Table 29). 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 32).

In 2018, acoustic counting from the neighboring Kárášjohka indicated continued low exploitation and the exploitation estimate in Iešjohka was set equal to the Kárášjohka rates (Table 32).

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 complicates the count interpretation and its use for estimating exploitation rates. In line with the approach taken in earlier years, the 2019 exploitation rates were therefore set equal to the Kárášjohka (Table 32).

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 32).

Table 32. Summary of stock data used to estimate annual spawning stock sizes in Iešjohka in the years with catch statistics (2006-2020). The catch data are a combination of reported catches in Iešjohka and an estimated Iešjohka catch from the lower Kárášjohka 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	1 531	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	0.20	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

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 smaller than 3 kg, 428 salmon between 3 and 7 kg and 141 salmon larger than 7 kg. The same setup was used to count salmon in 2024, yielding a count of 180 salmon smaller than 3 kg, 247 salmon between 3 and 7 kg and 187 salmon larger than 7 kg (Table 33).

Due to closed fisheries and no counting, Iešjohka had to be assessed through alternative means in 2021 and 2023. We base the evaluation in these two years on the average ratio between the Iešjohka count and the Polmak sonar count in 2022 and 2024. For the three size groups, the average was 6 % for salmon smaller than 3 kg, 6 % for salmon between 3 and 7 kg and 9 % for salmon larger than 7 kg. The resulting number and weight estimates are listed in Table 33.

Table 33. Summary of count data used to estimate annual spawning stock sizes in Iešjohka in the years with either counting (2022, 2024) or an estimate based on the average ratio between Iešjohka count and Polmak sonar count (2021, 2023).

Year	Count (<3 kg)	Count (3-7 kg)	Count (>7 kg)	Avg. size (<3 kg)	Avg. size (3-7 kg)	Avg. size (>7 kg)	Weight (<3 kg)	Weight (3-7 kg)	Weight (>7 kg)
2021	1 008	392	157	2.12	4.68	8.99	2 141	1 834	1 413
2022	471	428	141	2.01	4.81	8.69	945	2 061	1 227
2023	516	445	181	2.12	4.68	8.99	1 096	2 082	1 632
2024	180	247	187	2.24	4.55	9.29	403	1 126	1 738

To account for uncertainty, the exploitation rate and female proportion estimates in Table 32 were treated as modal values, with a 10 % uncertainty used to estimate minimum and maximum values of exploitation and 10 % uncertainty used for female proportions. The modal, minimum and maximum values were then used to construct a triangular probability distribution for exploitation and female proportion, and these distributions in combination with catches result in triangular probability distributions for the spawning stock estimates. A similar triangular probability distribution was constructed for the spawning target, using 6 072 kg as the mode, 4 278 kg as the minimum and 9 107 kg as the maximum value.

A Monte Carlo simulation with 10 000 iterations was then used to compare the spawning stock distribution with the spawning target distribution. For each iteration, one number is randomly drawn from the spawning stock distribution and one number drawn from the spawning target distribution. The two random numbers are divided (random number from spawning stock distribution / random number from spawning target distribution) to obtain a percentage, the extent to which the spawning stock is higher or lower than the spawning target. The average of these 10 000 percentages then becomes the spawning target attainment. The proportion of the iterations where the random spawning stock size exceeds the random spawning target becomes the probability that the stock had enough spawners.

The spawning target attainment was 31 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 37 % (Figure 38).

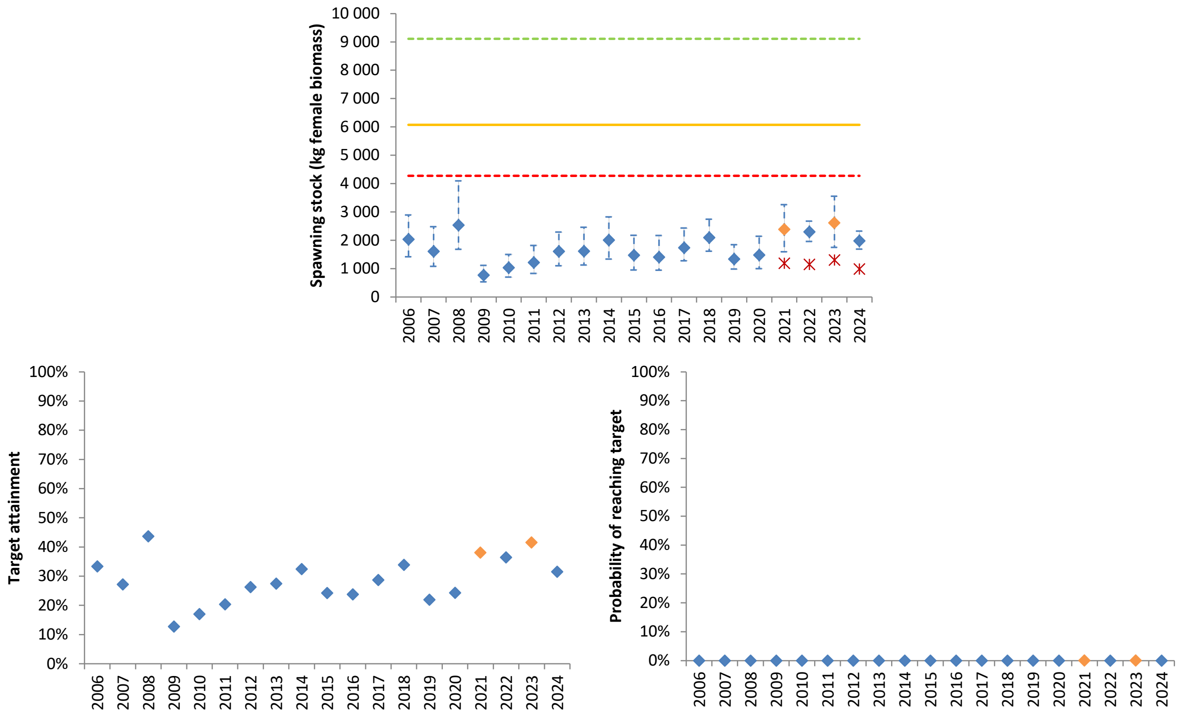


Figure 38. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the Norwegian tributary Iešjohka. The orange symbols in the panels show the years with the alternative assessment approach based on proportions of the Polmak count (2021, 2023). The red symbol in the upper panel show what the spawning stock size would have been in 2021-2024 if fishing had continued.

3.13.2 Pre-fishery abundance

The pre-fishery abundance (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 20 265 kg in 2008 down to 3 557 kg in 2024 (Figure 39; Table 34).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Iešjohka stock is 6 072 kg. 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 female PFA has varied between a maximum of 13 117 kg in 2008 down to a minimum of 2 159 kg in 2024 (Figure 39; Table 34).

Of the years 2006-2024, an exploitable surplus has been missing in the years 2018-2024. As an exploitable surplus has been missing in all the last four years, the Iešjohka 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 2018-2024 (Table 34). In contrast, as much as 54 % of the female PFA could have been exploited sustainably as recently as 2008.

In the years 2006-2020, Iešjohka salmon were overexploited at an average level of 67 % with a maximum of 83 % in 2010 (Table 34). The estimated average exploitation rate in 2006-2020 was 77 %. In the years 2021-2024, Iešjohka salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 7 % and an average overexploitation of 3 % (Table 34).

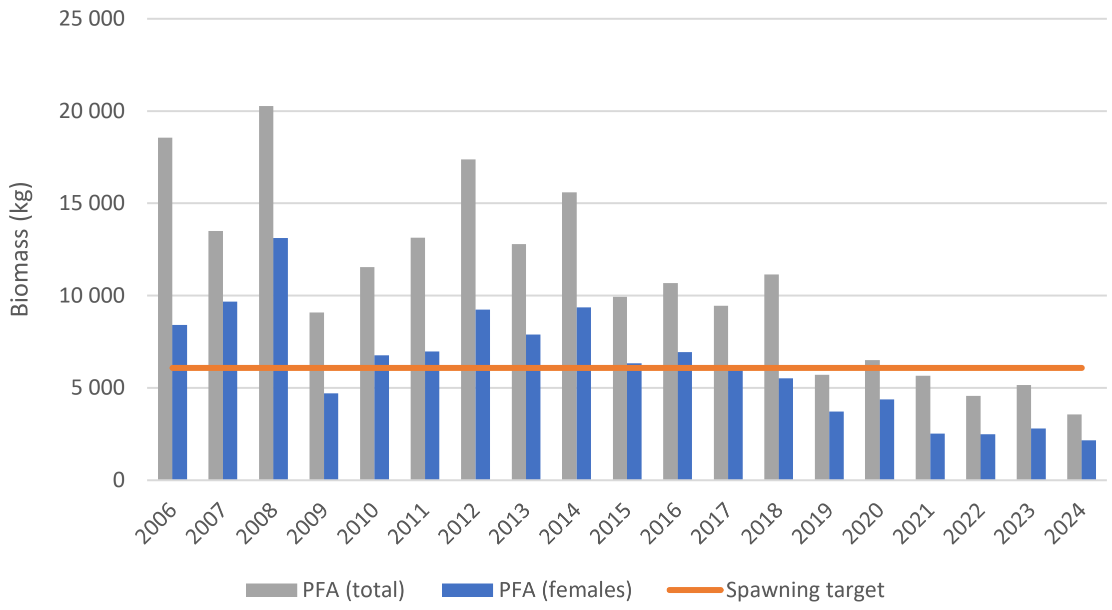


Figure 39. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Iešjohka stock in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 34. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Iešjohka stock in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	2 181	7 679	4 210	2 032	0.45	18 554	8 411	0.28	0.76	0.67
2007	2 054	6 872	2 320	1 609	0.72	13 492	9 667	0.37	0.83	0.74
2008	2 537	9 712	4 100	2 535	0.65	20 265	13 117	0.54	0.81	0.58
2009	1 283	5 147	1 169	769	0.52	9 081	4 712	0.00	0.84	0.65
2010	1 114	7 255	1 412	1 032	0.59	11 540	6 770	0.10	0.85	0.83
2011	1 349	7 535	1 968	1 213	0.53	13 143	6 964	0.13	0.83	0.80
2012	1 364	10 621	2 366	1 611	0.53	17 378	9 246	0.34	0.83	0.73
2013	1 388	6 582	2 200	1 617	0.62	12 791	7 893	0.23	0.80	0.73
2014	1 586	8 023	2 641	2 007	0.60	15 589	9 369	0.35	0.79	0.67
2015	1 054	4 688	1 885	1 474	0.64	9 937	6 339	0.04	0.77	0.76
2016	1 476	5 228	1 813	1 407	0.65	10 686	6 935	0.12	0.80	0.77
2017	1 309	4 410	1 059	1 739	0.65	9 455	6 143	0.01	0.72	0.71
2018	1 823	4 202	901	2 092	0.49	11 153	5 520	0.00	0.62	0.56
2019	723	2 242	681	1 340	0.65	5 703	3 717	0.00	0.64	0.39
2020	588	2 235	1 483	1 477	0.67	6 505	4 369	0.00	0.66	0.48
2021	318	0	0	2 381	0.45	5 664	2 523	0.00	0.06	0.02
2022	336	0	0	2 296	0.54	4 559	2 479	0.00	0.07	0.03
2023	345	0	0	2 613	0.54	5 161	2 800	0.00	0.07	0.03
2024	298	0	0	1 978	0.61	3 557	2 159	0.00	0.08	0.03

3.14 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. Salmon migration is not possible beyond 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.

3.14.1 Spawning stock

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 35. Female proportions in Table 35 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.

Table 35. Summary of stock data used to estimate annual spawning stock sizes in Anárjohka/Inarijoki in the years with catch statistics (2006-2020).

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

There are no salmon counts from 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 35). A similar level of exploitation (0.15) was estimated from the counting in 2019. We used a similar level of exploitation in 2017 and 2020.

In an earlier 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 indicated that the historic exploitation levels in Anárjohka/Inarijoki were significantly higher than 0.25 and more 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 2021-2024, spawning stocks in these years had to be estimated based either on Anárjohka/Inarijoki sonar count (2021, 2023) or on the average ratio between the Anárjohka/Inarijoki counts and the Polmak sonar counts (2022, 2024).

In 2021, the run size of Anárjohka/Inarijoki was counted using ARIS and a guiding fence similar to the one used for the neighbouring Kárášjohka. This resulted in a run size of 1 450 salmon smaller than 3 kg, 589 salmon between 3 and 7 kg and 41 salmon larger than 7 kg. The same setup was used to count salmon in 2023, yielding a count of 1 105 salmon smaller than 3 kg, 726 salmon between 3 and 7 kg and 67 salmon larger than 7 kg (Table 36).

Due to closed fisheries and no counting, Anárjohka/Inarijoki had to be assessed through an alternative approach in 2022 and 2024. We based the evaluation in these two years on the average ratio between the Anárjohka/Inarijoki count and the Polmak sonar count in 2021 and 2023. For the three size groups, the average ratio was 13 % for salmon smaller than 3 kg, 9 % for salmon between 3 and 7 kg and 3 % for salmon larger than 7 kg. The resulting number and weight estimates are listed in Table 36.

Table 36. Summary of count data used to estimate annual spawning stock sizes in Anárjohka/Inarijoki in the years with either counting (2021, 2023) or an estimate based on the average ratio of the Polmak count (2022, 2024).

Year	Count (<3 kg)	Count (3-7 kg)	Count (>7 kg)	Avg. size (<3 kg)	Avg. size (3-7 kg)	Avg. size (>7 kg)	Weight (<3 kg)	Weight (3-7 kg)	Weight (>7 kg)
2021	1 450	589	41	1.9	3.8	8.9	2 755	2 239	365
2022	1 200	772	52	1.9	3.8	8.9	2 279	2 932	459
2023	1 105	726	67	1.9	3.8	8.9	2 100	2 758	598
2024	367	318	52	1.9	3.8	8.9	697	1 209	462

To account for uncertainty, the exploitation rate and female proportion estimates in Table 35 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.

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 17 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 29 % (Figure 40).

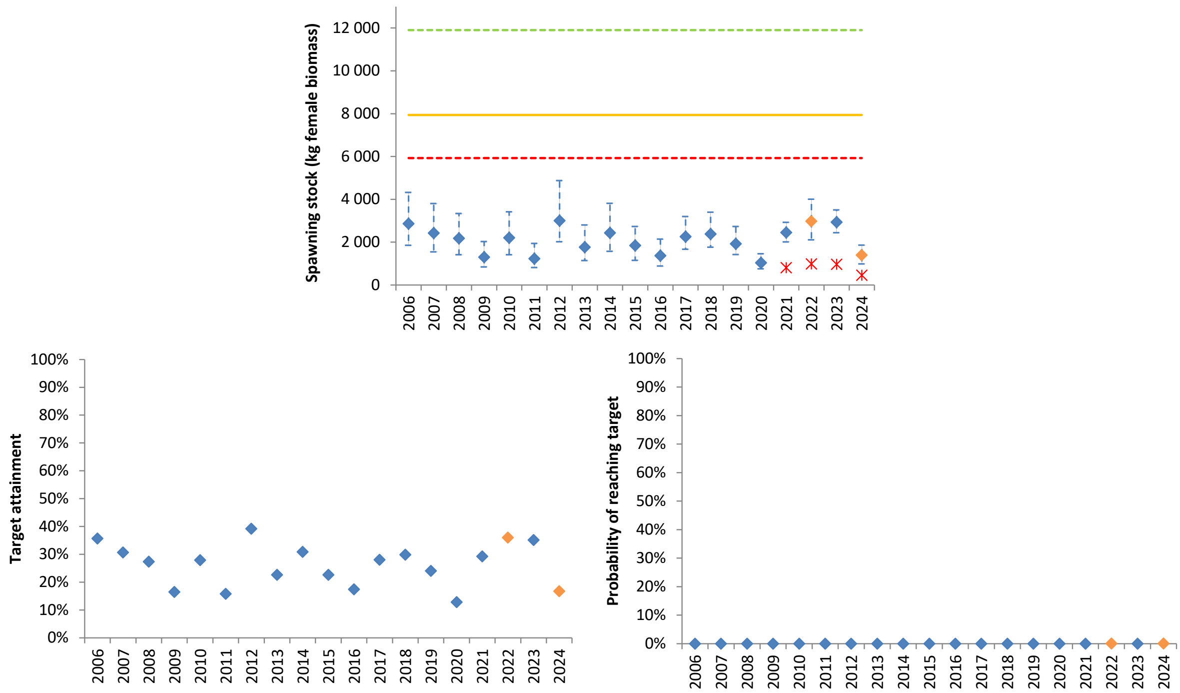


Figure 40. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 2006-2024 in the tributary Anárjohka/Inarijoki. The orange symbols in the panels show the years with the alternative assessment approach based on proportions of the Polmak count (2022, 2024). The red symbols in the upper panel show what the spawning stock size would have been in 2021-2024 if fishing had continued.

3.14.2 Pre-fishery abundance

The pre-fishery abundance (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 30 666 kg in 2012 down to 2 561 kg in 2024 (Figure 41; Table 37).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential. The spawning target of the Anárjohka/Inarijoki stock complex is 7 937 kg. 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 female PFA has varied between a maximum of 17 163 kg in 2007 down to a minimum of 1 509 kg in 2024 (Figure 41; Table 37).

Of the years 2006-2024, an exploitable surplus has been missing in the latest seven years (2018-2024). As an exploitable surplus has been missing in all the latest 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 2018-2024 (Table 37). In contrast, as much as 54 % of the female PFA could have been exploited sustainably as recently as 2007.

In the years 2006-2020, Anárjohka/Inarijoki salmon were overexploited at an average level of 69 % with a maximum of 83 % in 2016 ((Table 37). The estimated average exploitation rate in 2006-2020 was 80 %. In the years 2021-2024, Anárjohka/Inarijoki salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 7 % and an average overexploitation of 2 % ((Table 37).

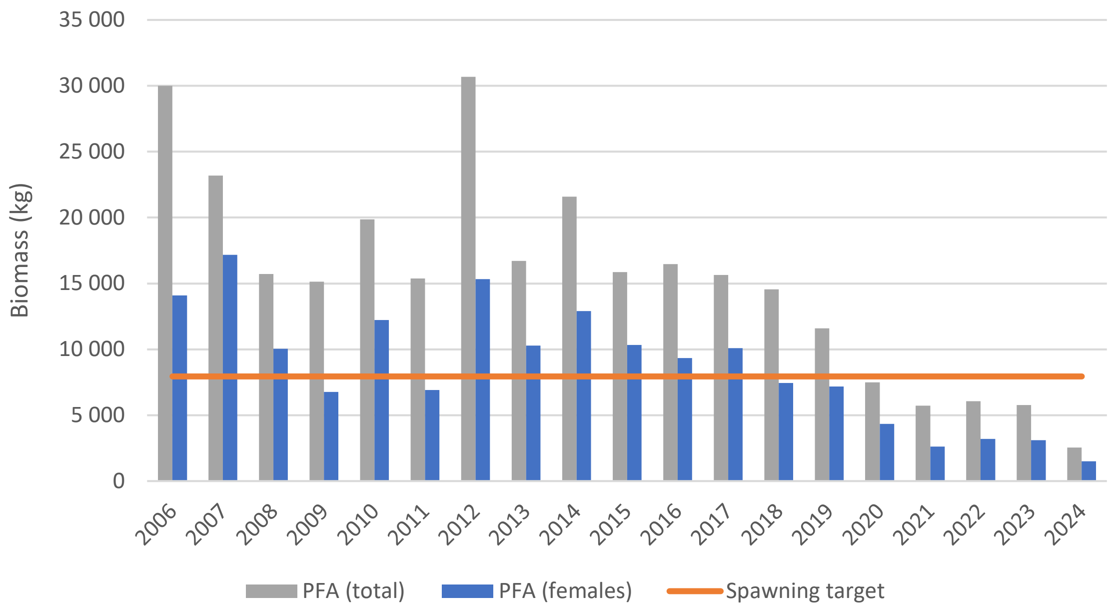


Figure 41. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock complex in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 37. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the Anárjohka/Inarijoki stock complex in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	3 088	16 913	4 134	2 758	0.47	30 003	14 101	0.44	0.80	0.65
2007	3 036	14 575	2 264	2 455	0.74	23 193	17 163	0.54	0.86	0.69
2008	2 126	7 902	2 321	2 153	0.64	15 712	10 056	0.21	0.79	0.73
2009	2 123	8 103	2 003	1 300	0.45	15 141	6 763	0.00	0.81	0.69
2010	2 426	11 422	2 440	2 198	0.62	19 856	12 233	0.35	0.82	0.72
2011	1 327	9 351	1 906	1 260	0.45	15 383	6 922	0.00	0.82	0.71
2012	2 524	17 594	4 281	3 133	0.50	30 666	15 333	0.48	0.80	0.61
2013	1 509	10 361	1 984	1 753	0.62	16 702	10 279	0.23	0.83	0.78
2014	1 996	12 630	2 830	2 469	0.60	21 587	12 901	0.38	0.81	0.69
2015	1 347	9 898	1 879	1 790	0.65	15 876	10 326	0.23	0.83	0.77
2016	1 414	11 039	1 653	1 346	0.57	16 482	9 334	0.15	0.86	0.83
2017	1 722	9 756	638	2 274	0.64	15 645	10 085	0.21	0.77	0.71
2018	2 088	6 933	787	2 428	0.51	14 544	7 458	0.00	0.67	0.63
2019	1 041	6 845	564	1 952	0.62	11 603	7 184	0.00	0.73	0.66
2020	418	4 944	326	1 054	0.58	7 505	4 353	0.00	0.76	0.42
2021	328	0	0	2 482	0.46	5 735	2 632	0.00	0.06	0.02
2022	436	0	0	2 989	0.53	6 067	3 220	0.00	0.07	0.03
2023	395	0	0	2 903	0.54	5 783	3 116	0.00	0.07	0.03
2024	211	0	0	1 384	0.59	2 561	1 509	0.00	0.08	0.02

3.15 Tana/Teno (total)

3.15.1 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 38. Female proportions in Table 38 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 38 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 2021-2024 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 river system 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, 2023 and 2024, 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 12 954 salmon <3 kg, 7 154 salmon between 3-7 kg and 1 877 salmon ≥7 kg. The total Tana/Teno run of salmon in 2022 was estimated at 10 863 salmon <3 kg, 9 334 salmon between 3-7 kg and 1 918 salmon ≥7 kg. Numbers in 2023 were estimated at 9 509 salmon <3 kg, 8 878 salmon between 3-7 kg and 2 167 salmon ≥7 kg. Numbers from 2024 were 3 280 salmon <3 kg, 3 860 salmon between 3-7 kg and 1 966 salmon ≥7 kg.

Table 38. 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	0.54
2022	0	0	0.58
2023	0	0	0.59
2024	0	0	0.63

To account for uncertainty, the exploitation rate and female proportion estimates in Table 38 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 45 % in 2024 and the probability of meeting the spawning target was 0 %. The management target was not reached, as the last 4 years' (2021-2024) overall probability of reaching the spawning target was 0 % with an overall attainment of 67 % (Figure 42).

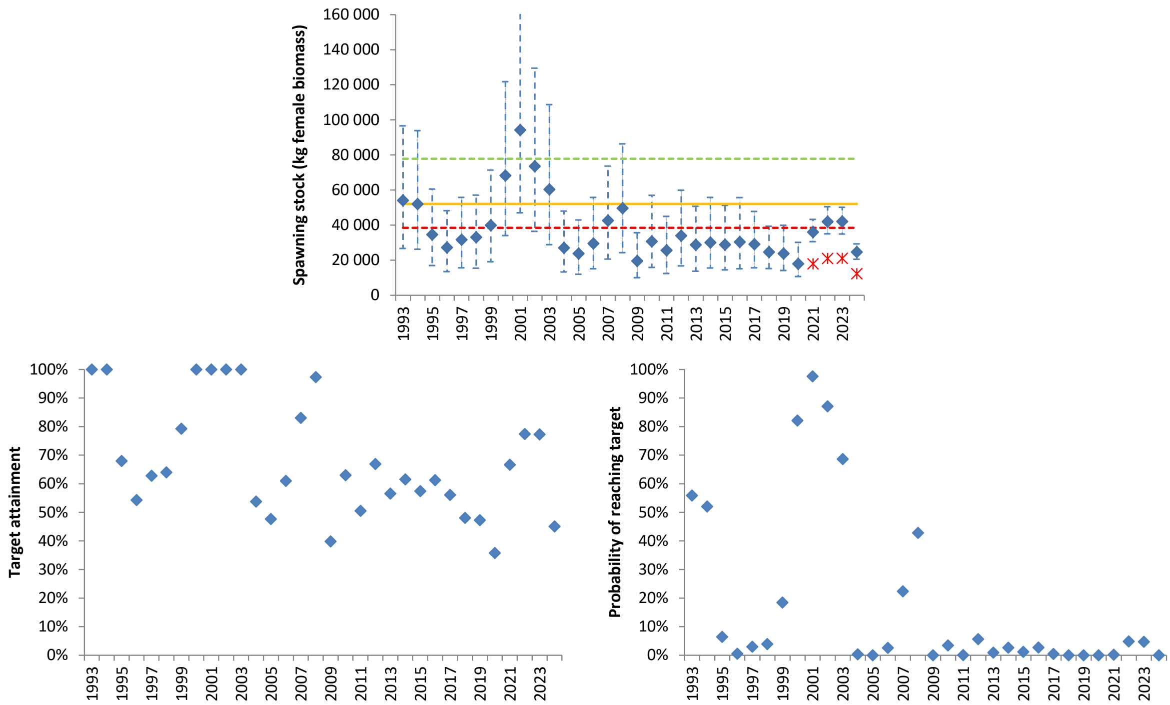


Figure 42. The estimated spawning stock (top row), percent truncated spawning target attainment (bottom row, left) and probability of reaching the spawning target (bottom row, right) in the period 1993-2024 for Tana/Teno (total). The red symbols in the upper panel show what the spawning stock size would have been in 2021-2024 if fishing had continued.

3.15.2 Pre-fishery abundance

The pre-fishery abundance (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 239 373 kg in 2008 down to 42 423 kg in 2024 (Figure 43; Table 39).

The spawning target, expressed as female biomass, represents the spawning biomass needed to reach the production potential of the Tana/Teno river system. The spawning target of the entire Tana/Teno is 52 105 kg. 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 female PFA has varied between a maximum of 148 203 kg in 2008 down to a minimum of 26 775 kg in 2024 (Figure 43; Table 39).

Of the years 2006-2024, an exploitable surplus has been missing in the latest five years (2020-2024). As an exploitable surplus has been missing in all the last five years, Tana/Teno total 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 2020-2024 (Table 39). In contrast, as much as 65 % of the female PFA could have been exploited sustainably as recently as 2008.

In the years 2006-2020, Tana/Teno salmon were overexploited at an average level of 42 % with a maximum of 61 % in 2009 (Table 39). The estimated average exploitation rate in 2006-2020 was 65 %. In the years 2021-2024, Tana/Teno salmon were only exploited in coastal fisheries, which accounted for an average exploitation rate of 6 % and an average overexploitation of 5 % (Table 39).

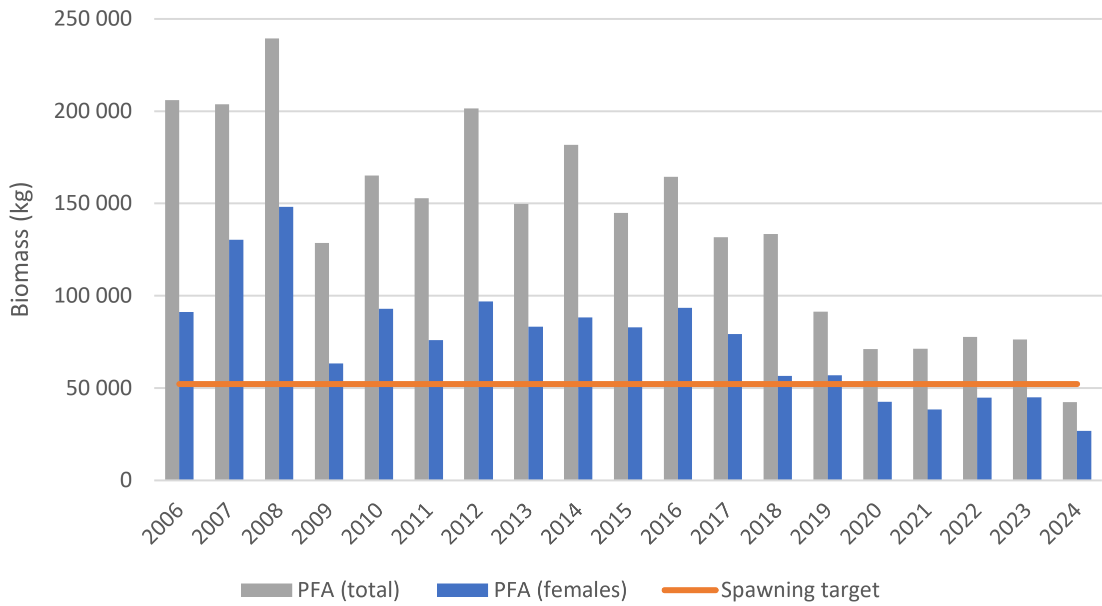


Figure 43. The estimated total (grey bars) and female (blue bars) pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system in the period 2006-2024. The horizontal red line is the stock spawning target. Any female biomass above the target is the exploitable surplus and any female salmon caught below the target will all be overexploitation.

Table 39. Numbers involved in the calculation of pre-fishery abundance (PFA) of salmon belonging to the entire Tana/Teno river system in 2006-2024.

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	Actual expl. rate	Over-expl.
2006	30 845	88 269	19 354	29 869	0.44	205 992	91 118	0.43	0.67	0.43
2007	38 365	87 836	11 933	41 961	0.64	203 712	130 349	0.60	0.68	0.19
2008	39 355	104 089	16 981	48 879	0.62	239 373	148 203	0.65	0.67	0.06
2009	23 812	53 193	9 826	20 550	0.49	128 573	63 297	0.18	0.68	0.61
2010	24 654	74 978	11 487	30 403	0.56	165 155	92 924	0.44	0.67	0.42
2011	22 743	68 015	10 820	25 487	0.50	152 910	75 922	0.31	0.66	0.51
2012	22 907	91 301	16 845	33 858	0.48	201 422	96 914	0.46	0.65	0.35
2013	19 515	68 016	11 335	28 234	0.56	149 646	83 205	0.37	0.66	0.46
2014	23 833	82 912	15 694	28 813	0.49	181 812	88 231	0.41	0.67	0.45
2015	16 768	64 973	12 660	28 905	0.57	144 939	82 899	0.37	0.65	0.45
2016	27 162	72 464	11 809	30 166	0.57	164 500	93 515	0.44	0.68	0.42
2017	24 684	52 193	7 629	28 368	0.60	131 633	79 235	0.34	0.64	0.46
2018	26 195	41 395	7 379	24 741	0.42	133 380	56 495	0.08	0.56	0.53
2019	13 708	33 254	5 997	23 904	0.62	91 362	56 868	0.08	0.58	0.54
2020	9 512	26 451	4 864	18 110	0.60	71 022	42 595	0.00	0.57	0.47
2021	4 059	0	0	36 176	0.54	71 237	38 362	0.00	0.06	0.04
2022	4 985	0	0	41 895	0.58	77 620	44 770	0.00	0.06	0.06
2023	4 596	0	0	42 330	0.59	76 364	45 041	0.00	0.06	0.05
2024	3 267	0	0	24 713	0.63	42 423	26 775	0.00	0.08	0.04

4 Conclusions and further insights into the status assessment and stock development

Stock status over the last four years (2021-2024) was poor in thirteen (including the Tana/Teno total) of the fourteen areas that we evaluated (Figure 44). 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 44) should, following NASCO guidelines, automatically trigger the formulation of a recovery plan for the affected stock. Thirteen of the evaluated areas were below the 40 % management target threshold that indicates a need for stock recovery. The only exception was the River Ohcejohka/Utsjoki, which was still placed to yellow status category. The stock development in Utsjoki has, however, been dramatically decreasing during the last two years. To further underline the severity of the situation, all the thirteen stocks were missing an exploitable surplus for two or more of the last four years. 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.

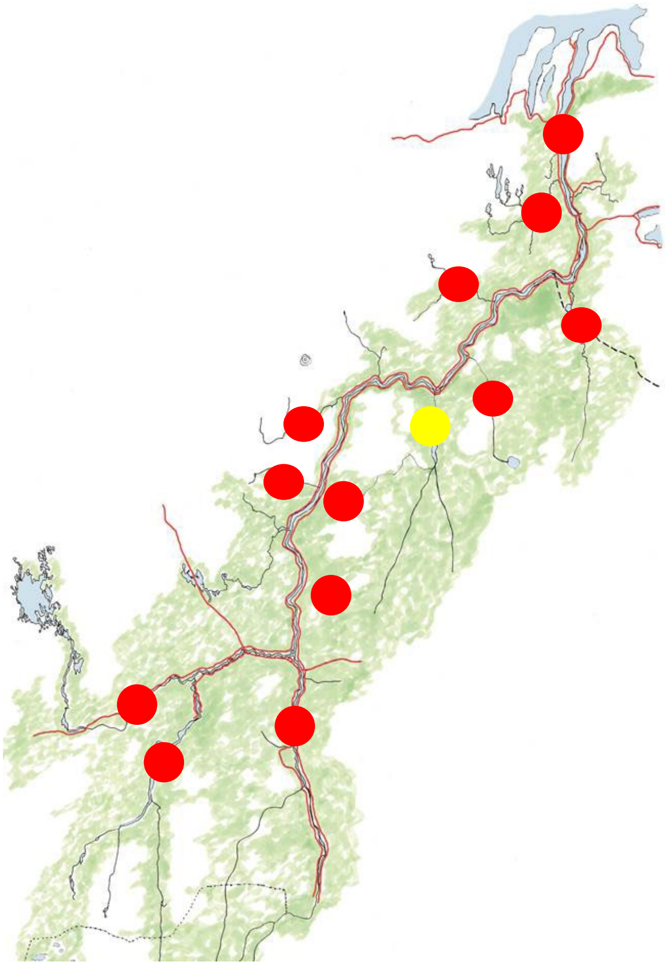


Figure 44. Map summary of the 2021-2024 stock status of the evaluated parts of the Tana/Teno river system. Symbol colour designates stock status over the last four years. Possible colours are: Dark green = overall probability of attaining spawning target higher than 75 %, overall target attainment over 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.

The salmon fisheries in the Tana/Teno have been closed since 2021, and in terms of stock recovery, little progress has been made and 2024 can be seen as a significant step backwards. The Tana/Teno overall spawning stock (female biomass) increased 37 % from the average of 2013-2020 to the average of 2021-2023, but then decreased 32 % from 2021-2023 to 2024 (Table 40). When looking at individual areas, some contrasts are evident. The most significant increases in average spawning stocks from 2013-2020 to 2021-2023 were estimated for the main stem and upper headwaters, increasing between 30 and 41 %. In contrast, the lowermost tributaries Máskejohka and Buolbmátjohka/Pulmankijoki saw decreases of 48-55 %. This might be 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, all these areas saw significant decreases in spawning stock from 2021-2023 to 2024 (15-43 %).

The changes in female PFA from 2013-2020 to 2021-2023 were grim throughout the river system with decreases varying from 37 to 93 % (Table 40). There were significant further declines from 2021-2023 to 2024, varying from 13 to 91 %.

Table 40. Changes in spawning stock (female biomass, kg) and female pre-fishery abundance (PFA, kg) from the average of 2013-2020 to 2021-2023 to 2024 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 spawning stock from 2021-2023 to 2024	Change in female PFA from 2013-2020 to 2021-2023	Change in female PFA from 2021-2023 to 2024
Tana/Teno MS	35 %	-19 %	-37 %	-18 %
Máskejohka	-55 %	-44 %	-79 %	-42 %
Buolbmátjohka/Pulmankijoki	-48 %	-44 %	-75 %	-43 %
Lákšjohka	-47 %	-85 %	-75 %	-85 %
Veahčajohka/Vetsijoki	-3 %	-49 %	-65 %	-48 %
Ohcejohka/Utsjoki	-25 %	-62 %	-67 %	-62 %
Leavvajohka	-63 %	-28 %	-81 %	-27 %
Báišjohka	-87 %	-91 %	-93 %	-91 %
Njiljohka/Nilijoki	-50 %	-60 %	-78 %	-57 %
Áhkojohka/Akujoki	4 %	-83 %	-72 %	-83 %
Kárášjohka	30 %	-39 %	-59 %	-38 %
Iešjohka	41 %	-15 %	-60 %	-13 %
Anárjohka/Inarijoki	30 %	-43 %	-71 %	-42 %
Tana/Teno (total)	37 %	-32 %	-47 %	-31 %

The first steps towards a stock recovery process within the Tana/Teno were taken with the revised agreement between Norway and Finland in 2017. A major goal of the 2017 agreement was to achieve a 30 % reduction in the river exploitation rate of Tana/Teno salmon stocks, and it was estimated that, if environmental conditions remained stable, a 30 % reduction in exploitation would lead to a spawning stock increase that was sufficient to initiate stock recovery within two salmon generations. 2017 was the first year with salmon spawning under this new regime. Given a 4-5 year smolt age, smolt from the 2017 spawning would leave the Tana/Teno in 2022/2023 and 2-3SW females from the 2017 spawning would start returning to spawn in 2024-2027.

Unfortunately, a regime shift happened between 2018 and 2019 that significantly worsened the return rate (sea-survival) of salmon (Figure 45). In the years 2014-2018, approximately 170 1SW-sized salmon would return to Ohcejohka/Utsjoki per 1 000 smolt out. The average return per 1 000 smolt in 2019-2023 decreased to approximately 60 1SW-sized salmon, which is just slightly higher than a third of the return rate from before 2019. We have seen years with poor sea survival also earlier, most notably perhaps in 2004 and 2005, but never over such an extended number of years.

The survival situation deteriorated further in 2024, down to a point where only approximately 16 1SW-sized salmon returned per 1 000 smolt out (Figure 45). Consequently, despite smolt production being relatively good in 2023 (as seen in the Utsjoki video counting), a shockingly low number of 1SW-sized salmon returned to the Tana/Teno system in 2024. Historically, this is an unprecedented situation, and if such low levels of survival continue in the coming years, it will have serious implications for the prospects of stock recovery and the risk connected to any form of exploitation. As stock status becomes lower (i.e., spawning target attainment becomes lower), the negative consequences of removing one salmon increases, or said differently, the reproductive value of each female increases as the number of spawners fall.

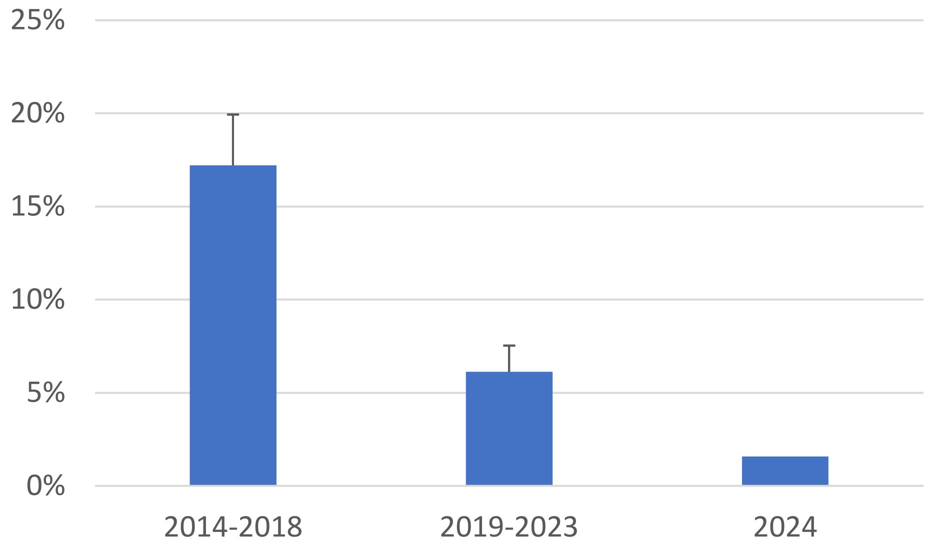


Figure 45. Average return rates of 1SW-sized salmon (number of 1SW-sized salmon counted on video in a year divided by the number of smolt out the previous year) in the Finnish tributary Ohcejohka/Utsjoki. Error bars represent the standard deviation.

Experience with recovering fish stocks in other ecosystems has shown that recovery can be challenging when stocks become severely depleted, showing little to no recovery response even 15 years after a collapse (Hutchings & Reynolds 2004). It is likely that a severely overexploited fish stock might not just experience a loss of biomass, but that there are also disruptions on several levels within the life cycle of the surviving fish and there is some evidence that these disruptions are particularly severe for migrating fish (Petitgas *et al*. 2010).

What then might be the disrupting factors responsible for the precarious situation of the Tana/Teno salmon, which seemingly sustain high mortality levels despite fishing having been closed since 2021? Looking at salmon in Norway on a national level, a threat factor analysis from the Norwegian Scientific Advisory Committee for Atlantic Salmon (NSACAS) has identified and ranked a number of anthropogenic threat factors (see Norwegian Scientific Advisory Committee for Atlantic Salmon 2024 for the latest analysis). Three of the threat factors that are ranked highest on a national level are related to aquaculture (salmon lice, escaped farmed salmon and aquaculture-related infections), none of these have any major relevance within the Tana/Teno river system. This is mainly due to the

Tanafjord being closed for fish farming activities, a threat situation that will change if the ban at some point is lifted. The latest evaluation of genetic integrity of Norwegian salmon stocks found a small change in the presence of aquaculture-related genetic markers in Tana/Teno salmon (Diserud *et al*. 2023), but it is highly likely that this change was the result of a methodological artefact and not reflecting an actual change caused by escaped salmon spawners.

The fourth of the most important factors identified by NSACAS is climate change. This factor is likely adversely affecting Tana/Teno salmon and will be described in more detail below, together with two factors that also play a role in Tana/Teno (overexploitation and pink salmon). None of the remaining threat factors in the NSACAS analysis are expected to affect Tana/Teno salmon. There is no hydropower regulation, no diversion of water for other uses, no acidification, no environmental poisoning, no mining activity, very little physical modifications to the river system, limited agricultural and community runoff, and no *Gyrodactylus salaris*.

In many ways, the stock decline in Tana/Teno is a classic example of what happens in fisheries when a resource is able to sustain a high exploitation rate under favourable environmental conditions, but gradually collapses when faced with declining survival rates. The salmon essentially becomes caught in an impossible situation, with lower sea survival leading to fewer adult salmon returning and a lowered exploitable surplus. In the absence of an adaptive flexible management, that can adjust exploitation rates as a response to the lowered surplus, exploitation will quickly lead to overexploitation with too few spawners, reduced recruitment and fewer adult salmon a few years into the future. In this downward spiral, salmon stocks become more vulnerable to further mortality. The relative consequence of exploitation becomes worse with decreasing stock status. Lowered status also leads to worsened consequences of natural mortality, most notably through predation and Allee effects.

What then might drive the changes illustrated for instance by Figure 45. One overarching factor that increasingly and chronically is affecting all stages of the salmon life cycle is climate change. There are several examples of how a changing climate has affected Tana/Teno salmon. For instance, the pattern of ice breakup and spring flooding have changed over the last couple of decades. Whereas the ice breakup traditionally was a rather violent happening, with lots of ice moving downstream and scouring the river substratum, ice breakup in recent years have been a subdued affair with little scouring. The result might be habitat degradation, with previously favourable areas for spawning and juveniles becoming increasingly sandy.

Another example of a negative change relates to higher water temperatures during the smolt migration. Downstream migrating smolt in the Tana/Teno has to swim actively over a long distance, and this migration becomes energetically costly with increasing water temperatures. This cost might be particularly increased if other factors cause further disruptions, as seen with the 2023 attempt to stop the pink salmon in the lower Tana/Teno with a fish trap. Even a small delay at the trap might have been enough to deplete smolt energy levels to the point where the smolt had problems adapting to the saltwater in the estuary.

A changing climate cause further complications for the smolt in the fjord. The environmental cues experienced by the smolt within the river means that the smolt migration timing has changed. Temporal changes to the smolt migration might cause the smolt to arrive in the fjord at a time when food availability is unfavourable. Arriving too early might mean that important fish larvae are unavailable. Arriving too late might mean that the fish larvae have grown too big. The changing climate and warming water also disrupts important marine fish species, as seen for instance for the capelin. Historically, the capelin seem to play a key role in the salmon stock dynamic with the best salmon years broadly coinciding with high capelin stock levels. In later years, the capelin seem to have moved northwards, meaning that salmon postsmolt relying on capelin would have to swim for a longer distance before the capelin becomes available.

The picture painted by the above examples is bleak. Environmental and ecosystem changes caused by a changing climate will continue and likely intensify in the coming decades, with largely unknown consequences for the salmon.

The long-term dynamic of the overall river ecosystem productivity can likely directly be related to the number of spawning salmon. A river will continuously deplete itself by moving nutrients downstream and into the ocean, and a river ecosystem therefore needs to have ways to retain and resupply nutrients. Organisms within the ecosystem play a key role in retaining and recirculating nutrients. The terrestrial ecosystem around the river contributes significantly to the nutrient supply in addition to the primary production happening within the river.

An additional source of nutrients is the anadromous transport of marine nutrients from the sea to freshwater. Post-spawning salmon carcasses, spawned eggs and the number of fry emerging the year after all represent an annual nutrient supply to the river ecosystem. This supply has been shown to have a significant effect on juvenile survival and growth (McLennan *et al*. 2019), which means that a chronically high exploitation rate will deplete the river ecosystem over time and lead to reduced productivity and lowered production potential. This is a serious situation that can lead to an equilibrium point at a low stock density, illustrated for instance by the predation pit figure in Falkegård *et al*. (2023), and doing stock recovery from such lowered equilibrium points is likely to prove very hard.

A key task for the MRG is identifying knowledge gaps and give advice on relevant monitoring and research (point 4 in the mandate, see Chapter 1). The stock situation and the apparent mortality development seen recently (the downward transition in return rates depicted in Figure 45) raise some key concerns that need answers. Most pertinent is the collapse in 1SW salmon seen in 2024, and its possible connections to either, or both, climate and the 2023 pink salmon trap. Both questions can be answered through the same research approach (a smolt telemetry study), and the MRG therefore urges prioritizing resources towards an individual-based telemetry study of the smolt migration in 2025, with emphasis on a study design that allows for gathering data on downstream migration and the cost of any delays at the 2025 trap site. Another crucial question, which could be studied simultaneously, is the upstream migration of adult Atlantic salmon and the possible delays and problems the pink salmon trap may cause.

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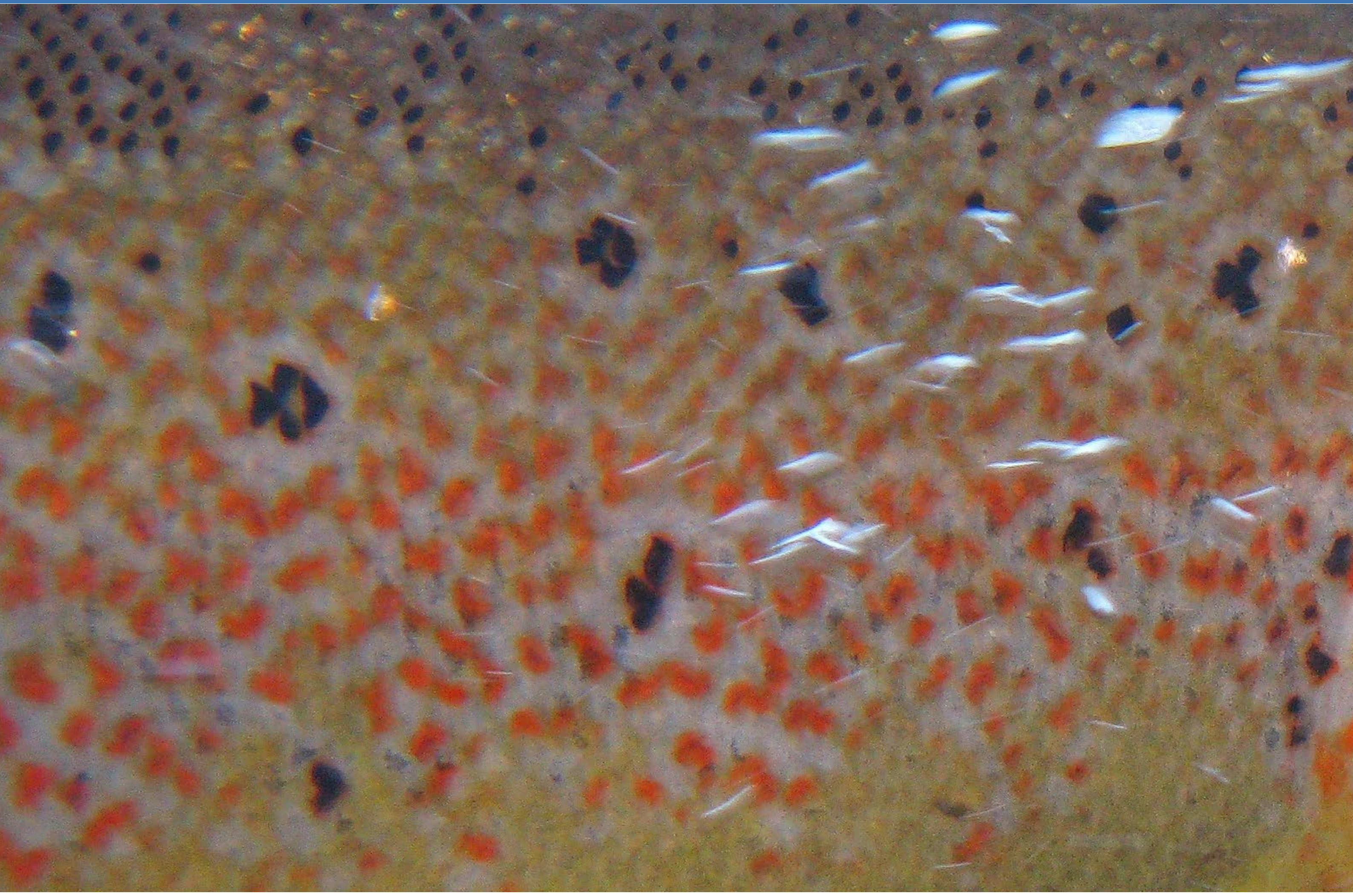

Contact:
Report from The Tana/Teno Monitoring and Research Group
Morten Falkegård, NINA, morten.falkegard@nina.no
Jaakko Erkinaro, Luke, jaakko.erkinaro@luke.fi

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